# CYPRUS

## National Greenhouse Gas Inventory 2025

**2025 submission**

**under the United Nations Convention on Climate Change and the Paris Agreement**

**Department of Environment,**
**Ministry of Agriculture, Rural Development and Environment**

**May 2025**

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| Title of Report | **Cyprus National Greenhouse Gas Inventory 2025** |
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# EXECUTIVE SUMMARY

## ES.1. Background information on greenhouse gas (GHG) inventories and climate change

The Republic of Cyprus ratified the UNFCCC in 1997 with Law No. 19(III) / 1997 as a non-Annex I party. The Kyoto Protocol was ratified by the Republic of Cyprus in 2003 with Law No. 29(III) / 2003. According to decision 10/CP.17 of COP17, as of 9 January 2013, the status of Cyprus changed from a non-Annex I to an Annex I party to the UNFCCC. As part of the EU, Cyprus has taken up commitments for the CP2 of the KP through the Doha amendment. The Republic of Cyprus ratified the Paris Agreement on 4 January 2017 with Law No. 30(III)/2016.

The first national inventory report for Cyprus was prepared in 2001 and covered the period 1990-1998. The inventory was prepared in the framework of the project "Strategic Plan for the Limitation of Greenhouse Gas Emissions in Cyprus".

The first Inventory report submitted by Cyprus to the European Commission for the purposes of Decision no. 280/2004/EC was in 2006 for the period 1990–2004. Cyprus at the time was a non-Annex I party and therefore had no obligation to submit annual inventories to the UNFCCC secretariat.

The first submission of a national inventory report to the UNFCCC secretariat as an Annex I party was made in April 2013.

The Department of Environment of the Ministry of Agriculture, Rural Development and Environment (DoE) is the governmental body responsible for the development and implementation of environmental policy in Cyprus, as well as for the provision of information concerning the state of the environment in Cyprus in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, the DoE is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Law 29(III)/2009 with which Cyprus ratified the Kyoto Protocol.

In this context, the DoE has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. (Contact person: Dr. Nicoletta Kythreotou, Environment Officer, Department of Environment, Ministry of Agriculture, Rural Development and Environment, Offices' address: 20-22 28th Oktovriou Ave., Engomi, 2414, Nicosia, Cyprus, Postal address: Department of Environment, 1498 Nicosia, Cyprus, Tel. +357 22 408 947, Fax. +357 22 774 945, Web. www.moa.gov.cy/environment).

Figure 1 provides an overview of the organisational structure of the National Inventory System. The entities participating in the National Inventory System are:

- The DoE, designated as the national entity responsible for the national inventory, holds the overall responsibility and maintains an active role in the inventory planning, preparation and management, including technical and scientific responsibility for the compilation of the annual inventory.[1]
- Governmental ministries and agencies ensure the data provision through their appointed focal persons.

International or national associations, along with individual public or private industrial companies contribute to data gathering and development of methodological issues as appropriate.

[1] For 2017, there is a contract with an external expert for scientific and technical support to the inventory team of the DoE and the QA of the GHG inventory. As of 2018, according to the Council of Ministers' Decision of 15/11/2017, the technical and scientific responsibility for the compilation of the annual inventory for all sectors will be assigned, on a contract basis, to an independent consultant by the DoE.

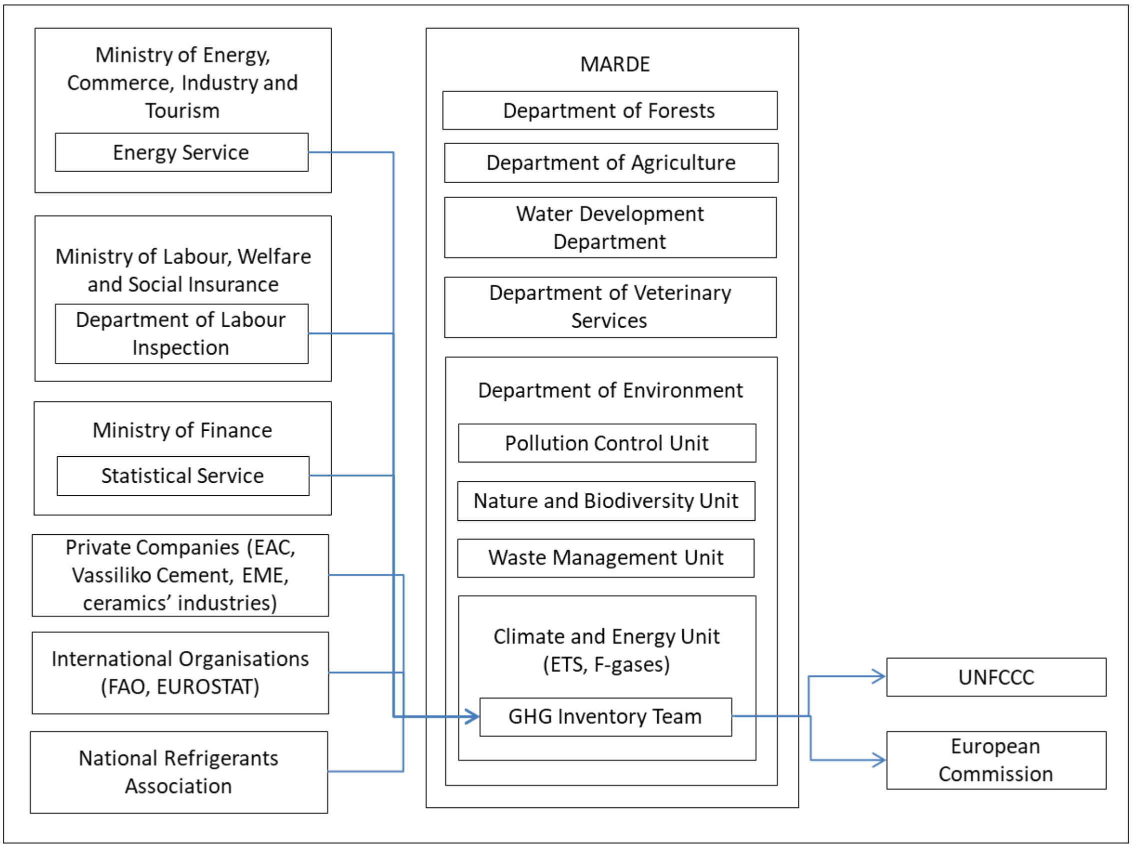


**Figure 1. Overview of the organisational structure of the National Inventory System**

The legal framework defining the roles, responsibilities, and the co-operation between the DoE Inventory team and the designated contact points of the competent Ministries was formalized by the Council of Ministers' Decision adopted 15 November 2017, entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the required activity data and solving data access restriction problems raised due to confidentiality issues.

# ES.2. Summary of national emission and removal-related trends

GHG emissions trends by gas for the period 1990–2023 are presented in Table 1.

**Table 1. GHG emissions trends by gas for the period 1990–2023**

| | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|
| $CO_2$ emissions without LULUCF | 4647.76 | 5136.10 | 5508.84 | 5752.78 | 5994.99 |
| $CO_2$ emissions with LULUCF | 4494.63 | 4968.94 | 5336.11 | 5577.54 | 5810.59 |
| $CH_4$ emissions without LULUCF | 776.43 | 791.34 | 816.41 | 847.23 | 861.42 |
| $CH_4$ emissions with LULUCF | 776.46 | 791.44 | 816.44 | 847.49 | 862.07 |
| $N_2O$ emissions without LULUCF | 146.17 | 145.94 | 160.59 | 169.35 | 164.69 |
| $N_2O$ emissions with LULUCF | 146.20 | 146.01 | 160.64 | 169.53 | 165.09 |
| HFCs | NA,NE,NO | NA,NE,NO | 23.04 | 24.62 | 26.27 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 2.73 | 3.37 | 4.01 | 4.65 | 5.29 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 5573.09 | 6076.75 | 6512.90 | 6798.63 | 7052.66 |
| **Total (with LULUCF)** | 5420.02 | 5909.76 | 6340.25 | 6623.82 | 6869.31 |

| | | | | | |
|---|---|---|---|---|---|
| **Total (without LULUCF, with indirect)** | 5580.67 | 6083.71 | 6520.14 | 6805.92 | 7060.44 |
| **Total (with LULUCF, with indirect)** | 5427.61 | 5916.72 | 6347.49 | 6631.12 | 6877.09 |
| | | | | | |
| | **1995** | **1996** | **1997** | **1998** | **1999** |
| $CO_2$ emissions without LULUCF | 5865.76 | 6215.68 | 6302.38 | 6596.85 | 6863.43 |
| $CO_2$ emissions with LULUCF | 5685.27 | 6029.59 | 6117.14 | 6403.08 | 6664.92 |
| $CH_4$ emissions without LULUCF | 887.53 | 909.43 | 914.84 | 917.52 | 919.68 |
| $CH_4$ emissions with LULUCF | 887.79 | 909.85 | 915.45 | 919.60 | 919.70 |
| $N_2O$ emissions without LULUCF | 178.14 | 171.66 | 165.60 | 173.79 | 172.42 |
| $N_2O$ emissions with LULUCF | 178.35 | 171.96 | 166.01 | 174.98 | 172.55 |
| HFCs | 28.48 | 33.57 | 38.61 | 46.75 | 53.50 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 5.93 | 6.57 | 7.21 | 7.85 | 8.49 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 6965.84 | 7336.90 | 7428.64 | 7742.75 | 8017.53 |
| **Total (with LULUCF)** | 6785.81 | 7151.54 | 7244.43 | 7552.26 | 7819.15 |
| **Total (without LULUCF, with indirect)** | 6973.05 | 7344.16 | 7436.28 | 7750.19 | 8025.32 |
| **Total (with LULUCF, with indirect)** | 6793.01 | 7158.80 | 7252.07 | 7559.70 | 7826.94 |
| | | | | | |
| | **2000** | **2001** | **2002** | **2003** | **2004** |
| $CO_2$ emissions without LULUCF | 7106.90 | 6979.66 | 7171.94 | 7560.77 | 7787.10 |
| $CO_2$ emissions with LULUCF | 6957.46 | 6808.50 | 6969.52 | 7345.91 | 7571.28 |
| $CH_4$ emissions without LULUCF | 938.26 | 975.82 | 1003.66 | 994.67 | 985.00 |
| $CH_4$ emissions with LULUCF | 942.73 | 977.33 | 1003.70 | 994.86 | 985.37 |
| $N_2O$ emissions without LULUCF | 174.20 | 191.66 | 195.84 | 192.06 | 183.41 |
| $N_2O$ emissions with LULUCF | 176.67 | 192.72 | 196.28 | 192.71 | 184.30 |
| HFCs | 61.52 | 69.94 | 79.29 | 90.60 | 107.26 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 9.13 | 9.80 | 10.45 | 11.11 | 11.76 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 8290.01 | 8226.88 | 8461.18 | 8849.20 | 9074.54 |
| **Total (with LULUCF)** | 8147.51 | 8058.28 | 8259.24 | 8635.19 | 8859.99 |
| **Total (without LULUCF, with indirect)** | 8298.25 | 8234.86 | 8470.77 | 8860.05 | 9087.14 |
| **Total (with LULUCF, with indirect)** | 8155.74 | 8066.27 | 8268.83 | 8646.03 | 8872.59 |
| | | | | | |
| | **2005** | **2006** | **2007** | **2008** | **2009** |
| $CO_2$ emissions without LULUCF | 7951.67 | 8183.13 | 8475.07 | 8691.64 | 8437.99 |
| $CO_2$ emissions with LULUCF | 7729.81 | 7959.17 | 8286.46 | 8440.57 | 8158.95 |
| $CH_4$ emissions without LULUCF | 960.16 | 962.47 | 964.66 | 963.70 | 964.68 |
| $CH_4$ emissions with LULUCF | 960.29 | 962.79 | 967.74 | 963.81 | 964.87 |
| $N_2O$ emissions without LULUCF | 169.30 | 172.05 | 169.72 | 162.12 | 159.40 |
| $N_2O$ emissions with LULUCF | 170.20 | 173.20 | 172.35 | 163.24 | 160.59 |
| HFCs | 121.85 | 137.15 | 153.22 | 171.91 | 181.73 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 12.42 | 11.47 | 11.78 | 12.09 | 12.39 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 9215.40 | 9466.28 | 9774.43 | 10001.45 | 9756.19 |
| **Total (with LULUCF)** | 8994.57 | 9243.79 | 9591.55 | 9751.61 | 9478.54 |
| **Total (without LULUCF, with indirect)** | 9228.59 | 9479.83 | 9788.60 | 10013.78 | 9767.91 |
| **Total (with LULUCF, with indirect)** | 9007.77 | 9257.34 | 9605.71 | 9763.94 | 9490.25 |
| | | | | | |

| | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| $CO_2$ emissions without LULUCF | 8071.82 | 7792.36 | 7261.67 | 6578.17 | 6929.79 |
| $CO_2$ emissions with LULUCF | 7804.55 | 7489.50 | 6965.82 | 6279.34 | 6629.09 |
| $CH_4$ emissions without LULUCF | 973.80 | 972.61 | 962.67 | 947.60 | 948.16 |
| $CH_4$ emissions with LULUCF | 974.52 | 973.22 | 963.35 | 947.84 | 948.43 |
| $N_2O$ emissions without LULUCF | 168.54 | 166.08 | 163.09 | 147.99 | 145.44 |
| $N_2O$ emissions with LULUCF | 170.05 | 167.55 | 164.63 | 149.30 | 146.76 |
| HFCs | 198.03 | 216.05 | 220.76 | 224.32 | 231.73 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 12.70 | 14.36 | 14.97 | 15.58 | 16.18 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 9424.88 | 9161.46 | 8623.16 | 7913.67 | 8271.30 |
| **Total (with LULUCF)** | 9159.84 | 8860.68 | 8329.54 | 7616.38 | 7972.20 |
| **Total (without LULUCF, with indirect)** | 9437.36 | 9168.98 | 8630.62 | 7923.67 | 8279.10 |
| **Total (with LULUCF, with indirect)** | 9172.32 | 8868.20 | 8337.00 | 7626.39 | 7979.99 |
| | | | | | |
| | **2015** | **2016** | **2017** | **2018** | **2019** |
| $CO_2$ emissions without LULUCF | 6952.48 | 7349.93 | 7469.28 | 7324.20 | 7324.48 |
| $CO_2$ emissions with LULUCF | 6655.04 | 7145.75 | 7160.68 | 7019.96 | 7025.73 |
| $CH_4$ emissions without LULUCF | 955.51 | 978.91 | 997.53 | 1011.69 | 1032.22 |
| $CH_4$ emissions with LULUCF | 955.60 | 986.85 | 997.78 | 1012.19 | 1032.57 |
| $N_2O$ emissions without LULUCF | 150.87 | 152.95 | 158.82 | 160.87 | 166.63 |
| $N_2O$ emissions with LULUCF | 152.10 | 158.29 | 160.14 | 162.31 | 168.00 |
| HFCs | 243.96 | 264.78 | 285.96 | 305.83 | 330.00 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 16.79 | 15.61 | 15.80 | 16.00 | 15.44 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 8319.60 | 8762.17 | 8927.40 | 8818.59 | 8868.78 |
| **Total (with LULUCF)** | 8023.49 | 8571.28 | 8620.37 | 8516.28 | 8571.74 |
| **Total (without LULUCF, with indirect)** | 8325.88 | 8770.07 | 8935.54 | 8825.81 | 8875.62 |
| **Total (with LULUCF, with indirect)** | 8029.77 | 8579.18 | 8628.51 | 8523.50 | 8578.58 |
| | | | | | |
| | **2020** | **2021** | **2022** | **2023** | **Change from 1990 to 2023 (%)** |
| $CO_2$ emissions without LULUCF | 6903.17 | 6950.78 | 7070.78 | 7188.09 | 54.66 |
| $CO_2$ emissions with LULUCF | 6602.80 | 6706.06 | 6770.05 | 6876.22 | 52.99 |
| $CH_4$ emissions without LULUCF | 1062.76 | 1083.51 | 1075.68 | 1080.76 | 39.20 |
| $CH_4$ emissions with LULUCF | 1063.19 | 1088.98 | 1075.96 | 1081.09 | 39.23 |
| $N_2O$ emissions without LULUCF | 171.07 | 172.71 | 171.48 | 171.80 | 17.53 |
| $N_2O$ emissions with LULUCF | 172.47 | 176.62 | 172.55 | 172.76 | 18.16 |
| HFCs | 336.65 | 364.61 | 394.92 | 414.96 | 100 |
| PFCs | NO | NO | NO | NO | 0.00 |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | 0.00 |
| $SF_6$ | 18.74 | 17.58 | 17.84 | 17.84 | 553.28 |
| $NF_3$ | NO | NO | NO | NO | 0.00 |
| **Total (without LULUCF)** | 8492.39 | 8589.18 | 8730.70 | 8873.45 | 59.22 |
| **Total (with LULUCF)** | 8193.85 | 8353.86 | 8431.31 | 8562.87 | 57.99 |
| **Total (without LULUCF, with indirect)** | 8501.10 | 8597.20 | 8736.79 | 8880.10 | 59.12 |
| **Total (with LULUCF, with indirect)** | 8202.56 | 8361.87 | 8437.40 | 8569.52 | 57.89 |
| | | | | | |

# ES.3. Overview of source and sink category emission estimates and trends

Energy, with 6266 Gg $CO_2$ eq., continues to be the largest contributor to the total national GHG emissions (73.2% compared to the total without LULUCF). 3050 Gg $CO_2$ eq. of these emissions is from the production of electricity, while another 2146 Gg $CO_2$ eq. is from transport. Table 2 and Figure 2 present the emissions for the period 1990–2023 by sector.

**Table 2. GHG emissions by sector for the period 1990–2023**

| | **Energy** | **IPPU** | **Agriculture** | **LULUCF** | **Waste** | **Total (excl. LULUCF)** | **Total (incl. LULUCF)** |
|---|---|---|---|---|---|---|---|
| **1990** | 3955.24 | 727.93 | 454.74 | -153.07 | 435.18 | 5573.09 | 5420.02 |
| **1991** | 4486.90 | 687.86 | 461.29 | -166.98 | 440.71 | 6076.75 | 5909.76 |
| **1992** | 4810.19 | 762.12 | 491.51 | -172.65 | 449.08 | 6512.90 | 6340.25 |
| **1993** | 4985.64 | 833.49 | 519.70 | -174.80 | 459.80 | 6798.63 | 6623.82 |
| **1994** | 5195.44 | 870.23 | 514.25 | -183.35 | 472.74 | 7052.66 | 6869.31 |
| **1995** | 5100.38 | 839.71 | 544.36 | -180.03 | 481.39 | 6965.84 | 6785.81 |
| **1996** | 5393.40 | 904.12 | 551.74 | -185.36 | 487.64 | 7336.90 | 7151.54 |
| **1997** | 5514.13 | 876.05 | 541.38 | -184.22 | 497.08 | 7428.64 | 7244.43 |
| **1998** | 5854.56 | 840.12 | 543.56 | -190.49 | 504.51 | 7742.75 | 7552.26 |
| **1999** | 6116.57 | 852.94 | 534.94 | -198.38 | 513.07 | 8017.53 | 7819.15 |
| **2000** | 6341.69 | 882.17 | 542.91 | -142.51 | 523.24 | 8290.01 | 8147.51 |
| **2001** | 6231.79 | 875.27 | 586.21 | -168.60 | 533.60 | 8226.88 | 8058.28 |
| **2002** | 6391.43 | 918.24 | 609.97 | -201.94 | 541.54 | 8461.18 | 8259.24 |
| **2003** | 6779.11 | 932.75 | 592.67 | -214.02 | 544.68 | 8849.20 | 8635.19 |
| **2004** | 6938.54 | 1014.78 | 572.69 | -214.55 | 548.53 | 9074.54 | 8859.99 |
| **2005** | 7129.10 | 1003.19 | 525.54 | -220.83 | 557.57 | 9215.40 | 8994.57 |
| **2006** | 7317.73 | 1059.55 | 531.15 | -222.49 | 557.86 | 9466.28 | 9243.79 |
| **2007** | 7612.99 | 1072.03 | 529.50 | -182.89 | 559.92 | 9774.43 | 9591.55 |
| **2008** | 7829.24 | 1093.84 | 508.12 | -249.84 | 570.25 | 10001.45 | 9751.61 |
| **2009** | 7748.43 | 929.89 | 500.49 | -277.65 | 577.38 | 9756.19 | 9478.54 |
| **2010** | 7516.29 | 809.86 | 514.80 | -265.04 | 583.92 | 9424.88 | 9159.84 |
| **2011** | 7254.07 | 811.54 | 506.90 | -300.78 | 588.96 | 9161.46 | 8860.68 |
| **2012** | 6767.31 | 772.13 | 484.68 | -293.62 | 599.05 | 8623.16 | 8329.54 |
| **2013** | 5842.15 | 1013.20 | 449.17 | -297.29 | 609.15 | 7913.67 | 7616.38 |
| **2014** | 5973.19 | 1241.75 | 437.17 | -299.11 | 619.19 | 8271.30 | 7972.20 |
| **2015** | 6097.70 | 1157.02 | 441.85 | -296.11 | 623.02 | 8319.60 | 8023.49 |
| **2016** | 6488.46 | 1185.18 | 462.38 | -190.89 | 626.15 | 8762.17 | 8571.28 |
| **2017** | 6568.77 | 1248.89 | 476.12 | -307.03 | 633.61 | 8927.40 | 8620.37 |
| **2018** | 6495.10 | 1198.37 | 481.79 | -302.31 | 643.33 | 8818.59 | 8516.28 |
| **2019** | 6548.31 | 1170.76 | 495.52 | -297.04 | 654.18 | 8868.78 | 8571.74 |
| **2020** | 6039.19 | 1268.32 | 531.54 | -298.54 | 653.35 | 8492.39 | 8193.85 |
| **2021** | 6092.14 | 1290.19 | 546.27 | -235.33 | 660.59 | 8589.18 | 8353.86 |
| **2022** | 6210.45 | 1324.48 | 528.61 | -299.39 | 667.16 | 8730.70 | 8431.31 |
| **2023** | 6265.97 | 1404.72 | 530.45 | -310.58 | 672.31 | 8873.45 | 8562.87 |
| **Change 1990–2023** | 58.42 | 92.98 | 16.65 | 102.90 | 54.49 | 59.22 | 57.99 |

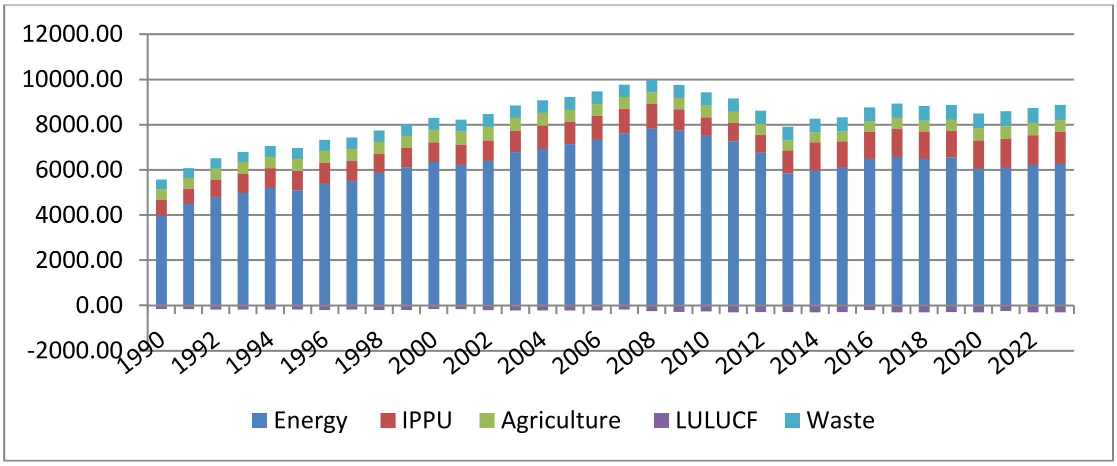


**Figure 2. GHG emissions by sector for the period 1990–2023**

# ES.4. Other information

The role of carbon monoxide (CO), nitrogen oxides ($NO_x$) and non-methane organic volatile compounds (NMVOC) is important for climate change as these gases act as precursors of tropospheric ozone. In this way, they contribute to ozone formation and alter the atmospheric lifetimes of other greenhouse gases. For example, CO interacts with the hydroxyl radical (OH), the major atmospheric sink for methane, to form carbon dioxide. Therefore, increased atmospheric concentration of CO limits the number of OH compounds available to destroy methane, thus increasing the atmospheric lifetime of methane.

The emissions for these gases have been estimated by the Department of Labour Inspection, which is the competent authority for the preparation of air pollutants inventories under Directive 2001/81/EC. An overview of the period is presented in the following Tables.

**Table 3. $NO_x$, CO, NMVOCs and SOx emissions 1990–2023 (Gg)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ | 17.89 | 17.67 | 19.86 | 20.36 | 20.94 | 20.81 | 20.99 | 21.37 | 21.81 | 22.07 |
| CO | 44.83 | 43.41 | 42.39 | 40.51 | 40.83 | 39.11 | 37.77 | 36.25 | 34.18 | 32.34 |
| NMVOCs | 14.13 | 13.74 | 13.96 | 13.92 | 14.40 | 14.05 | 13.92 | 14.08 | 13.66 | 13.50 |
| $SO_x$ | 31.92 | 32.78 | 37.61 | 39.91 | 41.85 | 39.63 | 41.63 | 43.98 | 47.34 | 49.57 |
| | | | | | | | | | | |
| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| $NO_x$ | 22.36 | 22.36 | 22.01 | 22.32 | 22.12 | 21.78 | 21.40 | 21.11 | 19.74 | 19.91 |
| CO | 29.71 | 28.36 | 26.78 | 26.24 | 24.89 | 23.40 | 21.35 | 19.32 | 16.89 | 15.27 |
| NMVOCs | 13.21 | 13.05 | 13.51 | 14.14 | 14.05 | 13.71 | 12.89 | 13.38 | 12.28 | 11.66 |
| $SO_x$ | 47.41 | 45.09 | 45.26 | 47.00 | 40.32 | 37.84 | 31.32 | 29.18 | 22.24 | 17.60 |
| | | | | | | | | | | |
| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| $NO_x$ | 18.63 | 21.39 | 20.74 | 15.18 | 15.89 | 13.63 | 13.36 | 13.33 | 12.98 | 14.07 |
| CO | 14.55 | 13.23 | 12.25 | 11.54 | 11.75 | 11.23 | 11.18 | 10.89 | 10.11 | 9.80 |
| NMVOCs | 11.85 | 9.37 | 9.07 | 9.84 | 9.69 | 9.93 | 7.66 | 8.60 | 8.04 | 7.87 |
| $SO_x$ | 21.77 | 20.77 | 16.05 | 13.50 | 16.67 | 12.85 | 16.08 | 16.28 | 16.95 | 15.87 |
| | | | | | | | | | | |
| | **2020** | **2021** | **2022** | **2023** | | | | | | |
| $NO_x$ | 12.11 | 12.46 | 11.98 | 12.10 | | | | | | |
| CO | 8.63 | 8.91 | 8.89 | 8.83 | | | | | | |
| NMVOCs | 8.50 | 8.13 | 7.19 | 7.42 | | | | | | |
| $SO_x$ | 11.57 | 9.98 | 11.34 | 10.05 | | | | | | |

# Chapter 1.
# Introduction

## 1.1. Background information on GHG inventories and climate change

A greenhouse gas (GHG) is a gas in the atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary natural greenhouse gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone. Hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride ($SF_6$) and nitrogen trifluoride ($NF_3$) are man-made GHG and are mainly used in a number of industrial activities in replacement of CFCs. Other naturally occurring gases, which do not contribute directly to the greenhouse effect are carbon monoxide (CO), oxides of nitrogen ($NO_x$), non-methane volatile organic compounds (NMVOC) and sulphur dioxide ($SO_2$).

Human activities since the beginning of the Industrial Revolution have produced an increase in the atmospheric concentration of carbon dioxide. This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle. Anthropogenic carbon dioxide ($CO_2$) emissions (i.e., emissions produced by human activities) come predominately from combustion of fossil fuels and deforestation.

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, as a framework for international cooperation to combat climate change by limiting average global temperature increases, and coping with impacts.

The objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to stabilise greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent and reduce dangerous human-induced interference with the climate system. The ability of the international community to achieve this objective is dependent on accurate knowledge of GHG emissions trends, and on our collective ability to alter these trends.

In accordance with Articles 4 and 12 of the Convention and the relevant decisions of the Conference of the Parties (COP), Annex I Parties to the Convention compile national emission inventories of anthropogenic sources and sinks of all greenhouse gases not controlled by the Montreal protocol, and submit them to the Climate Change secretariat. These inventories are subject to an annual technical review process.

By 1995, countries had launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed country Parties to emission reduction targets. The Protocol’s first commitment period started in 2008 and ended in 2012. The second commitment period began on 1 January 2013 and ended in 2020.

There are now 197 Parties to the Convention and 192 Parties to the Kyoto Protocol.

The 2015 Paris Agreement, adopted in Paris on 12 December 2015, marks the latest step in the evolution of the UN climate change regime and builds on the work undertaken under the Convention. The Paris Agreement charts a new course in the global effort to combat climate change.

### 1.1.1. Background information on climate change

**International framework**

United Nations Framework Convention on Climate Change[2]

In response to the emerging evidence that climate change could have a major global impact, the United Nations Framework Convention on Climate Change (henceforth the Convention) was adopted on 9 May 1992 and was opened for signature in Rio de Janeiro in June 1992.

The ultimate objective of the Convention is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The Convention recognises that the developed countries should take the lead in combating climate change and calls these countries to:

- Adopt policies and measures to mitigate climate change.
- Return, individually or jointly, to 1990 levels of carbon dioxide and other greenhouse gas by the year 2000.
- Provide technology transfer and financial resources to help developing countries so as to confront climate change impacts and to develop, ensuring at the same time the environmental protection through the restraint of GHG emissions.

Kyoto Protocol[3]

Recognising early the need for an effective instrument to provide confidence in addressing the climate change challenge, the Parties at the third meeting of the Conference of the Parties (COP) to the Convention, held in Kyoto (1-11 December 1997), finalised negotiations related to the establishment of such a legal instrument, the Kyoto Protocol on Climate Change (KP). The KP established, for the first time, legally binding targets for the reduction of greenhouse gas emissions. The KP provides a foundation upon which future action can be intensified, and also confirms the capacity of the international community to cooperate in action to deal with a major global environmental problem.

The KP called for legally binding commitments of the developed countries to individually or jointly reduce emissions of 6 greenhouse gases ($CO_2$, $CH_4$, $N_2O$, HFC, PFC and $SF_6$) in the period 2008 to 2012 by more than 5% compared with 1990 levels. The EU and its Member States at the time agreed to an 8% reduction. For the achievement of these targets, the Protocol provided the use of the following:

- Adoption of national policies and measures,
- Establishment of an emissions trading regime,
- Establishment of the joint implementation mechanism,
- Establishment of a clean development mechanism, and
- Protection and promotion of sinks to enhance $CO_2$ removals.

Detailed rules for the implementation of the Protocol were set out at the 7th Conference of the Parties (in Marrakesh) and are described in the Marrakesh Accords adopted in 2001. The Protocol entered into force on 16 February 2005, after its ratification from 141 Parties (including developed countries with a contribution of more than 55% to global $CO_2$ emissions in 1990).

The Doha Amendment[4]

At the eighth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol held in Doha, Qatar, in December 2012, parties to the Kyoto Protocol adopted an amendment to the Kyoto Protocol by decision 1/CMP.8 in accordance with Articles 20 and 21 of the Kyoto Protocol.

Pursuant to Article 21, paragraph 7 and Article 20, paragraph 4, the amendment is subject to acceptance by Parties to the Kyoto Protocol. In accordance with Article 20, paragraph 4, the amendment will enter

[2] More information available at https://unfccc.int/essential_background/convention/items/6036.php
[3] More information available at https://unfccc.int/essential_background/kyoto_protocol/items/6034.php
[4] More information available at https://unfccc.int/kyoto_protocol/doha_amendment/items/7362.php

into force for those Parties having accepted it on the ninetieth day after the date of receipt by the Depositary of an instrument of acceptance by at least three fourths of the Parties to the Kyoto Protocol. A total of 144 instruments of acceptance are required for the entry into force of the amendment.

The Doha Amendment and the KP Decision set out the rules related to the second commitment period of the Kyoto Protocol (CP2). The key aspects of CP2 are as follows:

- CP2 will be eight years long, running from 1 January 2013 until 31 December 2020;
- Parties taking on commitments in CP2 (CP2 Parties) are required to reduce their aggregate emissions by 18% below 1990 levels in CP2. The commitments of individual Parties range from a 24% reduction (in the case of Ukraine) to a 0.5% reduction (in the case of Australia). The European Union, as a whole, is required to reduce its emissions by 20%;
- CP2 Parties are required to review their commitments by the end of 2014 with a view at increasing the level of their mitigation ambition;
- Notwithstanding the commitments set out in Annex B to the Kyoto Protocol (as amended), each CP2 Party's commitment in CP2 must be at least as ambitious as its actual annual average emissions between 2008 and 2010;
- CP2 Parties may carry over surplus CP1 AAUs into CP2 without limit, but may only use or acquire such AAUs in limited circumstances;
- Access to all of the Kyoto Protocol's market mechanisms remains uninterrupted for CP2 Parties; and
- KP Parties agreed to the implementation of the Doha Amendment pending its formal entry into force, thus ensuring the Kyoto Protocol's operational continuity.

The Paris Agreement[5]

The 2015 Paris Agreement is a historically significant landmark in the global fight against climate change. The Paris Agreement entered into force on 4 November 2016. The Paris Agreement builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The key features of the Paris Agreement are as follows:

- It sets out a long term goal to put the world on track to limit global warming to well below 2°C above pre-industrial levels – and pursue efforts to limit the temperature increase to 1.5°C; The aspirational goal of 1.5°C was agreed to drive greater ambition, and to highlight the concerns of the most vulnerable countries that are already experiencing the impacts of climate change.
- It sends a clear signal to all stakeholders, investors, businesses, civil society and policy-makers that the global transition to clean energy is here to stay and that resources have to shift away from fossil fuels; With 189 national climate plans covering some 98% of all emissions, tackling climate change is now become a truly global effort. With Paris, we are moving from action by a few to action by all.
- It provides a dynamic mechanism to take stock and strengthen ambition over time. Starting from 2023, Parties will come together every five years in a "global stocktake" to consider progress in emissions reductions, adaptation and support provided and received in view of the long-term goals of the Agreement.
- Parties have a legally binding obligation to pursue domestic mitigation measures, with the aim of achieving the objectives of their contributions.
- It sets up an enhanced transparency and accountability framework, including the biennial submission by all Parties of greenhouse gas inventories and the information necessary to track their progress, a technical expert review, a facilitative, multilateral consideration of Parties' progress and mechanism to facilitate implementation of and promote compliance.
- It provides an ambitious solidarity package with adequate provisions on climate finance and on addressing needs linked to adaptation and loss and damage associated with adverse effects of climate change. To promote individual and collective action on adaptation, the Paris Agreement establishes for the first time a global goal with the aim to enhance capacity, climate resilience and reduce climate vulnerability. Internationally, it encourages greater cooperation among Parties to share scientific

[5] Available at https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

knowledge on adaptation as well as information on practices and policies.

**Climate change and Cyprus**

The Republic of Cyprus ratified the UNFCCC in 1997 with Law No. 19(III) / 1997 as a non-Annex I party. The Kyoto Protocol was ratified by the Republic of Cyprus in 2003 with Law No. 29(III) / 2003. According to decision 10/CP.17 of COP17, as of 9 January 2013, the status of Cyprus changed from a non-Annex I to an Annex I party to the UNFCCC. As part of the EU, Cyprus has taken up commitments for the CP2 of the KP through the Doha amendment. The Republic of Cyprus ratified the Paris Agreement on 4 January 2017 with Law No. 30(III)/2016.

### 1.1.2. Background information on greenhouse gas inventories

**International framework**

Annual inventories of greenhouse and other gas emissions form an essential element of each national environmental policy-making process. They can be used to derive information on emissions trends with reference to a pre-selected base year, and can assist in monitoring the progress of existing abatement measures for the reduction of greenhouse gas emissions and the fulfilment of the KP target.

According to Article 4 of the Convention, Annex I Parties have the obligation to submit national inventories of GHG emissions and removals. At COP2, the annual submission of inventories was decided (Decision 9/CP.2). The Conference of the Parties (COP), by decision 24/CP.19[6], adopted the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories" (UNFCCC Annex I inventory reporting guidelines) and tables of the common reporting format to implement the use of the 2006 IPCC Guidelines for National Greenhouse Gas inventories[7].

The UNFCCC Annex I inventory reporting guidelines also cover the establishment and maintenance of national inventory arrangements for the purpose of the continued preparation of timely, complete, consistent, comparable, accurate and transparent annual GHG inventories.

An annual GHG inventory submission consists of an NID and the CRT tables, as set out in annexes I and II to decision 24/CP.19. The annual submission also comprises information provided by an Annex I Party in addition to its submitted NID and CRT tables.

**Cyprus**

The first national inventory report for Cyprus was prepared in 2001 and covered the period 1990-1998. The inventory was prepared in the framework of the project "Strategic Plan for the Limitation of Greenhouse Gas Emissions in Cyprus".

The first Inventory report submitted by Cyprus to the European Commission for the purposes of Decision no. 280/2004/EC, was in 2006 for the period 1990–2004. Cyprus at the time was a non-Annex I party and therefore had no obligation to submit annual inventories to the UNFCCC secretariat.

The first submission of a national inventory report to the UNFCCC secretariat as an Annex I party was made in April 2013.

## 1.2. A description of the national inventory arrangements

According to decision 24/CP.19, each Annex I Party should implement and maintain national inventory arrangements for the estimation of anthropogenic GHG emissions by sources and removals by sinks. The national inventory arrangements include all institutional, legal and procedural arrangements made within

[6] Available at http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf
[7] Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/

an Annex I Party for estimating anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

National inventory arrangements should be designed and operated:

(a) To ensure the transparency, consistency, comparability, completeness and accuracy of inventories;

(b) To ensure the quality of inventories through the planning, preparation and management of inventory activities. Inventory activities include collecting AD, selecting methods and EFs appropriately, estimating anthropogenic GHG emissions by sources and removals by sinks, implementing uncertainty assessment and QA/QC activities, and carrying out procedures for the verification of the inventory data at the national level, as described in the UNFCCC Annex I inventory reporting guidelines.

In the implementation of its national inventory arrangements, each Annex I Party should perform the following general functions:

(a) Establish and maintain the institutional, legal and procedural arrangements necessary to perform the functions defined in decision 24/CP.19, as appropriate, between the government agencies and other entities responsible for the performance of all functions defined in these reporting guidelines;

(b) Ensure sufficient capacity for the timely performance of the functions defined in these reporting guidelines, including data collection for estimating anthropogenic GHG emissions by sources and removals by sinks and arrangements for the technical competence of the staff involved in the inventory development process;

(c) Designate a single national entity with overall responsibility for the national inventory;

(d) Prepare national annual GHG inventories in a timely manner in accordance with these reporting guidelines and relevant decisions of the COP, and provide the information necessary to meet the reporting requirements defined in these reporting guidelines and in relevant decisions of the COP;

(e) Undertake specific functions relating to inventory planning, preparation and management.

## 1.2.1. Institutional, legal and procedural arrangements

In article 5, paragraph 1 of the Protocol, it is specified that "Each Party included in Annex I shall have in place, no later than one year prior to the start of the first commitment period, a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol". A national system includes all institutional, legal and procedural arrangements made within an Annex I Party of the Convention that is also a Party to the Protocol for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

The Department of Environment of the Ministry of Agriculture, Rural Development and Environment (DoE), is the governmental body responsible for the development and implementation of environmental policy in Cyprus, as well as for the provision of information concerning the state of the environment in Cyprus in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, the DoE is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Law 29(III)/2009 with which Cyprus ratified the Kyoto Protocol.

In this context, the DoE has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. (Contact person: Dr. Nicoletta Kythreotou, Environment Officer, Department of Environment, Ministry of Agriculture, Rural Development and Environment, Offices' address: 20-22 28th Oktovriou Ave., Engomi, 2414, Nicosia, Cyprus, Postal address: Department of Environment, 1498 Nicosia, Cyprus, Tel. +357 22 408 947, Fax. +357 22 774 945, Web. www.moa.gov.cy/environment).

Figure 1.1 provides an overview of the organisational structure of the National Inventory System. The entities participating in the National Inventory System are:

- The DoE, designated as the national entity responsible for the national inventory, holds the overall responsibility and maintains an active role in the inventory planning, preparation and management, including technical and scientific responsibility for the compilation of the annual inventory.[8]
- The 2020 submission was the first submission for which a team of external experts from the Cyprus Institute[9] worked for the preparation of the emissions and the reporting, under the guidance of the DoE (contractor).
- Governmental ministries and agencies through their appointed focal persons, ensure the data provision.

International or national associations, along with individual public or private industrial companies contribute to data providing and development of methodological issues as appropriate.

The legal framework defining the roles-responsibilities and the co-operation between the DoE Inventory team and the designated contact points of the competent Ministries was formalized by Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities, concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

#### 1.2.1.1. Roles and responsibilities for inventory preparation

**Department of Environment**

The DoE is the Single National Entity with the overall responsibility for the national GHG inventory. Among its responsibilities are the following:

- The co-ordination of all ministries and other institutions involved, as well as any relevant public or private organization. In this context, it oversees the operation of the National System and decides on the necessary arrangements to ensure compliance with relevant decisions of the COP and the COP/CMP.
- The official consideration and approval of the inventory prior to its submission.
- The response to any issues raised by the inventory review process under Article 8 of the Kyoto Protocol[10].
- The timely submission of the GHG inventory to the European Commission and to the UNFCCC Secretariat.
- The keeping of the Centralised Inventory File, which is delivered to the inventory team which has the technical responsibility for the inventory planning, preparation and management at the beginning of each inventory cycle. The Centralised Inventory File is kept at the premises of the DoE.
- The administration of the National Registry. Cyprus cooperates with the Member States of the European Union and with the supplementary transaction log and the registry of the European Community by maintaining the national registries in a consolidated system.
- The supervision and implementation of Quality Assurance/Quality Control Plan (QA/QC)

[8] For 2017, there is a contract with an external expert for scientific and technical support to the inventory team of the DoE and the QA of the GHG inventory. As of 2018, according to the Council of Ministers' Decision of 15/11/2017, the technical and scientific responsibility for the compilation of the annual inventory for all sectors will be assigned, on a contract basis, to an independent consultant by the DoE.

[9] The Cyprus Institute (CyI) is a non-profit research and educational institution with a strong scientific and technological orientation, addressing issues of regional interest but of global significance, with an emphasis on cross-disciplinary research and international collaborations. The team of experts is working at the Energy, Environment and Water Research Center (EEWRC) of the CyI, of which the work and collaborations focus on societally relevant issues related to Energy and Renewables, Environment, Atmosphere and Climate, Water and Natural Resources (www.cyi.ac.cy).

[10] in co-operation with future technical and scientific consultants

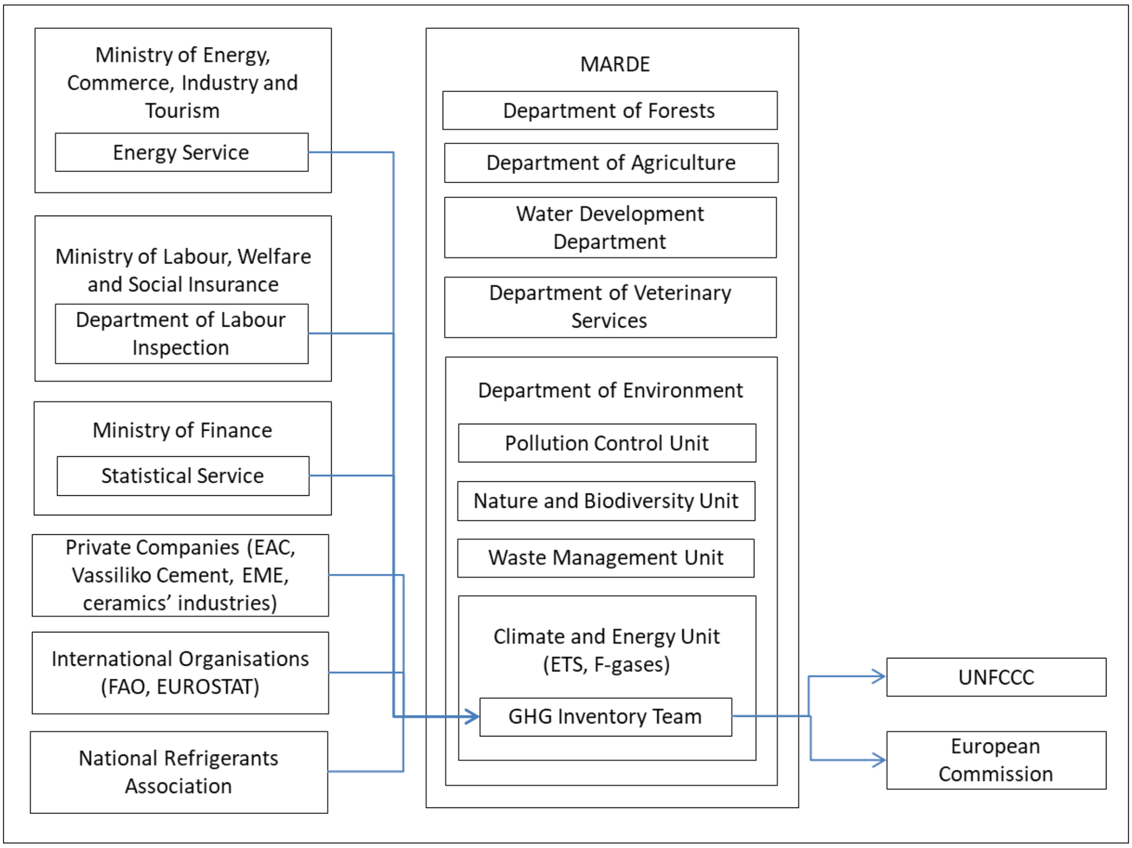


**Figure 1.1. Overview of the organisational structure of the National Inventory System**

In addition, DoE, in close collaboration with the contractor, currently has the technical and scientific responsibility for the planning, preparation and management of the annual national inventory, which includes the following tasks:

1. Data collection (activity data and emission factors) for all source categories that are Energy, Industrial Processes, Solvents and Other Product Use, Agriculture, Waste and LULUCF.
2. Reliability check of input data through
   - the comparison of the same or similar data from alternative data sources and
   - time-series assessment in order to identify changes that cannot be explained.
3. Selection of the appropriate methodologies according to the 2006 IPCC guidelines, preparation of GHG emissions estimates by applying the methodologies and models having been selected.
4. Data processing and archiving.
5. Assessment of the consistency of the methodologies applied, inventory improvement – recalculations.
6. Reliability check of results.
7. Key categories analysis.
8. Uncertainty assessment.
9. Preparation of Common Reporting Format (CRT) tables.
10. Preparation of National Inventory Document (NID).
11. Reporting of the required information according to Regulation 525/2013 of the European Parliament and of the Council and its implementing acts.
12. Preparation and keeping of annual Centralised Inventory File.
13. Development of QA/QC procedures.
14. Implementing the QA/QC procedures.
15. Training the representatives of data providing agencies on inventory issues.

The names and contact details of the DoE inventory team follows:

(a) Dr. Nicoletta Kythreotou
Environment Officer, Department of Environment, Ministry of Agriculture, Rural Development and Environment, Offices’ address: 20-22 28th Oktovriou Ave., Engomi, 2414, Nicosia, Cyprus, Postal address: Department of Environment, 1498 Nicosia, Cyprus, Tel. +357 22 408 947, Email. nkythreotou@environment.moa.gov.cy
BSc Environmental Science, MSc Environmental Engineering, PhD Mechanical Engineering

(b) Mr. Marios Papanicolaou
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BSc Physics, BSc Mechanical Engineering, MSc Renewable Energy Technology

(c) Mr. Iordanis Tzamtzis
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BSc Forest Engineer, MSc Environmental Protection and Sustainable Development

(d) Mr. Demetris Demetriou
Technical Research Specialist for Greenhouse Gases and Air Pollutants Inventory, the Cyprus Institute, address. 20, Konstantinou Kavafi Street, 2121, Nicosia, Cyprus, Tel. +357 22 397 559 Email. d.demetriou@cyi.ac.cy
BSc Mechanical Engineering, MSc Environmental Science, Policy and Management, MSc Environmental Dynamics and Climate Change.

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BSc Chemistry, Med Science Education.

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BSc Statistics and Financial Mathematics, MSc Statistics and Data Science

**Government Ministries/ Government agencies**

Data from all the involved parties come in MS Excel spread-sheets and any other additional descriptive information in word documents. The main database maintained by the inventory compiler is also in the form of MS Excel spread-sheets. The collected data is transferred to the main database of the inventory compiler. No special software is used or applied for processing or storage of the data used in the inventory.

The inventory compiler has one MS Excel spread-sheet containing all the data collected and one MS Excel spread-sheet containing the calculations performed for the estimation of the GHG emissions.

***Contact points for data collection***

Data from the annual ETS submissions from installations participating is the EU-ETS scheme has been obtained since 2006 from the ETS team, which is also part of the Climate Action Unit of the Department of Environment (contact point Ms. Chrystalla Papastavrou, tel. no. +357 22 408962, cpapastavrou@environment.moa.gov.cy). Apart from the fuel consumption data is also obtained for $CO_2$ emissions (combustion and process emissions) and net calorific value (NCV) of fuels consumed.

The energy balance is obtained from the Energy Service of the Ministry of Commerce, Industry and Tourism. The contact point is Dr. Christina Karapitta–Zachariadou (tel. no. +357 22409388, ckarapitta@mcit.gov.cy).

Information on vehicle registration for the estimation of emissions from road transport is obtained from the Department of Road Transport, Ministry of Transport, Communications and Works (Mr. Renos Venezis, tel. +357 22807002, rvenezis@rtd.mcw.gov.cy).

The contact point for the energy balance prepared by the National Statistical Service (CYstat) for the submission to EUROSTAT is Ms. Nafsika Apostolou (tel. no. +357 22602199, napostolou@cystat.mof.gov.cy). Other contacts at CYstat are: for waste data Mrs. Marilena Kythreotou (tel. no. +357 22602137, mkythreotou@cystat.mof.gov.cy), for population data Ms. Loukia Makri (tel. no.+357 22602150, lmakri@cystat.mof.gov.cy), for industrial production Mr. Charalambos Alkiviadous (tel. 22602189, calkiviadous@cystat.mof.gov.cy) and for agricultural data (cultivated areas and animal population) Mrs. Sofia Pelagia (spelagia@cystat.mof.gov.cy).

Department of Labour Inspection is the competent authority for the preparation of air pollutants inventories under Directive 2001/81/EC. The inventory is communicated to the GHG inventory compiler, Mr. Christos Papadopoulos (tel. no. +357 22405683, cpapadopoulos@dli.mlsi.gov.cy).

The activity data for the estimation of emissions from F-gases (sectors 2F) is obtained by Mr. Pavlos Pavlou, part of the Climate Action Unit, Department of Environment (tel. no. +357 24 202866, ppavlou@environment.moa.gov.cy), Department of Road Transport, Ministry of Transport, Communications and Works (Mr. Renos Venezis, tel. +357 22807002, rvenezis@rtd.mcw.gov.cy).

Other data on municipal solid waste management is obtained from Mrs. Elena Christodoulidou, part of the Waste Management Unit, at the Department of Environment (tel. no. +357 22408951, echristodoulidou@environment.moa.gov.cy).

Municipal liquid waste production and management data is obtained from Mrs. Stella Perikenti part of the Pollution Control Unit, Department of Environment (tel. no. +357 22408942, sperikenti@environment.moa.gov.cy) and Ms. Lia Georgiou, Senior Sanitary Engineer at the Water Development Department (tel. no. +357 22409186, lgeorgiou@wdd.moa.gov.cy)

Agricultural waste management information on practices applied is obtained from Mr. Antis Athanasiades part of the Pollution Control Unit, Department of Environment (tel. no. +357 22408935, aathanasiades@environment.moa.gov.cy).

Industrial liquid waste management data is obtained from Dr. Chrystalla Stylianou head of the Pollution Control Unit, Department of Environment (tel. no. +357 22408941, cstylianou@environment.moa.gov.cy).

Livestock population data is provided by Mr. Christodoulos Pipis, Veterinary Services (tel. no. +357 22 80 52 00).

Fertiliser consumption data is provided by Mr. George Theofanous, Department of Agriculture (tel. no. +357 22464028). Details necessary for the implementation of Tier 2 methodology for dairy cattle was obtained from Mr. Georgios Papaioannou, Department of Agriculture (tel. no. +357 22408566).

Land cover data (which includes forest cover data) is obtained from Mr. Andreas Antoniou, part of the Nature & Biodiversity Unit, Department of Environment (tel. no. +357 22408918, aantoniou@envrironment.moa.gov.cy).

Forest wildfire data is obtained from Ms. Areti Christodoulou, Department of Forests (tel. no. +357 22459003, archristodoulou@fd.moa.gov.cy).

Data is also obtained from International Organisations as the Food and Agricultural Organization of the United Nations (FAO) and EUROSTAT. This data is supplementary to the data collected from the aforementioned data providers. Furthermore, other government organisations, associations, and individual public and private industrial companies contribute to data providing and development of methodological issues as appropriate (Lime, cement and ceramics (bricks and tiles) production data is obtained directly from the installations).

## 1.2.2. Overview of inventory planning, preparation and management

### 1.2.2.1. GHG inventory, data collection, processing and storage

The preparation of the Cyprus' GHG emissions inventory is the responsibility of the Climate Action Unit of the Department of Environment of the Ministry of Agriculture, Rural Development and Environment.

The preparation of the Cyprus' GHG emissions inventory is primarily based on the application of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The compilation of the inventory is completed in three main stages (Figure 1.2).

The preparation of the Cyprus' GHG emissions inventory is based on the application of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The compilation of the inventory is completed in three main stages (Figure 1.2).

- Stage 1: The first stage consists of data collection and checks for all source/sink categories. The main data sources used are the National Statistical Service, the national energy balance, the government ministries/agencies involved, along with the verified reports from installations under the EU ETS. Quality control of activity data include the comparison of the same or similar data from alternative data sources (e.g. National Statistical Service, EU ETS reports and energy balance) as well as time-series assessment to identify changes that cannot be explained. In cases where problems and/or inconsistencies are identified, the agency's representative, responsible for data providing, is called to explain the inconsistency and/or help solving the problem.
- Stage 2: Once the reliability of input data is checked and certified, emissions/removals per source/sink category are estimated. Emissions estimates are then transformed to the format required by the CRT Reporter. This stage also includes the evaluation of the emission factors used and the assessment of the consistency of the methodologies applied in relation to the provisions of the 2006 IPCC Guidelines. Quality control checks, when at this stage, are related to time-series assessment as well as to the identification and correction of any errors/gaps while estimating emissions/removals and entering the data in the CRT Reporter.
- Stage 3: The last stage involves the compilation of the NID and its internal check. During this period, the Inventory Team must revise the report according to the observations and recommendations of the QA. Based on this interaction process, the final version of the report is compiled. The Director of the Department of Environment approves the inventory and then the contact points submit the NID to the European Commission for compliance with Regulation (EU) No 525/2013 and thereafter to the UNFCCC secretariat.

As shown in the timetable (Figure 1.3), the government ministries and agencies and the individual private or public industrial companies referred to previously should have collected and delivered to the Inventory Team [11] the respective activity data needed for the inventory (for year X-2) and any changes in activity data for the period 1990 to year X-2, within the time period of May to November of year X-1 (X is the submission year of CRT tables and NID referred to X-2 GHG emissions inventory).

The information that is related to the annual GHG emissions inventory (activity data, emission factors, analytic results, compilation in the required analysis level of the CRT tables) is stored in MS Excel spreadsheets. Moreover, the final results (NID and CRT tables) are available in the DoE website[12].

In addition, and within the context of the Quality Assurance/Quality Control system developed, two master files have been organized aiming at the systematic and safe archiving of inventory information: the Input Data File and the Centralised Inventory File.

[11] and the technical consultants (in the future).

[12] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/All/21395032E3B9BB6CC225 7FF0003813DD?OpenDocument

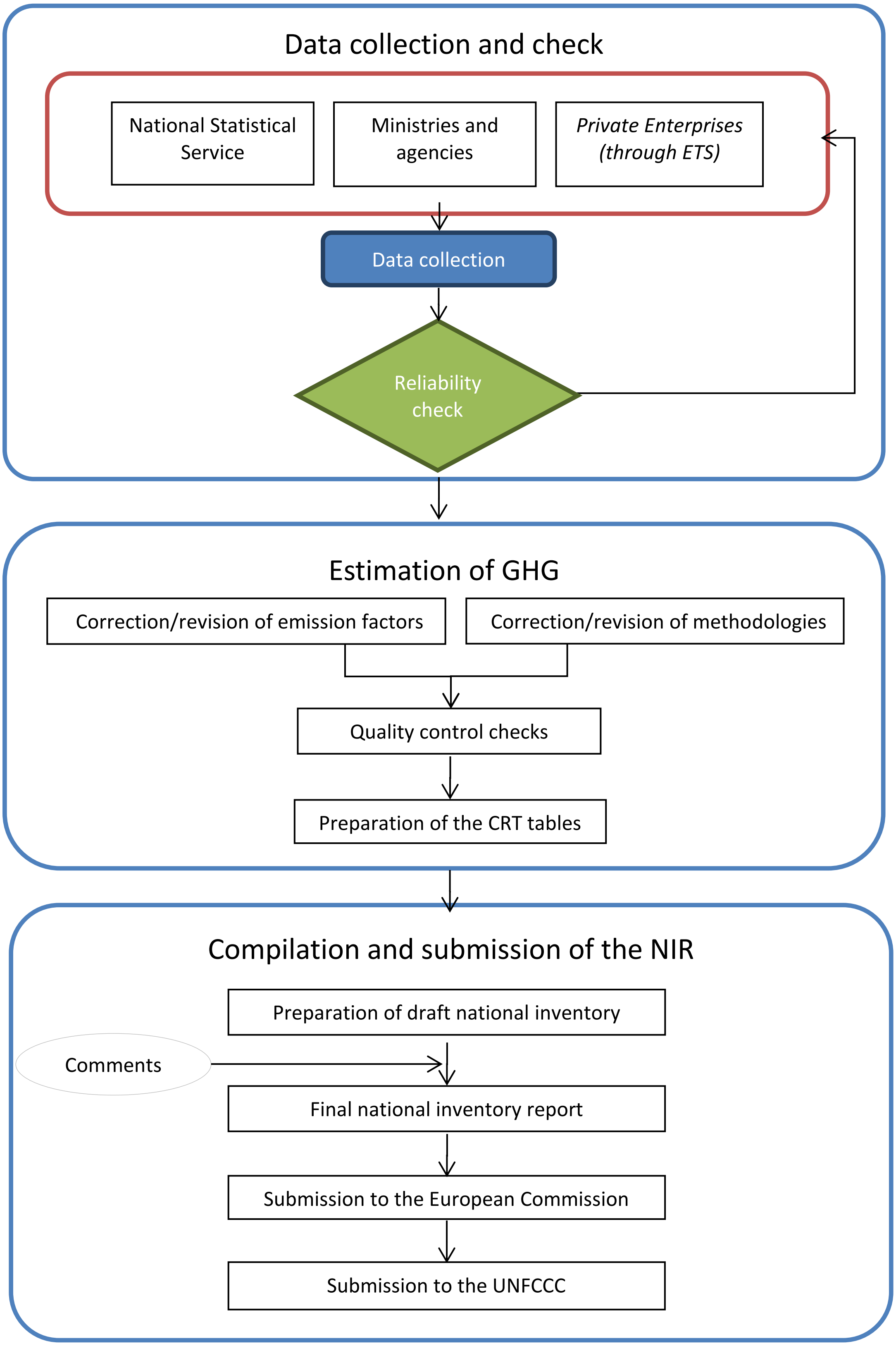


**Figure 1.2. GHG emissions inventory preparation process in Cyprus**

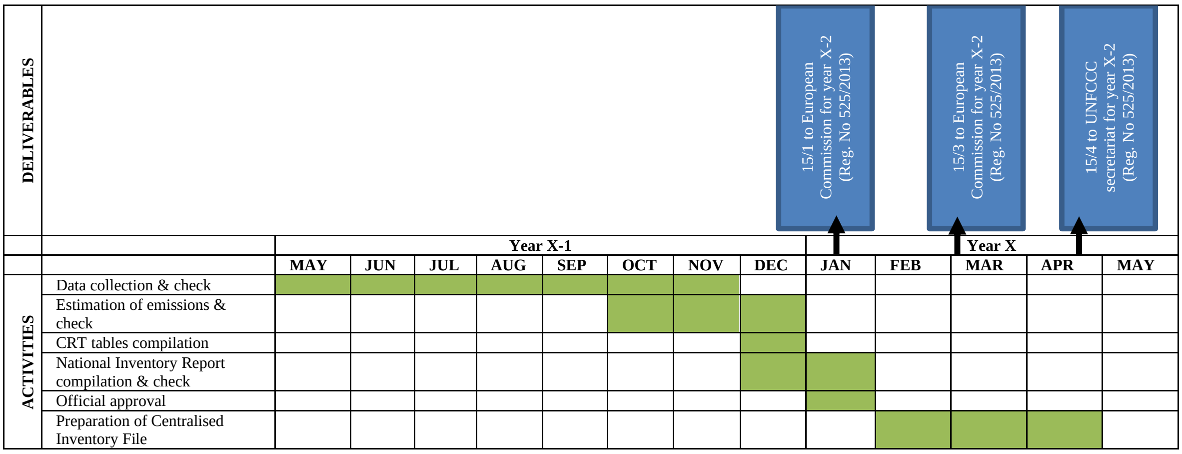


**Figure 1.3. Timetable for inventory preparation**

- The Input Data File contains (in electronic format and/or hard copy) all input data and parameters that are necessary for the estimation of GHG emissions/removals. Data is stored in sheets by sector and reference year.
- The Centralised Inventory File includes all information relevant to the GHG emissions/removals inventory. At the end of each cycle of the inventory preparation, all inventory related information is handled by the inventory team to the person responsible for keeping the Centralised Inventory File (member of the Climate Team) in the DoE, who in turn provides the latest version of all relevant files (calculation files and NID) to the Inventory Team at the beginning of the next inventory cycle.

More specifically the information stored in the Centralised Inventory Files includes:

- A list of the reports, the input data files and the calculation/estimation files.
- The members of the Inventory Team.
- Final versions, in electronic format and hard copy, of the NID.
- CRT tables in electronic format and a hard copy of the CRT tables for the last year covered by each submission.
- XML file and database of CRT reporter.
- Calculation files, including the uncertainty estimation files.
- Expert review reports.
- Any comments from the public review of the inventory.
- Documentation derived from the implementation of the QA/QC procedures.

## 1.2.3. Quality assurance, quality control and verification plan

A QA/QC plan is an internal document to organise and implement all activities across all of the emissions inventory activities including:

- Stakeholder engagement (stakeholders = e.g. suppliers of data, reviewers, recipients, other inventory compiling institutes (e.g. NFR))
- Data collection
- Data management
- Inventory compilation
- Consolidating the inventory estimates (e.g. into a single national database)
- Reporting

The QA/QC plan is a fundamental element of an inventory management system. The plan needs to clearly identify all important activities used by the inventory compiler and ensure that the minimum data quality objectives required under any relevant reporting obligations are met.

The development and the implementation of an inventory QA/QC plan represents a key tool for meeting the objectives of National Systems under Article 5 Paragraph 1 of the Protocol as described in Decision

20/CP.7.

Quality management is essential in order to comply with the requirements of (a) producing transparent, consistent, comparable, complete and accurate emissions estimates, (b) establishing a reliable central archiving system concerning all necessary information for GHG emissions inventories development and (c) compiling national reports according to the provisions of the CMP adopted decisions.

In this framework, a QA/QC system was first prepared in 2012, then revised to reflect 2016 and 2017 ERT recommendations.

Any external experts (through contracts) in close co-operation with the DoE are responsible for the implementation of the QA/QC system. The quality objectives of the system are the following:

1. Compliance with the 2006 IPCC guidelines and the UNFCCC reporting guidelines while estimating and reporting emissions/removals.
2. Continuous improvement of GHG emissions/removals estimates.
3. Timely submission of necessary information in compliance with relevant requirements defined in international conventions, protocols and agreements.

The accomplishment of these objectives can only be ensured by the implementation of the following QA/QC procedures, from all the members of the Inventory Team (see Figure 1.4 for the flow chart of activities concerning emissions inventory):

- Data collection and processing;
- Applying methods consistent with 2006 IPCC Guidelines for calculating/recalculating emissions or removals, and 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol;
- Making quantitative estimates of inventory uncertainty;
- Archiving information and record keeping; and,
- Compiling national inventory reports.

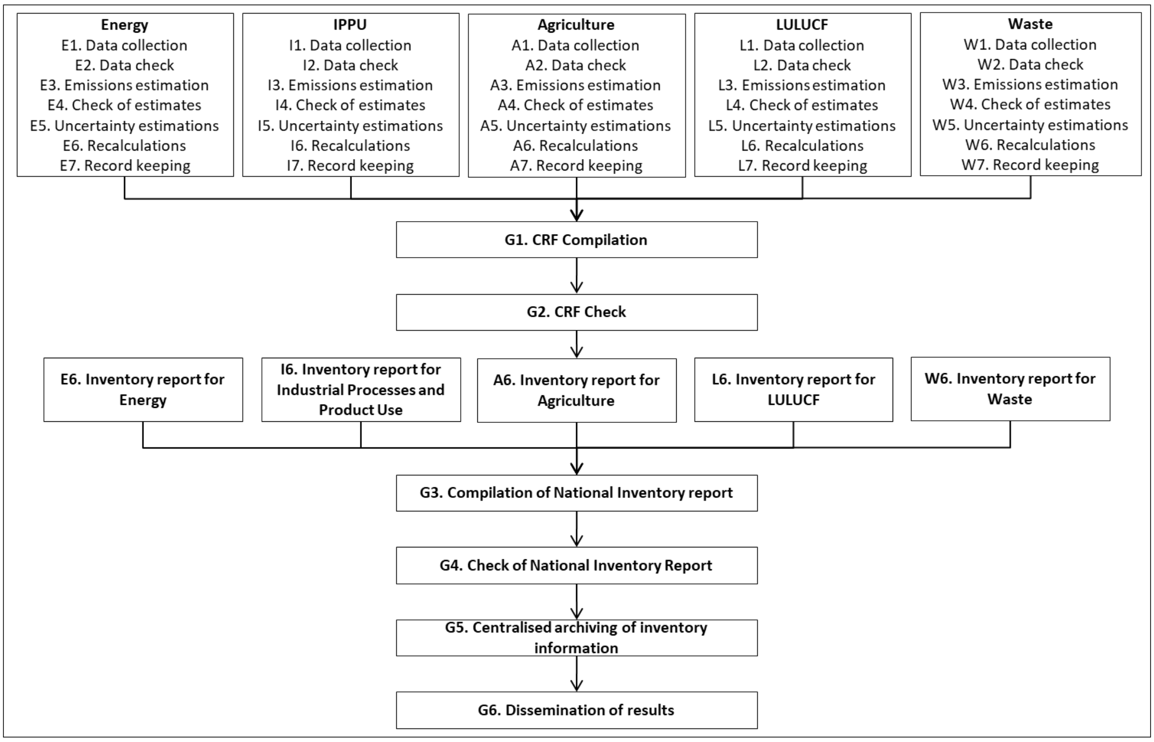


**Figure 1.4. Flow chart of activities concerning emissions inventory**

The QA/QC system developed covers the following processes:

- *QA/QC system management*, comprising all activities that are necessary for the management and control of the inventory team in order to ensure the accomplishment of the abovementioned quality objectives.

- *Quality control*, which is directly related to the estimation of emissions. The process includes activities related to (a) data inquiry, collection and documentation, (b) methodological choice in accordance with the 2006 IPCC Guidelines, (c) quality control checks for data from secondary sources and (d) record keeping.
- *Archiving inventory information*, comprising activities related to centralised archiving of inventory information and the compilation of the national inventory report.
- *Quality assurance*, comprising activities related to the different levels of review processes including the review of input data from experts, if necessary, and comments from the public
- *Estimation of uncertainties*, defining procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory.
- *Inventory improvement*, that is related to the preparation and the justification of any recalculations made.

Table 1.1 presents the list of procedures within each process and Figure 1.5 the relationship between the processes and the activities of the inventory team.

**Table 1.1. QA/QC procedures for the GHG emissions inventory**

| Process | Procedure code | Procedure |
|---|---|---|
| Quality management | QM01 | System review |
| | QM02 | System improvement |
| | QM03 | Training |
| | QM04 | Record keeping |
| | QM05 | Internal reviews |
| | QM06 | Non-compliance-corrective and preventing actions |
| | QM07 | Quality management system |
| | QM08 | Documents control |
| | QM09 | Internal communication |
| Quality control | QC01 | Data collection |
| | QC02 | Estimation of emissions/removals |
| | QC03 | Data quality control check |
| | QC04 | Input data record keeping |
| Archiving of inventory information | AI01 | Centralised archiving of inventory information |
| | AI02 | Compilation of reports |
| Quality assurance | QA01 | Expert review of input data and parameters |
| | QA02 | Expert review of GHG emissions/removals inventory |
| | QA03 | Review from public |
| Uncertainty estimation | UE01 | Uncertainty analysis |
| Inventory improvement | II01 | Recalculations management |

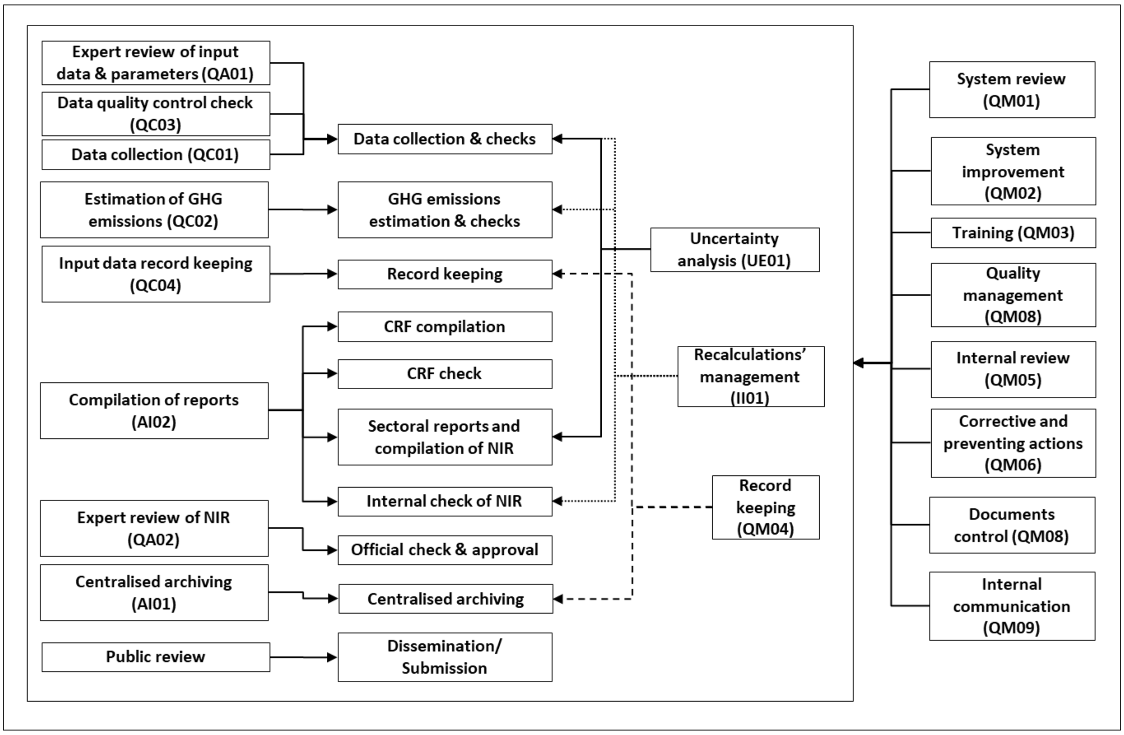


**Figure 1.5. QA/QC process and procedures and inventory related activities**

All the procedures described in the QA/QC manual are followed by any consultants (where applicable) and the DoE. Audits by independent local experts are planned and implemented at least once every five years.

Each year the EU performs QA/QC checks (called initial checks) to its Member States as a part of EU QA/QC system. These tests are performed annually between 15/1 and 28/2. These checks have been designed to verify the transparency, accuracy, consistency, comparability and completeness of the information submitted and include:

(a) An assessment whether all emission source categories and gases required under Regulation (EU) No 525/2013 are reported;
(b) An assessment whether emissions data time series are consistent;
(c) An assessment whether implied emission factors across Member States are comparable taking the IPCC default emission factors for different national circumstances into account;
(d) An assessment of the use of 'Not Estimated' notation keys where IPCC tier 1 methodologies exist and where the use of the notation key is not justified in accordance with paragraph 37 of the UNFCCC reporting guidelines on annual greenhouse gas inventories as included in Annex I to Decision 24/CP.19;
(e) An analysis of recalculations performed for the inventory submission, in particular if the recalculations are based on methodological changes;
(f) A comparison of the verified emissions reported under the Union's Emissions Trading System with the greenhouse gas emissions reported pursuant to Article 7 of Regulation (EU) No 525/2013 with a view of identifying areas where the emission data and trends as submitted by the Member State under review deviate considerably from those of other Member States;
(g) A comparison of the results of Eurostat's reference approach with the Member States' reference approach;
(h) A comparison of the results of Eurostat's sectoral approach with the Member States' sectoral approach;
(i) An assessment whether recommendations from earlier Union or UNFCCC reviews, not implemented by the Member State could lead to a technical correction;
(j) An assessment whether there are potential overestimations or underestimations relating to a key category in a Member State's inventory.

Moreover, EU carries out comprehensive reviews (similar to centralised UNFCCC reviews) of the national inventory data submitted by Member States. Two comprehensive reviews of Cyprus' inventory, for all sectors except LULUCF, have been performed by the EU in 2012 and 2016.

### 1.2.3.1. Roles, responsibilities and timing

This section presents the allocation of inventory activities in relation to QA/QC activities to the members of the inventory team and other experts involved in the QA/QC process of Cyprus. The activities are presented schematically in Figure 4 and Figure 5.

Table 1.2 and Figure 1.6 present timing and responsibilities of team members.

**Table 1.2. Timing and responsibilities**

| | **Responsible** | **Timing** |
|---|---|---|
| Data collection | Data providers<br>Nicoletta Kythreotou[13] | by 30/11 of year X-1 |
| Data check | Nicoletta Kythreotou[14]<br>Corey McClintock (Energy)<br>Demetris Demetriou (IPPU, Agriculture)<br>Marios Christoforides (Waste)<br>Iordanis Tzamtzis (LULUCF) | by 30/11 of year X-1 |
| Emissions estimation | Nicoletta Kythreotou<br>Corey McClintock (Energy)<br>Demetris Demetriou (IPPU, Agriculture)<br>Marios Christoforides (Waste)<br>Iordanis Tzamtzis (LULUCF) | 1/10-15/12 of year X-1 |
| Check of estimates | Corey McClintock | 1/10-15/12 of year X-1 |
| Uncertainty estimations | Nicoletta Kythreotou (Energy, IPPU, Agriculture, Waste)<br>Iordanis Tzamtzis (LULUCF) | 1-30/12 of year X-1 |
| Recalculations | Corey McClintock (Energy)<br>Demetris Demetriou (IPPU, Agriculture)<br>Marios Christoforides (Waste)<br>Iordanis Tzamtzis (LULUCF) | 1-30/12 of year X-1 |
| Record keeping | Corey McClintock (Energy)<br>Demetris Demetriou (IPPU, Agriculture)<br>Marios Christoforides (Waste)<br>Iordanis Tzamtzis (LULUCF)<br>Angelos Violaris (checks) | 1/10-30/12 of year X-1 |
| CRT compilation | Nicoletta Kythreotou (Energy, IPPU, Agriculture, Waste)<br>Iordanis Tzamtzis (LULUCF) | 1-27/12 of year X-1 |
| CRT check | Demetris Demetriou<br>Marios Christoforides<br>Corey McClintock | 27-30/12 of year X-1 |
| Sectoral reports | Corey McClintock (Energy)<br>Demetris Demetriou (IPPU, Agriculture)<br>Marios Christoforides (Waste)<br>Iordanis Tzamtzis (LULUCF) | 1-30/12 of year X-1 |
| Compilation of NID | Angelos Vilaris | 20-30/12 of year X-1 |
| Check of NID | | |
| - internal | Nicoletta Kythreotou | 31/12 of year X-1 – 5/1 |

[13] According to the relevant Council of Ministers' Decision, all data shall be sent electronically/via email to the email addresses info@environment.moa.gov.cy, nkythreotou@environment.moa.gov.cy and tmesimeris@environment.moa.gov.cy.
[14] If any discrepancies exist/ noticed, these are discussed with the data providers for explanations/correction.

| | Responsible | Timing |
|---|---|---|
| | | of year X |
| → correction of any errors found | Corey McClintock<br>Demetris Demetriou<br>Marios Christoforides<br>Iordanis Tzamtzis | 5-8/1 of year X |
| - official (expert review) | | 8-11/1 of year X |
| → correction of any errors found | Corey McClintock<br>Demetris Demetriou<br>Marios Christoforides<br>Iordanis Tzamtzis | 11-13/1 of year X |
| - Official check & approval | Theodoulos Mesimeris | 13-15/1 of year X |
| Submission to European Commission | Nicoletta Kythreotou | 15/1 of year X |
| Centralised archiving | Angelos Violaris | 15/1 of year X |
| EU QA/QC procedure | | 15/1-28/2 of year X |
| Review by stakeholders & public | | 15/1-28/2 of year X |
| Corrections to NID/calculations | Corey McClintock<br>Demetris Demetriou<br>Marios Christoforides<br>Iordanis Tzamtzis | 28/2-15/3 of year X |
| Final Submission to European Commission | Nicoletta Kythreotou | 15/3 of year X |
| Submission to UNFCCC secretariat | Nicoletta Kythreotou | 15/4 of year X |

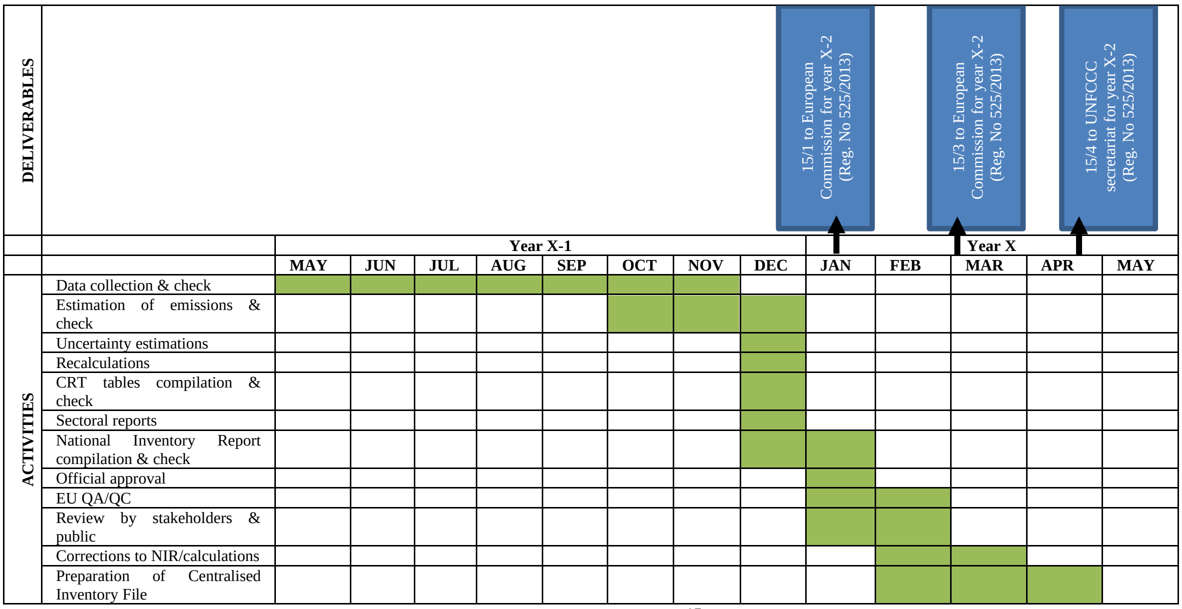


**Figure 1.6. Timing and responsibilities of QA/QC tasks**[15]

## 1.3. Brief general description of methodologies and data sources used

According to decision 24/CP.19, Annex I Parties should use the methodologies provided in the 2006 IPCC Guidelines, unless stated otherwise in the UNFCCC Annex I inventory reporting guidelines, and any supplementary methodologies agreed by the COP, and other relevant COP decisions to estimate anthropogenic emissions by sources and removals by sinks of GHGs not controlled by the Montreal

[15] Shall be revised upon the recruitment on contract basis of the consultants for future submissions according to Council of Ministers' Decision.

Protocol.

Annex I Parties may use different methods (tiers) contained in the 2006 IPCC Guidelines, prioritising these methods in accordance with the 2006 IPCC Guidelines. Annex I Parties may also use national methodologies which they consider better able to reflect their national situation, provided that these methodologies are compatible with the 2006 IPCC Guidelines and are well documented and scientifically based.

For categories that are determined to be key categories, in accordance with the 2006 IPCC Guidelines, and estimated in accordance with the provisions in decision 24/CP.19, Annex I Parties should make every effort to use a recommended method, in accordance with the corresponding decision trees in the 2006 IPCC Guidelines. Annex I Parties should also make every effort to develop and/or select emission factors (EFs), and collect and select activity data (AD), in accordance with IPCC good practice. Where national circumstances prohibit the use of a recommended method, then the Annex I Party should explain in its annual GHG inventory submission the reason(s) as to why it was unable to implement a recommended method in accordance with the decision trees in the 2006 IPCC Guidelines.

The 2006 IPCC Guidelines provide default methodologies which include default EFs and in some cases default AD for the categories to be reported. As the assumptions implicit in these default data, factors and methods may not be appropriate for specific national circumstances, Annex I Parties should use their own national EFs and AD, where available, provided that they are developed in a manner consistent with the 2006 IPCC Guidelines and are considered to be more accurate than the defaults. If Annex I Parties lack country-specific information, they could also use EFs or other parameters provided in the IPCC Emission Factor Database[16], where available, provided that they can demonstrate that those parameters are appropriate in the specific national circumstances and are more accurate than the default data provided in the 2006 IPCC Guidelines. Annex I Parties should transparently explain in their annual GHG inventory submissions what data and/or parameters have been used.

Parties are encouraged to refine estimates of anthropogenic emissions and removals in the land use, land-use change and forestry (LULUCF) sector through the application of tier 3 methods, provided that they are developed in a manner consistent with the 2006 IPCC Guidelines, and information for transparency is provided in accordance with decision 24/CP.19.

The estimation of GHG emissions / removals per source / sink category is predominately based on the methods described in the revised 2006 IPCC Guidelines. The emission factors used were derived from the 2006 IPCC Guidelines and special attention was paid in selecting the emission factors that are most representative of practices and conditions in Cyprus. Furthermore, emission factors were obtained from plant specific information contained in EU ETS reports. Due to data unavailability, for the estimation of the emissions of the sectors Refrigeration and Air Conditioning (2F1), Foam Blowing Agents (2F2), Fire Protection (2F3) and Metered Dose Inhalers (2F4a) the implied emission factors per capita from the average of Greece, Italy, Malta and Spain (NIR2015) have been used. For Use of Electrical Equipment (2G1) and $N_2O$ from Product Uses (2G3), the implied emission factor per capita from Greece was used. Details on the methods applied for the calculation of emissions/removals are given the chapters that follow. The methodologies and EF used for the compilation of the 2018 GHG inventory submission are presented in Table 1.3.

The key categories analysis (see Section 1.4) constitutes the basic tool for methodological choice and for the prioritisation of the necessary improvements. In addition, the results of the various review processes (at national, EU and UNFCCC level) represent key input information for the identification of possible improvements. It should be mentioned however, that data availability as well as availability of resources (both human and financial) also have to be considered.

**Table 1.3. Methodologies used for the preparation of Cyprus' GHG inventory**

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 1A1a.i | Energy Industries - Public electricity and heat production – Energy generation - Liquid fuels | $CO_2$ | CS | CS |
| 1A1a.i | Energy Industries - Public electricity and heat production – Energy generation Liquid fuels | $CH_4/N_2O$ | D | T1 |

[16] http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 1A1b | Energy Industries – Petroleum Refining – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A1c.iv | Manufacture of solid fuels and Other Energy Industries – Charcoal production- biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2b | Manufacturing Industries and Construction – Non-ferrous Metals - Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2c | Manufacturing Industries and Construction – Chemicals – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2c | Manufacturing Industries and Construction – Chemicals – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2d | Manufacturing Industries and Construction – Pulp, Paper and Print – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2e. | Manufacturing Industries and Construction – Food processing, beverages and tobacco – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2e. | Manufacturing Industries and Construction – Food processing, beverages and tobacco – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel | $CO_2$ | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel | $CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – solid fuel | $CO_2$ | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – solid fuel | $CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – other fossil fuel | $CO_2$ | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – other fossil fuel | $CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – biomass (2000 and later) | CO | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – biomass (2000 and later) | $CH_4/N_2O$ | D | T1 |
| 1A2g (iii). | Manufacturing Industries and Construction – Other - Mining (excluding fuels) and Quarrying – liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2g (v). | Manufacturing Industries and Construction - Other - Construction – liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2g (viii). | Manufacturing Industries and Construction – Other -Non-specified Industry – liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A3a. | Transport - Domestic aviation – Jet kerosene | $CO_2$ | M | T3 |
| 1A3a. | Transport - Domestic aviation – Jet kerosene | $CH_4/N_2O$ | D | T1 |
| 1A3bi. | Transport - Road transportation – Gasoline | $CO_2/CH_4/N_2O$ | M | T2 |
| 1A3bi. | Transport - Road transportation - Diesel | $CO_2/CH_4/N_2O$ | M | T2 |
| 1A3bi. | Transport - Road transportation - Biomass | $CO_2/CH_4/N_2O$ | M | T1 |
| 1A3d | Transport - Domestic Navigation – Gas/Diesel Oil | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4a. | Other Sectors - Commercial/institutional - Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4a. | Other Sectors - Commercial/institutional - Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4b. | Other Sectors - Residential – Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4b. | Other Sectors - Residential – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4ci. | Agriculture/forestry/fishing - Stationary- Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 1A4ci. | Agriculture/forestry/fishing – Stationary-Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4ciii | Agriculture/forestry/fishing – Fishing – Gas/Diesel Oil | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5a | Other - Non-Specified – Stationary – Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5a | Other - Non-Specified – Stationary – Solid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5a | Other - Non-Specified – Stationary – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5b | Other - Non-Specified – Mobile - Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1B2a4 | Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Refining/Storage | $CH_4$ | D | T1 |
| 1B2a4 | Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Refining/Storage | $CO_2/N_2O$ | NA | NA |
| 2A1. | Industrial Processes and Product Use – Mineral Industry - Cement production | $CO_2$ | CS | CS |
| 2A2 | Industrial Processes and Product Use – Mineral Industry - Lime Production | $CO_2$ | D | T1 |
| 2A4a | Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Ceramics | $CO_2$ | CS | CS |
| 2A4b | Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Other uses of soda-ash | $CO_2$ | D | T1 |
| 2A4b | Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Other uses of soda-ash | $CH_4/N_2O$ | NA | NA |
| 2D1 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use-Lubricant Use | $CO_2$ | D | T1 |
| 2D1 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use-Lubricant Use | $CH_4/N_2O$ | NA | NA |
| 2D2 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use - Paraffin Wax Use | $CO_2$ | D | T1 |
| 2D2 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use - Paraffin Wax Use | $CH_4/N_2O$ | NA | NA |
| 2D3 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other (Dry cleaning, coating applications, chemical products, asphalt roofing, domestic solvent use including fungicides, road paving with asphalt, printing) | $CO_2$ | CS | CS |
| 2D3 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other (Dry cleaning, coating applications, chemical products, asphalt roofing, domestic solvent use including fungicides, road paving with asphalt, printing) | $CH_4/N_2O$ | NA | NA |
| 2D3 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts | $CO_2$ | D | D |
| 2D3 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts | $CH_4/N_2O$ | NA | NA |

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 2F1 | Product Uses as Substitutes for ODS - Refrigeration and air conditioning | HFCs | D | T2a |
| 2F2 | Product Uses as Substitutes for ODS - Foam Blowing Agents | HFCs | CS | CS |
| 2F3 | Product Uses as Substitutes for ODS - Fire Protection | HFCs | CS | CS |
| 2F4. | Product Uses as Substitutes for ODS - Aerosols | HFCs | CS | CS |
| 2G1 | Electrical equipment | $SF_6$ | D | T1 |
| 2G3a | Other Product Manufacture and Use - $N_2O$ from product uses – Medical Applications | $N_2O$ | CS | CS |
| 2G3b | Other Product Manufacture and Use - $N_2O$ from product uses – Other –Propellant for pressure and aerosol products | $N_2O$ | CS | CS |
| 3A | Enteric Fermentation – Dairy Cattle | $CH_4$ | CS | T2 |
| 3A | Enteric Fermentation - Non-dairy cattle, sheep, goats, horses, mules and asses and swine | $CH_4$ | D | T1 |
| 3B1.1 | Manure Management – Dairy Cattle and Non-dairy cattle | $CH_4$ | D | T2 |
| 3B1.2<br>3B1.4 | Manure Management – sheep, goats, horses, mules and asses, poultry | $CH_4$ | D | T1 |
| 3B1.3 | Manure Management –swine (market & breeding) | $CH_4$ | D | T2 |
| 3B2.1<br>3B2.2<br>3B2.3<br>3B2.4 | Direct $N_2O$ emissions – Dairy and non-dairy cattle, Sheep, swine (market & breeding), goats, horses, poultry, mules and asses | $N_2O$ | D | T1 |
| 3B2.5 | Indirect $N_2O$ emissions | $N_2O$ | D | T1 |
| 3D1.1 | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils- Inorganic fertilizers | $N_2O$ | D | T1 |
| 3D1.2a | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils - Organic N fertilizers - Animal manure used as fertilizers | $N_2O$ | D | T1 |
| 3D1.2b | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils - Organic N fertilizers - Sewage sludge applied to soils | $N_2O$ | D | T1 |
| 3D1.4 | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils - Crop residues | $N_2O$ | D | T1 |
| 3D2.1 | Indirect $N_2O$ emissions from managed soils – Atmospheric Deposition | $N_2O$ | D | T1 |
| 3D2.2 | Indirect $N_2O$ emissions from managed soils Nitrogen Leaching and run-off | $N_2O$ | D | T1 |
| 3F1 | Field Burning of Agricultural Residues – Cereals – Wheat, Barley, Oats | $N_2O/CH_4$ | D | T1 |
| 3F2 | Field Burning of Agricultural Residues – Pulses – Bean and Pulses | $N_2O/CH_4$ | D | T1 |
| 3F3 | Field Burning of Agricultural Residues –Tubers and Roots | $N_2O/CH_4$ | D | T1 |
| 3H | Urea Application | $CO_2$ | D | T1 |
| 4A1 | Forest land remaining forest land | $CO_2$ | CS,D | T1,T2 |
| 4A1 | Forest land remaining forest land | $N_2O/CH_4$ | D | T1 |
| 4A2 | Land converted to forest land | $CO_2$ | CS,D | T1,T2 |
| 4B1 | Cropland remaining cropland | $CO_2$ | D | T1 |
| 4B2 | Land converted to cropland | $CO_2$ | CS,D | T1,T2 |
| 4B2 | Land converted to cropland | $N_2O$ | D | T1 |
| 4C1 | Grassland remaining grassland | $CO_2$ | CS,D | T1 |
| 4C2 | Land converted to grassland | $CO_2$ | CS,D | T1,T2 |
| 4D2 | Land converted to wetlands | $CO_2$ | CS,D | T1 |
| 4E1 | Settlements remaining settlements | $CO_2$ | NA | T1 |

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 4E2 | Land converted to settlements | $CO_2$ | CS,D | T1,T2 |
| 4E2 | Land converted to settlements | $N_2O$ | D | T1 |
| 4F2 | Land converted to other land | $CO_2$ | CS,D | T1,T2 |
| 4F2 | Land converted to other land | $N_2O$ | D | T1 |
| 4G | Harvested wood products | $CO_2$ | D | T2 |
| 5A1.a | Solid Waste Disposal - Managed waste disposal sites- Anaerobic | $CH_4$ | D | T2 |
| 5A1.a | Solid Waste Disposal - Managed waste disposal sites- Anaerobic | $CO_2$ | NA | NA |
| 5A2. | Solid Waste Disposal - Unmanaged waste disposal sites | $CH_4$ | D | T2 |
| 5A2. | Solid Waste Disposal - Unmanaged waste disposal sites | $CO_2$ | NA | NA |
| 5B1 | Biological treatment of solid waste – Composting- municipal solid waste | $CH_4/N_2O$ | D | T1 |
| 5B2 | Biological treatment of solid waste – Anaerobic digestion at biogas facilities | $CH_4$ | D | T1 |
| 5D1. | Wastewater Treatment and Discharge - Domestic wastewater | $CH_4/N_2O$ | CS | T1 |
| 5D2. | Wastewater Treatment and Discharge - Industrial wastewater | $CH_4$ | D | T1 |
| 5D2. | Wastewater Treatment and Discharge - Industrial wastewater | $N_2O$ | OTH | OTH |

*where: OTH = Other, D = Default, T1 = Tier 1, T2 = Tier 2, CS = Country Specific, NA = Not Applicable, M = COPERT*

Data collection, processing and checks constitute the activity with the longest duration in the annual inventory cycle. The duration of this activity is related to the amount of the necessary data and the number of the entities involved. The on-time and successful completion of this activity has a major effect on the timeliness preparation and submission of the inventory as well as on its accuracy, completeness and consistency.

Table 1.4 gives an overview of the main data sets used for the estimation of GHG emissions/removals. Data from international organisations and databases are supplementary to the data collected from the listed data providers. Information and data collected (through questionnaires developed according to the guidelines described in the Commission Decision 2004/156/EC[17]) in the framework of the formulation of the National Allocation Plan (NAP) for the period 2005-2007, according to the Directive 2003/87/EC[18] (and its transposition to the national Law, 110(I)/2011[19]) along with the data from the verified reports from installations under the EU ETS for years 2005-2015 constituted significant source of information and an additional quality control check.

**Table 1.4. Data sources and data sets per IPCC sector, source category**

| Category-Classification | | Data | Sources |
|---|---|---|---|
| 1A1a. | Public electricity and heat production | Fuel consumption | ETS verified reports<br>Statistical Service<br>Department of Labour Inspection (DLI) |
| 1A1b. | Petroleum Refining | Fuel consumption | Statistical Service |
| 1A2b. | Non-ferrous metals | Fuel consumption | Statistical Service |
| 1A2c. | Chemical and petrochemical | Fuel consumption | Statistical Service |
| 1A2d. | Paper, pulp and printing | Fuel consumption | Statistical Service |
| 1A2e. | Food processing, beverages and tobacco | Fuel consumption | Statistical Service |
| 1A2f. | Non-metallic minerals – Liquid | Fuel consumption | ETS verified reports |

[17] Available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004D0156&from=EN (no longer in force)
[18] Available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0087&from=EN
[19] Available at http://www.moa.gov.cy/moa/environment/environmentnew.nsf/All/E526DA8D521738B9C2258020002E364D?OpenDocument (in Greek)

| Category-Classification | | Data | Sources |
|---|---|---|---|
| | fuel | | Statistical Service<br>DLI |
| 1A2f. | Non-metallic minerals – solid fuel | Fuel consumption | ETS verified reports<br>Statistical Service<br>DLI |
| 1A2f. | Non-metallic minerals – other fuel | Fuel consumption | ETS verified reports<br>Statistical Service<br>DLI |
| 1A2f. | Non-metallic minerals – biomass | Fuel consumption | ETS verified reports<br>Statistical Service<br>DLI |
| 1A2g(iii). | Other - Mining (excluding fuels) and Quarrying – liquid fuel | Fuel consumption | Statistical Service |
| 1A2g(v). | Other - Construction – liquid fuel | Fuel consumption | Statistical Service |
| 1A2g(viii). | Other -Non-specified Industry – liquid fuel | Fuel consumption | Statistical Service |
| 1A3a. | Domestic aviation – Jet kerosene | Fuel consumption | Statistical Service<br>/EUROCONTROL |
| 1A3bi. | Road transportation – Gasoline | Fuel consumption<br>Vehicles registration | Statistical Service<br>Dep. of Road Transport |
| 1A3bi. | Road transportation - Diesel | Fuel consumption<br>Vehicles registration | Statistical Service<br>Dep. of Road Transport |
| 1A3bi. | Road transportation - Biomass | Fuel consumption<br>Vehicles registration | Statistical Service<br>Dep. of Road Transport |
| 1A3d | Domestic Navigation – Gas/Diesel Oil | Fuel consumption | Statistical Service |
| 1A4a. | Commercial/institutional - Liquid fuel | Fuel consumption | Statistical Service<br>DLI |
| 1A4a. | Commercial/institutional - Biomass | Fuel consumption | Statistical Service<br>DLI |
| 1A4b. | Residential – Liquid fuel | Fuel consumption | Statistical Service<br>DLI |
| 1A4b. | Residential – Biomass | Fuel consumption | Statistical Service<br>DLI |
| 1A4ci. | Agriculture/forestry/fishing - Stationary- Liquid fuel | Fuel consumption | Statistical Service<br>DLI |
| 1A4ci. | Agriculture/forestry/fishing – Stationary- Biomass | Fuel consumption | Statistical Service<br>DLI |
| 1A4ciii | Agriculture/forestry/fishing – Fishing – Gas/Diesel Oil | Fuel consumption | Statistical Service |
| 1A5a. | Other - Non-Specified – Stationary – Liquid fuel | Fuel consumption | Statistical Service |
| 1A5a. | Other - Non-Specified – Stationary – Solid fuel | Fuel consumption | Statistical Service |
| 1A5a. | Other - Non-Specified – Stationary – Biomass | Fuel consumption | Statistical Service |
| 1A5b. | Other - Non-Specified – Liquid fuel | Fuel consumption | Statistical Service |
| 1B2a4. | Fugitive Emissions from Fuels-Oil and Natural Gas and Other Emissions from Energy Production- Refining/Storage | Fuel consumption | Statistical Service |
| 2A1. | Cement production | Clinker production | ETS verified reports<br>Statistical Service<br>DLI |
| 2A2 | Lime Production | Lime production | Statistical Service<br>DLI<br>Installation |

| Category-Classification | | Data | Sources |
|---|---|---|---|
| 2A4a. | Other process uses of carbonates - Ceramics | Bricks and Tiles Production | ETS verified reports<br>DLI |
| 2A4b. | Other process uses of carbonates - Other uses of soda-ash | Soda – Ash Imports | Statistical Service |
| 2D1. | Lubricant Use | Lubricants consumption | Statistical Service |
| 2D2. | Paraffin Wax Use | Paraffin Wax Imports | Statistical Service |
| 2D3. | Solvent Use (Dry cleaning, coating applications, chemical products, asphalt roofing, domestic solvent use including fungicides, road paving with asphalt, printing) | NMVOCs | DLI |
| 2D3. | Solvent Use - Urea-based catalysts | Fuel consumption | Statistical Service |
| 2F1. | Refrigeration and air conditioning | Commercial and industrial air-conditioning and refrigeration | Department of Environment – Inventory of equipment containing fluorinates and ozone depleting substances* |
| 2F2 | Foam Blowing Agents | Emissions Data | National Inventory of Malta, Spain, Italy, Greece |
| 2F3 | Fire Protection | Emissions Data | National Inventory of Malta, Spain, Italy, Greece |
| 2F4. | Aerosols | Emissions Data | National Inventory of Malta, Spain, Italy, Greece |
| 2G3a | $N_2O$ from product uses | Population | Statistical Service |
| 2G3b | $N_2O$ from product uses | Population | Statistical Service |
| 3A | Enteric Fermentation – Dairy Cattle | Livestock population<br>milk yield*<br>average weight* | Statistical Service<br>DLI<br>EUROSTAT<br>Veterinary Services<br>*Department of Agriculture |
| 3A | Enteric Fermentation - Non-dairy cattle, sheep, goats, horses, mules and asses and swine | Livestock population | Statistical Service<br>DLI<br>EUROSTAT<br>Veterinary Services<br>Department of Agriculture |
| 3B1.1 | Manure Management – Dairy Cattle and Non-dairy cattle | Livestock population | Statistical Service<br>DLI<br>EUROSTAT<br>Veterinary Services<br>Department of Agriculture |
| 3B1.2<br>3B1.4 | Manure Management – sheep, goats, horses, mules and asses, poultry | Livestock population | Statistical Service<br>DLI<br>EUROSTAT<br>Veterinary Services<br>Department of Agriculture |
| 3B1.3 | Manure Management –swine (market & breeding) | Livestock population | Statistical Service<br>DLI<br>EUROSTAT<br>Veterinary Services<br>Department of Agriculture |
| 3B2.1<br>3B2.2<br>3B2.3<br>3B2.4 | Direct $N_2O$ emissions – Dairy and non-dairy cattle, Sheep, swine (market & breeding), goats, horses, poultry, mules and asses | Livestock population | Statistical Service<br>DLI<br>EUROSTAT<br>Veterinary Services |

| Category-Classification | | Data | Sources |
|---|---|---|---|
| | | | Department of Agriculture |
| 3B2.5 | Indirect $N_2O$ emissions | Livestock population | Statistical Service<br>DLI<br>EUROSTAT<br>Veterinary Services<br>Department of Agriculture |
| 3D1.1 | Agricultural soils- Inorganic fertilizers | Fertilizers use | Statistical Service<br>Department of Agriculture |
| 3D1.2a | Use of organic N fertilizers - Animal manure used as fertilizers | Fertiliser use<br>Livestock population | Statistical Service<br>Department of Agriculture |
| 3D1.2b | Use of organic N fertilizers - Sewage sludge applied to soils | Fertiliser use Sewage sludge applied to soils | Statistical Service<br>Department of Agriculture |
| 3D1.4 | Crop residues | Cultivated areas<br>Crop production | Statistical Service |
| 3D2.1 | Indirect $N_2O$ emissions from managed soils – Atmospheric Deposition | Fertiliser use | Statistical Service<br>Department of Agriculture |
| 3D2.2 | Indirect $N_2O$ emissions from managed soils Nitrogen Leaching and run-off | Fertiliser use<br>Livestock population<br>Sewage sludge applied to soils | Statistical Service<br>Department of Agriculture |
| 3F1 | Field Burning of Agricultural Residues – Cereals – Wheat, Barley, Oats | Cultivated areas<br>Crop production | Statistical Service |
| 3F2 | Field Burning of Agricultural Residues – Pulses – Bean and Pulses | Cultivated areas<br>Crop production | Statistical Service |
| 3F3 | Field Burning of Agricultural Residues –Tubers and Roots | Cultivated areas<br>Crop production | Statistical Service |
| 3H | Urea Application | Urea use | Statistical Service |
| 5A1.a | Managed waste disposal sites | Municipal solid waste production<br>Recycling<br>Population | Statistical Service<br>Department of Environment |
| 5A2. | Unmanaged waste disposal sites | Municipal solid waste production<br>Population | Statistical Service<br>Department of Environment |
| 5B1 | Biological treatment of solid waste – Composting- municipal solid waste | Composting | Statistical Service |
| 5B2 | Biological treatment of solid waste – Anaerobic digestion at biogas facilities | Composting | Statistical Service |
| 5D1. | Wastewater Treatment and Discharge - Domestic wastewater | Population connected | Statistical Service<br>Water Development Department<br>Department of Environment |
| 5D2. | Wastewater Treatment and Discharge - Industrial wastewater | Industrial production | Statistical Service<br>Department of Environment |

*outsourced contract

### 1.3.1. Global Warming Potential

Emissions from anthropogenic activities affect the concentration and distribution of greenhouse gases in the atmosphere. These changes can potentially produce a radiative forcing of the Earth's surface and lower atmosphere, by changing either the reflection or absorption of solar radiation or the emissions and absorption of long-wave radiation. A simple measure of the relative radiative effects of the emissions of various greenhouse gases is the Global Warming Potential (GWP) index. This index is defined as the cumulative radiative forcing between the present and some chosen time-horizon caused by a unit mass of gas emitted now, expressed relative to that for some reference gas. The values for GWP for the greenhouse gases that are used in this inventory are according to Decision 18/CMA.1[20] (Annex II).

Corresponding values of GWP for other gases ($NO_x$, CO, NMVOC) are not given by the IPCC (nor by other sources for this purpose), since at present it is impossible to calculate the indirect results of these gases, as the scientific knowledge on their chemical reactions taking place in the atmosphere is not sufficient.

**Table 1.5. Direct Global Warming Potentials (mass basis) relative to carbon dioxide for the 100-year horizon**

| Gas | Chemical Compound | 100-year Global Warming Potential |
|---|---|---|
| Carbon dioxide | $CO_2$ | 1 |
| Methane | $CH_4$ | 28 |
| Nitrous Oxide | $N_2O$ | 265 |
| HFC-32 | $CH_2F_2$ | 677 |
| HFC-125 | $CHF_2CF_2$ | 3170 |
| HFC-134a | $CH_2FCF_3$ | 1300 |
| HFC-143a | $CF_3CH_3$ | 4800 |
| HFC-227ea | $CF_3CHFCF_3$ | 3350 |
| HFC-245fa | $CH_2FCF_2CHF_2$ | 858 |
| HCF-365mfc | $CH_3CF_2CH_2CH_2CF_3$ | 804 |
| Sulphur hexafluoride | $SF_6$ | 23500 |
| Nitrogen trifluoride | $NF_3$ | 16100 |

## 1.4. Brief description of key categories

The 2006 IPCC Guidelines define procedures (in the form of decision trees) for the choice of estimation methods within the context of the IPCC Guidelines. Decision trees formalize the choice of the estimation method most suited to national circumstances considering at the same time the need for accuracy and the available resources (both financial and human). It is considered good practice to identify those source categories (key source categories) that have the greatest contribution to overall inventory uncertainty in order to make the most efficient use of available resources.

In that context, a key source category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions (level assessment) or/and to the trend of emissions (trend assessment). As far as possible, key source categories should receive special consideration in terms of two important inventory aspects:

1. The use of source category-specific good practice methods is preferable, unless resources are unavailable.

2. The key source categories should receive additional attention with respect to quality assurance (QA) and quality control (QC).

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[20] Decision 18/CP.1 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement.

As a result of the adoption of the LULUCF Good Practice Guidance (Decision 13/CP.9) the concept of key sources has been expanded in order to cover LULUCF emissions by sources and removals by sinks. Therefore the term key category is used in order to include both sources and sinks.

The determination of the key categories for the Cyprus' inventory system is based on the application of the Tier 1 methodology (see Annex I for an analytic presentation of calculations) described in the 2006 IPCC Guidelines. Tier 1 methodology for the identification of key categories assesses the impacts of various source categories on the level and the trend of the national emissions inventory. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms.

It should be mentioned that source category uncertainty estimates are not taken into consideration and base year estimates were calculated considering 1990 as base year.

The key categories for Cyprus' inventory system (without LULUCF) for the year 2023 are presented in Table 1.6. Nine key source categories are found in the energy sector, five in the IPPU sector, five in agriculture and five in waste sector in 2023 (without LULUCF). Detailed presentation of the key category analysis is presented in Annex 1.

**Table 1.6. Key categories for Cyprus' inventory system without LULUCF for 2023**

| IPCC Source category | Direct GHG | Level | Trend |
|---|---|---|---|
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.3.a Domestic Aviation | $CO_2$ | | ✓ |
| 1.A.3.b Road Transportation | $CO_2$ | ✓ | ✓ |
| 1.A.4 Other Sectors - Liquid Fuels | $CO_2$ | ✓ | ✓ |
| 2A1. Cement production | $CO_2$ | ✓ | ✓ |
| 2A4. Othe process uses of carbonate | $CO_2$ | | ✓ |
| 2F1. Refrigeration and air conditioning | HFCs | ✓ | ✓ |
| 3.A Enteric Fermentation | $CH_4$ | ✓ | ✓ |
| 3.B Manure Management | $CH_4$ | ✓ | ✓ |
| 3.B Manure Management | $N_2O$ | | ✓ |
| 3.D.1 Direct N2O Emissions From Managed Soils | $N_2O$ | | ✓ |
| 5.A Solid Waste Disposal | $CH_4$ | ✓ | ✓ |
| 5.D Wastewater Treatment and Discharge | $CH_4$ | | ✓ |

The methodology applied for the determination of the key categories with LULUCF is similar to the one presented above. The key categories identified for the year 2023 are presented in Table 1.7 (see Annex 1 for an analytical presentation of calculations). The comparison of the results of the analysis with and without LULUCF reveals no major differences in the source categories identified, apart from the categories from the LULUCF sector. In the analysis including LULUCF ten categories from the Energy Sector, five from the IPPU sector, five from agriculture, five from the waste sector and five from LULUCF have been identified as key.

**Table 1.7. Key categories for Cyprus' inventory system with LULUCF for 2023**

| IPCC Source category | Direct GHG | Level | Trend |
|---|---|---|---|
| 1A1a. Public electricity and heat production | $CO_2$ | ✓ | ✓ |
| 1A2e. Food processing, beverages and tobacco | $CO_2$ | ✓ | ✓ |
| 1A2f. Non-metallic minerals | $CO_2$ | ✓ | ✓ |
| 1A2g. Other (please specify) | $CO_2$ | ✓ | ✓ |

| IPCC Source category | Direct GHG | Level | Trend |
|---|---|---|---|
| 1A3a. Domestic aviation | $CO_2$ | | ✓ |
| 1A3b. Road transportation | $CO_2$ | ✓ | ✓ |
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels | $CO_2$ | ✓ | ✓ |
| 1.A.3.a Domestic Aviation | $CO_2$ | | ✓ |
| 1.A.3.b Road Transportation | $CO_2$ | ✓ | ✓ |
| 1.A.4 Other Sectors - Liquid Fuels | $CO_2$ | ✓ | ✓ |
| 2A1. Cement production | $CO_2$ | ✓ | ✓ |
| 2A4. Othe process uses of carbonate | $CO_2$ | | ✓ |
| 2F1. Refrigeration and air conditioning | HFCs | ✓ | ✓ |
| 2.G Other Product Manufacture and Use | HFCs | | ✓ |
| 3.A Enteric Fermentation | $CH_4$ | ✓ | ✓ |
| 3.B Manure Management | $CH_4$ | ✓ | ✓ |
| 3.B Manure Management | $N_2O$ | | ✓ |
| 3.D.1 Direct N2O Emissions From Managed Soils | $N_2O$ | | ✓ |
| 3D. Agricultural soils | $N_2O$ | ✓ | ✓ |
| 4A1. Forest land remaining forest land | $CO_2$ | ✓ | ✓ |
| 4A2. Land converted to forest land | $CO_2$ | | ✓ |
| 4B1. Cropland remaining cropland | $CO_2$ | ✓ | ✓ |
| 4G. Harvested wood products | $CO_2$ | | ✓ |
| 5.A Solid Waste Disposal | $CH_4$ | ✓ | ✓ |
| 5.D Wastewater Treatment and Discharge | $CH_4$ | | ✓ |

## 1.5. General uncertainty evaluation

To evaluate the accuracy of an emissions inventory, an uncertainty analysis has to be carried out for both annual estimates of emissions and emissions trends over time. The estimated uncertainty of emissions from individual sources is either a function of instrument characteristics, calibration and sampling frequency of direct measurements, or (more often) a combination of the uncertainties in the emission factors for typical sources and the corresponding activity data.

Emission factors reported in the literature usually derive from measurements at specific installations, the characteristics of which are judged to be typical for a set of similar installations. The validity of this assumption given the national circumstances represents the crucial factor determining uncertainty.

Activity data are more closely linked to economic activity than are emission factors. Therefore, there are often well-established incentives requirements for accurate accounting. As a result, activity data tend to have lower uncertainties and lower correlation between years. Data availability at the level of analysis required for the estimation of GHG emissions / removals as well as the definitions used by the statistical agencies represent some of the parameters affecting the uncertainty of activity data.

The uncertainty analysis for Cyprus' GHG inventory is based on Tier 1 methodology described in the 2006 IPCC Guidelines, with 1990 as base year for $CO_2$, $CH_4$, $N_2O$ and 1995 for F-gases emissions. For the estimation of uncertainties per gas, a combination of the information provided by the IPCC and critical evaluation of information from indigenous sources was applied.

The total uncertainty with LULUCF in 2023 is 10.1% and the trend uncertainty 2.52% compared to 1.91% and 1.63% respectively in 1990. The uncertainty evaluation is also submitted in xls format. Detailed presentation of the assessment of uncertainty is presented in Annex 2.

## 1.6. General assessment of completeness

Where methodological or data gaps in inventories exist, information on these gaps should be presented in a transparent manner. Annex I Parties should clearly indicate the sources and sinks which are not considered in their inventories, but which are included in the 2006 IPCC Guidelines, and explain the reasons for such exclusion. Similarly, Annex I Parties should indicate the parts of their geographical area, if any, not covered by their inventory and explain the reasons for their exclusion. In addition, Annex I Parties should use the notation keys presented below to fill in the blanks in all the CRT tables. This approach facilitates the assessment of the completeness of an inventory. The notation keys are as follows:

(a) “NO” (not occurring) for categories or processes, including recovery, under a particular source or sink category that do not occur within an Annex I Party.

(b) “NE” (not estimated) for AD and/or emissions by sources and removals by sinks of GHGs which have not been estimated but for which a corresponding activity may occur within a Party.6 Where “NE” is used in an inventory to report emissions or removals, the Annex I Party shall indicate in both the NIR and the CRT completeness table why such emissions or removals have not been estimated. Furthermore, a Party may consider that a disproportionate amount of effort would be required to collect data for a gas from a specific category that would be insignificant in terms of the overall level and trend in national emissions and in such cases use the notation key “NE”. The Party should in the NIR provide justifications for exclusion in terms of the likely level of emissions. An emission should only be considered insignificant if the likely level of emissions is below 0.05 per cent of the national total GHG emissions, and does not exceed 500 kt $CO_2$ eq. The total national aggregate of estimated emissions for all gases and categories considered insignificant shall remain below 0.1 per cent of the national total GHG emissions. Parties should use approximated AD and default IPCC EFs to derive a likely level of emissions for the respective category. Once emissions from a specific category have been reported in a previous submission, emissions from this specific category shall be reported in subsequent GHG inventory submissions.

(c) “NA” (not applicable) for activities under a given source/sink category that do occur within the Party but do not result in emissions or removals of a specific gas. If the cells for categories in the CRT tables for which “NA” is applicable are shaded, they do not need to be filled in.

(d) “IE” (included elsewhere) for emissions by sources and removals by sinks of GHGs estimated but included elsewhere in the inventory instead of under the expected source/sink category. Where “IE” is used in an inventory, the Annex I Party should indicate, in the CRT completeness table, where in the inventory the emissions or removals for the displaced source/sink category have been included, and the Annex I Party should explain such a deviation from the inclusion under the expected category, especially if it is due to confidentiality.

(e) “C” (confidential) for emissions by sources and removals by sinks of GHGs of which the reporting could lead to the disclosure of confidential information, given the provisions of decision 24/CP.19. Annex I Parties are encouraged to estimate and report emissions and removals for source or sink categories for which estimation methods are not included in the 2006 IPCC Guidelines. If Annex I Parties estimate and report emissions and removals for country specific sources or sinks or of gases which are not included in the 2006 IPCC Guidelines, they should explicitly describe what source/sink categories or gases these are, as well as what methodologies, EFs and AD have been used for their estimation, and provide references for these data.

In the present inventory report, estimates of GHG emissions in Cyprus for the years 1990–2021 are presented. All major sources are reported including emissions estimates for indirect greenhouse gases and $SO_2$ (Annex 5).

The main deficiency identified is the lack of available data/methods to estimate emissions for Transport of oil (1.B.2.a.3) and Distribution of oil products (1.B.2.a.5). Moreover, there are still some empty cells in the xml. Work is in progress to fill all the cells and use the appropriate notation keys. Further details on deficiencies are provided in the appropriate chapter. A national inventory improvement plan is available and implemented.

**Information related to the geographical scope**

On July 20, 1974, the Turkish armed forces staged a full scale invasion against Cyprus. Turkey proceeded to occupy the northern part of the island and empty it of its Greek Cypriot inhabitants. By the end of the following year, the majority of the Turkish Cypriots living in the areas remaining under the control of the Republic of Cyprus had also made their way to the part of Cyprus occupied by the Turkish army.

On November 15, 1983, the Turkish Cypriot leadership unilaterally declared that area an independent state, and named it the "Turkish Republic of Northern Cyprus". Despite the fact that this act has been condemned by the UN and that no country other than Turkey has recognised this illegal secessionist entity, the situation continues.

For further information on this situation please refer to the website of the Ministry of Foreign Affairs of the Republic of Cyprus[21].

As the secessionist area is not under the effective control of the Republic of Cyprus, no data from official sources are available for the activities taking place in the particular areas, and no emissions can be estimated for any activities.

This inventory estimates emissions only for areas under the effective control of the Republic of Cyprus.

**Implementation of recommendations and adjustments**

The implementation status of all the recommendations made to the 2024 NIR submission by the EU review team (TERT) during the two review processes are presented in Annex 6.

[21] https://www.gov.cy/mfa/en/documents/turkish-military-invasion-and-occupation/

# Chapter 2.
## Trends in greenhouse gas emissions

***The economy of Cyprus***[22]

The economic profile of a country has a strong link to greenhouse gas emissions, with the overall level and types of economic activity strongly correlated to energy use. However, this is also dependent on factors such as energy efficiency and the structure of the economy.

The economy of Cyprus can generally be characterized as small, open and dynamic, with services constituting its engine power. Since the accession of the country to the European Union on 1 May 2004 the subsequent participation to the ERMII on 29 April 2005 and finally membership to the EURO area as of January 1st, 2008, its economy has undergone significant economic and structural reforms that have transformed the economic landscape. Interest rates have been liberalized, exchange rates and monetary policy were undertaken by the ECB, while other wide-ranging structural reforms have been promoted, covering the areas of competition, the financial sector and the business sector.

The tertiary sector (services) is the biggest contributor to Gross Value Added (GVA), accounting for about 86.8% in 2023. This development reflects the gradual restructuring of the Cypriot economy from an exporter of minerals and agricultural products in the period 1961-73 and an exporter of manufactured goods in the later part of the 1970s and the early part of the 80s, to an international tourist, business and services center during the 1980s, 1990s and the 2000s. The secondary sector (manufacturing) accounted for around 11.9% of GVA in 2023. The primary sector (agriculture and fishing) is continuously shrinking and only reached 1.3% of GVA in 2023.

**Table 2.1. Main economic indicators**

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|
| GDP (in € mln) | 21,808 | 23,401 | 22,374 | 25,680 | 29,416 | 31,340 |
| Real GDP growth rate | 6.3 | 5.9 | -3.2 | 11.4 | 7.4 | 2.6 |
| Per capita GDP in PPS, (EU27_2020=100) | 91 | 93 | 91 | 94 | 94 | 95 |
| Rate of Inflation HICP | 0.8 | 0.5 | -1.1 | 2.3 | 8.1 | 3.9 |
| Unemployment Rate | 8.4 | 7.1 | 7.6 | 7.1 | 6.2 | 5.8 |

The private sector, which is dominated by small and medium-sized enterprises, has a leading role in the production process. On the other hand, the government's role is mainly to support the private sector and regulate the markets to maintain conditions of macroeconomic stability and a favourable business environment, via the creation of the necessary legal and institutional framework and secure conditions of fair competition.

The Cyprus economy, following the recession in 2014 had presented a positive growth path of five consecutive years, with an average annual real growth of 5.6% during the period 2015-2019. In 2020 due to the outbreak of the COVID-19 crisis the economy went into recession contracting at a rate of -3.2%. In 2021-2022, the economy rebounded significantly with a growth rate of 11.4% and 7.4% equivalently. In 2023 though, following the sanctions on Russia, the economy presented a slowdown with a growth rate of 2.6%. Robust economic activity levels are expected to be maintained over the medium-term.

Inflation in 2023 was reduced to 3.9% after increasing by 8.1% in 2022. Inflation is mainly driven by developments in international oil prices, with a significant impact on domestic prices of energy products. In the medium-term it will hover around 2%.

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In the labour market, unemployment has declined from its peak of 16.1% of the labour force in 2014 to 7.1% in 2019 following good economic performance. In 2020 it increased only to 7.6% and this was due to the timely and targeted measures taken by the Government to mitigate the repercussions caused by the pandemic. In 2021-2022, following the strong economic recovery it reduced to 7.1% and 6.2% and in 2023 it was reduced further to 5.8%. In the short to medium-term, it is expected to have a downward trend due to improved economic activity.

In 2023, the budget balance recorded a surplus of 2.0% of GDP from a surplus of 2.6% of GDP in 2022. This positive outcome was attributed to the significant economic performance. Consequently, in 2023 the general government's gross debt to GDP ratio has marked a significant decrease reaching 73.6% of GDP from 81.0% in 2022.

In the longer term, the recent explorations for hydrocarbon reserves that have taken place in the Exclusive Economic Zone of Cyprus have revealed positive prospects for the development of the industry, which will have significant implications for the Cyprus economy.

## 2.1. Description and interpretation of emission trends for aggregated GHG emissions

GHG emissions in 2023 were 8873 Gg $CO_2$ eq. excluding LULUCF. Total national emissions excluding LULUCF increased by 59.2% between 1990 and 2023 and increased by 1.6% between 2022 and 2023. The total GHG emissions trends for the period 1990–2023 are presented in Table 2.2 and Figure 2.1 in kt $CO_2$ eq.

The GWP values used for the conversion of emissions estimates into the common unit of carbon dioxide equivalent are presented in Table 1.4. Per the IPCC Guidelines, emissions estimates for international marine and aviation bunkers were not included in the national totals but rather reported separately as memo items.

**Table 2.2. Total GHG emissions trend for the period 1990–2023**

| Total emissions (Gg $CO_2$ eq.) | 1990 | 2000 | 2005 | 2010 | 2015 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|
| With LULUCF | 5420.02 | 8147.51 | 8994.57 | 9159.84 | 8023.49 | 8193.85 | 8353.86 |
| Without LULUCF | 5573.09 | 8290.01 | 9215.40 | 9424.88 | 8319.60 | 8492.39 | 8589.18 |

| Total emissions (Gg $CO_2$ eq.) | 2022 | 2023 | | | | | |
|---|---|---|---|---|---|---|---|
| With LULUCF | 8431.31 | 8562.87 | | | | | |
| Without LULUCF | 8730.70 | 8873.45 | | | | | |

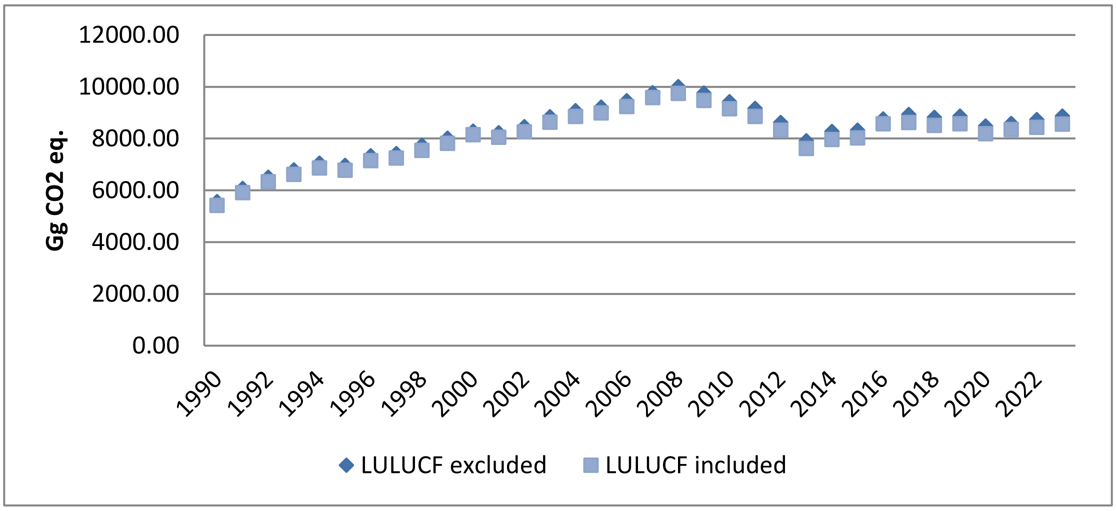


**Figure 2.1. Total GHG emissions trend for the period 1990–2023**

## 2.2. Description and interpretation of emission trends by sector

Energy, with 6266 Gg $CO_2$ eq., continues to be the largest contributor to the total national GHG emissions (73.2% compared to the total without LULUCF). 3050 Gg $CO_2$ eq. of these emissions is from the production of electricity, while another 2146 Gg $CO_2$ eq. is from transport. Table 2 and Figure 2 present the emissions for the period 1990–2023 by sector.

**Table 2.3. GHG emissions by sector for the period 1990–2023**

| | Energy | IPPU | Agriculture | LULUCF | Waste | Total (excl. LULUCF) | Total (incl. LULUCF) |
|---|---|---|---|---|---|---|---|
| **1990** | 3955.24 | 727.93 | 454.74 | -153.07 | 435.18 | 5573.09 | 5420.02 |
| **1991** | 4486.90 | 687.86 | 461.29 | -166.98 | 440.71 | 6076.75 | 5909.76 |
| **1992** | 4810.19 | 762.12 | 491.51 | -172.65 | 449.08 | 6512.90 | 6340.25 |
| **1993** | 4985.64 | 833.49 | 519.70 | -174.80 | 459.80 | 6798.63 | 6623.82 |
| **1994** | 5195.44 | 870.23 | 514.25 | -183.35 | 472.74 | 7052.66 | 6869.31 |
| **1995** | 5100.38 | 839.71 | 544.36 | -180.03 | 481.39 | 6965.84 | 6785.81 |
| **1996** | 5393.40 | 904.12 | 551.74 | -185.36 | 487.64 | 7336.90 | 7151.54 |
| **1997** | 5514.13 | 876.05 | 541.38 | -184.22 | 497.08 | 7428.64 | 7244.43 |
| **1998** | 5854.56 | 840.12 | 543.56 | -190.49 | 504.51 | 7742.75 | 7552.26 |
| **1999** | 6116.57 | 852.94 | 534.94 | -198.38 | 513.07 | 8017.53 | 7819.15 |
| **2000** | 6341.69 | 882.17 | 542.91 | -142.51 | 523.24 | 8290.01 | 8147.51 |
| **2001** | 6231.79 | 875.27 | 586.21 | -168.60 | 533.60 | 8226.88 | 8058.28 |
| **2002** | 6391.43 | 918.24 | 609.97 | -201.94 | 541.54 | 8461.18 | 8259.24 |
| **2003** | 6779.11 | 932.75 | 592.67 | -214.02 | 544.68 | 8849.20 | 8635.19 |
| **2004** | 6938.54 | 1014.78 | 572.69 | -214.55 | 548.53 | 9074.54 | 8859.99 |
| **2005** | 7129.10 | 1003.19 | 525.54 | -220.83 | 557.57 | 9215.40 | 8994.57 |
| **2006** | 7317.73 | 1059.55 | 531.15 | -222.49 | 557.86 | 9466.28 | 9243.79 |
| **2007** | 7612.99 | 1072.03 | 529.50 | -182.89 | 559.92 | 9774.43 | 9591.55 |
| **2008** | 7829.24 | 1093.84 | 508.12 | -249.84 | 570.25 | 10001.45 | 9751.61 |
| **2009** | 7748.43 | 929.89 | 500.49 | -277.65 | 577.38 | 9756.19 | 9478.54 |
| **2010** | 7516.29 | 809.86 | 514.80 | -265.04 | 583.92 | 9424.88 | 9159.84 |
| **2011** | 7254.07 | 811.54 | 506.90 | -300.78 | 588.96 | 9161.46 | 8860.68 |
| **2012** | 6767.31 | 772.13 | 484.68 | -293.62 | 599.05 | 8623.16 | 8329.54 |
| **2013** | 5842.15 | 1013.20 | 449.17 | -297.29 | 609.15 | 7913.67 | 7616.38 |
| **2014** | 5973.19 | 1241.75 | 437.17 | -299.11 | 619.19 | 8271.30 | 7972.20 |
| **2015** | 6097.70 | 1157.02 | 441.85 | -296.11 | 623.02 | 8319.60 | 8023.49 |
| **2016** | 6488.46 | 1185.18 | 462.38 | -190.89 | 626.15 | 8762.17 | 8571.28 |
| **2017** | 6568.77 | 1248.89 | 476.12 | -307.03 | 633.61 | 8927.40 | 8620.37 |
| **2018** | 6495.10 | 1198.37 | 481.79 | -302.31 | 643.33 | 8818.59 | 8516.28 |
| **2019** | 6548.31 | 1170.76 | 495.52 | -297.04 | 654.18 | 8868.78 | 8571.74 |
| **2020** | 6039.19 | 1268.32 | 531.54 | -298.54 | 653.35 | 8492.39 | 8193.85 |
| **2021** | 6092.14 | 1290.19 | 546.27 | -235.33 | 660.59 | 8589.18 | 8353.86 |
| **2022** | 6210.45 | 1324.48 | 528.61 | -299.39 | 667.16 | 8730.70 | 8431.31 |
| **2023** | 6265.97 | 1404.72 | 530.45 | -310.58 | 672.31 | 8873.45 | 8562.87 |
| **Change 1990–2023** | 58.42 | 92.98 | 16.65 | 102.90 | 54.49 | 59.22 | 57.99 |

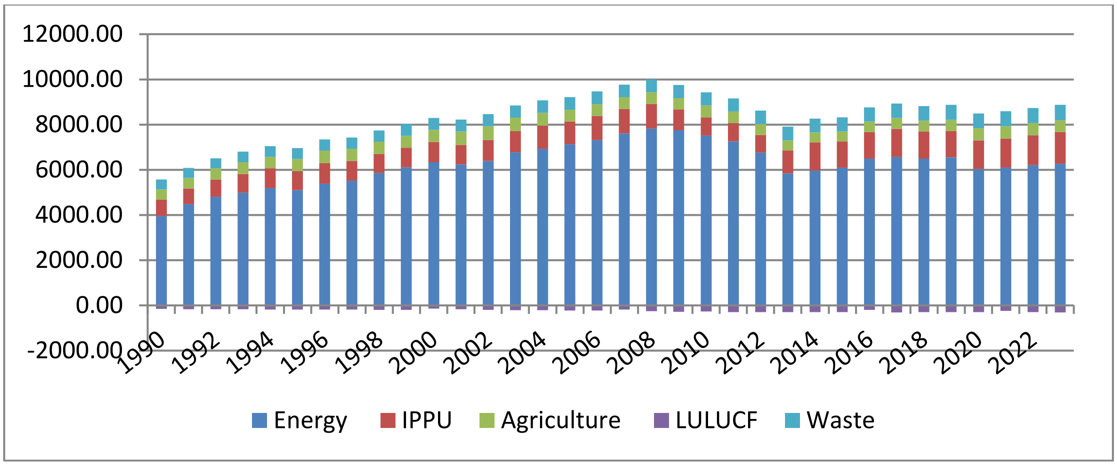


**Figure 2.2. GHG emissions by sector for the period 1990–2023**

## 2.3. Description and interpretation of emission trends by gas

GHG emissions trends by gas for the period 1990–2023 are presented in Table 2.4.

**Table 2.4. GHG emissions trends by gas for the period 1990–2023**

| | **1990** | **1991** | **1992** | **1993** | **1994** |
|---|---|---|---|---|---|
| $CO_2$ emissions without LULUCF | 4647.76 | 5136.10 | 5508.84 | 5752.78 | 5994.99 |
| $CO_2$ emissions with LULUCF | 4494.63 | 4968.94 | 5336.11 | 5577.54 | 5810.59 |
| $CH_4$ emissions without LULUCF | 776.43 | 791.34 | 816.41 | 847.23 | 861.42 |
| $CH_4$ emissions with LULUCF | 776.46 | 791.44 | 816.44 | 847.49 | 862.07 |
| $N_2O$ emissions without LULUCF | 146.17 | 145.94 | 160.59 | 169.35 | 164.69 |
| $N_2O$ emissions with LULUCF | 146.20 | 146.01 | 160.64 | 169.53 | 165.09 |
| HFCs | NA,NE,NO | NA,NE,NO | 23.04 | 24.62 | 26.27 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 2.73 | 3.37 | 4.01 | 4.65 | 5.29 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 5573.09 | 6076.75 | 6512.90 | 6798.63 | 7052.66 |
| **Total (with LULUCF)** | 5420.02 | 5909.76 | 6340.25 | 6623.82 | 6869.31 |
| **Total (without LULUCF, with indirect)** | 5580.67 | 6083.71 | 6520.14 | 6805.92 | 7060.44 |
| **Total (with LULUCF, with indirect)** | 5427.61 | 5916.72 | 6347.49 | 6631.12 | 6877.09 |
| | | | | | |
| | **1995** | **1996** | **1997** | **1998** | **1999** |
| $CO_2$ emissions without LULUCF | 5865.76 | 6215.68 | 6302.38 | 6596.85 | 6863.43 |
| $CO_2$ emissions with LULUCF | 5685.27 | 6029.59 | 6117.14 | 6403.08 | 6664.92 |
| $CH_4$ emissions without LULUCF | 887.53 | 909.43 | 914.84 | 917.52 | 919.68 |
| $CH_4$ emissions with LULUCF | 887.79 | 909.85 | 915.45 | 919.60 | 919.70 |
| $N_2O$ emissions without LULUCF | 178.14 | 171.66 | 165.60 | 173.79 | 172.42 |
| $N_2O$ emissions with LULUCF | 178.35 | 171.96 | 166.01 | 174.98 | 172.55 |
| HFCs | 28.48 | 33.57 | 38.61 | 46.75 | 53.50 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 5.93 | 6.57 | 7.21 | 7.85 | 8.49 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 6965.84 | 7336.90 | 7428.64 | 7742.75 | 8017.53 |
| **Total (with LULUCF)** | 6785.81 | 7151.54 | 7244.43 | 7552.26 | 7819.15 |
| **Total (without LULUCF, with indirect)** | 6973.05 | 7344.16 | 7436.28 | 7750.19 | 8025.32 |
| **Total (with LULUCF, with indirect)** | 6793.01 | 7158.80 | 7252.07 | 7559.70 | 7826.94 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | **2000** | **2001** | **2002** | **2003** | **2004** |
| $CO_2$ emissions without LULUCF | 7106.90 | 6979.66 | 7171.94 | 7560.77 | 7787.10 |
| $CO_2$ emissions with LULUCF | 6957.46 | 6808.50 | 6969.52 | 7345.91 | 7571.28 |
| $CH_4$ emissions without LULUCF | 938.26 | 975.82 | 1003.66 | 994.67 | 985.00 |
| $CH_4$ emissions with LULUCF | 942.73 | 977.33 | 1003.70 | 994.86 | 985.37 |
| $N_2O$ emissions without LULUCF | 174.20 | 191.66 | 195.84 | 192.06 | 183.41 |
| $N_2O$ emissions with LULUCF | 176.67 | 192.72 | 196.28 | 192.71 | 184.30 |
| HFCs | 61.52 | 69.94 | 79.29 | 90.60 | 107.26 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 9.13 | 9.80 | 10.45 | 11.11 | 11.76 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 8290.01 | 8226.88 | 8461.18 | 8849.20 | 9074.54 |
| **Total (with LULUCF)** | 8147.51 | 8058.28 | 8259.24 | 8635.19 | 8859.99 |
| **Total (without LULUCF, with indirect)** | 8298.25 | 8234.86 | 8470.77 | 8860.05 | 9087.14 |
| **Total (with LULUCF, with indirect)** | 8155.74 | 8066.27 | 8268.83 | 8646.03 | 8872.59 |
| | | | | | |
| | **2005** | **2006** | **2007** | **2008** | **2009** |
| $CO_2$ emissions without LULUCF | 7951.67 | 8183.13 | 8475.07 | 8691.64 | 8437.99 |
| $CO_2$ emissions with LULUCF | 7729.81 | 7959.17 | 8286.46 | 8440.57 | 8158.95 |
| $CH_4$ emissions without LULUCF | 960.16 | 962.47 | 964.66 | 963.70 | 964.68 |
| $CH_4$ emissions with LULUCF | 960.29 | 962.79 | 967.74 | 963.81 | 964.87 |
| $N_2O$ emissions without LULUCF | 169.30 | 172.05 | 169.72 | 162.12 | 159.40 |
| $N_2O$ emissions with LULUCF | 170.20 | 173.20 | 172.35 | 163.24 | 160.59 |
| HFCs | 121.85 | 137.15 | 153.22 | 171.91 | 181.73 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 12.42 | 11.47 | 11.78 | 12.09 | 12.39 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 9215.40 | 9466.28 | 9774.43 | 10001.45 | 9756.19 |
| **Total (with LULUCF)** | 8994.57 | 9243.79 | 9591.55 | 9751.61 | 9478.54 |
| **Total (without LULUCF, with indirect)** | 9228.59 | 9479.83 | 9788.60 | 10013.78 | 9767.91 |
| **Total (with LULUCF, with indirect)** | 9007.77 | 9257.34 | 9605.71 | 9763.94 | 9490.25 |
| | | | | | |
| | **2010** | **2011** | **2012** | **2013** | **2014** |
| $CO_2$ emissions without LULUCF | 8071.82 | 7792.36 | 7261.67 | 6578.17 | 6929.79 |
| $CO_2$ emissions with LULUCF | 7804.55 | 7489.50 | 6965.82 | 6279.34 | 6629.09 |
| $CH_4$ emissions without LULUCF | 973.80 | 972.61 | 962.67 | 947.60 | 948.16 |
| $CH_4$ emissions with LULUCF | 974.52 | 973.22 | 963.35 | 947.84 | 948.43 |
| $N_2O$ emissions without LULUCF | 168.54 | 166.08 | 163.09 | 147.99 | 145.44 |
| $N_2O$ emissions with LULUCF | 170.05 | 167.55 | 164.63 | 149.30 | 146.76 |
| HFCs | 198.03 | 216.05 | 220.76 | 224.32 | 231.73 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 12.70 | 14.36 | 14.97 | 15.58 | 16.18 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 9424.88 | 9161.46 | 8623.16 | 7913.67 | 8271.30 |
| **Total (with LULUCF)** | 9159.84 | 8860.68 | 8329.54 | 7616.38 | 7972.20 |
| **Total (without LULUCF, with indirect)** | 9437.36 | 9168.98 | 8630.62 | 7923.67 | 8279.10 |
| **Total (with LULUCF, with indirect)** | 9172.32 | 8868.20 | 8337.00 | 7626.39 | 7979.99 |
| | | | | | |
| | **2015** | **2016** | **2017** | **2018** | **2019** |
| $CO_2$ emissions without LULUCF | 6952.48 | 7349.93 | 7469.28 | 7324.20 | 7324.48 |
| $CO_2$ emissions with LULUCF | 6655.04 | 7145.75 | 7160.68 | 7019.96 | 7025.73 |

| | | | | | |
|---|---|---|---|---|---|
| $CH_4$ emissions without LULUCF | 955.51 | 978.91 | 997.53 | 1011.69 | 1032.22 |
| $CH_4$ emissions with LULUCF | 955.60 | 986.85 | 997.78 | 1012.19 | 1032.57 |
| $N_2O$ emissions without LULUCF | 150.87 | 152.95 | 158.82 | 160.87 | 166.63 |
| $N_2O$ emissions with LULUCF | 152.10 | 158.29 | 160.14 | 162.31 | 168.00 |
| HFCs | 243.96 | 264.78 | 285.96 | 305.83 | 330.00 |
| PFCs | NO | NO | NO | NO | NO |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | NO |
| $SF_6$ | 16.79 | 15.61 | 15.80 | 16.00 | 15.44 |
| $NF_3$ | NO | NO | NO | NO | NO |
| **Total (without LULUCF)** | 8319.60 | 8762.17 | 8927.40 | 8818.59 | 8868.78 |
| **Total (with LULUCF)** | 8023.49 | 8571.28 | 8620.37 | 8516.28 | 8571.74 |
| **Total (without LULUCF, with indirect)** | 8325.88 | 8770.07 | 8935.54 | 8825.81 | 8875.62 |
| **Total (with LULUCF, with indirect)** | 8029.77 | 8579.18 | 8628.51 | 8523.50 | 8578.58 |
| | | | | | |
| | **2020** | **2021** | **2022** | **2023** | **Change from 1990 to 2023 (%)** |
| $CO_2$ emissions without LULUCF | 6903.17 | 6950.78 | 7070.78 | 7188.09 | 54.66 |
| $CO_2$ emissions with LULUCF | 6602.80 | 6706.06 | 6770.05 | 6876.22 | 52.99 |
| $CH_4$ emissions without LULUCF | 1062.76 | 1083.51 | 1075.68 | 1080.76 | 39.20 |
| $CH_4$ emissions with LULUCF | 1063.19 | 1088.98 | 1075.96 | 1081.09 | 39.23 |
| $N_2O$ emissions without LULUCF | 171.07 | 172.71 | 171.48 | 171.80 | 17.53 |
| $N_2O$ emissions with LULUCF | 172.47 | 176.62 | 172.55 | 172.76 | 18.16 |
| HFCs | 336.65 | 364.61 | 394.92 | 414.96 | 100 |
| PFCs | NO | NO | NO | NO | 0.00 |
| Unspecified mix of HFCs and PFCs | NO | NO | NO | NO | 0.00 |
| $SF_6$ | 18.74 | 17.58 | 17.84 | 17.84 | 553.28 |
| $NF_3$ | NO | NO | NO | NO | 0.00 |
| **Total (without LULUCF)** | 8492.39 | 8589.18 | 8730.70 | 8873.45 | 59.22 |
| **Total (with LULUCF)** | 8193.85 | 8353.86 | 8431.31 | 8562.87 | 57.99 |
| **Total (without LULUCF, with indirect)** | 8501.10 | 8597.20 | 8736.79 | 8880.10 | 59.12 |
| **Total (with LULUCF, with indirect)** | 8202.56 | 8361.87 | 8437.40 | 8569.52 | 57.89 |

# Chapter 3.
# Energy (CRT sector 1)

## 3.1. Overview of sector

Energy systems are for most economies largely driven by the combustion of fossil fuels. During combustion the carbon and hydrogen of the fossil fuels are converted mainly into carbon dioxide ($CO_2$) and water ($H_2O$), releasing the chemical energy in the fuel as heat. This heat is generally either used directly or used (with some conversion losses) to produce mechanical energy, often to generate electricity or for transportation. The energy sector is usually the most important sector in greenhouse gas emission inventories. The energy sector mainly comprises exploration and exploitation of primary energy sources, conversion of primary energy sources into more useable energy forms in refineries and power plants, and the transmission and distribution of fuels and use of fuels in stationary and mobile applications. Emissions arise from these activities by combustion and as fugitive emissions, or escape without combustion.

***The energy sector in Cyprus***[23]

A key challenge for Cyprus is its high dependency on imported fossil fuels for energy, which makes it crucial for the country to develop both its hydrocarbon and renewable energy sources. The primary energy consumption in 2023 was 2.52 million tonnes of oil equivalent (Mtoe), a slight increase from 2.48 Mtoe in 2022.

In 2020 the Renewable Energy Sources (RES) share in gross final consumption of energy in Cyprus (1,64 Mtoe) was 17.04%, exceeding the national mandatory target of 13% RES in 2020, as set in the Directive 2009/28/EC [24]. This share comes from the use of solar water heaters, the installation of PV systems, wind parks, biomass/ biogas units and biofuels for transport sector, in combination with the use of heat pumps and biomass use for heating.

Additionally, RES accounted for 20.94% of electricity production in 2023, up from 16.96% in 2022. In 2023 the electricity from RES was 74% from photovoltaic systems, 21% from wind parks and 5% from biomass/biogas units.

Since 2015, electricity from renewable sources is no more promoted through feed-in-tariff schemes. Since 2013 is in operation a net metering, net-billing and self-consumption scheme and since 2022 a virtual net-metering scheme. Moreover, in the period 2018-2019 two schemes operated regarding the installation or RES units mainly PV parks that will eventually participate in the competitive electricity market.

Access of electricity from renewable energy sources to the grid is granted according to the principle of non-discrimination. Grid development is a matter of central planning (Transmission Grid Development Plan 2021-2030 by the Cyprus TSO). In addition, renewable heating and cooling (RES H&C) is promoted by support schemes offering subsidies to households for the installation of solar thermal systems.

However, the country's national grid system has certain intrinsic and technical limitations affecting RES penetration, and reliability of the energy system. The lack of electricity interconnections to the trans-

[23] Cyprus Profile, 2017, Energy and Environment, available at http://www.cyprusprofile.com/en/sectors/energy-and-environment (accessed 20/12/2017).

[24] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L 140, 5.6.2009, p. 16–62

European electricity networks, limits the amount of intermittent renewable energy that can be connected to the electricity system, and the lack of natural gas interconnections does not allow the supply of Cyprus with electricity produced from natural gas, a fuel that significantly contributes to the reduction of greenhouse gas emissions. In addition, there is a lack of centralised storage capability.

To tackle these problems the country is exploring ways to introduce smart grids in the national network and is on the look-out for projects that could facilitate energy storage, and ventures that have production on a 24-hour basis. Also, the EuroAsia Interconnector could bring more solutions in its wake.

The island is already one of the highest users per capita in the world of solar water heaters in households, with over 90% of households equipped with solar water heaters and over 50% of hotels using large systems of this kind. With almost year-round sunshine, Cyprus certainly has plenty of energy to harness, but competitive energy storing capabilities are crucial in order to fully tap into its solar potential and facilitate better RES penetration.

There continues to be much ground to cover in terms of renewable energy production, but international interest in developing the sector in Cyprus has been on the rise. In this respect, the production of renewable energy is expected to experience considerable growth in coming years, and significant investment is required in order Cyprus to achieve its targets – opening the field for companies with expertise in renewables.

The Cyprus Energy Regulatory Authority (CERA) has worked towards the full opening of the electricity market and enabling the consumers in exercising their right to choose their own supplier – with expectations of a full liberalisation in 2023. CERA has approved the Trade and Settlement Rules which are based on a 'net pool' model, i.e. a combination of bilateral agreements with centralized day-ahead, intra-day (at a later stage) and balancing markets. In addition, CERA has issued Regulatory Decisions with respect to the functional and accounting unbundling of the vertically integrated Electricity Authority of Cyprus.

In respect to the supply of natural gas to Cyprus, on 13 of December 2019, the tender for the engineering, construction, operation and maintenance of the LNG Import Terminal, was awarded by ETYFA (DEFA subsidiary) to the joint venture (consortium) China Petroleum Pipeline Engineering, Metron, Hudong-Zhongua Shipbuilding and Wilhelmsen Ship Management. On 28th September 2020 ETYFA approved the revised work program for the project, which is also considered as the official start date of the construction works. Due to the Covid-19 restrictions, which had several effects on the project due to an overall global impact on logistics and availability of materials and equipment, as well the price spike of certain goods, such as steel, the consortium submitted a revised wok program which indicates that project works will be completed by end H2 2023.

With respect to the supply of natural gas, on 4 June 2019, through a pre-qualification - Request for Expressions of Interest (RfEoI) process, DEFA invited prospective LNG suppliers to express an interest in supplying LNG to the LNG Import Terminal in order to be added to DEFA's list of pre-qualified LNG suppliers. DEFA intends to procure its LNG requirements through a combination of: (a) medium/long-term supply via one or more LNG Sales and Purchase Agreements (SPAs); and (b) supplemental cargos via multiple Master Sales Agreements (MSAs) and a bidding process. The deadline for submission of EoI was the 6 September 2019, and 25 companies submitted their interest. 16. This first stage of the above tender procedure was completed successfully in 21 December 2020. DEFA is expected to proceed to the next stage of the process within 2023 with the negotiation and execution of MSAs and with an RfP for the selection of the medium-term contract supplier of LNG.

Also the first Open Season process for the determination of the allocation of the demand (timely, spatially and quantitatively) of natural gas/LNG by potential buyers within Cyprus (distance of 5km radius from the LNG Import Terminal as per the guidelines set by CERA) was initiated in H1 2022 and is currently ongoing.

Cyprus is promoting the project of common interest «EuroAsia Interconnector», an electricity interconnection which is aiming to start commissioning in in the first half of 2026, and the electricity interconnection between Cyprus, Egypt and Greece, following the trilateral MOU that has been signed in October 2021. In addition, the promotion of the project of common interest «EastMed Pipeline», an offshore/onshore natural gas pipeline connecting East Mediterranean resources to Greece via Cyprus and

Crete is aiming to start commissioning in Q3 2027. These projects will effectively contribute to the internal energy market integration, security of energy supply by enhancing diversification of sources and routes and reduction of GHG emissions by allowing the countries in the region to use natural gas deposits and increase the RES electricity production, in the case of EuroAsia Interconnector.

### 3.1.1. Trends

The energy sector in Cyprus relies on fossil fuel combustion to meet the bulk of energy requirements. Final consumption in 2023 amounted to approximately 85 PJ, with 91.7% of the consumption coming from liquid fuels, 1.23% from solid fuels, 2.31% other fossil fuels and 4.77% from biomass. In comparison with 1990, total fuel consumption in 2023 (including biomass) increased by 63.3%.

After robust growth rates in the 1980s (average annual growth was 6.1%), economic performance in the 1990s was mixed: real GDP growth was 9.7% in 1992, 1.7% in 1993, 6.0% in 1994, 6.0% in 1995, 1.9% in 1996 and 2.3% in 1997. This pattern underlined the economy's vulnerability to swings in tourist arrivals (i.e. to economic and political conditions in Cyprus, Western Europe, and the Middle East) and the need to diversify the economy. Declining competitiveness in tourism and especially in manufacturing acted as a drag on growth prior to actualization of structural changes. This greatly affected the energy sector.

The emissions from the energy sector in Cyprus increased by 58.5% during the period 1990–2023. The greatest increase in emissions was between 1990 and 2008 (97%), when the emissions reached their peak (7829 Gg $CO_2$ eq.). All the emissions in 2023 are from fuel combustion. The contribution of the emissions from the energy sector to the total without LULUCF in 2023 was 70.6% compared to 70.9% in 1990.

While energy is mainly responsible for carbon dioxide emissions, it also contributes to methane and nitrous oxide emissions. Fugitive emissions from fuels have not been estimated since 2004 when the refining activities stopped in Cyprus. The contribution of each source and gas to the total emissions of the energy sector over the period 1990 to 2023 are presented in Table 3.1 and Figure 3.1.

**Table 3.1. Emissions from energy 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| **1. Energy** | 3955 | 6342 | 7129 | 7516 | 7254 | 6767 | 5842 | 5973 | 6098 |
| A. Fuel combustion (sectoral approach) | 3955 | 6341 | 7129 | 7516 | 7254 | 6767 | 5842 | 5973 | 6098 |
| 1. Energy industries | 1767 | 2964 | 3483 | 3880 | 3722 | 3557 | 2839 | 2950 | 3033 |
| 2. Manufacturing industries and construction | 505 | 802 | 903 | 670 | 579 | 460 | 540 | 680 | 596 |
| 3. Transport | 1238 | 1822 | 2113 | 2375 | 2304 | 2129 | 1916 | 1849 | 1911 |
| 4. Other sectors | 434 | 731 | 610 | 571 | 622 | 600 | 521 | 457 | 532 |
| 5. Other | 11 | 22 | 19 | 21 | 27 | 21 | 27 | 38 | 25 |
| B. Fugitive emissions from fuels | 0 | 1 | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA |
| 1. Solid fuels | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2. Oil and natural gas and other emissions from energy production | 0 | 1 | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA |
| C. $CO_2$ transport and storage | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | | | |
| $CO_2$ | 3925 | 6298 | 7087 | 7478 | 7216 | 6731 | 5810 | 5941 | 6061 |
| $CH_4$ | 0.51 | 0.57 | 0.57 | 0.61 | 0.61 | 0.61 | 0.53 | 0.50 | 0.62 |
| $N_2O$ | 0.06 | 0.10 | 0.10 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 |
| **Gg CO2 eq.** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| 1. Energy | 6488 | 6569 | 6495 | 6548 | 6039 | 6092 | 6210 | 6266 | |
| A. Fuel combustion (sectoral approach) | 6488 | 6569 | 6495 | 6548 | 6039 | 6092 | 6210 | 6266 | |
| 1. Energy industries | 3311 | 3298 | 3353 | 3293 | 3033 | 3088 | 3115 | 3060 | |
| 2. Manufacturing industries and construction | 597 | 616 | 546 | 555 | 561 | 562 | 566 | 566 | |
| 3. Transport | 2030 | 2094 | 2105 | 2132 | 1910 | 1937 | 1993 | 2161 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4. Other sectors | 526 | 536 | 464 | 542 | 510 | 483 | 512 | 457 | |
| 5. Other | 25 | 26 | 27 | 26 | 26 | 23 | 24 | 23 | |
| B. Fugitive emissions from fuels | NO,NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | |
| 1. Solid fuels | NO | NO | NO | NO | NO | NO | NO | NO | |
| 2. Oil and natural gas and other emissions from energy production | NO,NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | NO, NA | |
| C. CO2 transport and storage | NO | NO | NO | NO | NO | NO | NO | NO | |
| | | | | | | | | | |
| CO2 | 6450 | 6528 | 6453 | 6505 | 5996 | 6049 | 6165 | 6222 | |
| CH4 | 0.64 | 0.71 | 0.70 | 0.73 | 0.72 | 0.72 | 0.76 | 0.68 | |
| N2O | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | |

* This category includes manufacturing of charcoal and other energy industries. Other energy industries only had emissions in 2020 and 2022. Manufacturing of charcoal does take place in Cyprus but only the small contribution from $CH_4$ and $N_2O$ emissions appear in the table as the fuel consumed is solid biomass.

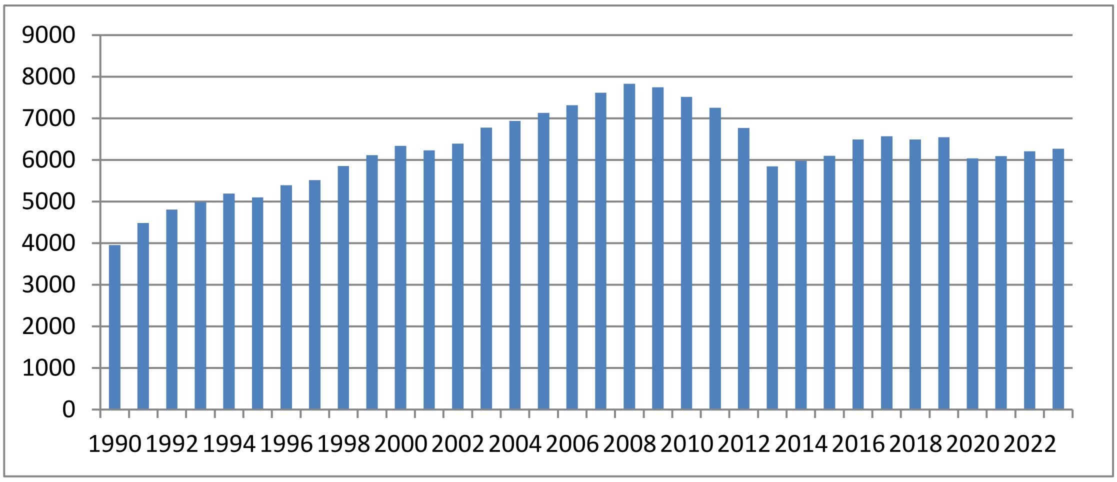


**Figure 3.1. Emissions from the energy sector 1990–2023**

## 3.1.2. Methodology

There are three methods provided in the IPCC Guidelines: two Tier 1 approaches (the ‘Reference Approach’ and the ‘Sectoral Approach’) and the Tier 2/Tier 3 approach (a detailed technology-based method, also called ‘bottom-up’ approach). For the Tier 1 Sectoral Approach, total $CO_2$ is summed across all fuels (excluding biomass) and all sectors. For Tiers 2 and 3, the Detailed Technology-Based Approach, total $CO_2$ is summed across all fuels and sectors, plus combustion technologies (e.g. stationary and mobile sources). Both approaches provide more disaggregated emission estimates, but also require more data. The sectoral approach is presented in this chapter. The estimation of emissions from Biodiesel throughout the whole sector was done using the methodology presented in the “Note on fossil carbon content in biofuels”, prepared by Ioannis Sempos, with input from Graham Anderson, Marc Schuman, Nora Becker, Peter Brown, Jean-Pierre Chang, Ole-Kenneth Nielsen, Veronica Eklund, Edith Brodda, Fernando Diaz-Alonso, Andreas Gumbert (FCCC/ARR/2023/CYP(E.4)).The reference approach is presented in details in Section 3.2.8. A comparison of the results of the two approaches is presented in Section 3.2.9.

The calculation of GHG emissions from energy is based on the IPCC 2006 Guidelines. Where data is available for installations included in the Emissions Trading System of the EU, emission factors have been reported as country- or plant-specific. The methodologies applied for the calculation of emissions by source category are presented in Table 3.2.

**Table 3.2. Methodology for the estimation of emissions from energy**

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 1A1a.i | Energy Industries - Public electricity and heat production – Energy generation - Liquid fuels | $CO_2$ | CS | CS |
| 1A1a.i | Energy Industries - Public electricity and heat production – Energy generation Liquid fuels | $CH_4/N_2O$ | D | T1 |
| 1A1b | Energy Industries – Petroleum Refining – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A1c.iv | Manufacture of solid fuels and Other Energy Industries – Charcoal production- biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2a | Manufacturing Industries and Construction – Iron and Steel - Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2b | Manufacturing Industries and Construction – Non-ferrous Metals - Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2c | Manufacturing Industries and Construction – Chemicals – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2c | Manufacturing Industries and Construction – Chemicals – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2d | Manufacturing Industries and Construction – Pulp, Paper and Print – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2e. | Manufacturing Industries and Construction – Food processing, beverages and tobacco – Liquid fuels | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2e. | Manufacturing Industries and Construction – Food processing, beverages and tobacco – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel | $CO_2$ | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel | $CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – solid fuel | $CO_2$ | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – solid fuel | $CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – other fossil fuel | $CO_2$ | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – other fossil fuel | $CH_4/N_2O$ | D | T1 |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – biomass | $CO_2$ | CS | CS |
| 1A2f. | Manufacturing Industries and Construction – Non-metallic minerals – biomass | $CH_4/N_2O$ | D | T1 |
| 1A2g (iii). | Manufacturing Industries and Construction – Other - Mining (excluding fuels) and Quarrying – liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2g (v). | Manufacturing Industries and Construction - Other - Construction – liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A2g (viii). | Manufacturing Industries and Construction – Other -Non-specified Industry – liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A3a. | Transport - Domestic aviation – Jet kerosene | $CO_2/CH_4/N_2O$ | M | T3 |
| 1A3bi. | Transport - Road transportation – Gasoline | $CO_2/CH_4/N_2O$ | M | T2 |
| 1A3bi. | Transport - Road transportation - Diesel | $CO_2/CH_4/N_2O$ | M | T2 |
| 1A3bi. | Transport – Road transportation - LPG | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A3bi. | Transport - Road transportation - Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A3d | Transport - Domestic Navigation – Gas/Diesel Oil | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4a. | Other Sectors - Commercial/institutional - Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4a. | Other Sectors - Commercial/institutional - Biomass | $CO_2/CH_4/N_2O$ | D | T1 |

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 1A4b. | Other Sectors - Residential – Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4b. | Other Sectors - Residential – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4ci. | Agriculture/forestry/fishing - Stationary- Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4ci. | Agriculture/forestry/fishing – Stationary-Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A4ciii | Agriculture/forestry/fishing – Fishing – Gas/Diesel Oil | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5a | Other - Non-Specified – Stationary – Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5a | Other - Non-Specified – Stationary – Solid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5a | Other - Non-Specified – Stationary – Biomass | $CO_2/CH_4/N_2O$ | D | T1 |
| 1A5b | Other - Non-Specified – Mobile - Liquid fuel | $CO_2/CH_4/N_2O$ | D | T1 |
| 1B2a4 | Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Refining/Storage | $CH_4$ | D | T1 |
| 1B2a4 | Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Refining/Storage | $CO_2/N_2O$ | NA | NA |
| 1B2c1i | Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Venting - tanker trucks | $CH_4$ | NA | NA |

T1: IPCC methodology Tier 1; D: IPCC default methodology and emission factor; CS: Country specific emission factor; PS: Plant-specific emission factor; OTH: Other; NA: not available; T2: IPCC methodology Tier 2; T3: IPCC methodology Tier 3; M: COPERT.

**Key categories**

The results of the key categories assessment are presented in Section 1.4.

**Uncertainty**

The uncertainty analysis is presented in Section 1.5.

### 3.1.3. Completeness

The emissions from energy are complete.

## 3.2. Fuel combustion (CRT 1.A)

### 3.2.1. Source category description

The emissions from the fuel combustion in Cyprus contribute 70.6% to the total national emissions excluding LULUCF in 2023 and increased by 58.6% during the period 1990–2023. The greatest increase in emissions was between 1990 and 2008 (97%), when the emissions reached their peak (7810 Gg $CO_2$ eq.). The majority of energy related GHG emissions in 2023 were derived from energy industries (48.8%), while transport contributed 34.5%, manufacturing industries and construction 9.03%, other sectors 7.29% and other 0.37%, respectively.

**Table 3.3. Emissions from fuel combustion 1990–2023**
* The fuel consumed for Manufacturing of charcoal is solid biomass.

| Gg $CO_2$ eq. | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| **A. Fuel combustion** | 3955 | 6341 | 7129 | 7516 | 7254 | 6767 | 5842 | 5973 | 6098 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **activities** | | | | | | | | | |
| 1. Energy industries | 1767 | 2964 | 3483 | 3880 | 3722 | 3557 | 2839 | 2950 | 3033 |
| a. Public electricity and heat production | 1681 | 2859 | 3483 | 3880 | 3722 | 3557 | 2839 | 2950 | 3032 |
| b. Petroleum refining | 86 | 104 | NO | NO | NO | NO | NO | NO | NO |
| c. Manufacture of solid fuels and other energy industries* | 0.2 | 0.5 | 0.3 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 |
| 2. Manufacturing industries and construction | 505 | 802 | 903 | 670 | 579 | 460 | 540 | 680 | 596 |
| a. Iron and steel | 0.56 | 1.04 | 0.88 | 0.56 | 0.64 | 0.80 | NO | NO | NO |
| b. Non-ferrous metals | 4.39 | 6.04 | 5.56 | 4.66 | 4.90 | 5.38 | NO | NO | 2.99 |
| c. Chemicals | 2.21 | 4.30 | 3.58 | 2.13 | 2.44 | 3.20 | NO | 3.28 | 6.43 |
| d. Pulp, paper and print | 4.84 | 9.15 | 5.17 | 3.69 | 6.27 | 3.51 | 3.01 | 3.14 | 3.14 |
| e. Food processing, beverages and tobacco | 73 | 131 | 82 | 60 | 95 | 53 | 43 | 44 | 56 |
| f. Non-metallic minerals | 382 | 577 | 718 | 526 | 395 | 334 | 443 | 560 | 483 |
| g. Other | 38 | 73 | 89 | 74 | 76 | 60 | 51 | 69 | 45 |
| 3. Transport | 1238 | 1822 | 2113 | 2375 | 2304 | 2129 | 1916 | 1849 | 1911 |
| a. Domestic aviation | 26.24 | 17.88 | 12.26 | 7.83 | 2.50 | 1.85 | 1.41 | 1.06 | 1.19 |
| b. Road transportation | 1209 | 1802 | 2099 | 2364 | 2299 | 2125 | 1913 | 1846 | 1908 |
| c. Railways | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| d. Domestic navigation | 2.23 | 1.72 | 2.36 | 3.06 | 2.87 | 2.02 | 1.53 | 1.81 | 2.05 |
| 4. Other sectors | 434 | 731 | 610 | 571 | 622 | 600 | 521 | 457 | 532 |
| a. Commercial/ institutional | 76 | 117 | 100 | 120 | 114 | 108 | 105 | 83 | 89 |
| b. Residential | 302 | 508 | 421 | 373 | 425 | 412 | 339 | 307 | 360 |
| c. Agriculture/ forestry/ fishing | 56 | 106 | 89 | 77 | 83 | 80 | 77 | 67 | 83 |
| 5. Other | 11.1 | 21.6 | 19.2 | 20.5 | 26.9 | 20.5 | 26.7 | 38.2 | 25.4 |
| a. Stationary | 11.1 | 21.6 | 19.2 | 17.3 | 20.5 | 17.3 | 20.3 | 31.8 | 22.2 |
| b. Mobile | NA,NO | NA,NO | NA,NO | 3.2 | 6.3 | 3.2 | 6.3 | 6.3 | 3.2 |
| | | | | | | | | | |
| $CO_2$ | 6298 | 7087 | 7478 | 7216 | 6731 | 5810 | 5941 | 6061 | 6298 |
| $CH_4$ | 0.49 | 0.54 | 0.57 | 0.61 | 0.61 | 0.61 | 0.53 | 0.50 | 0.62 |
| $N_2O$ | 0.06 | 0.10 | 0.10 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 |
| | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| **A. Fuel combustion activities** | 6488 | 6569 | 6495 | 6548 | 6039 | 6092 | 6210 | 6266 | |
| 1. Energy industries | 3311 | 3298 | 3353 | 3293 | 3033 | 3088 | 3115 | 3060 | |
| a. Public electricity and heat production | 3310 | 3298 | 3353 | 3292 | 3013 | 3087 | 3109 | 3060 | |
| b. Petroleum refining | NO | NO | NO | NO | NO | NO | NO | NO | |
| c. Manufacture of solid fuels and other energy industries* | 0.3 | 0.3 | 0.2 | 0.2 | 19.6 | 0.2 | 6.1 | 0.1 | |
| 2. Manufacturing industries and construction | 597 | 616 | 546 | 555 | 561 | 562 | 566 | 566 | |
| a. Iron and steel | 0.80 | 0.12 | 0.10 | 0.01 | 0.02 | NO | 0.02 | 0.02 | |
| b. Non-ferrous metals | 5.38 | 2.06 | 2.09 | 2.15 | 3.30 | 2.75 | 2.22 | 1.95 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| c. Chemicals | 6.37 | 6.75 | 7.87 | 8.23 | 7.83 | 6.77 | 10.09 | 11.85 | |
| d. Pulp, paper and print | 3.14 | 2.73 | 2.61 | 3.08 | 3.12 | 3.50 | 1.65 | 1.98 | |
| e. Food processing, beverages and tobacco | 50 | 71 | 66 | 67 | 62 | 64 | 67 | 50 | |
| f. Non-metallic minerals | 481 | 475 | 416 | 408 | 427 | 417 | 401 | 412 | |
| g. Other | 51 | 58 | 52 | 67 | 58 | 68 | 84 | 89 | |
| 3. Transport | 2030 | 2094 | 2105 | 2132 | 1910 | 1937 | 1993 | 2161 | |
| a. Domestic aviation | 0.78 | 1.24 | 0.88 | 0.36 | 0.52 | 1.28 | 1.15 | 1.07 | |
| b. Road transportation | 2027 | 2090 | 2102 | 2129 | 1908 | 1933 | 1988 | 2154 | |
| c. Railways | NO | NO | NO | NO | NO | NO | NO | NO | |
| d. Domestic navigation | 1.53 | 2.09 | 2.18 | 2.84 | 1.17 | 2.68 | 4.52 | 5.91 | |
| 4. Other sectors | 526 | 536 | 464 | 542 | 510 | 483 | 512 | 457 | |
| a. Commercial/ institutional | 83 | 93 | 91 | 120 | 88 | 96 | 105 | 106 | |
| b. Residential | 363 | 358 | 293 | 337 | 333 | 302 | 325 | 278 | |
| c. Agriculture/ forestry/ fishing | 80 | 85 | 79 | 85 | 89 | 85 | 82 | 73 | |
| 5. Other | 25.4 | 25.5 | 26.7 | 26.0 | 26.1 | 23.1 | 24.3 | 23.3 | |
| a. Stationary | 22.2 | 21.7 | 22.2 | 22.0 | 21.4 | 19.0 | 19.5 | 20.3 | |
| b. Mobile | 3.2 | 3.9 | 4.5 | 4.0 | 4.7 | 4.1 | 4.8 | 3.0 | |
| | | | | | | | | | |
| $CO_2$ | 6450 | 6528 | 6453 | 6505 | 5996 | 6049 | 6165 | 6222 | |
| $CH_4$ | 0.64 | 0.71 | 0.70 | 0.73 | 0.72 | 0.72 | 0.76 | 0.68 | |
| $N_2O$ | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | |

The renewal of the passenger car fleet and the implied improvement of energy efficiency limit the increase of GHG emissions. The implemented, adopted and planned measures for the improvement of public transport are expected to moderate the high use of passenger cars. The contribution of each source and gas to the total of the sector is presented in Table 3.3. The trend of the emissions from fuel consumption (1A) is presented in Figure 3.2.

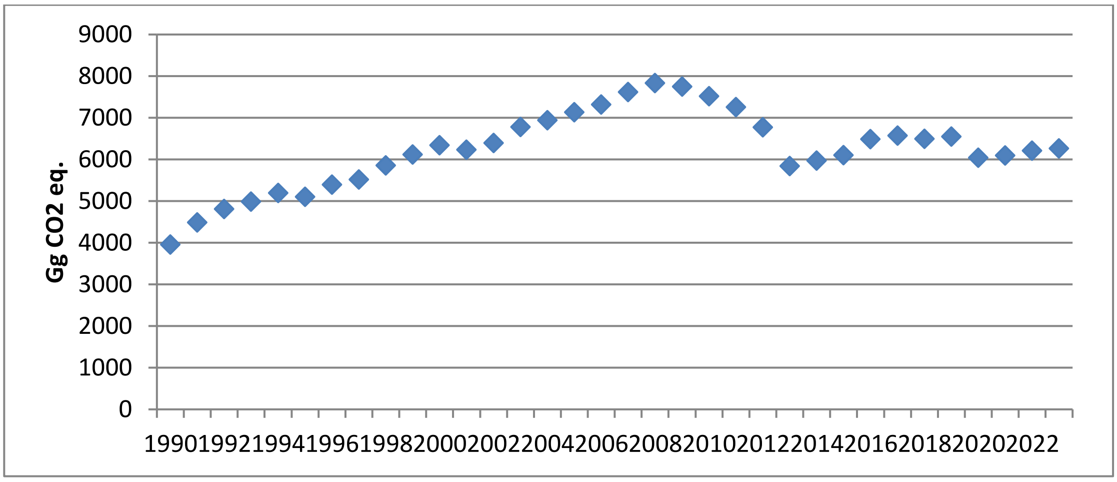


**Figure 3.2. Emissions from fuel combustion 1990–2023**

## 3.2.2. Methodological issues

**Emission factors**

The emission factors used are predominately the defaults proposed by the IPCC guidelines. Further details on the emission factor are provided in the methodological issues Section of each source.

**Activity data**

The predominant source of the activity data is the national energy balance prepared by the Statistical Service[25]. While data is avaialable for all sources for the recent years, several assumptions have to be made to complete the time-series. Detailed presentation of the methodologies applied to complete the time-series for the years where data is not available is given in Annex 3.1. Other sources of data are the EU-ETS, EUROCONTROL, Department of Road Transport and Department of Labour Inspection. Data sets are compared to national data obtained from the Department of Labour Inspection, the energy balance prepared by the Energy Service, and international sources such as IEE and EUROSTAT. Detailed presentation of the data used is given in the respective section.

## 3.2.3. Energy industries (CRT 1A1)

Category Energy industries (1A1) comprises emissions from fuels combusted by the fuel extraction or energy-producing industries.

### 3.2.3.1. Category description

The Electricity Authority of Cyprus (EAC) was the sole provider of electrical energy in Cyprus until the introduction of electricity production from renewable energy sources. EAC remains the single electricity producer for the public. Heat production (included in 1A1a) does not occur in Cyprus. Refining activities in the country stopped in 2004 following a government decision not to upgrade it to EU standards, instead turning it into a fuel import and storage terminal. Consequently, emissions from petroleum refinery (1A1b) are reported for the years 1990–2004 only. Emissions from the manufacture of solid fuels and other energy industries (1A1c) are reported for the first time in 2017 (production of charcoal). Gas and Oil Extraction is reported for the first time in 2020 with no activity in 2021 or 2023, but some activity in 2022.

The consumption of fossil fuels by energy industries including biomass in 2023 (39.9 PJ) increased by 71.2% compared to 1990 (23.3 PJ). Since 2005, when the refinery stopped its operations, the emissions from energy industries are entirely caused by the production of electricity (1A1a). Emissions from energy industries account for 34.5% of total national emissions without LULUCF for 2023, while in 1990 the contribution was 31.7%. The total GHG emissions from energy industries in 2023 excluding biomass (3.06 Tg $CO_2$ eq.) increased by 73.1% compared to 1990 (1.77 Tg $CO_2$ eq). The emissions from energy industries are presented in Table 3.4. During the period 2009-2013, a decreasing trend of emissions has been observed, attributed to the penetration of renewable energy technologies to the energy mix, and to the economic recession that the country is facing since 2010. The trend changes in 2014 to an increasing trend with an annual average of 4%. The emissions from energy industries (1A1) for the period 1990–2023 are presented in Figure 3.3.

**Table 3.4. Emissions from energy industries 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| **1. Energy industries** | 1767 | 2964 | 3483 | 3880 | 3722 | 3557 | 2839 | 2950 | 3033 |
| a. Public electricity and heat production | 1681 | 2859 | 3483 | 3880 | 3722 | 3557 | 2839 | 2950 | 3032 |
| b. Petroleum refining | 86 | 104 | NO | NO | NO | NO | NO | NO | NO |
| c. Manufacture of solid fuels and other energy industries* | 0.2 | 0.5 | 0.3 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 |
| | | | | | | | | | |
| CO2 (Gg) | 1761 | 2955 | 3472 | 3868 | 3710 | 3546 | 2830 | 2940 | 3023 |
| CH4 (Gg) | 0.07 | 0.12 | 0.14 | 0.15 | 0.15 | 0.14 | 0.11 | 0.11 | 0.12 |
| N2O (Gg) | 0.01 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 |
| | | | | | | | | | |

[25] Ms. Nafsika Apostolou, Statistical Officer, Statistical Service, Ministry of Finance (+357 22602199, napostolou@cystat.mof.gov.cy)

| Gg $CO_2$ eq. | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|---|---|
| **1. Energy industries** | 3311 | 3298 | 3353 | 3293 | 3033 | 3088 | 3115 | 3060 | |
| a. Public electricity and heat production | 3310 | 3298 | 3353 | 3292 | 3013 | 3087 | 3109 | 3060 | |
| b. Petroleum refining | NO | NO | NO | NO | NO | NO | NO | NO | |
| c. Manufacture of solid fuels and other energy industries* | 0.3 | 0.3 | 0.2 | 0.2 | 19.6 | 0.2 | 6.1 | 0.1 | |
| | | | | | | | | | |
| CO2 (Gg) | 3300 | 3288 | 3342 | 3282 | 3023 | 3078 | 3105 | 3050 | |
| CH4 (Gg) | 0.13 | 0.13 | 0.13 | 0.13 | 0.12 | 0.12 | 0.13 | 0.12 | |
| N2O (Gg) | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | |

* This category includes manufacturing of charcoal and other energy industries. Other energy industries only had emissions in 2020 and 2022. Manufacturing of charcoal does take place in Cyprus but only the small contribution from $CH_4$ and $N_2O$ emissions appear in the table as the fuel consumed is solid biomass.

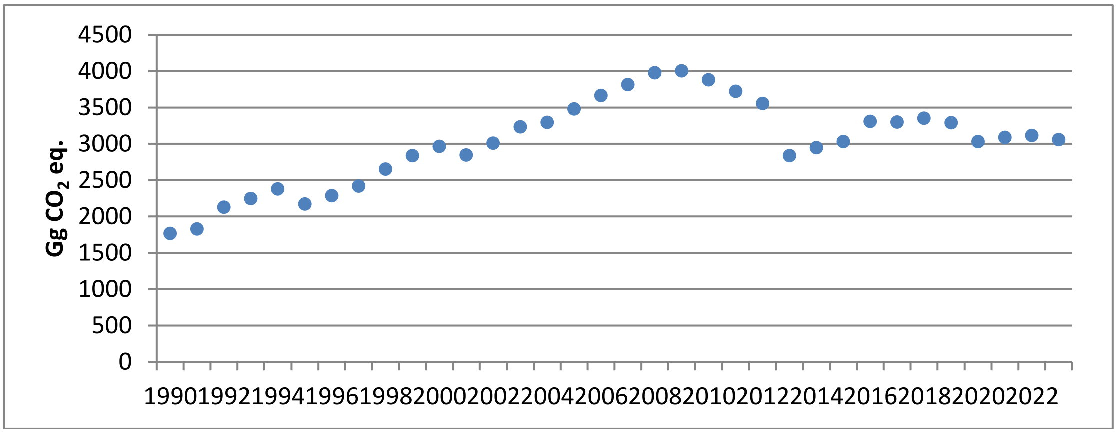


**Figure 3.3. Energy industries emissions (1A1) 1990–2023**

### 3.2.3.2. Methodological issues

Main activity electricity and heat production (1A1a)

The IPCC approach to the calculation of emission inventories encourages the use of fuel statistics collected by an officially recognised national body, as this is usually the most appropriate and accessible activity data. As already mentioned, there is only one electricity-producing company in Cyprus, therefore the fuel consumption for public electricity and heat production was obtained from this one company.

The fuel consumption data for all the years was obtained in kt. The fuel consumption data used for the years 1990–2004 is presented in Table 3.5. Fuel consumption for the period 1990–2004 was converted from kt to TJ using the NCV of 2005 (40.446 TJ/kt for HFO and 42.815 TJ/kt for diesel) which is the earliest available country specific NCV. The emissions for 1990–2004 were estimated using the implied emission factors derived from the annual report of the company for 2005 (earliest available) in compliance with the ETS law: 76.67 t $CO_2$/TJ HFO and 72.43 t $CO_2$/TJ diesel. The emission factor was multiplied with the fuel consumption of the respective fuel. This method and the EF are considered as country specific method, since it does not follow the methodologies proposed by the IPCC guidelines.

The estimation of country- or plant-specific EF for these years (1990–2004) is not possible since the necessary information is not available[26].

**Table 3.5. Fuel consumption data obtained from the electricity production company in Cyprus (1990–2004)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|

[26] Information provided by Mr. George Platides, Assistant Generation Manager, Generation & Supply Business Unit | Generation Department, Electricity Authority of Cyprus | t: +357 22 201521 | m: +357 99 428064 | f: +357 22 201509 | georgeplatides@eac.com.cy.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fuel consumption (kt) | | | | | | | | |
| HFO | 540.4 | 560.5 | 644.6 | 694.8 | 726.4 | 661.2 | 702.5 | 742.9 |
| Diesel | 0.0 | 0.0 | 10.5 | 3.5 | 2.0 | 8.2 | 5.9 | 5.8 |
| Net calorific value (TJ/kt)* | | | | | | | | |
| HFO | 40.446 | 40.446 | 40.446 | 40.446 | 40.446 | 40.446 | 40.446 | 40.446 |
| Diesel | 42.815 | 42.815 | 42.815 | 42.815 | 42.815 | 42.815 | 42.815 | 42.815 |
| $CO_2$ emissions (Gg) | | | | | | | | |
| HFO | 1675.8 | 1738.0 | 1999.0 | 2154.5 | 2252.6 | 2050.5 | 2178.5 | 2303.7 |
| Diesel | 0.0 | 0.0 | 32.62 | 10.79 | 6.09 | 25.45 | 18.39 | 17.83 |
| | | | | | | | | |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | |
| Fuel consumption (kt) | | | | | | | | |
| HFO | 810.9 | 856.1 | 900.5 | 893.8 | 930.8 | 1000.3 | 1042.1 | |
| Diesel | 11.6 | 21.0 | 18.7 | 3.7 | 1.6 | 5.1 | 8.4 | |
| Net calorific value (TJ/kt)* | | | | | | | | |
| HFO | 40.446 | 40.446 | 40.446 | 40.446 | 40.446 | 40.446 | 40.446 | |
| Diesel | 42.815 | 42.815 | 42.815 | 42.815 | 42.815 | 42.815 | 42.815 | |
| $CO_2$ emissions (Gg) | | | | | | | | |
| HFO | 2514.8 | 2654.9 | 2792.5 | 2771.6 | 2886.5 | 3102.2 | 3231.6 | |
| Diesel | 35.91 | 64.97 | 57.89 | 11.48 | 4.91 | 15.73 | 26.14 | |

* NCV of 2005 data submitted through ETS.

Detailed data on fuel consumption and other parameters have been submitted annually by the installation since 2005, in compliance with the national Emissions Trading System law (110(I)/2011). The data collected through the ETS for the period 2005-2023 and used for the estimation of the emissions is presented in Table 3.6. For the years 2005-2015, the $CO_2$ emissions used are those reported by the installation in compliance with the ETS law.

**Table 3.6. Data collected through the ETS for electricity production in Cyprus (2005-2023)**

| | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
|---|---|---|---|---|---|---|---|---|
| Fuel consumption (kt) | | | | | | | | |
| HFO | 1103.2 | 1137.3 | 1174.7 | 1218.5 | 1163.1 | 1053.0 | 1057.8 | 895.5 |
| Diesel | 16.3 | 6.9 | 16.0 | 22.9 | 91.9 | 157.5 | 111.7 | 213.9 |
| Net calorific value (TJ/kt)* | | | | | | | | |
| HFO | 40.446 | 40.460 | 40.463 | 40.690 | 40.795 | 40.641 | 40.741 | 40.791 |
| Diesel | 42.815 | 42.821 | 42.806 | 42.598 | 42.660 | 42.938 | 42.714 | 42.715 |
| $CO_2$ emissions (Gg) | | | | | | | | |
| HFO | 3421.2 | 3632.1 | 3751.9 | 3896.3 | 3707.6 | 3377.5 | 3373.4 | 2869.8 |
| Diesel | 50.60 | 21.28 | 49.72 | 70.98 | 284.84 | 490.53 | 336.65 | 676.13 |
| Implied EF (Gg $CO_2$/TJ) | | | | | | | | |
| HFO | 76.672 | 78.935 | 78.938 | 78.582 | 78.141 | 78.919 | 78.274 | 78.562 |
| Diesel | 72.431 | 72.421 | 72.444 | 72.798 | 72.640 | 72.532 | 70.572 | 74.018 |
| | | | | | | | | |
| | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
| Fuel consumption (kt) | | | | | | | | |
| HFO | 649.3 | 793.3 | 857.9 | 882.7 | 777.9 | 804.3 | 770.9 | 602.5 |
| Diesel | 237.5 | 123.6 | 89.4 | 150.0 | 255.2 | 246.1 | 258.6 | 342.3 |
| Net calorific value (TJ/kt)* | | | | | | | | |
| HFO | 40.613 | 40.691 | 40.880 | 40.646 | 40.632 | 40.559 | 40.630 | 40.688 |
| Diesel | 42.580 | 42.354 | 42.709 | 42.717 | 42.668 | 42.657 | 42.580 | 42.603 |
| $CO_2$ emissions (Gg) | | | | | | | | |
| HFO | 2085.9 | 2553.1 | 2742.3 | 2828.1 | 2489.3 | 2570.7 | 2473.1 | 1935.4 |
| Diesel | 743.85 | 387.23 | 280.73 | 471.94 | 798.54 | 771.62 | 808.93 | 1068.31 |
| Implied EF (Gg $CO_2$/TJ) | | | | | | | | |
| HFO | 79.098 | 79.089 | 78.196 | 78.827 | 78.753 | 78.807 | 78.95 | 78.95 |
| Diesel | 73.571 | 73.980 | 73.560 | 73.670 | 73.330 | 73.499 | 73.47 | 73.25 |
| | | | | | | | | |
| | **2021** | **2022** | **2023** | | | | | |
| Fuel consumption (kt) | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| HFO | 679.6 | 658.6 | 668.4 | | | | | |
| Diesel | 289.3 | 320.3 | 289.6 | | | | | |
| Net calorific value (TJ/kt)* | | | | | | | | |
| HFO | 40.58 | 41.08 | 41.08 | | | | | |
| Diesel | 42.66 | 42.62 | 42.62 | | | | | |
| $CO_2$ emissions (Gg) | | | | | | | | |
| HFO | 2176.3 | 2094.8 | 2141.1 | | | | | |
| Diesel | 901.37 | 1004.1 | 908.9 | | | | | |
| Implied EF (Gg $CO_2$/TJ) | | | | | | | | |
| HFO | 78.92 | 77.42 | 77.97 | | | | | |
| Diesel | 73.04 | 73.56 | 73.56 | | | | | |
| | | | | | | | | |

* weighted average based on consumption

The overall implied emission factor for $CO_2$ emissions during the period 2005-2023 shows fluctuations that have been caused by (a) change in the consumption of each fuel; i.e. in years that more diesel is consumed the IEF reduces, while when more HFO consumed the IEF increases; (b) fluctuations in fuel quality and therefore NCV (whereas in previous years it is considered constant); (c) the age and efficiency of the electricity productions used.

Non-$CO_2$ emissions were estimated using the default EF proposed by the IPCC 2006 guidelines (vol.2, pg. 2.16); i.e. 3 kg $CH_4$ /TJ and 0.6 kg $N_2O$ /TJ for both fuels.

Petroleum refining (1Ab)

Data for the consumption of fuel for petroleum refining was obtained from the National Statistical Service in kt (Table 3.7). No information is available on the characteristics of the consumption reported as other oil products. The fuel consumption was converted to TJ using the default NCVs of 40.4 TJ/kt RFO, 40.2 TJ/kt other oil product and 49.5 TJ/kt refinery gas which is the default proposed by the 2006 IPCC guidelines (vol.2, pg. 1.18). $CO_2$ emission factors are also the defaults proposed by the revised IPCC 2006 guidelines (vol. 2, pg. 2.16); i.e. 77.4 t $CO_2$/TJ RFO, 73.3 t $CO_2$/TJ other oil product and 57.6 t $CO_2$/TJ refinery gas.

**Table 3.7. Fuel consumed for petroleum refining in Cyprus (1990–2004)**

| Fuel consumption (kt) | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| RFO | 11 | 12 | 13 | 13 | 14 | 17 | 16 | 14 |
| Other products | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Refinery gas | 18 | 17 | 17 | 13 | 24 | 13 | 12 | 16 |

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | |
|---|---|---|---|---|---|---|---|---|
| RFO | 15 | 16 | 16 | 0 | 0 | 0 | 0 | |
| Other products | 0 | 0 | 0 | 0 | 16 | 16 | 0 | |
| Refinery gas | 16 | 20 | 19 | 19 | 21 | 21 | 9 | |

Non-$CO_2$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines for energy industries (vol. 2, pg. 2.16); i.e. 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for RFO and other oil products and 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for Refinery gas.

Manufacture of Solid Fuels and Other energy industries (1A1c)

The solid fuel produced in Cyprus is charcoal. The amount of wood (biomass) consumed for the production of charcoal is obtained by the Statistical Service (national energy balance) in TJ and is presented in Table 3.8. Table 3.8 also presents the amount of charcoal produced (TJ) and the conversion efficiency.

Emissions are estimated using the T1 methodology and the default EF proposed by the IPCC 2006 guidelines for wood (vol.2, pg. 2.17): 112000 kg $CO_2$/TJ, 30 kg $CH_4$/TJ and 4 kg $N_2O$/TJ.

**Table 3.8. Solid biomass consumed for the production of charcoal**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| Solid biomass (TJ) | 112 | 112 | 112 | 112 | 405 | 388 | 328 |
| Charcoal produced (TJ) | 29.5 | 29.5 | 29.5 | 29.5 | 147.5 | 118 | 118 |
| Conversion efficiency | 26.34% | 26.34% | 26.34% | 26.34% | 36.42% | 30.41% | 35.98% |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| Solid biomass (TJ) | 288 | 314 | 281 | 248 | 253 | 235 | 209 |
| Charcoal produced (TJ) | 88.5 | 118 | 118 | 88.5 | 88.5 | 88.5 | 88.5 |
| Conversion efficiency | 30.73% | 37.58% | 41.99% | 35.69% | 34.98% | 37.66% | 42.34% |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Solid biomass (TJ) | 184 | 174 | 135 | 274 | 211 | 47 | 48 |
| Charcoal produced (TJ) | 59.0 | 59.0 | 59.0 | 118 | 88.5 | 29.5 | 29.5 |
| Conversion efficiency | 32.07% | 33.91% | 43.70% | 43.07% | 41.94% | 62.77% | 61.46% |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Solid biomass (TJ) | 45 | 82 | 71 | 58 | 94 | 163 | 172 |
| Charcoal produced (TJ) | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 | 59.0 | 73.5 |
| Conversion efficiency | 65.56% | 35.98% | 41.55% | 50.86% | 31.38% | 36.20% | 42.75% |
| | | | | | | | |
| | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| Solid biomass (TJ) | 112 | 93 | 80 | 91 | 142 | 77 | |
| Charcoal produced (TJ) | 47.7 | 39.8 | 34.2 | 38.7 | 60.5 | 33.0 | |
| Conversion efficiency | 42.75% | 42.75% | 42.7% | 42.8% | 42.8% | 42.7% | |

Oil and Gas Extraction(1A1cii)

Diesel consumption for Oil and Gas extraction was reported for the first time in 2020. The consumption includes technical support for the extraction. It does not include the extraction itself. The are no emissions related to transmission or pipeline leakage since the transport of the extracted oil and gas did not start yet.

Emissions are estimated using the T1 methodology and the default EF proposed by the IPCC 2006 for guidelines for diesel-oil consumption (vol.2, pg. 2.18): 74100 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ. The consumption for 2020 was 261.5 TJ. There was no activity reported for 2021, but some activity took place in 2022.

#### 3.2.3.3. Uncertainties and time-series consistency

In general, the uncertainty of emissions from the stationary combustion sector is relatively small. The uncertainty associated with activity data (i.e. fuel consumption) is less than 5%, since the AD are obtained from the national energy balance and are cross-checked with data from other sources (e.g. plant specific data). On the other hand, the uncertainty associated with emission factors is also very low for the case of $CO_2$, less than 5%, since plant and country specific EFs are mainly applied. For the case of $CH_4$ and $N_2O$ EFs, the uncertainty is higher, about 100 and 300% respectively, since IPCC defaults emission factors per technology/activity are applied. The results of the uncertainty analysis are presented in Table 1.9. The detailed calculations of uncertainty are presented in Annex 2.

The time-series consistency of emissions is controlled by applying consistent methodologies and verified activity data in-line with IPCC guidelines. In case of changes or refinements in methodologies and EFs based on plant-specific data, e.g. from the European Union emissions trading scheme (EU ETS) reports, time-series consistency is ensured by performing recalculations according to the IPCC good practice guidance, if sufficient data is available.

#### 3.2.3.4. Category-specific QA/QC and verification

The following source-specific QC procedures are applied to the stationary combustion sector. These procedures are based on the plant-specific data that become available through the ETS reports. It should be mentioned that ETS reports have been both verified by external verification bodies and reviewed by the competent authorities of the Department of Environment.

1. Activity data comparison: Cross-checking between energy consumption data derived from the national energy balance and plant-specific energy consumption data of major industrial plants derived from verified ETS reports is performed. The findings of the above quality check are communicated to the competent department of Department of Environment. In this way both the national energy balance and the energy consumption used in emission calculations are verified and improved.

2. Emissions comparison: Verified ETS reports were used for the computation of plant-specific $CO_2$ EFs and NCVs. For quality control purposes emissions calculated by applying plant-specific EFs and NCVs are compared with the emissions calculated by using IPCC default EFs and NCVs.

#### 3.2.3.5. Category-specific recalculations

No recalculations to report.

#### 3.2.3.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 3.2.4. Manufacturing industries and construction (1A2)

#### 3.2.4.1. Category description

Emissions from energy consumption for the production of steam and process heat are mainly reported under Manufacturing industry and construction.

Even though the shock inflicted on the manufacturing sector by the Turkish invasion of 1974 was severe, recovery during the period 1975-1983 was remarkable. By 2002 the sector accounted for about 10% of GDP and 12% of employment. However, during the past decade, the manufacturing industry of Cyprus has been going through difficult times, experiencing a fall in the growth of production, exports and employment. This development is the result of erosion in competitiveness, both abroad and in the local market, at a time of increasingly intensified, international competition. At the root of these problems lie the structural weaknesses of the sector, the drastic reduction of tariff protection due to the participation of Cyprus in the World Trade Organization, the rising labour costs and low productivity. As a result the share of the manufacturing sector in the Gross Domestic Product and in employment remained stagnant. International competition is increasingly intensified mainly from two directions: the high-wage producers, who have combined design, quality and new forms of flexible production to cut working and capital costs and improve response times; and the low-wage mass producers of South-East Asia. The main industrial activities that take place in Cyprus are food and beverage processing, cement and gypsum production, light chemicals (predominately pharmaceuticals), metal and wood products.

The GHG emissions caused by energy consumption in manufacturing industries and construction in 2023 were 566 Gg $CO_2$ eq, representing 9.0% of the emissions from the energy sector, and 6.4% of total emissions, excluding LULUCF. The total GHG emissions from manufacturing industries and construction in 2023 increased by 12.1% compared to 1990. There is no available information to explain the large change in emissions between 1990 and 1991. The emissions from manufacturing industries and construction 1990–2023 are presented in Figure 3.4 and Table 3.9.

**Table 3.9. Emissions from manufacturing industries and construction 1990–2023**

| Gg $CO_2$ eq. | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| **2. Manufacturing industries and construction** | 505 | 802 | 903 | 670 | 579 | 460 | 540 | 680 | 596 |
| a. Iron and steel | 0.56 | 1.04 | 0.88 | 0.56 | 0.64 | 0.80 | NO | NO | NO |
| b. Non-ferrous metals | 4.39 | 6.04 | 5.56 | 4.66 | 4.90 | 5.38 | NO | NO | 2.99 |
| c. Chemicals | 2.21 | 4.30 | 3.58 | 2.13 | 2.44 | 3.20 | NO | 3.28 | 6.43 |
| d. Pulp, paper and print | 4.84 | 9.15 | 5.17 | 3.69 | 6.27 | 3.51 | 3.01 | 3.14 | 3.14 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| e. Food processing, beverages and tobacco | 73 | 131 | 82 | 60 | 95 | 53 | 43 | 44 | 56 |
| f. Non-metallic minerals | 382 | 577 | 718 | 526 | 395 | 334 | 443 | 560 | 483 |
| g. Other | 38 | 73 | 89 | 74 | 76 | 60 | 51 | 69 | 45 |
| | | | | | | | | | |
| $CO_2$ (Gg) | 502 | 799 | 900 | 667 | 577 | 459 | 538 | 677 | 593 |
| $CH_4$ (Gg) | 0.03 | 0.04 | 0.05 | 0.05 | 0.03 | 0.02 | 0.02 | 0.04 | 0.05 |
| $N_2O$ (Gg) | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 |
| | | | | | | | | | |
| **Gg $CO_2$ eq.** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| 2. Manufacturing industries and construction | 597 | 616 | 546 | 555 | 561 | 562 | 566 | 566 | |
| a. Iron and steel | 0.80 | 0.12 | 0.10 | 0.01 | 0.02 | NO | 0.02 | 0.02 | |
| b. Non-ferrous metals | 5.38 | 2.06 | 2.09 | 2.15 | 3.30 | 2.75 | 2.22 | 1.95 | |
| c. Chemicals | 6.37 | 6.75 | 7.87 | 8.23 | 7.83 | 6.77 | 10.09 | 11.85 | |
| d. Pulp, paper and print | 3.14 | 2.73 | 2.61 | 3.08 | 3.12 | 3.50 | 1.65 | 1.98 | |
| e. Food processing, beverages and tobacco | 50 | 71 | 66 | 67 | 62 | 64 | 67 | 50 | |
| f. Non-metallic minerals | 481 | 475 | 416 | 408 | 427 | 417 | 401 | 412 | |
| g. Other | 51 | 58 | 52 | 67 | 58 | 68 | 84 | 89 | |
| | | | | | | | | | |
| $CO_2$ (Gg) | 593 | 611 | 540 | 549 | 553 | 553 | 558 | 558 | |
| $CH_4$ (Gg) | 0.05 | 0.07 | 0.09 | 0.09 | 0.11 | 0.13 | 0.13 | 0.12 | |
| $N_2O$ (Gg) | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | |

#### 3.2.4.2. Methodological issues

**Data**

The data used to estimate the emissions for the industrial activities from energy consumption in manufacturing industries and construction 1990–2023 is presented in Table 3.10. Consumption for Iron and steel (1A2a) was included in Non-ferrous metals (1A2b) until last 2019. It has reported separately for the first time for 2020. Consumption for RFO (1A2b) is reported for the first time in 2022. Consumption for LPG (1A2g) is reported for the first time in 2022. Biodiesel consumption is included for the first time in 2020. Consumption for Autoproducer electricity plants and CHP plants is included in Non-specified Industry (1A2m).

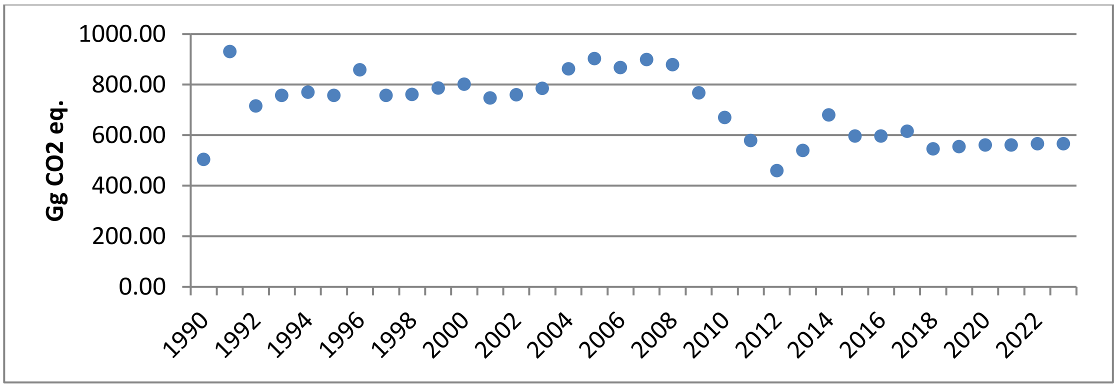


**Figure 3.4. Emissions from energy use in manufacturing industries and construction (1A2) 1990–2023**

Data for other bituminous coal in source category 1A2f for the years 2005-2023 is from reports submitted for ETS purposes by the cement installations. Waste (non-renewable) in source category 1A2f includes both industrial and municipal waste.

**Table 3.10. Fuel consumption in manufacturing industries and construction 1990–2023**
**(a) 1990-2003**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A2a Iron and Steel | | | | | | | | | | | | | | |
| Diesel/gasoil (kt) | 0.176 | 0.201 | 0.226 | 0.251 | 0.251 | 0.276 | 0.276 | 0.302 | 0.327 | 0.327 | 0.327 | 0.352 | 0.327 | 0.327 |
| 1A2b Non-ferrous metals | | | | | | | | | | | | | | |
| LPG (kt) | 0.9 | 0.9 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.1 |
| Diesel/gasoil (kt) | 0.52 | 0.60 | 0.67 | 0.75 | 0.75 | 0.82 | 0.82 | 0.90 | 0.97 | 0.97 | 0.97 | 1.05 | 0.97 | 0.97 |
| 1A2c Chemical and petrochemical | | | | | | | | | | | | | | |
| RFO (kt) | | | | | | | | | | | | | | |
| Diesel/gasoil (kt) | 0.7 | 0.8 | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 | 1.3 | 1.3 | 1.4 | 1.3 | 1.3 |
| Solid biofuels (TJ) | | | | | | | | | | | | | | |
| 1A2d Paper, pulp and printing | | | | | | | | | | | | | | |
| RFO (kt) | 1.5 | 5.2 | 4.9 | 4.2 | 4.6 | 4.0 | 4.6 | 2.9 | 2.8 | 2.8 | 2.9 | 2.3 | 2.3 | 2.6 |
| 1A2e Food, beverages and tobacco | | | | | | | | | | | | | | |
| Diesel/gasoil (kt) | 2.1 | 2.3 | 2.8 | 2.9 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 3.9 | 4.0 | 4.1 | 3.9 | 4.0 |
| RFO (kt) | 18.5 | 62.0 | 59.0 | 50.0 | 55.0 | 48.5 | 55.5 | 35.0 | 34.0 | 34.0 | 35.0 | 27.0 | 27.5 | 31.0 |
| LPG (kt) | 2.7 | 2.7 | 3.1 | 2.8 | 2.8 | 2.8 | 2.8 | 2.9 | 2.8 | 2.7 | 2.9 | 2.9 | 3.0 | 3.2 |
| Solid biofuels (TJ) | | | | | | | | | | | | | | |
| 1A2f Non-Metallic Minerals | | | | | | | | | | | | | | |
| Pet-coke (kt) | 40.0 | 93.0 | 85.0 | 114.0 | 112.0 | 125.0 | 147.0 | 152.0 | 150.0 | 154.0 | 141.0 | 133.0 | 139.0 | 137.0 |
| RFO (kt) | 9.3 | 31.0 | 29.5 | 25.0 | 27.5 | 24.3 | 27.8 | 17.5 | 17.0 | 17.0 | 17.5 | 13.5 | 13.8 | 15.5 |
| diesel (kt) | 2.1 | 2.3 | 2.8 | 2.9 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 3.9 | 4.0 | 4.1 | 3.9 | 4.0 |
| LPG (kt) | 0.9 | 0.9 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.1 |
| Other bituminous coal (kt) | 97.0 | 97.0 | 26.0 | 31.0 | 27.0 | 20.0 | 18.0 | 19.0 | 26.0 | 30.0 | 49.0 | 53.0 | 53.0 | 53.0 |
| Solid biomass (TJ) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 41.0 | 70.0 | 90.0 | 211.0 |
| Waste (non-renewable) (TJ) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.0 | 0.0 | 15.0 |
| 1A2i Mining and Quarrying | | | | | | | | | | | | | | |
| Diesel (kt) | 3 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 |
| 1A2k Construction | | | | | | | | | | | | | | |
| Diesel (kt) | 3 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 |
| RFO (kt) | | | | | | | | | | | | | | |
| 1A2m Non-specified Industry | | | | | | | | | | | | | | |
| Diesel (kt) | 2.1 | 2.3 | 2.8 | 2.9 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 3.9 | 4.0 | 4.1 | 3.9 | 4.0 |
| RFO (kt) | 6.2 | 20.7 | 19.7 | 16.7 | 18.3 | 16.2 | 18.5 | 11.7 | 11.3 | 11.3 | 11.7 | 9.0 | 9.2 | 12.3 |
| Other oil products (kt) | 0.0 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| White spirit (kt) | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 1.0 | 1.0 | 1.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Other kerosene (kt) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LPG (kt) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**(b) 2004-2020**

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | |
| 1A2a Iron and Steel | | | | | | | | | | | | | | | | | |
| Diesel/gasoil(kt) | 0.302 | 0.276 | 0.276 | 0.251 | 0.226 | 0.226 | 0.176 | 0.201 | 0.251 | 0.000 | 0.000 | 0.000 | 0.251 | 0.038 | 0.033 | 0.003 | 0.007 |
| 1A2b Non-ferrous metals | | | | | | | | | | | | | | | | | |
| LPG (kt) | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 1.0 | 1.0 | 1.0 | 1.0 | NO | NO | 1.0 | 1.0 | 0.569 | 0.594 | 0.658 | 0.764 |
| Diesel/gasoil (kt) | 0.90 | 0.82 | 0.82 | 0.75 | 0.67 | 0.67 | 0.52 | 0.60 | 0.75 | NO | NO | NO | 0.75 | 0.11 | 0.10 | 0.059 | 0.317 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.001 |
| 1A2c Chemical and petrochemical | | | | | | | | | | | | | | | | | |
| LPG (kt) | | | | | | | | | | | | | | 0.21 | 0.22 | 0.24 | 0.29 |
| RFO (kt) | | | | | | | | | | | | 1.0 | 1.0 | 0.775 | 1.235 | 0.979 | 0.95 |
| Diesel/gasoil (kt) | 1.2 | 1.1 | 1.1 | 1.0 | 0.9 | 0.9 | 0.7 | 0.8 | 1.0 | NO | 1.0 | 1.0 | 1.0 | 1.143 | 1.036 | 1.377 | 1.24 |
| Solid biofuels (TJ) | | | | | | | | | | | 42 | 52 | 21 | 21.6 | 18 | 18 | 14 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.03 |
| 1A2d Paper, pulp and printing | | | | | | | | | | | | | | | | | |
| LPG (kt) | | | | | | | | | | | | | | 0.285 | 0.297 | 0.329 | 0.142 |
| RFO (kt) | 2.8 | 1.6 | 1.1 | 1.6 | 1.5 | 1.0 | 1.2 | 2.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.57 | 0.52 | 0.492 | 0.674 |
| Diesel/gasoil (kt) | | | | | | | | | | | | | | 0.03 | 0.03 | 0.172 | 0.183 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.001 |
| 1A2e Food, beverages and tobacco | | | | | | | | | | | | | | | | | |
| Diesel/gasoil | 3.6 | 3.4 | 3.4 | 2.9 | 2.6 | 2.6 | 2.0 | 2.3 | 3.0 | 2.0 | 2.0 | 4.0 | 3.0 | 4.863 | 4.012 | 4.278 | 4.171 |
| RFO | 34.0 | 19.8 | 13.4 | 19.1 | 17.6 | 12.0 | 14.1 | 24.0 | 9.0 | 8.0 | 8.0 | 9.0 | 9.0 | 12.45 | 11.34 | 10.72 | 10.09 |
| LPG | 3.1 | 2.9 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 | 5.515 | 5.757 | 6.372 | 5.716 |
| Solid biofuels (TJ) | | | | | | | | | | | 44 | 7 | 36 | 50.15 | 67.19 | 99.15 | 68.94 |
| Biogases (TJ) | | | | | | 15 | 30 | 67 | 70 | 68 | 67 | 69 | 68 | 68.28 | 66.18 | 64.85 | 65.82 |
| Other kerosene (TJ) | | | | | | | | | | | | | | 1.314 | 1.01 | 4.073 | 0.525 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.004 |
| 1A2f Non-Metallic Minerals | | | | | | | | | | | | | | | | | |
| Pet-coke (kt) | 146.0 | 154.0 | 146.0 | 143.0 | 152.0 | 144.0 | 116.0 | 100.0 | 94.0 | 135.0 | 162.0 | 128.0 | 123.0 | 108.7 | 74.5 | 55.6 | 62.7 |
| RFO (kt) | 17.0 | 37.0 | 35.0 | 38.0 | 38.0 | 30.0 | 25.0 | 15.0 | 13.0 | 8.0 | 7.0 | 8.0 | 10.0 | 10.0 | 14.5 | 15.4 | 13.4 |
| diesel (kt) | 3.6 | 3.4 | 3.4 | 2.9 | 2.6 | 2.6 | 2.0 | 2.3 | 3.0 | 1.0 | 1.0 | 2.0 | 2.0 | 0.8 | 1.4 | 1.8 | 2.7 |
| LPG (kt) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.5 | 0.4 | 0.4 | 0.7 |
| other bituminous coal (kt) | 57.0 | 54.7 | 54.3 | 49.5 | 44.6 | 23.5 | 27.4 | 12.3 | 0.0 | 0.0 | 4.2 | 6.0 | 0.8 | 5.1 | 22.6 | 27.7 | 22.4 |
| Other kerosene (kt) | | | | | | | | | | | | | | 0.061 | 0.047 | 0.018 | 0.02 |
| Solid biomass (TJ) | 127.00 | 38.00 | 61.00 | 133.00 | 281.00 | 304.00 | 347.00 | 306.00 | 29.00 | 28.00 | 116.00 | 95.00 | 55.00 | 85.51 | 78.36 | 126.1 | 204.9 |
| Waste (non-renewable) (TJ) | 71.0 | 138.0 | 73.0 | 288.0 | 239.0 | 276.0 | 299.0 | 56.2 | 24.0 | 45.0 | 316.0 | 516.0 | 663.0 | 837.5 | 961.1 | 1289 | 1457 |
| Waste (biomass fraction) (TJ) | | | | | | | | | 88.0 | 150.0 | 161.0 | 325.0 | 427.0 | 752.0 | 1156.7 | 937.8 | 1377 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.095 |
| 1A2j Wood and wood products | | | | | | | | | | | | | | | | | |
| LPG (kt) | | | | | | | | | | | | | | 0.003 | 0.003 | 0.003 | 0.006 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diesel/gasoil kt) | | | | | | | | | | | | | | 0.025 | 0.023 | 0.025 | 0.03 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.001 |
| 1A2i Mining and Quarrying | | | | | | | | | | | | | | | | | |
| Diesel (kt) | 6 | 6 | 6 | 5 | 4 | 4 | 3 | 4 | 5 | 2 | 1 | 3 | 2 | 3.75 | 3.66 | 7.08 | 4.65 |
| RFO (kt) | | | | | | | | | | | | | | 0.12 | 0.11 | 0 | 0 |
| Other Kerosene (kt) | | | | | | | | | | | | | | | | | 0.111 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.298 |
| 1A2g Transport Equipment | | | | | | | | | | | | | | | | | |
| Diesel (kt) | | | | | | | | | | | | | | 0.005 | 0.006 | 0.001 | 0.001 |
| 1A2h Machinery | | | | | | | | | | | | | | | | | |
| LPG (kt) | | | | | | | | | | | | | | 0.082 | 0.086 | 0.095 | 0.26 |
| Diesel/Gasoil (kt) | | | | | | | | | | | | | | 0.257 | 0.224 | 0.248 | 0.278 |
| RFO (kt) | | | | | | | | | | | | | | 0.117 | 0.107 | 0.101 | 0 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.008 |
| 1A2k Construction | | | | | | | | | | | | | | | | | |
| Diesel (kt) | 6 | 6 | 6 | 5 | 4 | 4 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 8.845 | 7.17 | 8.334 | 7.751 |
| RFO (kt) | | | | | | | | | 1.0 | 1.0 | 3.0 | 2.0 | 3 | 2.42 | 2.2 | 2.086 | 1.94 |
| 1A2l Textiles and Leather | | | | | | | | | | | | | | | | | |
| Diesel (kt) | | | | | | | | | | | | | | 0.027 | 0.023 | 0.018 | 0.017 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.001 |
| 1A2m Non-specified Industry | | | | | | | | | | | | | | | | | |
| Diesel (kt) | 3.6 | 3.4 | 3.4 | 3.9 | 2.6 | 2.6 | 2.0 | 4.3 | 5.0 | 3.0 | 2.0 | 2.0 | 2.0 | 1.852 | 2.18 | 2.24 | 2.05 |
| RFO (kt) | 16.3 | 12.6 | 11.5 | 24.4 | 20.9 | 17.0 | 14.7 | 12.0 | 3.0 | 5.0 | 7.0 | 1.0 | 2.0 | 1.287 | 0.44 | 0.449 | 0.987 |
| Other oil products (kt) | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| White spirit (kt) | 0.0 | 1.0 | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other kerosene (kt) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2 | 0.0 | 0.0 | 0.007 | 0.005 | 0.005 | 0.002 |
| LPG (kt) | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.23 | 0.24 | 0.26 | 0.14 |
| Biodiesel (kt) | | | | | | | | | | | | | | | | | 0.003 |

**(c) 2021-2023**

| | 2021 | 2022 | 2023 |
|---|---|---|---|
| | | | |
| 1A2a Iron and Steel | | | |
| Diesel/gasoil(kt) | 0.000 | 0.006 | 0.007 |
| 1A2b Non-ferrous metals | | | |
| LPG (kt) | 0.758 | 0.724 | 0.636 |
| Diesel/gasoil (kt) | 0.152 | 0.010 | 0.012 |
| RFO (kt) | | 0.008 | 0.004 |
| Biodiesel (kt) | 0.001 | NO | NO |
| 1A2c Chemical and petrochemical | | | |
| LPG (kt) | 0.27 | 0.03 | 0.029 |
| RFO (kt) | 0.37 | 1.83 | 2.46 |
| Diesel/gasoil (kt) | 1.5 | 1.32 | 1.26 |
| Solid biofuels (TJ) | 11 | 11 | 5.3 |
| Biodiesel (kt) | 0.03 | 0.003 | 0.111 |
| 1A2d Paper, pulp and printing | | | |
| LPG (kt) | 0.125 | 0.046 | 1.9 |
| RFO (kt) | 0.811 | 0.305 | 0.426 |
| Diesel/gasoil (kt) | 0.181 | 0.175 | 0.165 |
| Biodiesel (kt) | 0.001 | NO | NO |
| 1A2e Food, beverages and tobacco | | | |
| Diesel/gasoil | 5.18 | 5.57 | 5.25 |
| RFO | 10.13 | 10.21 | 5.61 |
| LPG | 5.29 | 5.75 | 5.05 |
| Solid biofuels (TJ) | 47.65 | 179.9 | 130.0 |
| Biogases (TJ) | 67.36 | 64.57 | 67.4 |
| Other kerosene (TJ) | 0.263 | 0.088 | NO |
| Biodiesel (kt) | 0.006 | 0.028 | 0.025 |
| 1A2f Non-Metallic Minerals | | | |
| Pet-coke (kt) | 12.59 | 15.4 | 28.7 |
| RFO (kt) | 12.52 | 12.73 | 10.8 |
| diesel (kt) | 4.86 | 2.93 | 3.04 |
| LPG (kt) | 0.65 | 0.53 | 0.46 |
| other bituminous coal (kt) | 66.4 | 52.7 | 48.0 |
| Other kerosene (kt) | NO | NO | NO |
| Solid biomass (TJ) | 279 | 314 | 250 |
| Waste (non-renewable) (TJ) | 1692 | 1948 | 1922 |

| | | | |
|---|---|---|---|
| Waste (biomass fraction) (TJ) | 1481 | 1121 | 1088 |
| Biodiesel (kt) | 0.219 | 0.058 | 0.053 |
| 1A2j Wood and wood products | | | |
| LPG (kt) | 0.01 | 0.003 | 0.003 |
| Diesel/gasoil kt) | 0.047 | 0.036 | 0.037 |
| Biodiesel (kt) | 0.001 | 0.001 | 0.001 |
| 1A2i Mining and Quarrying | | | |
| Diesel (kt) | 5.39 | 8.25 | 9.34 |
| RFO (kt) | NO | NO | NO |
| Other Kerosene (kt) | NO | 0.013 | NO |
| Biodiesel (kt) | 0.245 | 0.398 | 0.365 |
| 1A2g Transport Equipment | | | |
| Diesel (kt) | 0.001 | 0.058 | 0.055 |
| LPG (kt) | NO | 0.037 | 0.033 |
| 1A2h Machinery | | | |
| LPG (kt) | 0.206 | 0.194 | 0.170 |
| Diesel/Gasoil (kt) | 0.272 | 0.314 | 0.352 |
| RFO (kt) | 0 | NO | NO |
| Biodiesel (kt) | 0.001 | 0.014 | 0.013 |
| 1A2k Construction | | | |
| Diesel (kt) | 9.11 | 9.50 | 8.94 |
| RFO (kt) | 0.507 | 3.35 | 4.23 |
| 1A2l Textiles and Leather | | | |
| Diesel (kt) | 0.01 | 0.006 | 0.006 |
| Biodiesel (kt) | NO | NO | NO |
| 1A2m Non-specified Industry | | | |
| Diesel (kt) | 2.399 | 3.069 | 3.709 |
| RFO (kt) | 0.582 | 1.357 | 0.722 |
| Other oil products (kt) | NO | NO | NO |
| White spirit (kt) | NO | NO | NO |
| Other kerosene (kt) | NO | NO | NO |
| LPG (kt) | 0.13 | 0.13 | 0.12 |
| Biodiesel (kt) | 0.002 | 0.013 | 0.012 |

**Methodology**

The emissions from energy use in manufacturing industries and construction were estimated using predominately the IPCC 2006 guidelines. Details for each industrial activity are presented below.

Iron and Steel (1A2a)

The liquid fuels consumed for iron and steel is Gas-Diesel oil. No data was available for Iron and Steel separately before 2019 and was included in Non-ferrous metals 1A2b. In 2023, the share of the diesel consumption in Iron and Steel to Non- ferrous metals was calculated for the last three years where data was available. The average of these years was then considered as the share to use for the rest of the timeseries, and this was reported in the 2024 NIR. This amount was subtracted from the non-ferrous metals consumption from 1990-2018 to avoid double counting (FCCC/ARR/2023/CYP(E.8)). In the 2025 NIR, this method was updated to use the five years of available data, with an adjustment then made according to both the 1A2a and 1A2b timeseries from 1990-2018. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ.

Non-ferrous metals (1A2b)

The liquid fuels consumed by non-ferrous metals are LPG and Gas-Diesel oil (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 63100 kg $CO_2$/TJ, 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for LPG and 74100 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for Gas-Diesel oil.

Biodiesel consumption was reported for the first time in 2020 for this category. Biofuels in Cyprus are 100% FAME. Emissions from the fossil part of the fuel have been calculated as follows: The default total carbon content has been used 76.5% kgC/kgFAME, as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg CH4/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts. As described in the section above on Iron and Steel, from 1990-2018 part of the diesel consumption from this category is allocated to diesel consumption of 1A2a Iron and Steel.

Even though activity for Non-ferrous metals has been reported as 'NO' for 2013 and 2014, operation of the installations continued during those years with the use of other energy sources, i.e. electricity from the main supply.

Chemicals (1A2c)

According to the energy balance, gas-diesel oil, LPG, RFO, biodiesel and solid biomass are consumed by chemical industries (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The $CO_2$, $CH_4$ and $N_2O$ emissions from all fuels were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for gas-diesel oil, 63100 kg $CO_2$/TJ, 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for LPG and 77400 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for RFO. Consumption of solid biomass is reported for the first time in 2014. The $CO_2$, $CH_4$ and $N_2O$ emissions from solid biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.19); i.e. 100000 kg $CO_2$/TJ, 30 kg $CH_4$/TJ and 4 kg $N_2O$/TJ. For 2013, the emissions are reported as "NO". There was some potential consumption of liquid fuels by chemical industries, but due to the number formats and the rounding of the values in the energy balance the consumption appears as 0. Biodiesel consumption was reported for the first time in 2020 for this category. Biofuels in Cyprus are 100% FAME. Emissions from the fossil part of the fuel have been calculated as follows: The default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

Pulp, Paper and Print (1A2d)

Fuel consumption for this category was reported for the first time in the 2014 energy balance. However, the activity did take place in previous years. Therefore, assumptions have been made to estimate the fuel consumption of the category (see previous Section) for the complete period. Consumption of RFO was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11) .The $CO_2$, $CH_4$ and $N_2O$ emissions from RFO were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 77400 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ. According to the energy balance LPG and Diesel were also consumed by pulp, paper and print for the first time in 2017. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The $CO_2$, $CH_4$ and $N_2O$ emissions from all fuels were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for gas-diesel oil, 63100 kg $CO_2$/TJ, 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for LPG. Biodiesel consumption was reported for the first time in 2020 for this category. Biofuels in Cyprus are 100% FAME. Emissions from the fossil part of the fuel have been calculated as follows: The default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

Food processing, beverages and tobacco (1A2e)

According to the energy balance, the fuels consumed by food processing, beverages and tobacco industries are LPG, gas-diesel, RFO and other kerosene (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 63100 kg $CO_2$/TJ, 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for LPG, 74100 kg $CO_2$/TJ, 3 kg $CH_4$/TJ, 0.6 kg $N_2O$/TJ for Gas-Diesel oil, 77400 kg $CO_2$/TJ, 3 kg $CH_4$/TJ, 0.6 kg $N_2O$/TJ for RFO and 71900 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for other kerosene. Consumption of solid biomass was reported for the first time in 2014.The $CO_2$, $CH_4$ and $N_2O$ emissions from solid biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.19); i.e. 100000 kg $CO_2$/TJ, 30 kg $CH_4$/TJ and 4 kg $N_2O$/TJ. Consumption of gas biomass was reported for the first time in 2009.The $CO_2$, $CH_4$ and $N_2O$ emissions from gas biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.19) assuming another biogas; i.e. 54600 kg $CO_2$/TJ, 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ. Biodiesel consumption was reported for the first time in 2020: Default total carbon content has been used 76.5% kgC/kgFAME, as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

Non-metallic minerals (1A2f)

According to the energy balance, the non-metallic minerals industries consume LPG, gas-diesel oil, RFO, other kerosene, pet-coke, other bituminous coal, solid biomass, biodiesel and municipal and industrial waste (non-renewable), as well as biomass fraction of waste (renewable) (Table 3.10). RFO consumption for 1990–2004 has been revised due to the addition of Pulp, Paper and Print industries.

All liquid fuel consumption (LPG, gas-diesel oil, RFO, other kerosene and pet-coke) was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). Pet-coke is consumed only by two cement producing installations during 1990-2011, which merged into one in 2011. These installations have been submitting annual emissions' report according to the requirements of the ETS law 110(I)/2011, since 2005. The $CO_2$ emissions from pet-coke for the period 2005- 2023 were used as reported for the ETS. $CO_2$ emissions for the period 1990–2004 were estimated using the IEF of 2005, resulting from the division of $CO_2$ emissions by the TJ fuel consumed (84.51 t $CO_2$/TJ). $CH_4$ and $N_2O$ emissions for fuels were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for gas-diesel oil, RFO and pet-coke and 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for LPG. Most liquid fuel consumption was accounted for by petroleum coke, whose default $CO_2$ EF of 97.5 t $CO_2$/TJ in the 2006 IPCC Guidelines (vol. 2, chap. 2) and this explains the high $CO_2$ IEF (FCCC/ARR/2020/CYP/E.8).

Other bituminous coal was consumed during the period 1990-2011 by only one cement-producing installation, which has been submitting annual emissions' report according to the requirements of the ETS law 110(I)/2011, since 2005. The new installation (after 2011) consumed other bituminous coal in 2014 and 2015. Fuel consumption for the period 2005-2015 was obtained in TJ from the annual ETS reports. Fuel consumption for the period 1990–2004 was converted to TJ with the NCV of the first ETS report submitted (i.e. 2005), which was 29.824 TJ/kt. The $CO_2$ emissions from other bituminous coal for the period 2005-2013 were used as reported for the ETS. $CO_2$ emissions for the period 1990–2004 were estimated using the IEF of 2005, resulting from the division of $CO_2$ emissions by the TJ fuel consumed (92.60 t $CO_2$/TJ). $CH_4$ and $N_2O$ emissions for other bituminous coal were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 10 kg $CH_4$/TJ and 1.5 kg $N_2O$/TJ.

Biomass consumption data (solid biomass, biomass fraction municipal waste) was available in TJ. Solid biomass is consumed by only one cement-producing installation, which has been submitting an annual emissions report since 2005, in accordance with the requirements of the ETS law 110(I)2011. In the renewable waste category we report the biomass fraction of biomass incinerated; sewage sludge, woodchips, tires, ASF, MBM, compost and PU Foam. As an update to previous submissions, the $CO_2$ emissions from biomass for the period 2005-2023 were used as reported for the ETS. The $CO_2$ emissions for 2001–2004 were estimated using the implied emission factors derived from the $CO_2$ emissions from the annual report of the company for 2005 (earliest available) in compliance with the ETS law, and the consumption from the national statistics agency: 105 t CO2/TJ biomass fraction waste. There were no emissions in this category prior to 2000. The consumption was used from the national statistics agency to be consistent across the timeseries. This method and the EF are considered as country specific method, since it does not follow the methodologies proposed by the IPCC guidelines. $CH_4$ and $N_2O$ emissions for solid biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines for "other primary solid biomass" (volume 2, pg. 2.19); i.e. 100000 kg $CO_2$/TJ, 30 kg $CH_4$/TJ and 4 kg $N_2O$/TJ.

Non-renewable waste (industrial waste, non-renewable municipal waste) consumption data was available in TJ. Non-renewable waste is consumed by only one cement-producing installation, which has been submitting an annual emissions report since 2005, in accordance with the requirements of the ETS law 110(I)2011. In the non-renewable waste category we report the non-biomass fraction of biomass incinerated; sewage sludge, woodchips, tires, ASF, MBM, compost and PU Foam. The waste is incinerated for production of thermal energy in the furnace which burns the raw material to produce the cement. This is the first submission where $CO_2$ for non-renewable waste from the period 2005-2023 were used as reported for the ETS. The $CO_2$ emissions for 2001–2004 were estimated using the implied emission factors derived from the $CO_2$ emissions from the annual report of the company for 2005 (earliest available) in compliance with the ETS law and the consumption from the national statistics agency: 82 t CO2/TJ non-renewable waste. There were no emissions in this category prior to 2001. The consumption was used from the national statistics agency in order to be consistent across the timeseries. This method and the EF are considered as country specific method, since it does not follow the methodologies proposed by the IPCC guidelines.

The $CH_4$ and $N_2O$ emissions for non-renewable waste, both industrial and municipal, were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.19); i.e. 30 kg $CH_4$/TJ and 4 kg $N_2O$/TJ.

Biodiesel consumption was reported for the first time in 2020: Default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

Transport Equipment (1A2g)

According to the energy balance, transport equipment consume diesel (Table 3.10). Fuel consumption in the energy balance was reported for the first time in 2017 and has been desegregated for the 2020 submission. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ.

Machinery (1A2h)

According to the energy balance, machinery consume diesel, LPG and RFO (Table 3.10). Fuel consumption in the energy balance was reported for the first time in 2017 and was desegregated for the 2020 submission. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for diesel oil, 63100kg $CO_2$/TJ, 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for LPG and 77400kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ. Biodiesel consumption was reported for the first time in 2020: Default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

Mining (excluding fuels) and Quarrying (1A2i)

According to the energy balance, mining and quarrying industries consume diesel. RFO and for the first time in 2021 other Kerosene. (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for gas – diesel oil, 77400 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for RFO and 71900 kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for Other Kerosene. Biodiesel consumption was reported for the first time in 2020: Default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.8 kg $CH_4$/TJ and 5.7 kg $N_2O$/TJ for both fossil and biogenic parts.

Wood and wood products (1A2j)

Fuel consumption for this category was reported for the first time in 2017 in the energy balance. Wood and wood products consume diesel oil and LPG and biodiesel. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for diesel oil and 63100kg $CO_2$/TJ, 1 kg $CH_4$/TJ and 0.1 kg $N_2O$/TJ for LPG. Biodiesel consumption was reported for the first time in 2020: Default total carbon content has been used 76.5% kgC/kgFAME, as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

Construction (1A2k)

According to the energy balance, construction industries consume only diesel (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ for gas – diesel oil.

Textile and Leather (1A2l)

According to the energy balance, Textile and Leather industries consume biodiesel and diesel oil: Diesel oil was reported for the first time in 2017. (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg $CO_2$/TJ, 3 kg $CH_4$/TJ and 0.6 kg $N_2O$/TJ. Biodiesel consumption was reported for the first time in 2020: Default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

Non-specified Industry (1A2m)

According to the energy balance, the fuels consumed by Non-specified industries are gas-diesel oil, RFO, other oil products and white spirit and biodiesel (Table 3.10). Other kerosene has been consumed in 2014, 2017 and 2018 by the gas exploration platforms. RFO consumption for 1990-2014 has been revised due to the addition of Pulp, Paper and Print industries. Gas-diesel oil consumption for 2017 has been revised due to the addition of Transport Equipment, Machinery, Wood and wood products, and Textile and leather industries. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100 kg $CO_2$/TJ for Gas-Diesel oil, 77400 kg $CO_2$/TJ for RFO, 71900 kg $CO_2$/TJ for other kerosene, 73300 kg $CO_2$/TJ for white spirit and other oil products. The emission factors for $CH_4$ and $N_2O$ are 3 kg $CH_4$/TJ, 0.6 kg $N_2O$/TJ for all fuels. Biodiesel consumption was reported for the first time in 2020: Default total carbon content has been used 76.5% kgC/kgFAME , as well as 5.4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.8 kg $CH_4$/TJ and 5.7 kg $N_2O$/TJ for both fossil and biogenic parts.

**Table 3.11. Parameters used for the estimation of emissions**

| | NCV (TJ/kt) | IEF ($tCO_2$/TJ)* |
|---|---|---|
| Gas-diesel oil | 43.0 | |
| RFO | 40.4 | |
| Other oil products | 40.2 | |
| White spirit | 40.2 | |
| Pet-coke | 32.5 | 84.505 |
| LPG | 47.3 | |
| Other kerosene | 43.8 | |
| Other bituminous coal | 25.8 | 92.600 |
| Biodiesel | 37.0 | |

* based on the ETS 2005 report; used for the years 1990–2004

### 3.2.4.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 3.2.4.4. Category-specific QA/QC and verification

Fuel consumption data for 1A2f is compared between data from the Department of Labour Inspection, the ETS and the Statistical Service.

### 3.2.4.5. Category-specific recalculations

Recalculations have been carried out for various subcategories in 1A2. These impacts are presented in the Table 3.12.

Diesel for 1990-2018 in 1A2a and 1A2b was recalculated to first correct the allocation of consumption between the two categories in the inventory file, and then update the calculation by including the more recent years of data in the average (described in full detail in the methodologies for the respective sub-categories). In addition, RFO (1A2b) was recalculated for 2022 to reflect the addition of these fuels to the 2022 energy balance, as it was not included in the 2024 NIR. Non-renewable and renewable waste (1A2f) were both recalculated for 2000-2022 due to an update in methodology (described in full detail in the 1A2f methodology for these fuels).

LPG was recalculated for 2022 in 1A2g, 2022 in 1A2i, and 2021-2022 in 1A2l, to reflect the addition of these fuels to the 2022 energy balance, as they were not included in the 2024 NIR.

**Table 3.12. Impact of recalculations on $CO_2$ eq. emissions for 1A2 Manufacturing industries and construction (1990-2022)**

**a. 1A2a, 1A2b, 1A2f**

| Gg $CO_2$ eq. | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A2a | | | | | | | | | | | |
| NIR 2025 | 0.562 | 0.643 | 0.723 | 0.803 | 0.803 | 0.884 | 0.884 | 0.964 | 1.044 | 1.044 | 1.044 |
| NIR 2024 | 0.013 | 0.015 | 0.018 | 0.019 | 0.019 | 0.021 | 0.022 | 0.023 | 0.024 | 0.025 | 0.026 |
| Change(%) | 4138% | 4255% | 3946% | 4231% | 4108% | 4166% | 3954% | 4113% | 4186% | 4070% | 3939% |
| 1A2b | | | | | | | | | | | |
| NIR 2025 | 4.39 | 4.63 | 5.20 | 5.21 | 5.16 | 5.45 | 5.45 | 5.75 | 5.88 | 5.82 | 6.04 |
| NIR 2024 | 3.27 | 3.33 | 3.79 | 3.60 | 3.56 | 3.69 | 3.73 | 3.83 | 3.79 | 3.76 | 4.01 |
| Change(%) | 34.3% | 39.0% | 37.1% | 45.0% | 44.7% | 47.9% | 46.1% | 49.9% | 55.2% | 54.9% | 50.6% |
| 1A2f | | | | | | | | | | | |
| NIR 2025 | - | - | - | - | - | - | - | - | - | - | - |
| NIR 2024 | - | - | - | - | - | - | - | - | - | - | - |
| Change(%) | - | - | - | - | - | - | - | - | - | - | - |
| | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| 1A2a | | | | | | | | | | | |
| NIR 2025 | 1.124 | 1.044 | 1.044 | 0.964 | 0.884 | 0.884 | 0.803 | 0.723 | 0.723 | 0.562 | 0.643 |
| NIR 2024 | 0.026 | 0.025 | 0.026 | 0.023 | 0.083 | 0.085 | 0.071 | 0.064 | 0.064 | 0.050 | 0.057 |
| Change(%) | 4204% | 4070% | 3960% | 4064% | 959% | 937% | 1031% | 1031% | 1031% | 1031% | 1031% |
| 1A2b | | | | | | | | | | | |
| NIR 2025 | 6.28 | 6.10 | 6.32 | 5.97 | 5.56 | 5.62 | 5.38 | 2.15 | 5.14 | 4.66 | 4.90 |
| NIR 2024 | 4.03 | 4.04 | 4.29 | 4.07 | 6.43 | 6.56 | 5.96 | 2.68 | 5.66 | 5.07 | 5.37 |
| Change(%) | 56.1% | 51.1% | 47.5% | 46.8% | -13.4% | -14.3% | -9.73% | -19.50% | -9.22% | -8.01% | -8.65% |
| 1A2f | | | | | | | | | | | |
| NIR 2025 | 553.8 | 569.2 | 571.2 | 613.3 | 717.7 | 702.3 | 681.5 | 692.7 | 608.7 | 525.5 | 395.0 |
| NIR 2024 | 554.8 | 569.0 | 571.7 | 617.6 | 726.1 | 706.4 | 712.7 | 720.0 | 643.4 | 554.8 | 389.8 |
| Change(%) | -0.18% | 0.03% | -0.10% | -0.69% | -1.16% | -0.58% | -4.38% | -3.79% | -5.39% | -5.28% | 1.32% |
| | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
| 1A2a | | | | | | | | | | | |
| NIR 2025 | 0.803 | 0.000 | 0.000 | 0.000 | 0.803 | 0.120 | 0.104 | 0.010 | 0.022 | 0.000 | 0.019 |
| NIR 2024 | 0.075 | 0.000 | 0.000 | 0.000 | 0.075 | 0.011 | 0.010 | 0.010 | 0.022 | 0.000 | 0.019 |
| Change(%) | 977% | | | | 977% | 977% | 977% | 0.00% | 0.00% | #DIV/0! | 0.00% |
| 1A2b | | | | | | | | | | | |
| NIR 2025 | 5.38 | 0.00 | 0.00 | 2.99 | 5.38 | 2.06 | 2.09 | 2.15 | 3.30 | 2.75 | 2.22 |
| NIR 2024 | 6.11 | 0.00 | 0.00 | 2.99 | 6.11 | 2.17 | 2.18 | 2.15 | 3.30 | 2.75 | 2.19 |
| Change(%) | -11.93% | | | 0.00% | -11.93% | -5.04% | -4.34% | 0.00% | 0.00% | 0.00% | 1.14% |
| 1A2f | | | | | | | | | | | |
| NIR 2025 | 334.2 | 442.8 | 560.5 | 483.1 | 480.6 | 475.0 | 415.7 | 408.1 | 426.7 | 416.7 | 400.6 |
| NIR 2024 | 334.1 | 442.6 | 576.4 | 492.9 | 482.4 | 476.0 | 422.5 | 418.6 | 439.4 | 430.2 | 415.2 |
| Change(%) | 0.03% | 0.05% | -2.76% | -1.99% | -0.37% | -0.21% | -1.61% | -2.49% | -2.91% | -3.14% | -3.53% |

**b. 1A2g, 1A2i, 1A2l**

| Gg $CO_2$ eq. | 2021 | 2022 |
|---|---|---|
| 1A2g | | |
| NIR 2025 | - | 0.296 |
| NIR 2024 | - | 0.185 |
| Change(%) | - | 59.6% |
| 1A2i | | |
| NIR 2025 | - | 26.83 |
| NIR 2024 | - | 26.49 |
| Change(%) | - | 1.28% |
| 1A2l | | |
| NIR 2025 | 0.03 | 0.03 |
| NIR 2024 | 0.03 | 0.02 |
| Change(%) | 9.34% | 31.15% |

#### 3.2.4.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 3.2.5. Transport (1A3)

### 3.2.5.1. Category description

The activity category of transport should include emissions from the combustion and evaporation of fuel for all transport activity (excluding military transport), regardless of the sector, specified by sub-categories below. Emissions from fuel sold to any air or marine vessel engaged in international transport (1A3ai and 1A3di) should, as far as possible, be excluded from the totals and subtotals in this category and should be reported separately.

Mobile sources produce direct greenhouse gas emissions of carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$) from the combustion of various fuel types, as well as several other pollutants such as carbon monoxide (CO), Non-methane Volatile Organic Compounds (NMVOCs), sulphur dioxide ($SO_2$), particulate matter (PM) and oxides of nitrate ($NO_x$), which cause or contribute to local or regional air pollution. Greenhouse gas emissions from mobile combustion are most easily estimated by major transport activity, i.e., road, off-road, air, railways, and water-borne navigation. For Cyprus' inventory, emissions of off-road activities are included in road. Railways do not exist in Cyprus.

This is the fifth year for which emissions are estimated from road transport with COPERT 5 and are therefore disaggregated into the appropriate vehicle type. Further details are given in the methodology section.

Between 1990 and 2023 emissions from transport increased by 74.6%. There was a notable decrease in emissions in 2020 due to the restrictions to movement during the COVID-19 pandemic (Table 3.13). In 2023 transport contributed 24.4% to the total emissions of the country without LULUCF and 34.5% to the emissions from the energy sector. Transport (1A3) emissions are also presented in Figure 3.5.

**Table 3.13. Transport emissions 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| **3. Transport** | 1238 | 1822 | 2113 | 2375 | 2304 | 2129 | 1916 | 1849 | 1911 |
| a.Domestic aviation | 26.2 | 17.9 | 12.3 | 7.83 | 2.50 | 1.85 | 1.41 | 1.06 | 1.19 |
| b.Road transportation | 1209 | 1802 | 2099 | 2364 | 2299 | 2125 | 1913 | 1846 | 1908 |
| c. Railways | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| d.Domestic navigation | 2.23 | 1.72 | 2.36 | 3.06 | 2.87 | 2.02 | 1.53 | 1.81 | 2.05 |
| | | | | | | | | | |
| $CO_2$ | 1219 | 1798 | 2092 | 2359 | 2289 | 2115 | 1903 | 1836 | 1899 |
| $CH_4$ | 0.28 | 0.23 | 0.23 | 0.19 | 0.17 | 0.17 | 0.14 | 0.14 | 0.13 |
| $N_2O$ | 0.04 | 0.07 | 0.06 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 |
| | | | | | | | | | |
| **Gg $CO_2$ eq.** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| **3. Transport** | 2030 | 2094 | 2105 | 2132 | 1910 | 1937 | 1993 | 2161 | |
| a.Domestic aviation | 0.78 | 1.24 | 0.88 | 0.36 | 0.52 | 1.28 | 1.15 | 1.07 | |
| b.Road transportation | 2027 | 2090 | 2102 | 2129 | 1908 | 1933 | 1988 | 2154 | |
| c. Railways | NO | NO | NO | NO | NO | NO | NO | NO | |
| d.Domestic navigation | 1.53 | 2.09 | 2.18 | 2.84 | 1.17 | 2.68 | 4.52 | 5.91 | |
| | | | | | | | | | |
| $CO_2$ | 2017 | 2080 | 2092 | 2118 | 1896 | 1924 | 1980 | 2146 | |
| $CH_4$ | 0.13 | 0.13 | 0.12 | 0.12 | 0.10 | 0.10 | 0.10 | 0.09 | |
| $N_2O$ | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | |

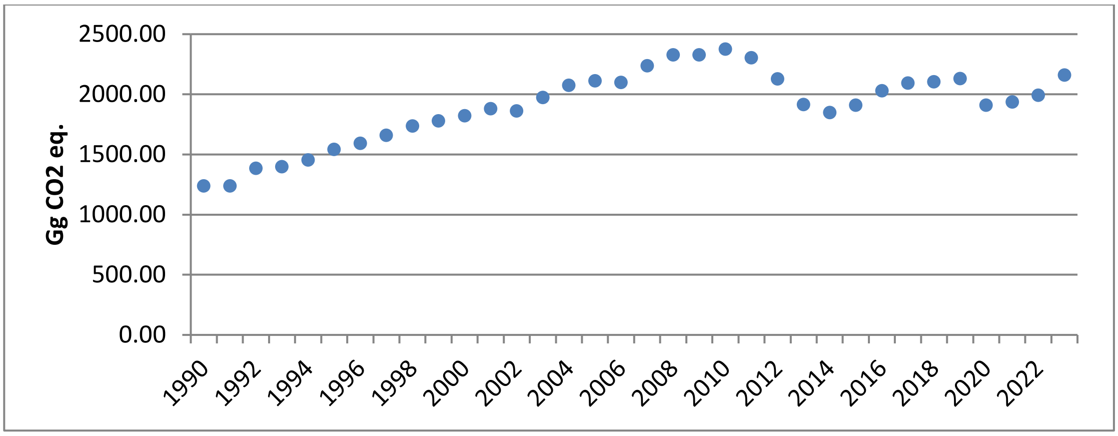


**Figure 3.5. Transport (1A3) emissions 1990–2023**

### 3.2.5.2. Methodological issues

**Civil aviation (1A3a)**

Civil aviation emissions should include emissions from international and domestic civil aviation, including take-offs and landings. Civil aviation comprises civil commercial use of airplanes, including scheduled and charter traffic for passengers and freight, air taxiing, and general aviation. This is the first year that CO2 emissions from civil aviation were estimated using a Tier 3 method, in line with recommendation FCCC/ARR/2023/CYP (E.8) to move to a higher tier. Although $CO_2$ emissions from civil aviation make a very small contribution to total emissions, they are a key category in the emissions trend. However, the implementation of the Tier 3 methodology had only a very small impact on the emissions, ranging from -0.10% to -0.16%. The Tier 1 methodology for 1990-2004 was thus not adjusted. As $CH_4$ and $N_2O$ emissions from civil aviation were not a key category, they are estimated with Tier 1 methodology across the timeseries. The default EF proposed by the IPCC 2006 guidelines used are 44.1 TJ/kt, 71.5 t $CO_2$/TJ, 0.5 kg $CH_4$/TJ and 2 kg $N_2O$/TJ.

Information on fuel consumption for domestic flights is not available from national statistics. To estimate the emissions from aviation, the available information on fuel consumption from EUROCONTROL was used (Table 3.14) for 2005-2023. This is the first year that consumption from the EUROCONTROL undetermined category has been included with the domestic consumption, based on a conversation with EUROCONTROL and national experts from other member states in a European Environment Agency webinar.

**Table 3.14. International and domestic flights' fuel consumptions, EUROCONTROL data (2005-2023)**

| **Fuel consumption (kt)** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
|---|---|---|---|---|---|---|---|---|
| Domestic | 3.863 | 3.289 | 2.937 | 2.839 | 2.321 | 2.467 | 0.787 | 0.583 |
| International | 263.3 | 265.2 | 261.2 | 269.8 | 255.2 | 260.2 | 269.7 | 260.4 |
| | | | | | | | | |
| | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
| Domestic | 0.445 | 0.333 | 0.374 | 0.246 | 0.391 | 0.279 | 0.114 | 0.163 |
| International | 243.5 | 244.0 | 238.1 | 278.1 | 316.5 | 326.9 | 319.9 | 101.0 |
| | | | | | | | | |
| | **2021** | **2022** | **2023** | | | | | |
| Domestic | 0.403 | 0.361 | 0.338 | | | | | |
| International | 175.1 | 250.4 | 302.3 | | | | | |

The share of domestic flights to the total fuel consumption is presented in Table 3.15. It can be noticed that there is a decreasing trend in the share of domestic flights to the total fuel consumption. The trend for these years can be represented by the equation $y=9E\text{-}05x^2 - 0.0026x + 0.018$. This equation was used to estimate the share of domestic flights to the total for the years 1990–2004 (Table 3.16), the period for which data is not available for domestic flights. The fuel consumption of domestic flights was estimated by multiplying the share of domestic flights by the total fuel consumption reported under all international flights by the Statistical Service for 1990–2004. The international flights consumption for 1990–2004 was revised by subtracting the estimated fuel consumption for domestic flights. The resulting fuel consumption for domestic and international flights for the years 1990–2004 is presented in Table 3.15. Fuel consumption obtained from the Statistical Service is in kt, and converted to TJ using the default NCV proposed by the 2006 IPCC Guidelines, i.e. 44.1 TJ/Gg (Table 1.2, pg.1.18, vol.2).

It was not possible to use LTOs data for the backcasting of the trend of the domestic/international aviation split, since there was no correlation between the available data and the LTOs (Figure 3.6).

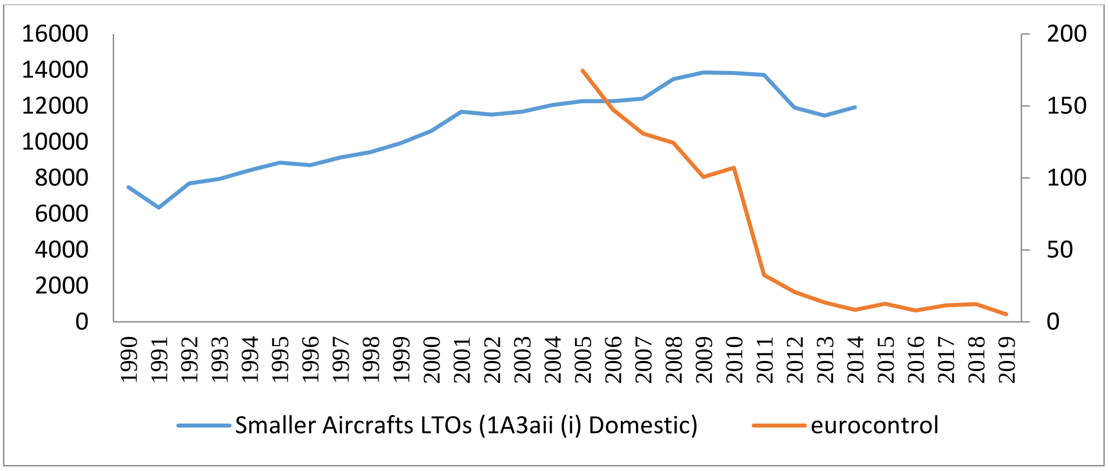


**Figure 3.6.** **Smaller aircrafts LTOs and EUROCONTROL data for domestic flights**

**Table 3.15. Share of domestic flights to the total fuel consumption, EUROCONTROL data (2005-2023)**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| Share of domestic to total | 1.45% | 1.22% | 1.11% | 1.04% | 0.90% | 0.94% | 0.29% | 0.22% |
| | | | | | | | | |
| | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
| Share of domestic to total | 0.18% | 0.14% | 0.16% | 0.09% | 0.12% | 0.09% | 0.04% | 0.16% |
| | | | | | | | | |
| | **2021** | **2022** | **2023** | | | | | |
| Share of domestic to total | 0.23% | 0.14% | 0.11% | | | | | |

**Table 3.16. Share of domestic flights to the total fuel consumption, consumption for domestic and international flights (1990–2004)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| Share of domestic to total | 3.50% | 3.36% | 3.22% | 3.08% | 2.94% | 2.80% | 2.66% | 2.52% |
| Domestic consumption (TJ) | 364 | 415 | 386 | 314 | 307 | 321 | 292 | 272 |
| International consumption (TJ) | 10043 | 11933 | 11609 | 9873 | 10144 | 11145 | 10689 | 10532 |
| TOTAL (TJ) | 10408 | 12348 | 11995 | 10187 | 10452 | 11466 | 10981 | 10805 |
| | | | | | | | | |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | |
| Share of domestic to total | 2.38% | 2.24% | 2.10% | 1.96% | 1.82% | 1.68% | 1.54% | |
| Domestic consumption (TJ) | 271 | 261 | 248 | 271 | 242 | 239 | 200 | |
| International consumption (TJ) | 11107 | 11382 | 11571 | 13576 | 13076 | 14005 | 12809 | |
| TOTAL (TJ) | 11378 | 11642 | 11819 | 13847 | 13318 | 14244 | 13010 | |

**Road transport (1A3b)**

Road transport emissions should include all combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on paved roads. GHG emissions from road transport were estimated using the COPERT 5.8 software. COPERT 5.8 is a MS Windows software program. In principle, COPERT 5.8 has been developed for use by the National Experts in order to estimate emissions from road transport which will be included in official annual national inventories. The use of a software tool to calculate road transport emissions allows for a transparent and standardized, hence consistent and comparable data collecting and emissions reporting procedure, in accordance with the requirements of international conventions and protocols and EU legislation.

The COPERT 5.8 methodology is part of the EMEP/CORINAIR Emission Inventory Guidebook 2016[27]. The Guidebook, developed by the UNECE Task Force on Emissions Inventories and Projections, is intended to support reporting under the UNECE Convention on Long-Range Transboundary Air Pollution and the EU directive on national emission ceilings.

COPERT 5.8 estimates emissions of all major air pollutants and GHG produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty vehicles, mopeds and motorcycles). Emissions estimated are distinguished in three sources:

- Emissions produced during thermally stabilized engine operation (hot emissions),
- emissions occurring during engine start from ambient temperature (cold-start and warming-up effects) and
- NMVOC emissions due to fuel evaporation.

Non-exhaust particulate emissions from tyre and brake wear are also included. The total emissions are calculated as a product of activity data provided by the user and speed-dependent emission factors calculated by the software.

In addition, the fuel consumed in this sector is taken into consideration. The COPERT 5.8 run estimates the fuel consumption (diesel and gasoline). These values are then compared to statistical fuel sold and the annual mileage values are corrected on the basis of the differences between calculated and statistical fuel consumption. A new COPERT run is performed with the adjusted data and all emissions are calculated.

COPERT 5.8 has been used for the calculations of the whole timeseries (1990 – 2023). The total number of road vehicles by type for the period 1990–2023 is shown in Table 3.17 and the corresponding trend is shown in Figure 3.7. Fuel consumption data was obtained from the energy balance prepared by the Statistical Service and is presented in Table 3.18. The calorific value used to convert mass to energy unit are according to the national energy balance; i.e. Diesel 43.0 TJ/kt, Gasoline 44.3 TJ/kt and Biodiesel 37.0 TJ/kt.

For the estimation of N2O emissions from diesel consumption by light duty vehicles, there is a fault in the COPERT 5.8 output files and the emisisons are missing for 1990-1994. When the fault will be fixed, the emissions will be recalculated normally with the software (FCCC/ARR/2023/CYP (E.2)).

The emissions from vehicles consuming LPG and Biodiesel have not been calculated using COPERT 5.8. They have been calculated with a Tier 1 method due to the lack of activity data regarding the fleet. Fuel consumption obtained from the Statistical Service is in kt, and converted to TJ using the default NCV proposed by the 2006 IPCC Guidelines, i.e. 47.3 TJ/Gg (Table 1.2, pg.1.18, vol.2). For the estimation of emissions, the default EF proposed by the IPCC 2006 guidelines are used; 63100 kg $CO_2$/TJ, 62 kg $CH_4$/TJ and 0.2 kg $N_2O$/TJ (IPCC 2006, page 3.21, vol.2).

Biofuels have been first introduced to the national energy mix in late 2007. Biofuel is mixed with diesel to a contribution ranging from 3-6.5%. During the first years (2007-2012), biofuels were solely from oil seeds. Since 2013 however, biodiesel used in Cyprus has an increasing contribution of used cooking oils (8.5% in 2013, 61.3% in 2014, 63.2% in 2015 and 97.1% in 2016).[28] According to the certificates of sustainability criteria which accompanied imported biofuels, all biofuels consumed in Cyprus were from biomass. The raw material used was cooking oil or oil crops.

The emissions from vehicles consuming Biofuels have not been calculated using COPERT 5.8. They have been calculated with a Tier 1 method.After the TERT recommendation, REVIEW 2020 (EU) (CY-1A3-2020-0001), emissions from the fossil part of the fuel have been calculated after Ioannis Sempos

[27] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 – September 2016, EEA Technical Report No. 21/2016

[28] Christina Karapitta, Energy Officer A', Energy Service, Ministry of Energy, Commerce and Industry (tel. 22409388, ckarapitta@mcit.gov.cy)

note. Biofuels in Cyprus are 100% FAME. The default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

**Table 3.17. Number of vehicles by type**

| | 1990 | 2000 | 2005 | 2010 | 2015 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|
| Buses | 2308 | 2949 | 3217 | 3403 | 2712 | 2646 | 2770 | 2899 | 3099 |
| Heavy Duty Trucks | 9633 | 11174 | 13605 | 16265 | 13142 | 13372 | 11473 | 11715 | 12165 |
| Mopeds & Motorcycles | 50953 | 43315 | 40381 | 40272 | 39282 | 41676 | 41189 | 40938 | 43253 |
| Light Commercial Vehicles | 64644 | 103436 | 104711 | 104437 | 90673 | 104576 | 104119 | 106858 | 119917 |
| Passenger Cars | 178602 | 267589 | 342146 | 462562 | 487692 | 575907 | 595771 | 601131 | 614805 |

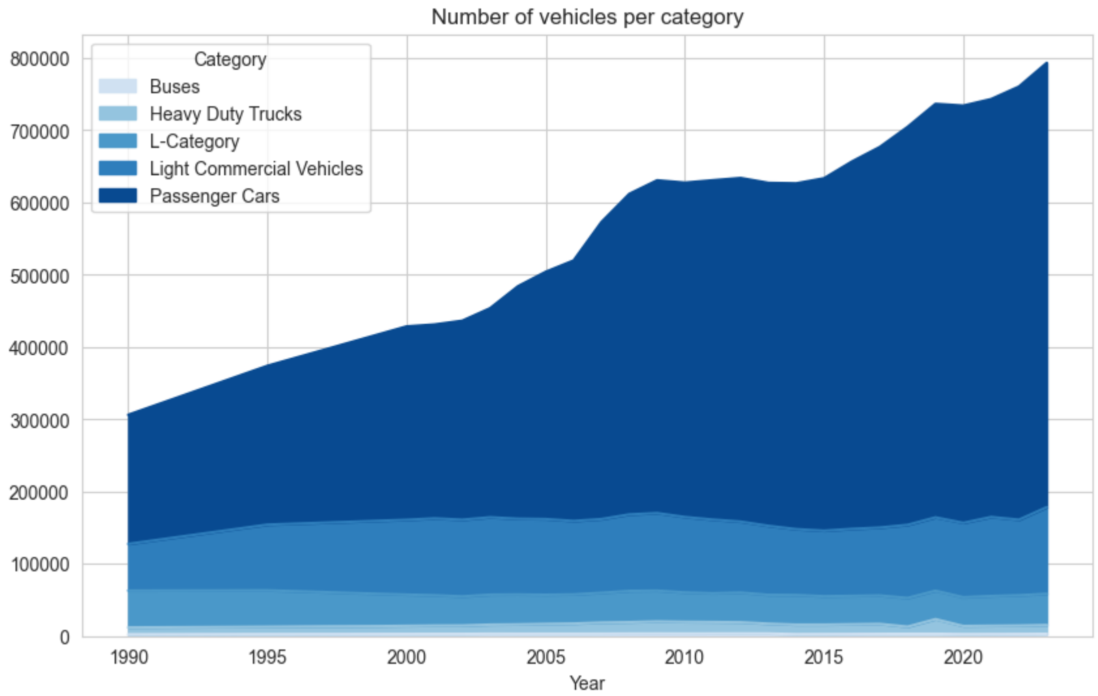


**Figure 3.7. Trend of vehicles population in the Road transport sector**

**Table 3.18. Fuel consumed by road transport (kt) during 1990–2023**

| kt | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 210 | 202 | 246 | 255 | 261 | 285 | 298 | 314 | 334 | 340 |
| Diesel | 163 | 170 | 172 | 169 | 180 | 183 | 186 | 191 | 195 | 203 |
| Biodiesel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LPG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| kt | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 350 | 355 | 341 | 351 | 354 | 346 | 323 | 338 | 344 | 336 |
| Diesel | 206 | 219 | 228 | 252 | 282 | 303 | 323 | 352 | 373 | 383 |
| Biodiesel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 | 17 |
| LPG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| kt | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 344 | 328 | 287 | 246 | 233 | 250 | 277 | 300 | 313 | 325 |
| Diesel | 390 | 385 | 372 | 349 | 341 | 345 | 353 | 350 | 341 | 336 |
| Biodiesel | 17 | 18 | 18 | 17 | 11 | 11 | 10 | 10 | 10 | 12 |
| LPG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0.5 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| kt | **2020** | **2021** | **2022** | **2023** | | | | | | |
| Gasoline | 307 | 328 | 314 | 318 | | | | | | |
| Diesel | 285 | 305 | 310 | 290 | | | | | | |
| Biodiesel | 27 | 28 | 26 | 24 | | | | | | |
| LPG | 0.4 | 0.5 | 0.5 | 0.4 | | | | | | |

After the TERT recommendation (CY-1A3b-2021-0002), emissions from lubricants combusted in two-stroke engines have been calculated with COPERT 5.8 and are reported separately for the first year in accordance with the IPCC 2006 Guidelines. The emissions are presented in table 3.19.

**Table 3.19. $CO_2$ emissions from lubricant use in two-stroke engines (kt) during 1990-2023**

| kt | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lubricants | 0.648 | 0.640 | 0.641 | 0.612 | 0.638 | 0.629 | 0.608 | 0.591 | 0.570 | 0.563 | 0.550 |
| kt | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Lubricants | 0.568 | 0.523 | 0.566 | 0.549 | 0.527 | 0.498 | 0.605 | 0.590 | 0.548 | 0.502 | 0.459 |
| kt | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
| Lubricants | 0.442 | 0.381 | 0.361 | 0.355 | 0.310 | 0.303 | 0.283 | 0.262 | 0.198 | 0.209 | 0.210 |
| kt | **2023** | | | | | | | | | | |
| Lubricants | 0.248 | | | | | | | | | | |

**Domestic water-borne navigation (1A3d(ii))**

Domestic water-borne navigation emissions should include emissions from fuels used by vessels of all flags that depart and arrive in the same country (excluding fishing, which should be reported under 1A4ciii, and military, which should be reported under 1A5b).

Estimation of emission from domestic water-borne navigation activities has been made possible due to data obtained from the Statistical Service on fuel consumption for the years 1998-2015 (Table 3.20). The consumption for remaining years has been estimated assuming the following: (a) for the years 1990-1997, the fuel consumption was estimated assuming that the contribution of domestic water-borne navigation activities to road transport remained the same as 1998 (0.33%). Indeed, in the energy balance, for 1990-1997, only one value was available for total transport and it was the same as the road transport one. There was no breakdown to domestic navigation or other subcategories. Note that international navigation was reported separately and was excluded from the total transport consumption.(FCCC/ARR/2023/CYP(E.3)). (b) for 2017 and 2018, activity data has been obtained from the Statistical Service. 2017 activity data has been revised.

Calorific values and emission factors of road diesel for the estimation of emissions from domestic water-borne navigation are according to IPCC 2006: NCV 43 TJ/kt (volume 2, pg. 1.18), 74100 kg $CO_2$/TJ (volume 2, pg. 3.50), 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ (assumed same as road - default, volume 2, pg. 3.21). Biodiesel consumption was reported for the first time in 2020:Default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

**Table 3.20. Fuel consumption by domestic water-borne navigation activities 1990-2023**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|---|---|---|---|
| Diesel (kt) | 0.69 | 0.66 | 0.81 | 0.84 | 0.86 | 0.94 | 0.98 | 1.03 | 1.10 | 1.24 |
| Biodiesel(kt) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |

| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|
| Diesel (kt) | 0.53 | 0.43 | 0.56 | 0.43 | 0.60 | 0.73 | 0.56 | 0.63 | 0.76 | 1.49 |
| Biodiesel(kt) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |

| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|---|---|---|---|
| Diesel (kt) | 0.95 | 0.89 | 0.63 | 0.47 | 0.56 | 0.63 | 0.47 | 0.65 | 0.67 | 0.88 |
| Biodiesel(kt) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2020** | **2021** | **2022** | **2023** | | | | | | |
| Diesel (kt) | 0.36 | 0.83 | 1.39 | 1.82 | | | | | | |
| Biodiesel(kt) | 0.03 | 0.07 | 0.13 | 0.12 | | | | | | |

#### 3.2.5.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 3.2.5.4. Category-specific QA/QC and verification

As described above, fuel consumption from EUROCONTROL and national statistics service is compared.

#### 3.2.5.5. Category-specific recalculations

Recalculations have been performed for 1A3d ii Domestic aviation for the years 2005-2022 due to the update in Tier methodology, and a revision to the methodology for fuel consumption during these years. The impact of these recalculations is presented in Table 3.21 below.

Recalculations have also been performed for 1A3b Road Transport for the whole time-series due to revised data from the department of Road Transport. The impact of the recalculations is presented in Table 3.22 below.

**Table 3.21. Impact of recalculations on $CO_2$ eq. emissions for Domestic Aviation 1990-2022**

| Gg $CO_2$ eq. | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|---|---|---|---|---|
| NIR 2025 | 12.261 | 10.439 | 9.323 | 9.009 | 7.367 | 7.831 | 2.499 | 1.849 | 1.413 | 1.057 |
| NIR 2024 | 12.576 | 10.623 | 9.427 | 8.970 | 7.252 | 7.716 | 2.348 | 1.495 | 0.968 | 0.606 |
| Change (%) | -2.51% | -1.73% | -1.11% | 0.44% | 1.59% | 1.49% | 6.43% | 23.65% | 46.02% | 74.53% |
| | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | | |
| NIR 2025 | 1.187 | 0.781 | 1.240 | 0.884 | 0.362 | 0.518 | 1.278 | 1.146 | | |
| NIR 2024 | 0.910 | 0.567 | 0.827 | 0.895 | 0.377 | 0.096 | 0.356 | 1.249 | | |
| Change (%) | 30.43% | 37.70% | 49.94% | -1.21% | -4.16% | 441% | 259% | -8.21% | | |

**Table 3.22. Impact of recalculations on $CO_2$ eq. emissions for Road Transport 1990-2022**

| **CO2 eq. (kt)** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|---|---|---|---|
| **NIR 2025** | 1,209 | 1,207 | 1,355 | 1,374 | 1,430 | 1,517 | 1,569 | 1,636 | 1,713 | 1,758 |
| **NIR 2024** | 1211 | 1209 | 1359 | 1380 | 1438 | 1527 | 1581 | 1650 | 1728 | 1776 |
| **Difference (%)** | 0.15% | 0.20% | 0.26% | 0.40% | 0.55% | 0.65% | 0.77% | 0.83% | 0.88% | 1.01% |
| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| **NIR 2025** | 1,802 | 1,860 | 1,844 | 1,954 | 2,058 | 2,099 | 2,088 | 2,226 | 2,316 | 2,317 |
| **NIR 2024** | 1820 | 1881 | 1866 | 1978 | 2059 | 2100 | 2089 | 2226 | 2313 | 2316 |
| **Difference (%)** | 0.97% | 1.11% | 1.17% | 1.21% | 0.05% | 0.06% | 0.04% | 0.00% | 0.11% | 0.03% |
| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| **NIR 2025** | 2,364 | 2,299 | 2,125 | 1,913 | 1,846 | 1,908 | 2,027 | 2,090 | 2,102 | 2,129 |
| **NIR 2024** | 2364 | 2299 | 2126 | 1916 | 1851 | 1918 | 2031 | 2097 | 2108 | 2134 |
| **Difference (%)** | 0.00% | 0.01% | 0.03% | 0.16% | 0.28% | 0.51% | 0.18% | 0.32% | 0.27% | 0.23% |
| | **2020** | **2021** | **2022** | | | | | | | |
| **NIR 2025** | 1,908 | 1,933 | 1,988 | | | | | | | |
| **NIR 2024** | 1908 | 2041 | 2126 | | | | | | | |
| **Difference (%)** | 0.00% | 5.30% | 6.51% | | | | | | | |

#### 3.2.5.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

### 3.2.6. Other sectors (1A4)

### 3.2.6.1. Category description

Other sectors source category (1A4) should include emissions from combustion activities in the sectors Commercial/Institutional (1A4a), Residential (1A4b) and Agriculture/Forestry/Fishing/Fish farms (1A4c), including combustion for the generation of electricity and heat for own use in these sectors. Thermal needs in these sectors are covered mainly by liquid fossil fuels, while the contribution of biomass (fuel wood), especially in the residential sector, is also significant (mainly in mountainous areas).

Due to the unavailability of consumption data for several years and sectors, using the fuel consumption data as published by the Statistical Service would create issues of consistency and comparability. Therefore, it was decided to complete the period using assumptions.

GHG emissions from other sectors in 2023 increased by 5.17% compared to 1990 emissions (from 434 Gg $CO_2$ eq in 1990 to 457 Gg $CO_2$ eq in 2023). Table 3.23 presents the trend between 1990 and 2023. Other sectors contributed 5.14% to the total emissions of the country in 2023 without LULUCF and 7.29% to the emissions from the energy sector. The emissions from Other sources (1A4) are presented in Figure 3.8.

**Table 3.23. GHG emissions from Other sectors 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| **4. Other sectors** | 434 | 731 | 610 | 571 | 622 | 600 | 521 | 457 | 532 |
| a. Commercial/ institutional | 76 | 117 | 100 | 120 | 114 | 108 | 105 | 83 | 89 |
| b. Residential | 302 | 508 | 421 | 373 | 425 | 412 | 339 | 307 | 360 |
| c. Agriculture/ forestry/ fishing | 56 | 106 | 89 | 77 | 83 | 80 | 77 | 67 | 83 |
| | | | | | | | | | |
| $CO_2$ | 430 | 725 | 605 | 563 | 613 | 591 | 513 | 450 | 522 |
| $CH_4$ | 0.10 | 0.14 | 0.15 | 0.22 | 0.25 | 0.27 | 0.25 | 0.21 | 0.32 |
| $N_2O$ | 0.003 | 0.005 | 0.004 | 0.005 | 0.006 | 0.006 | 0.005 | 0.004 | 0.006 |
| | | | | | | | | | |
| **Gg $CO_2$ eq.** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| **4. Other sectors** | 526 | 536 | 464 | 542 | 510 | 483 | 512 | 457 | |
| a. Commercial/ institutional | 83 | 93 | 91 | 120 | 88 | 96 | 105 | 106 | |
| b. Residential | 363 | 358 | 293 | 337 | 333 | 302 | 325 | 278 | |
| c. Agriculture/ forestry/ fishing | 80 | 85 | 79 | 85 | 89 | 85 | 82 | 73 | |
| | | | | | | | | | |
| $CO_2$ | 515 | 523 | 452 | 530 | 497 | 471 | 499 | 446 | |
| $CH_4$ | 0.32 | 0.37 | 0.36 | 0.38 | 0.39 | 0.37 | 0.40 | 0.34 | |
| $N_2O$ | 0.006 | 0.007 | 0.006 | 0.007 | 0.007 | 0.006 | 0.007 | 0.006 | |

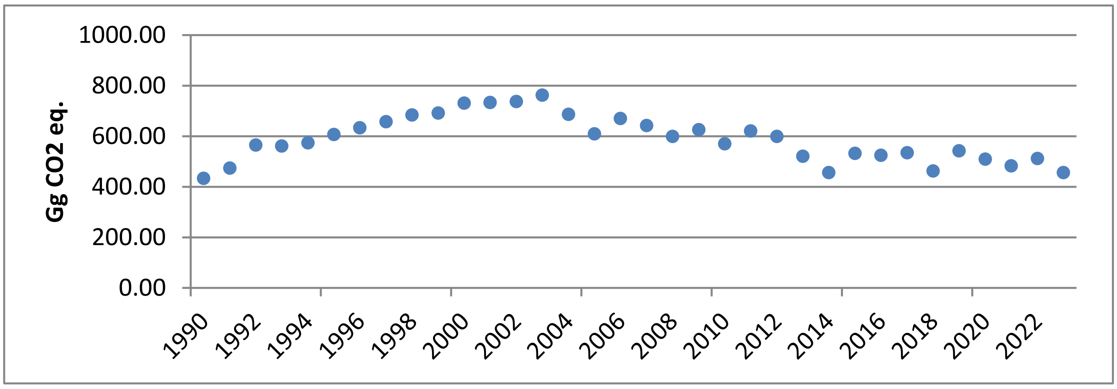


**Figure 3.8. Other sectors (1A4) emissions 1990–2023**

### 3.2.6.2. Methodological issues

As mentioned above, the unavailability of consumption data for several years and sectors mandated the use of assumptions to ensure consistency across the period. The activity data used for the estimation of GHG emissions of other sectors is presented at the end of the section in Table 3.26.

Gas biomass consumed by agriculture includes all biogas consumption. Diesel consumption by agriculture was revised to exclude diesel consumed for fishing (in red). Fuel consumption for fishing is added. Moreover RFO consumption by Off-road Vehicles and Other Machinery (1A4c ii) consumption is included in road transport (1A3b). The consumption of biogas by autoproducers is accounted for under category 1.A.4.c.i, as all the production and consumption of biogas occurs at farms with anaerobic digesters.

The GHG emissions from “other sectors” were estimated according to the IPCC 2006 guidelines. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.24). The oxidation factor used is 1, as proposed by the IPCC 2006 guidelines (pg. 1.20). The $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (IPCC 2006, pg. 2.20-2.22, oil) as presented in Table 3.24.

**Table 3.24. Parameters used for the estimation of emissions from other sectors**

| Fuel | NCV (TJ/kt) | kg $CO_2$ /TJ | kg $CH_4$ /TJ | kg $N_2O$ /TJ |
|---|---|---|---|---|
| Diesel | 43.0 | 74100 | 10 | 0.6 |
| Other Kerosene | 43.8 | 71900 | 10 | 0.6 |
| LPG | 47.3 | 63100 | 5 | 0.1 |
| RFO | 40.4 | 77400 | 10 | 0.6 |
| Solid Biomass | | 100000 | 300 | 4 |
| Charcoal | 29.5 | 112000 | 200 | 1 |
| Biodiesel | 37.0 | | 3.8 | 5.7 |
| Gas biomass | | 54600 | 5 | 0.1 |

#### 3.2.6.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 3.2.6.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 3.2.6.5. Category-specific recalculations

Recalculation was performed for Other Kerosene in the category 1A4a Commercial/Institutional from 2017-2022 due to a correction to the inventory files. There are also revisions to biomass in 1A4ci (2008-2022) for the same reason. The impact of these recalculations are shown below in Table 3.25.

**Table 3.25. Impact of recalculations on $CO_2$ eq. emissions for 1A4a, b, and c, 2008-2022**

| Gg $CO_2$ eq. | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|
| 1A4 | | | | | | | | |
| NIR 2025 | - | - | - | - | - | - | - | - |
| NIR 2024 | - | - | - | - | - | - | - | - |
| Change (%) | - | - | - | - | - | - | - | - |
| 1A4ci-Biomass | | | | | | | | |
| NIR 2025 | 4.4 | 10.3 | 12.9 | 20.5 | 21.9 | 21.4 | 21.9 | 21.7 |
| NIR 2024 | 4.3 | 10.0 | 12.7 | 20.3 | 21.6 | 21.2 | 21.7 | 21.4 |
| Change (%) | 2.56% | 2.81% | 1.18% | 0.95% | 1.06% | 0.91% | 0.63% | 1.41% |
| | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | |
| 1A4 | - | 105 | 5199 | 7021 | 7154 | 6407 | 6562 | |
| NIR 2025 | - | 113 | 5615 | 7582 | 7726 | 6919 | 7086 | |
| NIR 2024 | - | -7.40% | -7.40% | -7.40% | -7.40% | -7.40% | -7.40% | |
| Change (%) | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A4ci-Biomass | 22.6 | 23.3 | 24.6 | 25.8 | 26.2 | 25.8 | 24.8 | |
| NIR 2025 | 22.3 | 23.0 | 24.2 | 25.4 | 25.8 | 25.7 | 23.5 | |
| NIR 2024 | 1.30% | 1.65% | 1.60% | 1.66% | 1.63% | 0.60% | 5.66% | |
| Change (%) | 22.6 | 23.3 | 24.6 | 25.8 | 26.2 | 25.8 | 24.8 | |

### 3.2.6.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

**Table 3.26. Fuel consumption for "Other sectors" for the period 1990-2023**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1A4a Commercial / Institutional** | | | | | | | | | | | | | | | | | | |
| Gas-diesel oil (kt) | 11 | 12 | 15 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 22 | 21 | 21 | 19 | 18 | 19 | 18 |
| RFO (kt) | 2 | 5 | 5 | 4 | 5 | 4 | 5 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 1 | 2 | 2 |
| LPG (kt) | 12 | 12 | 13 | 12 | 12 | 12 | 12 | 13 | 12 | 12 | 13 | 13 | 13 | 14 | 13 | 13 | 13 | 13 |
| Solid biofuels (TJ) | 19 | 15 | 15 | 15 | 11 | 12 | 17 | 9 | 8 | 11 | 10 | 10 | 10 | 9 | 8 | 7 | 5 | 14 |
| Biogas (TJ) | | | | | | | | | | | | | | | | | | |
| Charcoal (kt) | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 7 |
| **1A4b Residential** | | | | | | | | | | | | | | | | | | |
| Other kerosene (kt) | 12 | 12 | 17 | 16 | 17 | 17 | 18 | 20 | 21 | 20 | 24 | 24 | 31 | 31 | 24 | 16 | 16 | 16 |
| Gas-diesel oil (kt) | 52 | 58 | 71 | 73 | 75 | 82 | 86 | 90 | 96 | 99 | 102 | 103 | 99 | 102 | 92 | 83 | 98 | 89 |
| LPG (kt) | 32 | 32 | 36 | 33 | 32 | 33 | 33 | 34 | 32 | 32 | 34 | 34 | 35 | 38 | 36 | 34 | 35 | 36 |
| Solid biofuels (TJ) | 126 | 105 | 103 | 102 | 74 | 79 | 119 | 61 | 56 | 77 | 68 | 70 | 64 | 58 | 53 | 51 | 74 | 95 |
| Charcoal (kt) | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 |
| **1A4c Agriculture / Forestry / Fishing / Fish farms** | | | | | | | | | | | | | | | | | | |
| ***1A4c i Stationary*** | | | | | | | | | | | | | | | | | | |
| Gas-diesel oil (kt) | 14 | 16 | 20 | 20 | 21 | 23 | 24 | 25 | 27 | 27 | 28 | 29 | 27 | 28 | 25 | 24 | 25 | 25 |
| LPG (kt) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Biogas (TJ) | | | | | | | | | | | | | | | | | | 15 |
| ***1A4c iii Fishing*** | | | | | | | | | | | | | | | | | | |
| Gas-diesel oil (kt) | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 |

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1A4a Commercial / Institutional** | | | | | | | | | | | | | | | | |
| Gas-diesel oil (kt) | 20 | 19 | 23 | 20 | 16 | 17 | 13 | 13 | 15 | 18.18 | 16.33 | 16.411 | 11.63 | 13.79 | 15.26 | 16.00 |
| RFO (kt) | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 3 | 4 | 4.21 | 3.2 | 3.6 | 2.4 | 4.3 | 3.9 | 4.5 |
| LPG (kt) | 14 | 13 | 13 | 14 | 14 | 12 | 11 | 12 | 11 | 13.17 | 13.75 | 15.53 | 11.12 | 9.71 | 11.54 | 10.74 |
| Other kerosene (kt) | | | | | | | | | | 0.03 | 1.64 | 2.21 | 2.59 | 2.02 | 2.07 | 2.01 |
| Solid biofuels (TJ) | 15 | 15 | 15 | 13 | 16 | 16 | 16 | 15 | 15 | 17 | 17 | 17 | 132 | 126 | 166 | 106 |
| Biogas (TJ) | | 11 | 12 | 11 | 11 | 11 | 11 | 11 | 12 | 17 | 45 | 54 | 20 | 24 | 27 | 37 |
| Charcoal (kt) | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7.07 | 5.98 | 5.63 | 5.46 | 5.82 | 6.49 | 5.91 |
| Biodiesel (kt) | | | | | | | | | | | | | 0.11 | 0.17 | 0.15 | 0.13 |
| **1A4b Residential** | | | | | | | | | | | | | | | | |
| Other kerosene (kt) | 14 | 19 | 14 | 16 | 17 | 12 | 9 | 14 | 14 | 14.25 | 9.30 | 12.56 | 12.79 | 11.46 | 11.74 | 8.05 |
| Gas-diesel oil (kt) | 78 | 83 | 70 | 80 | 76 | 62 | 57 | 65 | 65 | 65.04 | 53.44 | 60.44 | 59.7 | 49.49 | 54.59 | 45.31 |
| LPG (kt) | 34 | 36 | 34 | 38 | 37 | 33 | 31 | 34 | 35 | 32.47 | 28.45 | 32.15 | 31.31 | 33.46 | 35.18 | 33.60 |
| Solid biofuels (TJ) | 123 | 500 | 260 | 339 | 419 | 353 | 2491 | 551 | 531 | 691.3 | 709.2 | 769 | 644 | 610 | 634 | 538 |
| Charcoal (kt) | 6 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 8 | 8.64 | 8.51 | 8.4 | 10.2 | 8.7 | 9.7 | 8.9 |
| **1A4c Agriculture / Forestry / Fishing / Fish farms** | | | | | | | | | | | | | | | | |
| ***1A4c i Stationary*** | | | | | | | | | | | | | | | | |
| Gas-diesel oil (kt) | 23 | 20 | 19 | 22 | 21 | 21 | 19 | 22 | 21 | 22.11 | 20.57 | 21.98 | 23.78 | 22.69 | 21.12 | 18.7 |
| LPG (kt) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 2 | 2.42 | 2.53 | 2.86 | 2.58 | 2.41 | 2.80 | 2.59 |
| Biogas (TJ) | 78 | 198 | 262 | 437 | 465 | 455 | 464 | 460 | 475 | 419.4 | 442.7 | 463.7 | 470.9 | 468.7 | 429.3 | 403.8 |
| ***1A4c iii Fishing*** | | | | | | | | | | | | | | | | |
| Gas-diesel oil (kt) | 3 | 4 | 4 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1.79 | 1.91 | 1.48 | 1.62 | 1.65 | 1.58 |

## 3.2.7. Non-Specified (1A5)

### 3.2.7.1. Category description

All remaining emissions from fuel combustion that are not specified elsewhere should be reported under Non-Specified (1A5). Emissions from fuel delivered to the military in the country and delivered to the military of other countries that are not engaged in multilateral operations should also be included. The emissions during the period 1990–2023 are presented in Table 3.27 and Figure 3.9.

**Table 3.27. GHG emissions from Other (Not elsewhere specified) 1990–2023**

| Gg $CO_2$ eq. | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| **5. Other** | 11.1 | 21.6 | 19.2 | 20.5 | 26.9 | 20.5 | 26.7 | 38.2 | 25.4 |
| a. Stationary | 11.1 | 21.6 | 19.2 | 17.3 | 20.5 | 17.3 | 20.3 | 31.8 | 22.2 |
| b. Mobile | NA,NO | NA,NO | NA,NO | 3.2 | 6.3 | 3.2 | 6.3 | 6.3 | 3.2 |
| | | | | | | | | | |
| $CO_2$ | 11.0 | 21.4 | 19.0 | 20.3 | 26.6 | 20.3 | 26.4 | 38.0 | 25.3 |
| $CH_4$ | 0.001 | 0.003 | 0.006 | 0.006 | 0.007 | 0.006 | 0.007 | 0.005 | 0.003 |
| $N_2O$ | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0002 |
| | | | | | | | | | |
| **Gg $CO_2$ eq.** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| **5. Other** | 25.4 | 25.5 | 26.7 | 26.0 | 26.1 | 23.1 | 24.3 | 23.3 | |
| a. Stationary | 22.2 | 21.7 | 22.2 | 22.0 | 21.4 | 19.0 | 19.5 | 20.3 | |
| b. Mobile | 3.2 | 3.9 | 4.5 | 4.0 | 4.7 | 4.1 | 4.8 | 3.0 | |
| | | | | | | | | | |
| $CO_2$ | 25.3 | 25.4 | 26.6 | 25.9 | 26.0 | 23.0 | 24.1 | 23.1 | |
| $CH_4$ | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | |
| $N_2O$ | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | |

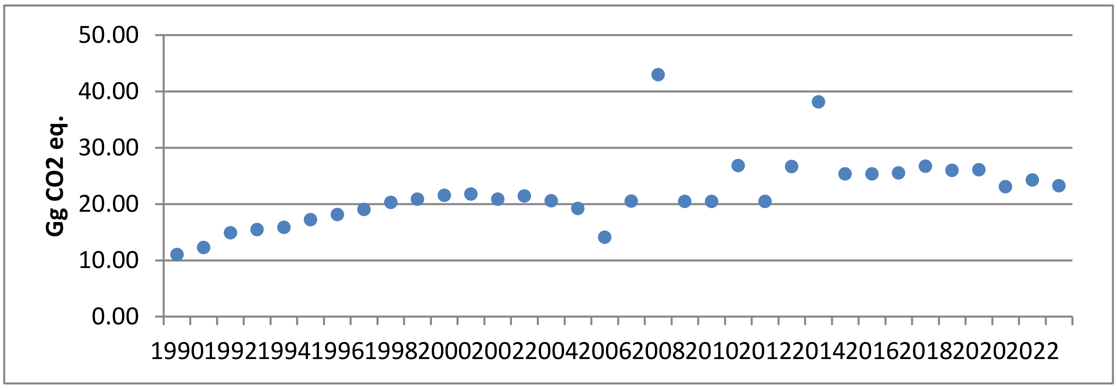


**Figure 3.9. GHG emissions from Other (Not elsewhere specified) (1A5) 1990–2023**

### 3.2.7.2. Methodological issues

Due to the unavailability of consumption data for several years and sectors, using the fuel consumption data as published by the Statistical Service would create issues of consistence and comparability. Therefore it was decided to complete the period using assumptions. Details on the methodology developed and applied are given in Annex 3. The activity data used for the estimation of GHG emissions of other sectors is presented in Table 3.28. Consumption of Gas-diesel oil, Lignite and LPG and biodiesel since 2020 is allocated to stationary combustion, whereas that of jet kerosene is allocated to mobile combustion.

**Table 3.28. Other non-specified fuel consumption 1990–2023**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|
| Gas-diesel oil (kt) | 3 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 6 |
| Lignite (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LPG (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jet kerosene (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
| Gas-diesel oil (kt) | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 4 | 6 |
| Lignite (kt) | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| LPG (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jet kerosene (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** |
| Gas-diesel oil (kt) | 13 | 5 | 5 | 6 | 5 | 5 | 9 | 6 | 6 |
| Lignite (kt) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| LPG (kt) | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| Jet kerosene (kt) | 0 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 |
| | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | | |
| Gas-diesel oil (kt) | 6 | 6 | 6 | 6 | 5 | 5 | 5 | | |
| Lignite (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| LPG (kt)0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| Jet kerosene (kt) | 1 | 1 | 1 | 1 | 1 | 2 | 1 | | |
| Biodiesel (kt) | NO | NO | NO | 0.214 | 0.197 | 0.222 | 0.339 | | |

**Methodology**

The GHG emissions were estimated according to the IPCC 2006 guidelines. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 1.23). The $CO_2$, $CH_4$ and $N_2O$ emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.22) as presented in Table 3.29. Biodiesel consumption was reported for the first time in 2020:Default total carbon content has been used 76.5% kgC/kgFAME , as well as 5,4% of carbon content fossil part. The $CH_4$ and $N_2O$ emissions have been been calculated using the EFs proposed by the 2006 IPCC Guidelines, i.e. 3.9 kg $CH_4$/TJ and 3.9 kg $N_2O$/TJ for both fossil and biogenic parts.

**Table 3.29. Parameters used for the estimation of other emissions**

| **Fuel** | **NCV (TJ/kt)** | **kg $CO_2$ /TJ** | **kg $CH_4$ /TJ** | **kg $N_2O$ /TJ** |
|---|---|---|---|---|
| Diesel | 43.0 | 74100 | 10 | 0.6 |
| LPG | 47.3 | 63100 | 5 | 0.1 |
| Jet kerosene | 44.1 | 71500 | 10 | 0.6 |
| Lignite | 11.9 | 101000 | 300 | 1.5 |
| Solid Biomass | 11.6 | 100000 | 300 | 4.0 |
| Biodiesel | 37.0 | | 3.9 | 3.9 |

### 3.2.7.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 3.2.7.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

### 3.2.7.5. Category-specific recalculations

Recalculation was performed for solid biomass in the category 1A5a for 2006, due to a correction in the inventory file. As shown in Table 3.30, this decreased $CO_2$ eq emissions from biomass from 0.6 to 0.

**Table 3.30. Impact of recalculations on CO2 eq. emissions for 1A5a**

| Gg $CO_2$ eq. | **2006** |
|---|---|
| NIR 2025 | 0 |
| NIR 2024 | 0.6 |

#### 3.2.7.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 3.2.8. Reference approach (1AB)

The Reference Approach is a top-down approach, using a country's energy supply data to calculate the emissions of $CO_2$ from combustion of mainly fossil fuels. The Reference Approach is a straightforward method that can be applied on the basis of relatively easily available energy supply statistics. Excluded carbon has increased the requirements for data to some extent. However, improved comparability between the sectoral and reference approaches continues to allow a country to produce a second independent estimate of $CO_2$ emissions from fuel combustion with limited additional effort and data requirements.

While the sectoral approach and the reference approach can each be used to estimate a country's $CO_2$ emissions from fuel combustion, the use of both allows the comparison of results from these two independent estimates. Significant differences may indicate possible problems/mistakes with the activity data, net calorific values, carbon content, excluded carbon calculation, etc.

The Reference Approach is designed to calculate the emissions of $CO_2$ from fuel combustion, starting from high level energy supply data. The assumption is that carbon is conserved so that, for example, carbon in crude oil is equal to the total carbon content of all the derived products. The Reference Approach does not distinguish between different source categories within the energy sector and only estimates total $CO_2$ emissions from Source category 1A, Fuel Combustion. Emissions derive both from combustion in the energy sector, where the fuel is used as a heat source in refining or producing power, and from combustion in final consumption of the fuel or its secondary products.

The estimation process is divided in six steps that are described below.

Step 1: Estimation of apparent consumption

This step concerns the estimation of apparent consumption in natural units or in the units commonly used for the recording of the relative fuel amounts. For secondary fuels production data are not included in the apparent consumption calculation, since they are already accounted for in the primary fuel consumption, from which they derive. Therefore, the apparent consumption of primary fuels is estimated by the following equation:

Apparent consumption = Primary production + Imports - Exports - International bunkers + Stock change

The apparent consumption of secondary fuels is estimated by the following equation:

Apparent consumption = Imports - Exports - International bunkers + Stock change

Step 2: Conversion of fuel data to a common energy unit

The values were multiplied by the net calorific values listed in Table 3.31 to provide the energy consumed in TJ. The NCV values used were the defaults proposed by the IPCC 2006 guidelines (volume 2, pg. 1.18) except for pet-coke and other bituminous coal. Pet-coke and other bituminous coal are consumed only from one cement producing installation. Therefore, in place of the default proposed by the IPCC, it was preferred to use the NCV implied by the annual reports submitted in accordance with national ETS legislation (law no. 110(I)/2011), which are available for the years 2000-2023. For the years 1990-1999 the NCV was assumed the same as 2000.

Step 3: Estimation of carbon content

Total carbon included in each fuel is calculated by multiplying energy consumption by an emission factor (Table 3.31) that reflects the amount of carbon per energy unit for each fuel. The result gives the maximum amount of carbon that could be potentially released if all carbon in the fuels were converted to $CO_2$. The carbon emission factor for fuels used in the reference approach are based predominately on the 2006 IPCC guidelines. The exceptions are pet-coke, other bituminous coal, waste (non-biomass fraction) and solid biomass. Pet-coke and other bituminous coal are consumed only from one cement producing installation. Therefore it was preferred to use the carbon emission factor implied by the annual reports submitted according to national ETS legislation (law no. 110(I)/2011), instead of the default proposed by the IPCC. Waste (non-biomass fraction) and solid biomass show annual variations because of the difference in ratios of the different types of waste and solid biomass consumed to the total.

Step 4: Estimation of carbon stored in products

Depending on the end use, non-energy uses of fuels can result in some or all of the carbon contained in the fuel being stored in the non-energy product. The non-energy consumption of fuels is multiplied by an emission factor that reflects the amount of the carbon content of the fuel stored in the non-energy product. The result is the maximum amount of carbon that could potentially be sequestered if that amount of carbon were stored in the non-energy product. By subtracting this amount from the total carbon calculated in step 3, the amount of carbon that could be theoretically converted to $CO_2$ is calculated.

Step 5: Estimation of carbon unoxidised during fuel use

The amount of carbon that was previously calculated is reduced by a fraction of 1%, in order to take account of the fact that a small part of the fuel carbon entering combustion escapes oxidation. It is assumed that the carbon that remains unoxidised is stored indefinitely.

Step 6: Estimation of $CO_2$ emissions

Carbon emissions from all fuels are multiplied by 44/12 to be converted to $CO_2$ emissions and are summed giving the total amount of $CO_2$ released in the atmosphere. The emissions estimated with the reference approach are presented in Table 3.32. Detailed presentation of the results is available in Annex 4.

**Table 3.31. Net calorific value (TJ/kt) and carbon emission factors (t $CO_2$/kt) of fuels consumed in Cyprus used for the reference approach**

**(a) Net calorific value (TJ/kt) and carbon emission factors (t $CO_2$/kt) that remain constant for the period 1990-2023**

| | Conversion factor (TJ/kt) | Carbon emission factor (tC/TJ) |
|---|---|---|
| Crude oil | 42.3 | 20.0 |
| Gasoline | 44.3 | 18.9 |
| Jet kerosene | 44.1 | 19.5 |
| Other kerosene | 43.8 | 19.6 |
| Gas-diesel oil | 43.0 | 20.2 |
| Residual fuel oil | 40.4 | 21.1 |
| Biodiesel | 37.5 | 7.65 |
| LPG | 47.3 | 17.2 |
| Bitumen | 40.2 | 22.0 |
| Lubricants | 40.2 | 20.0 |
| Pet-coke | 32.5 | table (b) |
| Other oil-refinery gas | 49.5 | 15.7 |
| Other oil-White spirit & SBP | 40.2 | 20.0 |
| Other bituminous coal | table (b) | table (b) |
| Lignite | 11.9 | 27.6 |
| Waste (non-biomass fraction) | NA | table (b) |
| Solid biomass | NA | table (b) |

**(b) Net calorific value (TJ/kt) and carbon emission factors (t $CO_2$/kt) that are not constant for the period 1990-2023**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| **NCV (TJ/kt)** | | | | | | | |
| Other bituminous coal | 27.650 | 27.650 | 27.650 | 27.650 | 27.650 | 27.650 | 27.650 |
| **Implied CEF (tC/TJ)** | | | | | | | |
| Pet-coke | 23.047 | 23.047 | 23.047 | 23.047 | 23.047 | 23.047 | 23.047 |
| Other bituminous coal | 25.254 | 25.254 | 25.254 | 25.254 | 25.254 | 25.254 | 25.254 |
| **C EF (tC/TJ)** | | | | | | | |
| Waste (non-biomass fraction) | NO | NO | NO | NO | NO | NO | NO |
| Solid biomass | 27.629 | 27.661 | 27.664 | 27.665 | 28.340 | 28.264 | 28.286 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| **NCV (TJ/kt)** | | | | | | | |
| Other bituminous coal | 27.650 | 27.650 | 27.650 | 27.650 | 26.840 | 26.400 | 27.300 |
| **Implied CEF (tC/TJ)** | | | | | | | |
| Pet-coke | 23.047 | 23.047 | 23.047 | 23.047 | 23.047 | 23.047 | 23.047 |
| Other bituminous coal | 25.254 | 25.254 | 25.254 | 25.254 | 25.254 | 25.254 | 25.254 |
| **C EF (tC/TJ)** | | | | | | | |
| Waste (non-biomass fraction) | NO | NO | NO | NO | 39.00 | NO | 39.00 |
| Solid biomass | 28.471 | 28.530 | 28.448 | 28.217 | 28.157 | 28.391 | 28.253 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| **NCV (TJ/kt)** | | | | | | | |
| Other bituminous coal | 28.621 | 28.621 | 29.995 | 28.360 | 25.950 | 26.080 | 26.819 |
| **Implied CEF (tC/TJ)** | | | | | | | |
| Pet-coke | 23.047 | 23.047 | 24.160 | 24.659 | 24.486 | 25.578 | 25.515 |
| Other bituminous coal | 25.254 | 25.254 | 25.156 | 22.815 | 25.788 | 25.661 | 25.794 |
| **C EF (tC/TJ)** | | | | | | | |
| Waste (non-biomass fraction) | 39.00 | 39.00 | 39.00 | 39.00 | 39.00 | 39.00 | 39.00 |
| Solid biomass | 28.542 | 28.971 | 28.956 | 28.664 | 28.351 | 28.172 | 28.344 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| **NCV (TJ/kt)** | | | | | | | |
| Other bituminous coal | 25.517 | NO | NO | 23.210 | 25.675 | 25.675 | 24.680 |
| **Implied CEF (tC/TJ)** | | | | | | | |
| Pet-coke | 25.301 | 24.795 | 25.238 | 25.583 | 25.150 | 25.313 | 28.710 |
| Other bituminous coal | 25.620 | NO | NO | 25.890 | 25.876 | 25.877 | 25.563 |
| **C EF (tC/TJ)** | | | | | | | |
| Waste (non-biomass fraction) | 39.00 | 25.00 | 25.00 | 37.36 | 30.996 | 30.996 | 27.553 |
| Solid biomass | 28.372 | 28.559 | 28.678 | 28.590 | 28.381 | 28.365 | 28.266 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| **NCV (TJ/kt)** | | | | | | | |
| Other bituminous coal | 25.800 | 25.800 | 26.135 | 25.800 | 24.300 | 21.840 | |
| **Implied CEF (tC/TJ)** | | | | | | | |
| Pet-coke | 24.609 | 24.932 | 24.125 | 27.356 | 25.624 | 25.645 | |
| Other bituminous coal | 25.767 | 25.773 | 26.025 | 25.824 | 26.122 | 26.328 | |
| **C EF (tC/TJ)** | | | | | | | |
| Waste (non-biomass fraction) | 27.298 | 26.66 | 27.67 | 27.40 | 26.30 | 26.55 | |
| Solid biomass | 28.239 | 28.181 | 28.217 | 28.156 | 28.099 | 28.188 | |

**Table 3.32. Apparent consumption (TJ) and $CO_2$ emissions (Gg) estimates according to the reference approach 1990–2023**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| **Liquid Fuels** | | | | | | | |
| Apparent consumption | 54375 | 56081 | 65181 | 69543 | 79397 | 68507 | 76527 |
| $CO_2$ | 4029 | 4186 | 4854 | 5185 | 5898 | 5088 | 5705 |
| **Solid Fuels** | | | | | | | |
| Apparent consumption | 2682 | 2682 | 719 | 857 | 747 | 553 | 498 |
| $CO_2$ | 248 | 248 | 67 | 79 | 69 | 51 | 46 |
| **Waste (non-biomass fraction)** | | | | | | | |
| Apparent consumption | NO | NO | NO | NO | NO | NO | NO |
| $CO_2$ | NO | NO | NO | NO | NO | NO | NO |
| **Biomass** | | | | | | | |
| Apparent consumption | 287 | 262 | 260 | 259 | 726 | 686 | 671 |
| $CO_2$ | 29 | 27 | 26 | 26 | 75 | 71 | 70 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| **Liquid Fuels** | | | | | | | |
| Apparent consumption | 74737 | 79902 | 80448 | 86282 | 85126 | 86041 | 94229 |
| $CO_2$ | 5562 | 5965 | 6007 | 6442 | 6337 | 6425 | 7049 |
| **Solid Fuels** | | | | | | | |
| Apparent consumption | 525 | 719 | 830 | 1355 | 1423 | 1399 | 1447 |
| $CO_2$ | 49 | 67 | 77 | 125 | 132 | 130 | 134 |
| **Waste (non-biomass fraction)** | | | | | | | |
| Apparent consumption | NO | NO | NO | NO | 18 | NO | 15 |
| $CO_2$ | NO | NO | NO | NO | 3 | NO | 2 |
| **Biomass** | | | | | | | |
| Apparent consumption | 565 | 614 | 487 | 515 | 551 | 606 | 694 |
| $CO_2$ | 59 | 64 | 51 | 53 | 57 | 63 | 72 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| **Liquid Fuels** | | | | | | | |
| Apparent consumption | 87897 | 89758 | 93369 | 98156 | 103844 | 101715 | 97847 |
| $CO_2$ | 6579 | 6740 | 7051 | 7410 | 7837 | 7679 | 7362 |
| **Solid Fuels** | | | | | | | |
| Apparent consumption | 1643 | 1500 | 1632 | 1402 | 1050 | 560 | 709 |
| $CO_2$ | 152 | 139 | 151 | 117 | 99 | 53 | 67 |
| **Waste (non-biomass fraction)** | | | | | | | |
| Apparent consumption | 71 | 138 | 73 | 288 | 239 | 276 | 299 |
| $CO_2$ | 10 | 20 | 10 | 41 | 34 | 39 | 43 |
| **Biomass** | | | | | | | |
| Apparent consumption | 608 | 565 | 570 | 915 | 1678 | 1859 | 1728 |
| $CO_2$ | 64 | 60 | 61 | 95 | 157 | 168 | 152 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| **Liquid Fuels** | | | | | | | |
| Apparent consumption | 94738 | 88673 | 75925 | 77428 | 78321 | 84258 | 86839 |
| $CO_2$ | 7115 | 6631 | 5689 | 5846 | 5884 | 6331 | 6503 |
| **Solid Fuels** | | | | | | | |
| Apparent consumption | 318 | 12 | 12 | 157 | 155 | 21 | 125 |
| $CO_2$ | 30 | 1 | 1 | 15 | 15 | 2 | 12 |
| **Waste (non-biomass fraction)** | | | | | | | |
| Apparent consumption | 56 | 24 | 45 | 316 | 516 | 663 | 902 |
| $CO_2$ | 8 | 2 | 4 | 43 | 59 | 66 | 91 |
| **Biomass** | | | | | | | |
| Apparent consumption | 1991 | 2031 | 1897 | 1811 | 2289 | 2453 | 3019 |
| $CO_2$ | 170 | 162 | 146 | 140 | 171 | 177 | 202 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| **Liquid Fuels** | | | | | | | |
| Apparent consumption | 86965 | 84634 | 78297 | 77783 | 81428 | 80053 | |
| $CO_2$ | 6496 | 6290 | 5809 | 5761 | 6020 | 5928 | |
| **Solid Fuels** | | | | | | | |
| Apparent consumption | 570 | 720 | 586 | 1679 | 1281 | 1048 | |
| $CO_2$ | 54 | 68 | 56 | 159 | 123 | 101 | |
| **Waste (non-biomass fraction)** | | | | | | | |
| Apparent consumption | 962 | 1289 | 1457 | 1676 | 1947 | 1922 | |
| $CO_2$ | 96 | 126 | 148 | 168 | 188 | 187 | |
| **Biomass** | | | | | | | |
| Apparent consumption | 3400 | 3395 | 4300 | 4388 | 4308 | 3882 | |
| $CO_2$ | 196 | 215 | 250 | 248 | 279 | 238 | |

### 3.2.9. Comparison of the sectoral approach with the reference approach (1AC)

The data used in the reference and the sectoral approach and the resulting emissions are presented in Annex 4. The comparison of the fuel consumption and the emissions is summarised in Table 3.33.

The small differences that occur between the two approaches have been caused (a) by the statistical difference that exists in the energy balance, between the Gross inland deliveries (Calculated) and the Gross inland deliveries (Observed) and (b) from differences in the data source used for sectoral approach. The statistical difference of the energy balance is presented in detail in Annex 4.

**Table 3.33. Difference between Reference and Sectoral Approach 1990–2023**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| **Fuel consumption (PJ)** | | | | | | | |
| Sectoral approach | 52.06 | 58.78 | 63.56 | 65.63 | 68.53 | 67.22 | 70.97 |
| Apparent energy consumption* | 55.45 | 57.72 | 63.61 | 67.71 | 77.38 | 66.57 | 74.34 |
| *Difference* | 6.50% | -1.81% | 0.08% | 3.18% | 12.92% | -0.96% | 4.75% |
| $CO_2$ **(Gg)** | | | | | | | |
| Reference approach | 4278 | 4435 | 4921 | 5265 | 5967 | 5140 | 5751 |
| Sectoral approach | 3925 | 4454 | 4776 | 4951 | 5159 | 5063 | 5355 |
| *Difference* | 9.00% | -0.44% | 3.04% | 6.33% | 15.66% | 1.50% | 7.40% |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| **Fuel consumption (PJ)** | | | | | | | |
| Sectoral approach | 72.65 | 77.09 | 80.55 | 83.44 | 82.03 | 84.15 | 89.30 |
| Apparent energy consumption* | 72.42 | 77.33 | 77.55 | 83.95 | 83.04 | 83.75 | 92.60 |
| *Difference* | -0.32% | 0.32% | -3.73% | 0.61% | 1.23% | -0.47% | 3.70% |
| $CO_2$ **(Gg)** | | | | | | | |
| Reference approach | 5611 | 6031 | 6083 | 6568 | 6471 | 6554 | 7185 |
| Sectoral approach | 5476 | 5815 | 6076 | 6298 | 6189 | 6348 | 6734 |
| *Difference* | 2.47% | 3.72% | 0.12% | 4.28% | 4.56% | 3.25% | 6.70% |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| **Fuel consumption (PJ)** | | | | | | | |
| Sectoral approach | 91.20 | 93.51 | 94.44 | 98.63 | 101.46 | 100.93 | 97.82 |
| Apparent energy consumption* | 86.56 | 88.31 | 92.22 | 97.20 | 102.12 | 100.02 | 95.64 |
| *Difference* | -5.08% | -5.56% | -2.35% | -1.45% | 0.66% | -0.90% | -2.22% |
| $CO_2$ **(Gg)** | | | | | | | |
| Reference approach | 6741 | 6899 | 7212 | 7568 | 7970 | 7772 | 7472 |
| Sectoral approach | 6895 | 7087 | 7276 | 7572 | 7787 | 7707 | 7478 |
| *Difference* | -2.23% | -2.65% | -0.88% | -0.05% | 2.36% | 0.84% | -0.07% |

|  | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| **Fuel consumption (PJ)** |  |  |  |  |  |  |  |
| Sectoral approach | 94.87 | 88.64 | 76.23 | 77.15 | 79.36 | 84.25 | 85.69 |
| Apparent energy consumption* | 92.30 | 87.11 | 74.78 | 76.86 | 77.99 | 83.34 | 86.16 |
| *Difference* | -2.71% | -1.73% | -1.90% | -0.38% | -1.73% | -1.08% | 0.55% |
| $CO_2$ **(Gg)** |  |  |  |  |  |  |  |
| Reference approach | 7153 | 6634 | 5695 | 5904 | 5957 | 6399 | 6606 |
| Sectoral approach | 7216 | 6731 | 5810 | 5941 | 6061 | 6450 | 6528 |
| *Difference* | -0.87% | -1.43% | -1.98% | -0.62% | -1.73% | -0.80% | 1.20% |

|  | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |  |
|---|---|---|---|---|---|---|---|
| **Fuel consumption (PJ)** |  |  |  |  |  |  |  |
| Sectoral approach | 84.82 | 85.62 | 79.15 | 81.06 | 82.07 | 81.36 |  |
| Apparent energy consumption* | 86.74 | 84.84 | 78.76 | 79.13 | 83.02 | 81.16 |  |
| *Difference* | 2.26% | -0.91% | -0.50% | -2.39% | 1.16% | -0.24% |  |
| $CO_2$ **(Gg)** |  |  |  |  |  |  |  |
| Reference approach | 6647 | 6484 | 6010 | 6088 | 6331 | 6217 |  |
| Sectoral approach | 6453 | 6505 | 5996 | 6049 | 6165 | 6222 |  |
| *Difference* | 2.99% | -0.32% | 0.23% | 0.65% | 2.69% | -0.09% |  |

* excluding non-energy use, reductants and feedstocks

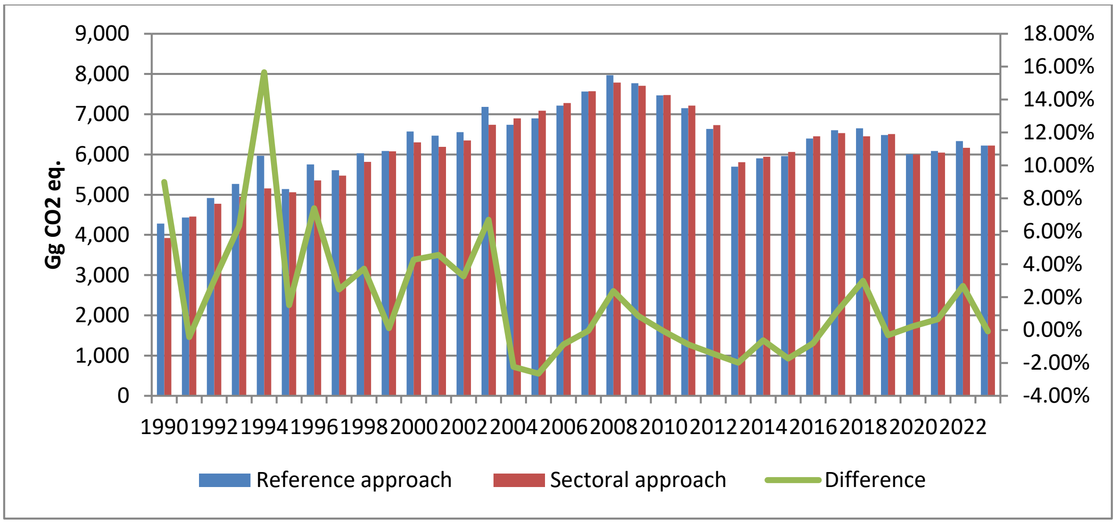


**Figure 3.10. $CO_2$ emissions from fuel combustion using sectoral and reference approach**

## 3.2.10. Feedstocks and non-energy use of fuels (1AD)

### 3.2.10.1. Category description

Carbon excluded from fuel combustion is either emitted in another sector of the inventory (for example as an industrial process emission) or is stored in a product manufactured from the fuel. The main flows of carbon concerned in the calculation of excluded carbon are those used as feedstock, reductant, or non-energy products. In Cyprus fuels that are used for non-energy uses are Lubricants and Bitumen.

Bitumen/asphalt is used for road paving and roof covering, where the carbon it contains remains stored for long periods of time. Consequently, there are no fuel combustion emissions arising from the deliveries of bitumen within the year of the inventory. Lubricating oil statistics usually cover not only use of lubricants in engines but also oils and greases for industrial purposes and heat transfer and cutting oils. All deliveries of lubricating oil should be excluded from the Reference Approach.

Non-energy use of fuels in Cyprus refers to the consumption of lubricants in transport and bitumen in construction. Data on the non-energy consumption of fuels was obtained from the national energy balance (Gross inland deliveries (Calculated)).

### 3.2.10.2. Methodological Issues

$CO_2$ emissions from non-energy use of fuels is calculated according to the methodology proposed by the IPCC 2006 guidelines. NCVs, carbon emission factor and fraction of C stored are also taken from the guidelines (Table 3.34) and after the TERT review recommendation (CY-1AB-2020-0001). Non-energy fuel use, carbon dioxide emissions and the amount of carbon stored in the final products are presented in Table 3.35.

The emissions are reported under 2D. The large difference that occurs for bitumen between the C stored estimated in Reference and 1AD between 1990–2004 is due to the production of bitumen by the refinery.

Consumption of lubricants is not available from the national energy balance for the years 1990-1992. These years have been completed using backwards extrapolation of activity data for 1993-1996. All the consumption has been assumed as imports of the purposes of the reference approach.

**Table 3.34. Parameters used for the calculation of emissions**

| | **Lubricants** | **Bitumen** |
|---|---|---|
| NCV (TJ/kt) | 40.2 | 40.2 |
| Carbon emission factor (t/TJ) | 20.00 | 0 |
| Oxidation factor | 1 | 1 |

**Table 3.35. Fuel consumption, carbon stored and $CO_2$ emissions for Feedstocks and non-energy use of fuels**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| **Lubricants** | | | | | | | | |
| Consumption (kt) | 7.00 | 7.00 | 7.00 | 7.81 | 10.81 | 10.81 | 11.81 | 10.82 |
| Carbon excluded (Gg) | 5.63 | 5.63 | 5.63 | 6.28 | 8.69 | 8.69 | 9.50 | 8.70 |
| $CO_2$ (Gg) | 4.13 | 4.13 | 4.13 | 4.60 | 6.37 | 6.37 | 6.96 | 6.38 |
| **Bitumen** | | | | | | | | |
| Consumption (kt) | 33 | 19 | 50 | 59 | 58 | 51 | 55 | 60 |
| Carbon excluded (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $CO_2$ (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| **Lubricants** | | | | | | | | |
| Consumption (kt) | 6.82 | 6.83 | 6.83 | 6.84 | 7.86 | 7.85 | 9.85 | 5.86 |
| Carbon excluded (Gg) | 5.49 | 5.49 | 5.49 | 5.50 | 6.32 | 6.31 | 7.92 | 4.71 |
| $CO_2$ (Gg) | 4.02 | 4.03 | 4.03 | 4.03 | 4.63 | 4.63 | 5.81 | 3.46 |
| **Bitumen** | | | | | | | | |
| Consumption (kt) | 75 | 86 | 85 | 81 | 84 | 69 | 66 | 71 |
| Carbon excluded (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $CO_2$ (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|---|---|---|---|
| **Lubricants** | | | | | | | | | |
| Consumption (kt) | 5.87 | 5.83 | 5.83 | 5.84 | 5.86 | 5.87 | 4.87 | 3.88 | 3.88 |
| Carbon excluded (Gg) | 4.72 | 4.69 | 4.69 | 4.70 | 4.71 | 4.72 | 3.92 | 3.12 | 3.12 |
| $CO_2$ (Gg) | 3.46 | 3.44 | 3.44 | 3.45 | 3.46 | 3.46 | 2.87 | 2.29 | 2.29 |
| **Bitumen** | | | | | | | | | |
| Consumption (kt) | 65 | 60 | 69 | 57 | 74 | 64 | 35 | 26 | 22 |
| Carbon excluded (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $CO_2$ (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
|---|---|---|---|---|---|---|---|---|---|
| **Lubricants** | | | | | | | | | |
| Consumption (kt) | 3.89 | 3.90 | 3.60 | 3.52 | 7.66 | 7.34 | 7.59 | 7.94 | 8.31 |
| Carbon excluded (Gg) | 3.13 | 3.14 | 2.89 | 2.83 | 6.16 | 5.90 | 6.10 | 6.39 | 6.68 |
| $CO_2$ (Gg) | 2.29 | 2.30 | 2.12 | 2.07 | 4.52 | 4.33 | 4.47 | 4.68 | 4.90 |
| **Bitumen** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Consumption (kt) | 21 | 36 | 38.95 | 40.16 | 37.12 | 31.59 | 42.29 | 31.63 | 39.4 |
| Carbon excluded (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $CO_2$ (Gg) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

#### 3.2.10.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 3.2.10.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 3.2.10.5. Category-specific recalculations

No recalculations are noted in the reference approach for this submission.

#### 3.2.10.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 3.3. Fugitive emissions from solid fuels and oil and natural gas and other emissions from energy production (1B)

Activities related to primary production (extraction), processing, storage and transmission/distribution of fossil fuels should be included in this sector. GHG released in the atmosphere during these operations is the direct result of leaks, disruptions and maintenance procedures. Moreover, the sector should also include emissions resulting from venting and flaring of gases that cannot be controlled by other means.

In Cyprus, there is no primary production of fuels or processing. There was one refinery in the country, which ceased its operation in 2004. Since then all fuels are imported. All transport of liquid fuels in Cyprus takes place by road transport. No central pipeline system is in place.

### 3.3.1. Oil & natural gas and other emissions from energy production

#### 3.3.1.1. Category description

Based on the above, the fugitive emissions from oil for Cyprus are caused by refining. For refining, no emissions are reported after 2004 when the refinery stopped operating (NO). Table 3.36 presents the emissions of the source. Methane emissions from refining activities (1.B.2.A.4) only occurred during 1990–2004 when the refinery was operating.

Transport of oil (1.B.2.a.3), as defined in the IPCC 2006 Guidelines, only took place during the time the refinery was operating; i.e. 1990–2004. As there is no activity data to estimate emissions for the years when the refinery was in operation, NE is used for this period. As no transport operations have taken place since the refinery closed, NO is used for the period after 2004.

Flaring (1.B.2.c.2.i) was taking place at the refinery, which ceased its operation in 2004. For the period the refinery was operating there is no activity data available to estimate emissions, therefore NE is used, while NO is used for the period after 2004.

Venting (1.B.2.c.1.i) occurs due to transport via Tanker Trucks from secondary fuel products. There is no primary production of fuel in Cyprus and the refining activities stopped in 2004. According to the definition of the IPCC 2006 Guidelines and the TERT recommendation CY-1B2C-2020-001, these emissions are included as “NA”.

**Table 3.36. Fugitive emissions from oil during 1990–2023, in tons**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|
| Refining (t $CH_4$) | 16.2 | 19.43 | 18.51 | 19.89 | 23.07 | 21.09 | 19.36 | 26.56 | 27.56 |
| Venting (t $CO_2$) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Venting (t $CH_4$) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | |
| | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
| Refining (t $CH_4$) | 30.05 | 29.87 | 29.44 | 27.66 | 24.73 | 7.11 | NO | NO | NO |
| Venting (t $CO_2$) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Venting (t $CH_4$) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | |
| | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2015** |
| Refining (t $CH_4$) | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Venting (t $CO_2$) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Venting (t $CH_4$) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | | | | | | | |
| | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | | |
| Refining (t $CH_4$) | NO | NO | NO | NO | NO | NO | NO | | |
| Venting (t $CO_2$) | NA | NA | NA | NA | NA | NA | NA | | |
| Venting (t $CH_4$) | NA | NA | NA | NA | NA | NA | NA | | |

### 3.3.1.2. Methodological issues

<u>Refining activities (1.B.2.A.4)</u>

GHG emissions from oil when the refinery was operating (through 2004) are estimated according to the Tier 1 methodology described in the IPCC 2006 guidelines. 0.0218 kg $CH_4$ /$m^3$ is used as the emission factor,[29] which is the default for oil refined from the IPCC 2006 guidelines (Table 4.2.4, pg. 4.53). The activity data used is from the energy balance of the National Statistical Service, and is presented in Table 3.37.

**Table 3.37. Oil refined during 1990–2004, kt**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Oil refined, kt | 743 | 891 | 849 | 912 | 1058 | 967 | 888 | 1218 | 1264 | 1379 |
| | | | | | | | | | | |
| | **2000** | **2001** | **2002** | **2003** | **2004** | | | | | |
| Oil refined, kt | 1370 | 1350 | 1269 | 1134 | 326 | | | | | |

### 3.3.1.3. Uncertainties and time-series consistency

The uncertainty analysis of all sectors is presented in Section 1.5. Time-series consistency is ensured by (a) using the same source of data for all years and (b) using the same methodology for the estimation of emissions for all years.

### 3.3.1.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

### 3.3.1.5. Category-specific recalculations

There are no reclaculations to be reported for this category.

### 3.3.1.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

[29] $(2.6+4.1)/2=3.35$ kg/$m^3$

# 3.4. $CO_2$ transport and storage (CRT 1.C)

Not occurring

# 3.5. Memo items (1.D)

All emissions from fuels used for international aviation (bunkers) and multilateral operations pursuant to the Charter of UN are to be excluded from national totals, and reported separately as memo items. Memo items are emissions that have to be estimated and reported but do not count towards the national total. The activities that occur in Cyprus under this category are International bunkers (1D1) and $CO_2$ from biomass (1D3). The emissions during the period 1990–2023 are presented below in Table 3.38.

**Table 3.38. Emissions from memo items (Gg $CO_2$ eq.)**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| 1D1. International bunkers | 909 | 1447 | 1764 | 1422 | 1490 | 1455 | 1538 | 1517 | 1533 |
| 1D3. $CO_2$ from biomass | 30 | 57 | 64 | 165 | 175 | 178 | 173 | 164 | 217 |
| | | | | | | | | | |
| **Gg $CO_2$ eq.** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| 1D1. International bunkers | 1800 | 1820 | 1906 | 1910 | 1206 | 1366 | 1716 | 1709 | |
| 1D3. $CO_2$ from biomass | 230 | 285 | 315 | 309 | 401 | 406 | 401 | 350 | |

## 3.5.1. International bunkers (1D1)

### 3.5.1.1. Category description

Emissions from flights and vessels of all flags that are engaged in international water-borne navigation that depart in one country and arrive in a different country should be included in international bunkers. Emissions from international bunkers as estimated for the period 1990–2023 are presented in Table 3.39.

**Table 3.39. Emissions from international bunkers 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| **International bunkers** | 909 | 1447 | 1764 | 1422 | 1490 | 1455 | 1538 | 1517 | 1533 |
| Aviation | 724 | 834 | 837 | 827 | 857 | 827 | 774 | 775 | 757 |
| Navigation | 185 | 613 | 927 | 595 | 633 | 627 | 764 | 742 | 776 |
| | | | | | | | | | |
| $CO_2$ (Gg) | 901 | 1434 | 1747 | 1408 | 1476 | 1441 | 1523 | 1503 | 1518 |
| $CH_4$ (Gg) | 0.02 | 0.05 | 0.08 | 0.05 | 0.06 | 0.05 | 0.06 | 0.06 | 0.07 |
| $N_2O$ (Gg) | 0.03 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 |
| **Gg $CO_2$ eq.** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| **International bunkers** | 1800 | 1820 | 1906 | 1910 | 1206 | 1366 | 1716 | 1709 | |
| Aviation | 884 | 1006 | 1039 | 1016 | 321 | 556 | 796 | 961 | |
| Navigation | 917 | 814 | 867 | 893 | 885 | 810 | 921 | 748 | |
| | | | | | | | | | |
| $CO_2$ (Gg) | 1783 | 1803 | 1888 | 1891 | 1193 | 1353 | 1699 | 1693 | |
| $CH_4$ (Gg) | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 | 0.06 | 0.07 | 0.06 | |
| $N_2O$ (Gg) | 0.06 | 0.06 | 0.06 | 0.06 | 0.04 | 0.05 | 0.06 | 0.05 | |

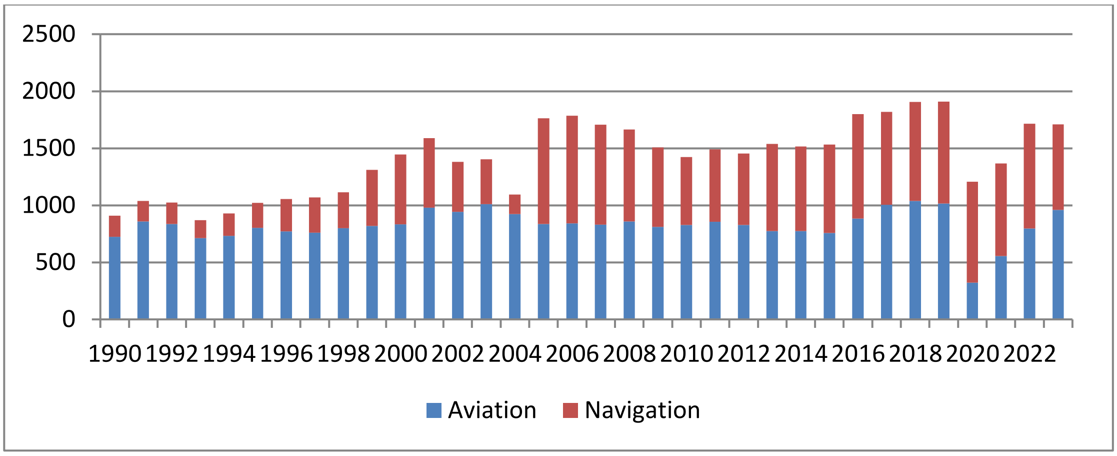


**Figure 3.11. Emissions from international bunkers 1990–2023**

### 3.5.1.2. Methodological issues

Activity data used for the estimation of emissions from bunkers is presented in Table 3.40. Data for all fuels except jet-kerosene was obtained from the energy balance of the national statistical service in kt of fuel consumed. Details on the method used to estimate the consumption of jet-kerosene are presented in section 3.2.5.2 and Annex 3. NCV and emission factors (Table 3.41) are the defaults proposed by the IPCC 2006 guidelines; i.e. 44.1 TJ/kt, 71.5 t $CO_2$/TJ, 0.5 kg $CH_4$/TJ and 2 kg $N_2O$/TJ.

**Table 3.40. Fuel consumption for international aviation and maritime activities 1990–2023 (kt)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Jet Kerosene | 228 | 271 | 263 | 224 | 230 | 253 | 242 | 239 | 252 | 258 |
| Gas/Diesel Oil | 24 | 20 | 21 | 14 | 12 | 15 | 25 | 27 | 35 | 46 |
| RFO | 34 | 36 | 38 | 36 | 50 | 54 | 65 | 71 | 63 | 108 |

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Jet Kerosene | 262 | 308 | 297 | 318 | 290 | 263 | 265 | 261 | 270 | 255 |
| Gas/Diesel Oil | 50 | 47 | 33 | 36 | 27 | 67 | 106 | 104 | 88 | 73 |
| RFO | 143 | 145 | 105 | 88 | 27 | 225 | 190 | 171 | 165 | 146 |

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Jet Kerosene | 260 | 270 | 260 | 243 | 244 | 238 | 278 | 317 | 327 | 320 |
| Gas/Diesel Oil | 53 | 58 | 69 | 83 | 80 | 75 | 95 | 101 | 117 | 123 |
| RFO | 134 | 141 | 128 | 157 | 153 | 169 | 193 | 154 | 154 | 156 |

| | 2020 | 2021 | 2022 | 2023 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Jet Kerosene | 101 | 175 | 250 | 302 | | | | | | |
| Gas/Diesel Oil | 119 | 113 | 123 | 87 | | | | | | |
| RFO | 158 | 141 | 165 | 147 | | | | | | |

**Table 3.41. Parameters used for the calculation of emissions**

| Fuel | NCV (TJ/kt) | kg $CO_2$/TJ | kg $CH_4$/ TJ | kg $N_2O$/ TJ |
|---|---|---|---|---|
| Jet Kerosene | 44.10 | 71500 | 0.5 | 2 |
| Gas/Diesel Oil | 43 | 74100 | 3.9 | 3.9 |
| RFO | 40.4 | 77400 | 3 | 0.6 |

### 3.5.1.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 3.5.1.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

### 3.5.1.5. Category-specific recalculations

An update to the methodology for fuel consumption in international aviation, as well as an update to Eurocontrol data from 2018 to 2023, resulted in some changes in emissions from 2005 to 2023, ranging from 0.0% to -2.5%.

### 3.5.1.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 3.5.2. $CO_2$ emissions from biomass (1.D.3)

### 3.5.2.1. Category description

Biomass in the energy sector is consumed by the sectors presented in Table 3.42. The resulting emissions from combustion of biomass are presented in Table 3.43 and Figure 3.12.

**Table 3.42. Activities consuming biomass in Cyprus**

| Source category | Solid biofuels | Charcoal | Liquid biofuels | Gas biofuels | Municipal Waste (Biomass Fraction) |
|---|---|---|---|---|---|
| 1A1c Manufacture of solid fuels and other energy industries | ✓ | | | | |
| 1A2b Non-ferrous metals | | | ✓ | | |
| 1A2c Chemical and petrochemical | ✓ | | | | |
| 1A2d Pupl, paper and print | | | ✓ | | |
| 1A2e Food, beverages and tobacco | ✓ | | | | |
| 1A2f Non-metallic minerals | ✓ | | | | ✓ |
| 1A2g Other | | | ✓ | | |
| 1A2m Non-specified Industry | | | ✓ | | |
| 1A3b Road transport | | | ✓ | | |
| 1A4a Commercial and public services | ✓ | ✓ | ✓ | ✓ | |
| 1A4b Residential | ✓ | ✓ | | | |
| 1A4c Agriculture/ Forestry | | | | ✓ | |

**Table 3.43. Emissions from $CO_2$ from biomass 1990–2023**

| | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ from biomass (Gg) | 30 | 57 | 64 | 165 | 175 | 178 | 173 | 164 | 217 |
| | | | | | | | | | |
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
| $CO_2$ from biomass (Gg) | 230 | 285 | 315 | 309 | 401 | 406 | 401 | 350 | |

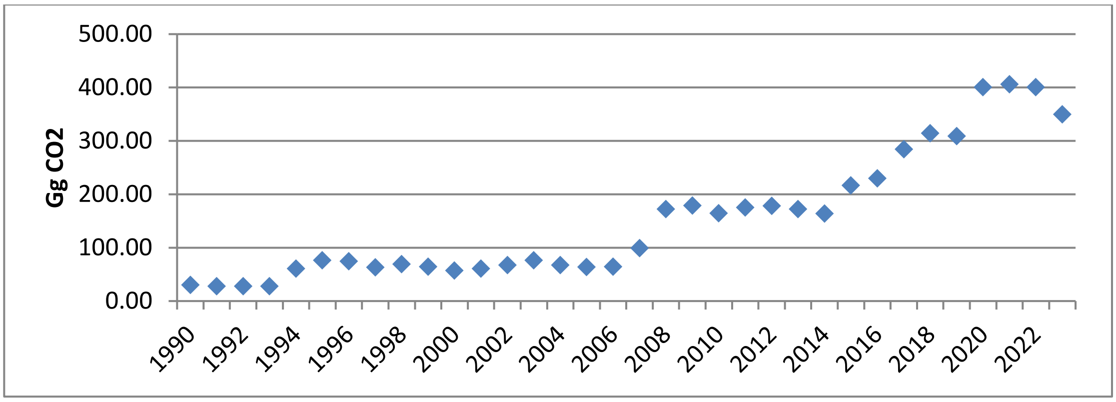


**Figure 3.12. Emissions from biomass 1990–2023**

#### 3.5.2.2. Methodological issues

Already described in the Sections where the biomass consumption occurs.

#### 3.5.2.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 3.5.2.4. Category-specific QA/QC and verification

Already described in the Sections where the biomass consumption occurs.

#### 3.5.2.5. Category-specific recalculations

Already described in the Sections where the biomass consumption occurs.

#### 3.5.2.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

# Chapter 4.
# Industrial processes and product use (CRT sector 2)

## 4.1. Overview of sector

The sector Industrial Processes and Product Use (IPPU) covers greenhouse gas emissions occurring from industrial processes, from the use of greenhouse gases in products, and from non-energy uses of fossil fuel carbon.

The main emission sources are releases from industrial processes that chemically or physically transform materials (for example, the cement industry is a notable example of industrial processes that release a significant amount of $CO_2$). During these processes, many different greenhouse gases, including carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), can be produced.

In addition, greenhouse gases often are used in products such as refrigerators, foams or aerosol cans. For example, HFCs are used as alternatives to ozone depleting substances (ODS) in various types of product applications. Similarly, sulphur hexafluoride ($SF_6$) and $N_2O$ are used in a number of products used in industry (e.g., $SF_6$ used in electrical equipment, $N_2O$ used as a propellant in aerosol products primarily in food industry) or by end-consumers (e.g., $SF_6$ used in running-shoes, $N_2O$ used during anaesthesia).

The main industrial activities that take place in Cyprus are food and beverage processing, cement and gypsum production, light chemicals (predominately pharmaceuticals), metal and wood products. Therefore, the source categories applicable for Cyprus in this sector are: Mineral products (2A), Non – energy products from Fuels and Solvent Use (2D), Product Uses as Substitutes for ODS (2F) and Other Product Manufacture and Use (2G).

### 4.1.1. Emissions trend

***Historic evolution of industrial activity in Cyprus***[30]

After gaining its independence in 1960, Cyprus demonstrated a successful economic performance in terms of full employment and economic stability, apart from some isolated events. The underdeveloped rural economy inherited from colonialism was transformed into a modern economy with dynamic services, light industry, a very good agricultural sector and advanced physical and social infrastructure. Once traditionally agricultural, Cyprus embraced industrial development in the 1960s and today specializes in the manufacture of medium and high-technology products and semi-customized small-batch products. Industry grew in a sheltered environment with tariffs and quotas which were introduced to protect local production.

Major events that have affected the growth and structure of the economy and specifically of the industrial sector were the Turkish invasion in 1974, accession to the World Trade Organization (WTO), the Customs Union Agreement with the EU in 1988 and eventual membership to the EU in 2004.

The Protocol for the Customs Union and Accession to the EU eliminated all restrictions to trade and increased competition in the local market. This had a major impact on the industrial sector, which had to face fierce competition both from EU markets and third countries.

1990-2002

[30] Irene Mitsiga, Industry and Technology Service, Ministry of Energy, Commerce, Industry and Tourism, Tel. +357 22 867192, fax. +357 22 375120, e-mail: imitsinga@mcit.gov.cy

In 2002, distribution of Value Added in Manufacturing by Industry, showed Food, beverages and tobacco, as the largest group contributing 38,8% to the manufacturing value added, registered a 1,0% increase in volume of production. This was mainly due to the increase of domestic demand. Other contributing subsectors were as follows: Basic Metals and Metal Products; Machinery and Electrical and Optical Equipment and Manufacture of Transport Equipment; Other Non-Metallic Mineral Products; Refined Petroleum Products; Chemicals and Chemical Products and Rubber and Plastic Products; Manufacturing n.e.c; Pulp, Paper and Paper Products; Publishing and Printing; Wood and Wood Products; Textiles and Textile Products; and Manufacture of Leather and Leather Products. Large increases were recorded in the exports of pharmaceutical products, plastic products, dairy products and perfumes and toilet preparations. Decreases were recorded in the exports of cigarettes, apparel, footwear, electricity distribution and control apparatus, kitchen furniture, and jewellery and related articles.

2004-2009

On 1 May 2004, Cyprus, together with nine other countries, formally took its place alongside the 15 member-states already in the European Union. During 2004, the Cyprus economy exhibited an accelerated rate of growth, in contrast to the conditions of subdued growth observed during the previous two years. The gradual improvement of the overall climate of confidence, which followed the accession of Cyprus to the EU, and the improved external environment of Cyprus, which positively affected the external demand for goods and services, constituted the main contributing factors towards this development. The significant increase of the oil price in international markets constituted a restraining factor towards further growth of the Cyprus economy. In summary, the Cyprus economy exhibited conditions of acceleration of economic activity in 2004, mainly due to the strengthening of domestic demand, and in particular private consumption demand along with investment demand in machinery, transport equipment and construction works.

2009-2014

In 2009, the Cypriot economy began to shrink as the economic crisis in Europe and elsewhere began to bite. The industrial sector was hit the hardest. Local investment was negatively affected by the financial crisis in 2013 where industry found it difficult to secure funding from the local banks.

Cyprus has no heavy industry and the expansion of its light industry is limited by the lack of raw materials and the size of the domestic market. Cyprus is radically restructuring its manufacturing base and actively seeking to attract new high-tech and knowledge-based industries. Main growth industries have been the ICT sector, specifically in manufacturing parts, instruments and electronics, as well as consumer products such as food and cosmetics. Cyprus' key industrial products are pharmaceuticals, food, beverages, chemicals, mineral products, machinery and equipment. Of these, only pharmaceuticals and non-metallic minerals have experienced growth in recent years. Today, manufacturing contributes approximately 5% of GDP and accounts for 9% of people in employment.

The majority of manufacturers are small and medium-sized enterprises (SMEs), which employ less than 10 workers. This makes the sector flexible and open to innovation. The government is seeking to improve SMEs' access to finance and overseas markets, and to maximize the commercial potential of local research and development in order to open up untapped areas of productivity.

In 2014, a stabilization trend began to appear for the industrial sector. Even though there was still a negative growth rate of the industrial sector due to the continuing recession, its value decreased to 0, 3% in 2014, compared to decreases of 6.9% in 2013. Its contribution to the GDP reached 7.1%. A total of 5,387 enterprises were operating in the industrial sector, and main exports were pharmaceutical products, food, basic metals, non-metallic mineral products (i.e. cement), machinery and equipment, and recycled material.

2015-2022

In 2015, the industrial sector registered a positive growth rate in real terms after six years of recession, reaching a rate of 6.1%. Its contribution to the GDP reached 7.0%. This was due to an increase in growth rate in all industrial sectors (NACE Rev.2 Sectors B-E) but especially in the manufacturing sector, where there was an increase in gross output and labour productivity per hour and a small increase in employment.

In 2016, Cyprus reached the end of a three-year economic adjustment program, rebounding significantly from the economic crisis. The industrial sector registered a positive growth rate in real terms for a second year in a row. This rate for the whole of the sector recorded an increase of 6.3% in 2016, compared to an increase of 6.1% in 2015. Manufacturing, which constitutes the largest industrial sector, recorded an increase of 6.3% compared to an increase of 5.9% in 2015 (according to provisional figures). In 2016, domestic industrial output exports grew by 2.6% compared to 2015. The most important categories exported were pharmaceuticals, food, non-metallic mineral products, recycled products, and machinery and equipment. Compared to 2015, large increases were recorded in exports of dairy products and fruit and vegetable products, due to new bilateral agreements (e.g. China) and access to their trading markets, while significant decreases were recorded in exports of cement and base metals.

In 2017, for the third consecutive year, industry experienced positive growth in real terms. In the industrial sector as a whole, production value at current prices increased by 12.8% in 2017 compared to 2016. Employment in the broader industrial sector in 2017 increased by 6.7% compared to 2016. The contribution of the whole industrial sector to the GDP reached 7.9% and 8.8% in total employment.

2018 is the fourth consecutive year that industry experienced positive growth in real terms. According to preliminary estimates from the Cyprus Statistical Office, in the industrial sector as a whole, production value at current prices increased by 8.2% in 2018 compared to 2017. In manufacturing, production value increased by 7.8%, in mines and quarries by 9.3%, in electricity supply by 12.2% and in water supply, sewerage and waste management by 3.4%. Employment in the broader industrial sector in 2018 increased by 3.8% compared to 2017. The contribution of the whole industrial sector to the GDP reached 7.9% and 8.3% in total employment.

According to 2019 statistics, Cyprus Industrial base was mainly operating in light industrial activities. Industry contributed 7.9% to GDP and about 9% of the total employment. The majority of manufacturing units were small- and medium-sized enterprises (SMEs), which occupied less than 10 employees. Main growth sectors were, among others, the ICT sector, the pharmaceutical sector, and the food and drink sector.

In 2022, Cyprus' industrial sector's contribution to the GDP further increased, reaching 8.5% compared to the 2020 contribution of 8.1%. Employment in the industrial sector in 2022 reached 9% of the total employment, marking an increase from the 8.1% recorded in 2020.

The Competitiveness of the industrial sector has still a lot of potentials and is rather low. This is mainly due to low productivity, high production costs and, in general, increased supply chain costs resulting from the small size of the market, the insularity of the economy and its geographic and energy "isolation", its limited resources, its low capacity for innovation (mainly due to a low percent of investment in R&D and to the very small size of businesses), insufficient use and implementation of quality standards, and lack of adequate tangible and intangible infrastructure.

Cyprus implements the New Industrial Policy, a policy document aiming to develop more high-value-added and innovative products and services that will contribute to the competitiveness of the Cyprus economy over all. At the same time Cyprus is aiming to increase productivity by strengthening the industrial ecosystem and promote the investment in digitalisation, sustainability, innovation and circular economy.

***Emissions***

In 2023, GHG emissions from Industrial processes accounted for 15.8% of total emissions excluding LULUCF compared to 13.3% in 1990. The emissions increased by 93% compared to 1990 and 6.1% compared to 2022. 68.4% of the industrial processes emissions were from mineral production, 29.5% from consumption of Halocarbons, 1.7% from Other Product Manufacture and Use and the remaining 0.4% from non-energy products from fuels and solvent use.

**Table 4.1. Total GHG emissions (in Gg $CO_2$ eq) from Industrial Processes, 1990–2023**

| | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| **2. Industrial Processes** | **727.93** | **882.17** | **1003.19** | **809.86** | **811.54** | **772.13** | **1013.20** |
| A. Mineral industry | 717.07 | 802.75 | 860.47 | 589.98 | 571.83 | 527.64 | 765.18 |
| B. Chemical industry | NO | NO | NO | NO | NO | NO | NO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C. Metal industry | NO | NO | NO | NO | NO | NO | NO |
| D. Non-energy products from fuels and solvent use | 4.19 | 4.10 | 3.46 | 3.53 | 3.53 | 2.96 | 2.37 |
| E. Electronic industry | NO | NO | NO | NO | NO | NO | NO |
| F. Product uses as ODS substitutes | NO,NE | 61.52 | 121.85 | 198.03 | 216.05 | 220.76 | 224.33 |
| G. Other product manufacture and use | 6.66 | 13.80 | 17.40 | 18.32 | 20.14 | 20.77 | 21.32 |
| H. Other | NO | NO | NO | NO | NO | NO | NO |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| **2. Industrial Processes** | **1241.75** | **1157.02** | **1185.18** | **1248.89** | **1198.37** | **1170.76** | **1268.32** |
| A. Mineral industry | 985.79 | 888.12 | 896.42 | 938.91 | 868.24 | 814.39 | 902.15 |
| B. Chemical industry | NO | NO | NO | NO | NO | NO | NO |
| C. Metal industry | NO | NO | NO | NO | NO | NO | NO |
| D. Non-energy products from fuels and solvent use | 2.38 | 2.47 | 2.66 | 2.43 | 2.44 | 4.97 | 4.78 |
| E. Electronic industry | NO | NO | NO | NO | NO | NO | NO |
| F. Product uses as ODS substitutes | 231.73 | 243.96 | 264.78 | 285.96 | 305.83 | 330.00 | 336.65 |
| G. Other product manufacture and use | 21.86 | 22.47 | 21.33 | 21.59 | 22.76 | 21.39 | 24.74 |
| H. Other | NO | NO | NO | NO | NO | NO | NO |

| | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| **2. Industrial Processes** | **1290.19** | **1324.48** | **1404.72** | | | | |
| A. Mineral industry | 896.99 | 900.39 | 960.28 | | | | |
| B. Chemical industry | NO | NO | NO | | | | |
| C. Metal industry | NO | NO | NO | | | | |
| D. Non-energy products from fuels and solvent use | 4.95 | 5.17 | 5.38 | | | | |
| E. Electronic industry | NO | NO | NO | | | | |
| F. Product uses as ODS substitutes | 364.61 | 394.92 | 414.96 | | | | |
| G. Other product manufacture and use | 23.64 | 24.00 | 24.09 | | | | |
| H. Other | NO | NO | NO | | | | |

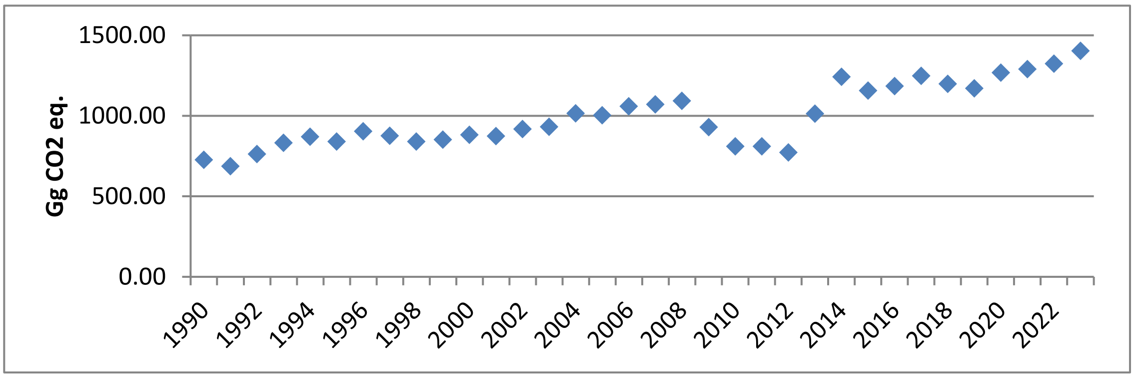


**Figure 4.1. GHG emissions from Industrial Processes (sector 2) for the period 1990–2023**

## 4.1.2. Completeness

Table 4.2 gives an overview of the IPCC source categories included in this chapter and presents the status of emissions estimates from all sub-sources in industrial processes.

**Table 4.2. Industrial Processes – completeness**

| | $CO_2$ | $CH_4$ | $N_2O$ | HFC | PFC | $SF_6$ |
|---|---|---|---|---|---|---|
| 2A1.Cement production | ✓ | NE | NE | NE | NE | NE |
| 2A2. Lime production | ✓ | NE | NE | NE | NE | NE |
| 2A3. Glass production | NO | NE | NE | NE | NE | NE |
| 2A4a. Other process Uses of Carbonates - Ceramics | ✓ | NE | NE | NE | NE | NE |
| 2A4b. Other uses of soda ash | ✓ | NE | NE | NE | NE | NE |
| 2B. Chemical industry | NO | NE | NE | NE | NE | NE |
| 2C. Metal Industry | NO | NE | NE | NE | NE | NE |
| 2D1. Non-energy Products from Fuels and Solvent Use – Lubricant Use | ✓ | NE | NE | NE | NE | NE |
| 2D2. Paraffin wax Use | ✓ | NE | NE | NE | NE | NE |
| 2D3. Non Energy Products from Fuels and Solvent Use | ✓ | NE | NE | NE | NE | NE |
| 2E. Electronics Industry | NE | NE | NE | NO | NO | NO |
| 2F1. Refrigeration & air conditioning | NE | NE | NE | ✓ | NO | NE |
| 2F2. Foam blowing agents | NE | NE | NE | ✓ | NO | NE |
| 2F3. Fire protection | NE | NE | NE | ✓ | NO | NE |
| 2F4a. Metered dose inhalers | NE | NE | NE | ✓ | NO | NE |
| 2F5. Solvents | NE | NE | NE | NO | NO | NE |
| 2G1. Electrical equipment | NE | NE | NE | NE | NO | ✓ |
| 2G3. $N_2O$ from product uses | NE | NE | ✓ | NE | NE | NE |
| 2G4. Other | ✓ | NE | NE | NE | NE | NE |

NO: Not Occurring; NE: Not Emitted during the specific industrial process

## 4.1.3. Methodology

The calculation of GHG emissions is based on the methodologies and emission factors suggested by the IPCC 2006 Guidelines for lime production (2A2), Other uses of soda ash (2A4b), Lubricant Use (2D1) and Urea-based catalysts. The emissions for remaining sectors are estimated using country specific methodologies. The methodologies and emission factors used are summarised in Table 4.3.

**Table 4.3. Industrial processes – methodologies and emission factors applied**

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 2A1. | Industrial Processes and Product Use – Mineral Industry - Cement production | $CO_2$ | CS | CS |
| 2A2 | Industrial Processes and Product Use – Mineral Industry - Lime Production | $CO_2$ | D | T1 |
| 2A4a | Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Ceramics | $CO_2$ | CS | CS |
| 2A4b | Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Other uses of soda-ash | $CO_2$ | D | T1 |
| 2A4b | Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Other uses of soda-ash | $CH_4/N_2O$ | NA | NA |
| 2D1 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use- Lubricant Use | $CO_2$ | D | T1 |
| 2D1 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use- Lubricant Use | $CH_4/N_2O$ | NA | NA |
| 2D2 | Industrial Processes and Product Use – Non Energy | $CO_2$ | D | T1 |

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| | Products from Fuels and Solvent Use - Paraffin Wax Use | | | |
| 2D2 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use - Paraffin Wax Use | $CH_4$/$N_2O$ | NA | NA |
| 2D3 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts | $CO_2$ | D | D |
| 2D3 | Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts | $CH_4$/$N_2O$ | NA | NA |
| 2F1 | Product Uses as Substitutes for ODS - Refrigeration and air conditioning | HFCs | D | T2a |
| 2F2 | Product Uses as Substitutes for ODS - Foam Blowing Agents | HFCs | CS | CS |
| 2F3 | Product Uses as Substitutes for ODS - Fire Protection | HFCs | CS | CS |
| 2F4. | Product Uses as Substitutes for ODS - Aerosols | HFCs | CS | CS |
| 2G1 | Other Product Manufacture and Use – Electrical Equipment | $SF_6$ | D | T1 |
| 2G3a | Other Product Manufacture and Use - $N_2O$ from product uses – Medical Applications | $N_2O$ | CS | CS |
| 2G3b | Other Product Manufacture and Use - $N_2O$ from product uses – Other –Propellant for pressure and aerosol products | $N_2O$ | CS | CS |

T1: IPCC methodology Tier 1; D: IPCC default methodology and emission factor; CS: Country specific; T2a: IPCC methodology Tier 2a

## 4.2. Mineral products (2.A)

This chapter outlines process-related carbon dioxide ($CO_2$) emissions resulting from the use of carbonate raw materials in the production and use of a variety of mineral industry products. There are two broad pathways for release of $CO_2$ from carbonates: calcination and the acid-induced release of $CO_2$. The primary process resulting in the release of $CO_2$ is the calcination of carbonate compounds, during which, through heating, a metallic oxide is formed.

The mineral products that are produced in Cyprus are cement, lime and ceramics. Other products that are consumed in Cyprus are limestone (only in cement and lime production - already accounted for in 2A1 and 2A2) and soda ash. According to the information obtained from the Customs, soda ash in Cyprus is imported for consumption by a bentonite quarry, lab supplies, swimming pools, production of building materials and cleaning products. The emissions estimated by product are presented in Table 4.4.

Emissions from mineral products in 2023 increased by 33.9% compared to 1990. An increase of emissions by 6.6% is observed in relation with the previous year (2022). The largest emitter continues to be cement production with 97.7% of the emissions (compared to 93.1% in 1990). The mineral materials produced in Cyprus are directly associated with the construction industry. Therefore, the economic situation in Cyprus after 2008 that directly affected constructions is also visible in the trend of the emissions of the sector. In 2013 however, even though the economic situation did not improve, emissions increase due to an increase in cement production caused by increase in exports.

**Table 4.4. Emissions from mineral industry 1990–2023 (Gg $CO_2$)**

| Gg $CO_2$ | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| **A. Mineral industry** | **717.07** | **802.75** | **860.47** | **589.98** | **571.83** | **527.64** | **765.18** |
| 1. Cement production | 667.66 | 762.71 | 788.18 | 555.05 | 546.04 | 504.54 | 752.29 |
| 2. Lime production | 5.33 | 5.41 | 12.06 | 7.20 | 7.15 | 3.39 | 2.73 |
| 3. Glass production | NO | NO | NO | NO | NO | NO | NO |
| 4. Other process uses of carbonates | 44.08 | 34.63 | 60.23 | 27.74 | 18.63 | 19.72 | 10.16 |
| | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $CO_2$ (Gg) | 717.07 | 802.75 | 860.47 | 589.98 | 571.83 | 527.64 | 765.18 |
| Total (Gg $CO_2$) | **717.07** | **802.75** | **860.47** | **589.98** | **571.83** | **527.64** | **765.18** |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| **A. Mineral industry** | **985.79** | **888.12** | **896.42** | **938.91** | **868.24** | **814.39** | **902.15** |
| 1. Cement production | 973.76 | 877.13 | 883.25 | 922.88 | 848.16 | 789.21 | 882.32 |
| 2. Lime production | 2.45 | 2.36 | 2.38 | 3.18 | 5.33 | 3.93 | 3.11 |
| 3. Glass production | NO | NO | NO | NO | NO | NO | NO |
| 4. Other process uses of carbonates | 9.58 | 8.64 | 10.78 | 12.86 | 14.74 | 21.24 | 16.72 |
| | | | | | | | |
| $CO_2$ (Gg) | 985.79 | 888.12 | 896.42 | 938.91 | 868.24 | 814.39 | 902.15 |
| Total (Gg $CO_2$) | **985.79** | **888.12** | **896.42** | **938.91** | **868.24** | **814.39** | **902.15** |

| | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| **A. Mineral industry** | **896.99** | **900.39** | **960.28** | | | | |
| 1. Cement production | 878.81 | 879.61 | 938.19 | | | | |
| 2. Lime production | 3.99 | 3.91 | 5.96 | | | | |
| 3. Glass production | NO | NO | NO | | | | |
| 4. Other process uses of carbonates | 14.19 | 16.87 | 16.13 | | | | |
| | | | | | | | |
| $CO_2$ (Gg) | 896.99 | 900.39 | 960.28 | | | | |
| Total (Gg $CO_2$) | **896.99** | **900.39** | **960.28** | | | | |

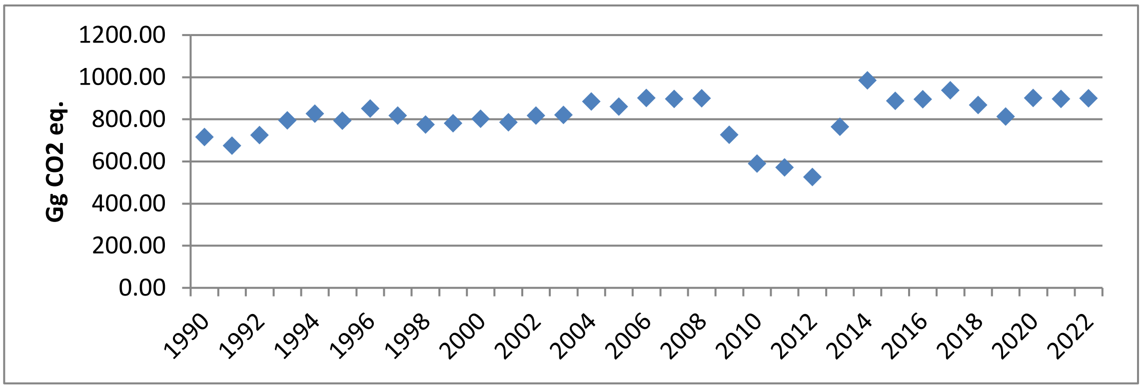


**Figure 4.2. GHG emissions from Mineral products (2A) for the period 1990–2023**

## 4.2.1. Cement production (2.A.1)

In cement manufacture, $CO_2$ is produced during the production of clinker, a nodular intermediate product that is then finely ground, along with a small proportion of calcium sulphate [gypsum ($CaSO_4 \cdot 2H_2O$) or anhydrite ($CaSO_4$)], into hydraulic (typically portland) cement. During the production of clinker, limestone, which is mainly calcium carbonate ($CaCO_3$), is heated, or calcined, to produce lime (CaO) and $CO_2$ as a by-product. The CaO then reacts with silica ($SiO_2$), alumina ($A_{l2}O_3$), and iron oxide ($Fe_2O_3$) in the raw materials to make the clinker minerals (chiefly calcium silicates). The proportion in the raw materials of carbonates other than $CaCO_3$ is generally very small. The other carbonates, if present, exist mainly as impurities in the primary limestone raw material.

The emissions for the source category are presented in Table 4.5 and Figure 4.3. After 2008 there was sharp decrease in activity of the construction industry in Cyprus, which is reflected in the emissions. The sharp increase between 2013 and 2014 is due to an increase of exports, while between 2014 and 2015 there was a reduction in demand for exports, which caused a reduction in production.

**Table 4.5. $CO_2$ emissions for Cement production (2.A.1) 1990–2023**

| | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Gg $CO_2$ | 667.66 | 762.71 | 788.18 | 555.05 | 546.04 | 504.54 | 752.29 | 973.76 | 877.13 |

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|---|---|
| Gg $CO_2$ | 883.25 | 922.88 | 848.16 | 789.21 | 882.32 | 878.81 | 879.61 | 938.19 | |

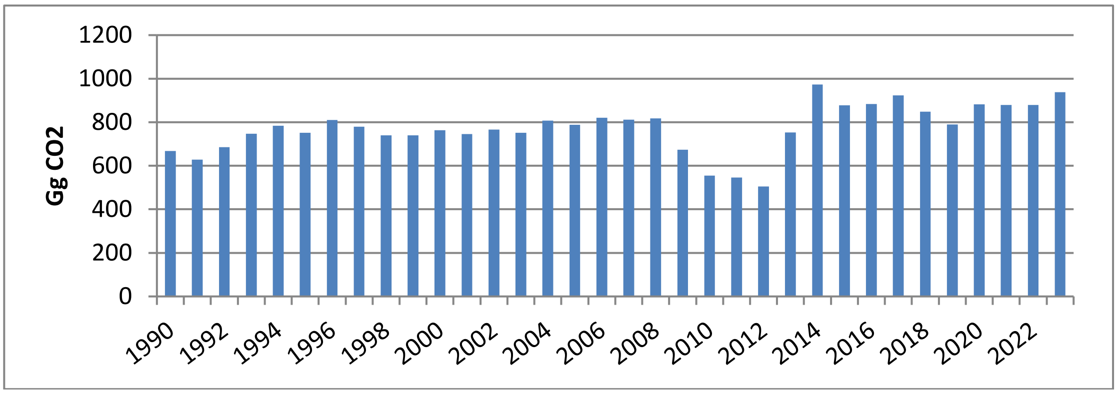


**Figure 4.3. $CO_2$ emissions for Cement production (2.A.1) 1990–2023**

In Cyprus, there is one cement producing installation, which provides information regarding $CO_2$ emissions in accordance with the EU-ETS legislation. Industrial installations covered by the EU ETS are required to have an approved monitoring plan for monitoring and reporting annual emissions. Every year, operators must submit an emissions report. The data for a given year must be verified by an accredited verifier by 31 March of the following year[31]. The EU ETS Directive was adopted in 2003 and the system was launched in 2005. The cap on allowances for the first trading period was set at national level through National Allocation Plans (NAPs)[32]. For the preparation of the NAP for the first trading period (2005-2007) historical data was collected for relevant installations. For the two cement installations that were operating at the time, data was available from 1997.

For the period 2012-2014 the clinker production increased annually due to an increase of exports to Lebanon. However, in 2015, the clinker production decreased 10% below the 2014 production. According to the information provided by the installation, two reasons accounted for this reduction: (a) there was a reduction in demand for exports; and (b) clinker production is regulated by available stocks, storage capacity and demand.

#### 4.2.1.1. Methodological issues

Data for clinker production was obtained from the installations that operate in Cyprus (2 installations 1990-2011, one installation thereafter) (Table 4.6).

The estimation of emissions is based on a country-specific methodology.

Information regarding $CO_2$ emissions has been submitted annually since 2005, in accordance with the EU-ETS legislation. Emissions are estimated using Tier 3 methodologies. The $CO_2$ emissions are reported through templates provided by the European Commission for annual emission reports that are based on the Monitoring and Reporting Regulation[33]. The emissions for 2005-2016 are used as submitted by the installations for the EU-ETS (Table 4.6) that are estimated according to EU legislation and are verified by external verifier accredited by the national authorities. The emissions for the period 1997-2004 are from the data submitted by the installations for the preparation of the National Allocation Plan.

[31] Commission Regulation (EU) No 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council Text with EEA relevance, available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012R0600.

[32] More information available at https://ec.europa.eu/clima/policies/ets/pre2013/nap_en

[33] Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council Text with EEA relevance, available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CEL EX:32012R0601.

For 1990-1996, the emission factor of 0.5347 $tCO_2$/t clinker was used, which is the implied emission factor estimated from the $CO_2$ process emissions reported by the two cement producing installations for 1997. The emissions were estimated by multiplying the IEF by the clinker production (Table 4.6).

**Table 4.6. Total clinker production (kt) and $CO_2$ process emissions ($GgCO_2$) from cement production**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| **Clinker production (kt)** | | | | | | | | |
| Installation 1 | 353 | 390 | 380 | 382 | 383 | 369 | 359 | 374 |
| Installation 2 | 895 | 786 | 902 | 1015 | 1083 | 1035 | 1158 | 1085 |
| Total | 1249 | 1176 | 1282 | 1397 | 1466 | 1405 | 1516 | 1459 |
| $CO_2$ **process emissions (Gg**$CO_2$**)** | | | | | | | | |
| Installation 1 | | | | | | | | 190 |
| Installation 2 | | | | | | | | 590 |
| Total | 668 | 629 | 686 | 747 | 784 | 751 | 811 | 780 |
| | | | | | | | | |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| **Clinker production (kt)** | | | | | | | | |
| Installation 1 | 337 | 334 | 362 | 361 | 373 | 363 | 367 | 333 |
| Installation 2 | 1045 | 1047 | 1065 | 1033 | 1059 | 1043 | 1142 | 1143 |
| Total | 1382 | 1382 | 1428 | 1394 | 1432 | 1405 | 1509 | 1473 |
| $CO_2$ **process emissions (Gg**$CO_2$**)** | | | | | | | | |
| Installation 1 | 180 | 180 | 193 | 193 | 200 | 194 | 197 | 181 |
| Installation 2 | 560 | 560 | 569 | 552 | 566 | 557 | 610 | 607 |
| Total | 740 | 740 | 763 | 745 | 766 | 751 | 808 | 788 |
| | | | | | | | | |
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2008** | **2009** |
| **Clinker production (kt)** | | | | | | | | |
| Installation 1 | 365 | 350 | 368 | 231 | 260 | 76 | 368 | 231 |
| Installation 2 | 1177 | 1166 | 1158 | 1033 | 783 | 961 | 1158 | 1033 |
| Total | 1542 | 1515 | 1526 | 1264 | 1043 | 1037 | 1526 | 1264 |
| $CO_2$ **process emissions (Gg**$CO_2$**)** | | | | | | | | |
| Installation 1 | 198 | 190 | 200 | 125 | 140 | 41 | 200 | 125 |
| Installation 2 | 623 | 622 | 618 | 548 | 415 | 505 | 618 | 548 |
| Total | 821 | 812 | 818 | 673 | 555 | 546 | 818 | 673 |
| | | | | | | | | |
| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| **Clinker production (kt)** | | | | | | | | |
| Installation 1 | 260 | 76 | 0 | 0 | 0 | 0 | 0 | 0 |
| Installation 2 | 783 | 961 | 953 | 1418 | 1822 | 1641 | 1648 | 1725 |
| Total | 1043 | 1037 | 953 | 1418 | 1822 | 1641 | 1648 | 1725 |
| $CO_2$ **process emissions (Gg**$CO_2$**)** | | | | | | | | |
| Installation 1 | 140 | 41 | 0 | 0 | 0 | 0 | 0 | 0 |
| Installation 2 | 415 | 505 | 505 | 752 | 974 | 877 | 883 | 923 |
| Total | 555 | 546 | 505 | 752 | 974 | 877 | 883 | 923 |
| | | | | | | | | |
| | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | | |
| **Clinker production (kt)** | | | | | | | | |
| Installation 1 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Installation 2 | 1603 | 1509 | 1694 | 1664 | 1650 | 1764 | | |
| Total | 1603 | 1509 | 1694 | 1664 | 1650 | 1764 | | |
| $CO_2$ **process emissions (Gg**$CO_2$**)** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Installation 1 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Installation 2 | 848 | 789 | 882 | 879 | 880 | 938 | | |
| Total | 848 | 789 | 882 | 879 | 880 | 938 | | |

All the Cement kiln dust (CKD) is bound and recycled into the production process and no CKD is being exported from the system; therefore, emissions from CKD are not estimated. According to the ETS inspectors this is the case for the two installations that were operating before 2011 and the one installation that has been operating since. The two installations operating before 2011 have been using the same production technologies and process.

The possibility to use an installation-specific or a country-specific emission factor for the period 1990-1996 was investigated with the installations. However, no data is available.

#### 4.2.1.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 4.2.1.3. Category-specific QA/QC and verification

Data for clinker production was compared to the data reported by the statistical service and the data used by the department of Labour Inspection for the preparation of air pollutants inventories under Directive 2001/81/EC.

Moreover, since 2005, all data associated with the calculations is undergoing external verification according to the provisions of the relevant ETS legislation.

#### 4.2.1.4. Category-specific recalculations

No recalculations to be reported.

#### 4.2.1.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

### 4.2.2. Lime Production (2.A.2)

Calcium oxide (CaO or quicklime) is formed by heating limestone to decompose the carbonates. This is usually done in shaft or rotary kilns at high temperatures and the process releases $CO_2$. Dolomite and dolomitic (high magnesium) limestones may also be processed at high temperature to obtain dolomitic lime (and release $CO_2$). The production of lime involves a series of steps, including the quarrying of raw materials, crushing and sizing, calcining the raw materials to produce lime, and (if required) hydrating the lime to calcium hydroxide.

In Cyprus there is one installation producing slaked lime. The final use of the produced lime is predominately in the construction of roads; lime is used as an additive to increase flexibility and reduce cracks.

The emissions for the source category are presented in Table 4.7 and Figure 4.4. After 2008 there was decrease in activity of the construction industry in Cyprus, which is reflected in the amount of lime used (and therefore produced) and the emissions. The sharp decrease between 2011 and 2012 is due to a reduction in production caused by further reduction of activity of the constructions' industry.

**Table 4.7. $CO_2$ emissions for Lime production (2.A.2) 1990–2023**

| | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Gg $CO_2$ | 5.33 | 5.41 | 12.06 | 7.20 | 7.15 | 3.39 | 2.73 | 2.45 | 2.36 |

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|---|---|

| Gg $CO_2$ | 2.38 | 3.18 | 5.33 | 3.93 | 3.11 | 3.99 | 3.91 | 5.96 | |
|---|---|---|---|---|---|---|---|---|---|

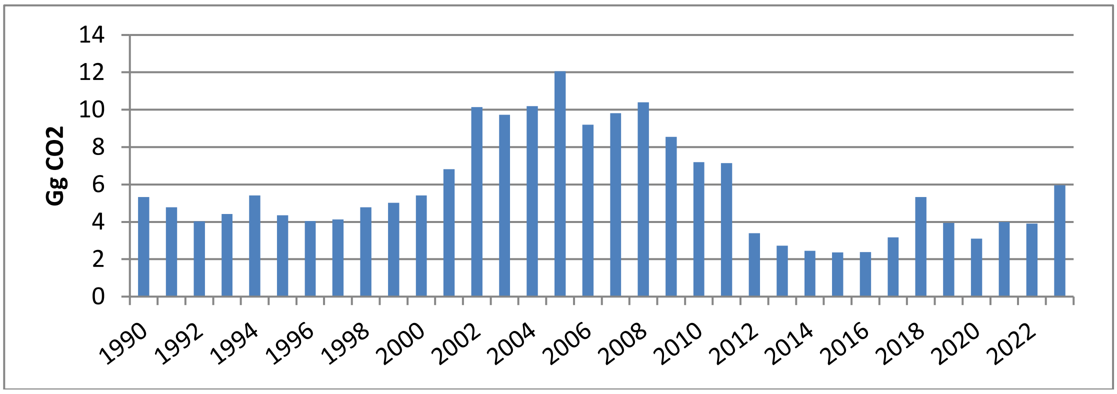


**Figure 4.4. $CO_2$ emissions for Lime production (2.A.2) 1990–2023**

#### 4.2.2.1. Methodological issues

The activity data for lime production was obtained from the one installation in Cyprus that produces slaked lime (Table 4.8). The emission factor chosen is the default proposed for high calcium lime according to the 2006 IPCC Guidelines (volume 3, pg. 2.22, table 2.4), 0.75 t $CO_2$/t lime produced.

Slaked lime is hydrated lime and there is a correction factor for this lime in the 2006 IPCC Guidelines (see vol.3 chapter 2. Mineral Industry, page 2.24). Also, according with 2006 IPCC guidelines: “It is good practice to include a correction for hydrated lime under Tier 2, and where data are available, under Tier 1."

**Table 4.8. Slaked lime production (t)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|---|---|---|---|
| Production (t) | 7330 | 6570 | 5540 | 6080 | 7440 | 5980 | 5550 | 5688 | 6579 | 6907 |

| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|
| Production (t) | 7439 | 9372 | 13934 | 13367 | 14004 | 16583 | 12640 | 13494 | 14285 | 11753 |

| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|---|---|---|---|
| Production (t) | 9890 | 9829 | 4659 | 3746 | 3366 | 3244 | 3277 | 4369 | 7333 | 5407 |

| | **2020** | **2021** | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Production (t) | 4274 | 5489 | 5375 | 8194 | | | | | | |

#### 4.2.2.2. Uncertainties and time-series consistency

Uncertainty estimates for lime production result predominantly from uncertainties associated with activity data, and to a lesser extent from uncertainty related to the emission factor. The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 4.2.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 4.2.2.4. Category-specific recalculations

No recalculations to be reported.

#### 4.2.2.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

### 4.2.3. Glass Production (2.A.3)

The publication 'Industrial Statistics – 2016' (page 156), available on the website of the Statistical Service of Cyprus, presents the manufacture of flat glass, fibre glass and glass articles in Cyprus. However, from the information obtained by the Statistical Service it has been revealed that glass production does not take place in Cyprus; only shaping and processing of imported glass. Therefore glass production is not occurring in Cyprus.

### 4.2.4. Other Process Uses of Carbonates (2.A.4)

Limestone ($CaCO_3$), dolomite ($CaMg(CO_3)_2$) and other carbonates (e.g., $MgCO_3$ and $FeCO_3$) are basic raw materials having commercial applications in a number of industries. In addition to those industries already discussed individually, carbonates also are consumed in metallurgy (e.g., iron and steel), agriculture, construction and environmental pollution control (e.g., flue gas desulphurisation.). The calcination of carbonates at high temperatures yields $CO_2$.

The two activities that take place in Cyprus are production of ceramics and other uses of soda ash.

Ceramics industries in Cyprus produce bricks and roof tiles. Process-related emissions from ceramics result from the calcination of carbonates in the clay, as well as the addition of additives. Similar to the cement and lime production processes, carbonates are heated to high temperatures in a kiln, producing oxides and $CO_2$. The raw materials are collected and finely crushed in successive grinding operations. The ground particles are then fired in a kiln to produce a powder. Additives are subsequently added and the ceramic is formed or moulded and 'machined' to smooth rough edges and achieve the desired characteristics of the ceramic. After firing, some ceramics may undergo additional treatment to achieve the final desired quality. $CO_2$ emissions result from the calcination of the raw material and the use of limestone as a flux.

Soda ash production and consumption (including sodium carbonate, $Na_2CO_3$) results in the release of $CO_2$. According to information received by the customs office[34] soda ash in Cyprus is imported by a betonite quarry, lab supplies companies, swimming pools companies, building materials companies, and cleaning products companies.

The emissions for the source category are presented in Table 4.9 and Figure 4.5. After 2008 there was sharp decrease in activity of the construction industry in Cyprus, which is reflected in the amount of bricks and tiles used (and therefore produced) and the respective emissions. Another reason for the reduction of emissions since 2013 is that one ETS installation and the one non-ETS installation have ceased operation.

**Table 4.9. $CO_2$ emissions for Other Process Uses of Carbonates (2.A.4) 1990–2023**

| Gg $CO_2$ | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| Ceramics | 43.82 | 34.07 | 59.95 | 27.44 | 18.31 | 19.49 | 10.02 | 9.41 | 8.51 |
| Soda-ash | 0.26 | 0.56 | 0.28 | 0.30 | 0.32 | 0.23 | 0.15 | 0.17 | 0.13 |
| **TOTAL** | **44.08** | **34.63** | **60.23** | **27.74** | **18.63** | **19.72** | **10.16** | **9.58** | **8.64** |

| Gg $CO_2$ | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
|---|---|---|---|---|---|---|---|---|---|
| Ceramics | 10.60 | 12.67 | 14.57 | 21.14 | 16.66 | 14.08 | 16.75 | 16.02 | |
| Soda-ash | 0.19 | 0.19 | 0.17 | 0.10 | 0.06 | 0.10 | 0.12 | 0.11 | |
| **TOTAL** | **10.78** | **12.86** | **14.74** | **21.24** | **16.72** | **14.19** | **16.87** | **16.13** | |

[34] email 28/9/2016, Solonas Papapolyviou

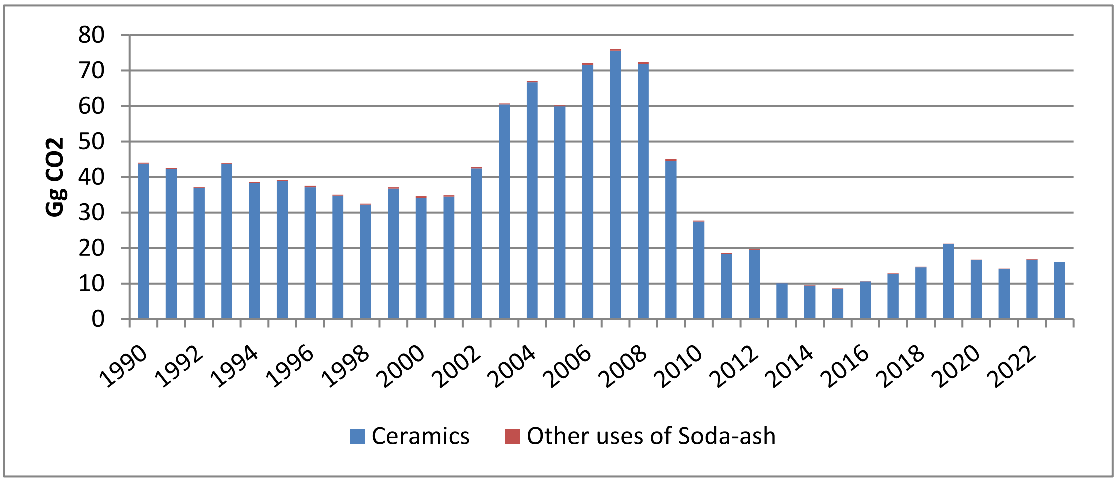


**Figure 4.5. $CO_2$ emissions for Other Process Uses of Carbonates (2.A.4) 1990–2023**

### 4.2.4.1. Ceramics

4.2.4.1.1. Methodological issues

In 2019, there were six ceramics-producing installations (comparing with five ceramics-producing installation in 2018), which provide information regarding $CO_2$ emissions in accordance to the EU-ETS legislation. Industrial installations covered by the EU ETS are required to have an approved monitoring plan for monitoring and reporting annual emissions. Every year, operators must submit an emissions report. The data for a given year must be verified by an accredited verifier by 31 March of the following year[35]. The EU ETS Directive was adopted in 2003 and the system was launched in 2005. The cap on allowances for the first trading period was set at national level through National Allocation Plans (NAPs)[36]. For the preparation of the NAP for the first trading period (2005-2007) historical data was collected for relevant installations. For the eight ceramics installations that were operating at the time, data was available from 2001.

Production data was obtained from the installations that operate in Cyprus (Table 4.10). For the period 1990-2015 there were eight installations in operation, seven in 2016, six in 2017, five in 2018 and six in 2019.

The estimation of emissions is based on a country-specific methodology.

Information regarding $CO_2$ emissions is annually submitted from 2005 in accordance with the EU-ETS legislation. Emissions are estimated using tier 3 methodologies. The $CO_2$ emissions are reported through templates provided by the European Commission for annual emission reports that are based on the Monitoring and Reporting Regulation[37]. The emissions for 2005-2016 are used as submitted by the installations for the EU-ETS (Table 4.10), which are estimated according to EU legislation and are verified by external verifier accredited by the national authorities. The emissions for the period 2001-2004 the data submitted by the installations for the preparation of the National Allocation Plan.

For the period 2001-2012, the emissions of the non-ETS installation were estimated using the emission factor of 0.160 $tCO_2/t$, which is the implied emission factor estimated from the $CO_2$ process emissions reported by the eight ceramics producing installations for 2003 (highest available). The highest emission factor was chosen, since as a non-ETS installation it does not have to regulate its emissions and therefore does not take any measures to reduce emissions. The emissions were estimated by multiplying the IEF

[35] Commission Regulation (EU) No 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council Text with EEA relevance, available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012R0600

[36] More information available at https://ec.europa.eu/clima/policies/ets/pre2013/nap_en

[37] Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council Text with EEA relevance, available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CEL EX:32012R0601

by the non-ETS ceramics production (Table 4.7). The additional, non-ETS installation ceased its operations, therefore there are no additional emissions to those reported under the ETS.

For 1990-2000, the emission factor of 0.123 $tCO_2$/t ceramics was used, which is the implied emission factor estimated from the $CO_2$ process emissions reported by the eight ceramics producing installations for 2001 (earliest available). The emissions were estimated by multiplying the IEF by the TOTAL ceramics production (Table 4.11); i.e. ETS and non-ETS production.

The possibility to use an installation-specific or a country-specific emission factor for the period 1990-2000 was investigated with the installations. However, no data is available.

**Table 4.10. Ceramics production (kt)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| Total production (kt) | 355.4 | 343.0 | 299.7 | 354.2 | 311.2 | 315.3 | 301.2 |
| ETS production (kt) | | | | | | | |
| Non-ETS production (kt) | | | | | | | |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| Total production (kt) | 281.7 | 261.3 | 297.9 | 276.3 | 277.8 | 332.4 | 377.9 |
| ETS production (kt) | | | | | 271.4 | 314.5 | 364.2 |
| Non-ETS production (kt) | | | | | 6.3 | 17.9 | 13.7 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Total production (kt) | 483.9 | 504.0 | 491.4 | 512.4 | 545.9 | 356.2 | 291.5 |
| ETS production (kt) | 470.4 | 493.2 | 483.6 | 500.4 | 532.9 | 338.4 | 282.1 |
| Non-ETS production (kt) | 13.6 | 10.8 | 7.8 | 12.0 | 13.0 | 17.8 | 9.3 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Total production (kt) | 223.0 | 168.0 | 90.0 | 83.7 | 84.5 | 111.6 | 152.6 |
| ETS production (kt) | 211.4 | 161.7 | 90.0 | 83.7 | 84.5 | 111.6 | 152.6 |
| Non-ETS production (kt) | 11.5 | 6.3 | 0 | 0 | 0 | 0 | 0 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| Total production (kt) | 151.8 | 224.8 | 206.7 | 231.5 | 275.3 | 263.4 | |
| ETS production (kt) | 151.8 | 224.8 | 206.7 | 231.5 | 275.3 | 263.4 | |
| Non-ETS production (kt) | 0 | 0 | 0 | 0 | 0 | 0 | |

**Table 4.11. $CO_2$ process emissions of the ETS ceramics installations and estimated annual implied emission factor (2001-2023)**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|
| ETS $CO_2$ emissions ($GgCO_2$) | 33.5 | 39.6 | 58.2 | 64.6 | 58.2 | 70.4 | 73.7 |
| IEF (Gg $CO_2$/Gg product) | 0.123 | 0.126 | 0.160 | 0.137 | 0.118 | 0.146 | 0.147 |

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| ETS $CO_2$ emissions (Gg $CO_2$) | 69.7 | 41.6 | 25.9 | 16.5 | 18.5 | 10.0 | 9.4 |
| IEF (Gg $CO_2$/Gg product) | 0.131 | 0.123 | 0.092 | 0.078 | 0.114 | 0.111 | 0.112 |

| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|
| ETS $CO_2$ emissions (Gg $CO_2$) | 8.5 | 10.6 | 12.7 | 14.6 | 21.1 | 16.7 | 14.1 |
| IEF (Gg $CO_2$/Gg product) | 0.101 | 0.095 | 0.083 | 0.096 | 0.094 | 0.081 | 0.061 |
| | | | | | | | |
| | 2022 | 2023 | | | | | |
| ETS $CO_2$ emissions (Gg $CO_2$) | 16.7 | 16.0 | | | | | |
| IEF (Gg $CO_2$/Gg product) | 0.061 | 0.061 | | | | | |

4.2.4.1.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

4.2.4.1.3. Category-specific QA/QC and verification

Data for ceramics production was compared to the data reported by the statistical service and the data used by the department of Labour Inspection for the preparation of air pollutants inventories under Directive 2001/81/EC.

Moreover, since 2005, all data associated with the calculations is undergoing external verification according to the provisions of the relevant ETS legislation.

4.2.4.1.4. Category-specific recalculations

No recalculations to be reported.

4.2.4.1.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

**4.2.4.2. Other uses of soda ash**

4.2.4.2.1. Methodological issues

The $CO_2$ emissions from other uses of soda-ash have been estimated using the T1 methodology proposed by the 2006 IPCC guidelines. Equation 2.14 (pg. 2.34, vol. 3, IPCC 2006 guidelines) was adopted for soda ash; i.e. $CO_2$ Emissions = Mc x EF

where:
$CO_2$ Emissions = emissions of $CO_2$ from other process uses of carbonates, tonnes;
Mc = mass of carbonate consumed, tonnes;
EF = emission factor for soda ash, tonnes $CO_2$/tonne carbonate (table 2.1, pg. 2.7, vol.3, 2006 IPCC guidelines), 0.41492 $tCO_2/t\ CO_3$ assuming 100% calcination.

Activity data (Table 4.12) was obtained from the imports statistics of the Statistical Service. It was assumed that all imported quantities have been consumed in the year the import has taken place. The imports of soda ash suffered a sharp increase for 2010 (1438 t), 51% above the 2009 value (711 t). For 2015 the imports are the lowest of the entire time series (326 t), which also affected the emissions. According to information obtained from the Customs Department, the main consumers of soda ash in Cyprus (90%) are engaged with the production of building materials. A large decline in the building industry began in 2010, and this is reflected in the consumption of building products and subsequently imports and use of soda ash.

**Table 4.12. Imports of Soda ash in Cyprus (t)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|---|---|---|---|
| Imports of Soda ash (t) | 615 | 499 | 383 | 502 | 504 | 529 | 1063 | 789 | 808 | 832 |

| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|
| Imports of Soda ash (t) | 1345 | 823 | 1003 | 813 | 837 | 664 | 1179 | 1132 | 1479 | 1438 |

| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|---|---|---|---|
| Imports of Soda ash (t) | 711 | 771 | 560 | 353 | 401 | 322 | 447 | 449 | 402 | 247 |

| | **2020** | **2021** | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Imports of Soda ash (t) | 154 | 246 | 288 | 255 | | | | | | |

4.2.4.2.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

4.2.4.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

4.2.4.2.4. Category-specific recalculations

No recalculations to be reported.

4.2.4.2.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

# 4.3. Chemical Industry (2.B)

## 4.3.1. Carbide production (2.B.5)

According to the imports statistics, there is import of carbides of calcium to Cyprus. According to information received by the customs office[38] carbides products are imported by a company importing raw materials for mattresses. Therefore, carbides of calcium are not used for the production of acetylene.

# 4.4. Non-Energy Products from Fuels and Solvent Use (2.D)

## 4.4.1. Category description

According to the 2006 Guidelines, “Non-energy products” are primary or secondary fossil fuels which are used directly for their physical or diluent properties. Examples are: lubricants, paraffin waxes, bitumen, and white spirits. In Cyprus there are imports and consumption of lubricants, paraffin waxes and bitumen. Lubricants in Cyprus are consumed by transport, while according to the information obtained from the Customs[39], paraffin wax is imported by dental and lab suppliers, importers of agricultural and beauty products and candle makers. The total $CO_2$ emissions from non-energy products from fuels and solvent use are presented in Table 4.13 and Figure 4.6.

**Table 4.13. $CO_2$ emissions from non-energy Products from Fuels and Solvent Use**

| Gg $CO_2$ | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| **D. Non-energy products from fuels and solvent use** | **4.19** | **4.10** | **3.46** | **3.53** | **3.53** | **2.95** | **2.37** |
| 1. Lubricant use | 4.13 | 4.03 | 3.45 | 3.46 | 3.46 | 2.87 | 2.29 |
| 2. Paraffin wax use | 0.06 | 0.07 | 0.003 | 0.03 | 0.02 | 0.04 | 0.04 |
| 3. Other: Urea used as a catalyst | NO | NO | NO | 0.04 | 0.04 | 0.04 | 0.03 |

| Gg $CO_2$ | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| **D. Non-energy products from fuels and solvent use** | **2.38** | **2.47** | **2.66** | **2.43** | **2.44** | **4.98** | **4.92** |
| 1. Lubricant use | 2.29 | 2.29 | 2.30 | 2.12 | 2.07 | 4.52 | 4.33 |

[38] email 28/9/2016, Solonas Papapolyviou, Department of Customs and Excise, Ministry of Finance (tel. +357 22 601756, spapapolyviou@customs.mof.gov.cy)
[39] email 28/9/2016, Solonas Papapolyviou, Department of Customs and Excise, Ministry of Finance (tel. +357 22 601756, spapapolyviou@customs.mof.gov.cy)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2. Paraffin wax use | 0.06 | 0.08 | 0.19 | 0.06 | 0.06 | 0.07 | 0.07 |
| 3. Other: Urea used as a catalyst | 0.03 | 0.10 | 0.17 | 0.25 | 0.31 | 0.39 | 0.53 |

| **Gg $CO_2$** | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| **D. Non-energy products from fuels and solvent use** | **5.03** | **5.13** | **5.38** | | | | |
| 1. Lubricant use | 4.47 | 4.68 | 4.90 | | | | |
| 2. Paraffin wax use | 0.05 | 0.01 | 0.08 | | | | |
| 3. Other: Urea used as a catalyst | 0.51 | 0.44 | 0.40 | | | | |

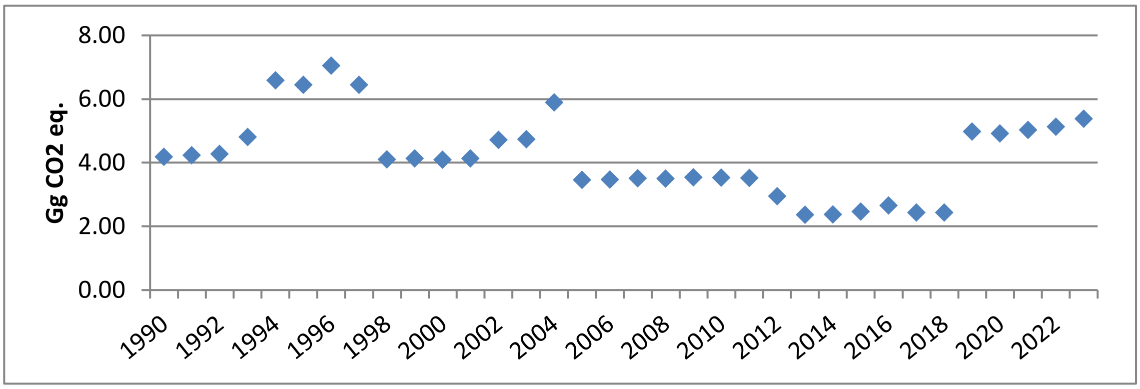


**Figure 4.6. Emissions from non-energy Products from Fuels and Solvent Use (2D) 1990–2023**

## 4.4.2. Methodological issues

The methods for calculating carbon dioxide ($CO_2$) emissions from non-energy product uses (paraffin waxes) follow a basic formula, in which the emission factor is composed of a carbon content factor and a factor that represents the fraction of fossil fuel carbon that is Oxidised During Use (ODU), e.g., actual co-combustion of the fraction of lubricants that slips into the combustion chamber of an engine. This concept is only applied to oxidation during first use of paraffin waxes, and not to subsequent uses (e.g., energy recovery). Emissions from the use of lubricants have been calculated with COPERT5.

The production and use of asphalt for road paving and roofing and the use of solvents derived from petroleum and coal are either not sources or are negligible sources of direct greenhouse gas emissions.

#### 4.4.2.1. Lubricant Use (2D1)

The use of lubricants in engines is primarily for their lubricating properties and associated emissions are therefore considered as non-combustion emissions and are reported under this category. However, in the case of 2-stroke engines, where the lubricant is mixed with another fuel and thus on purpose co-combusted in the engine, the emissions are estimated and reported as part of the combustion emissions in the Energy Sector (1A3b).

Lubricating oil statistics usually cover not only use of lubricants in engines but also oils and greases for industrial purposes and heat transfer and cutting oils. After the TERT recommendation (CY-1A3b-2021-0002), emissions from the use of lubricants in engines have been calculated with COPERT 5. The emissions from the use of lubricants in two-stroke engines were reported under 1A3b (Table 3.20). The rest of the emissions are reported under this category (Table 4.14 and Table 3.33). Figure 4.7 shows the consumption of lubricants for non-energy product uses (COPERT5).

**Table 4.14. Emissions from the use of lubricants (2D1)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|---|---|
| Emissions (Gg$CO_2$) | 4.13 | 4.13 | 4.13 | 4.60 | 6.37 | 6.37 | 6.96 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| Emissions ($GgCO_2$) | 6.38 | 4.02 | 4.03 | 4.03 | 4.03 | 4.63 | 4.63 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Emissions ($GgCO_2$) | 5.81 | 3.46 | 3.46 | 3.44 | 3.44 | 3.45 | 3.46 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Emissions ($GgCO_2$) | 3.46 | 2.87 | 2.29 | 2.29 | 2.29 | 2.30 | 2.12 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| Emissions ($GgCO_2$) | 2.07 | 4.52 | 4.33 | 4.47 | 4.68 | 4.90 | |

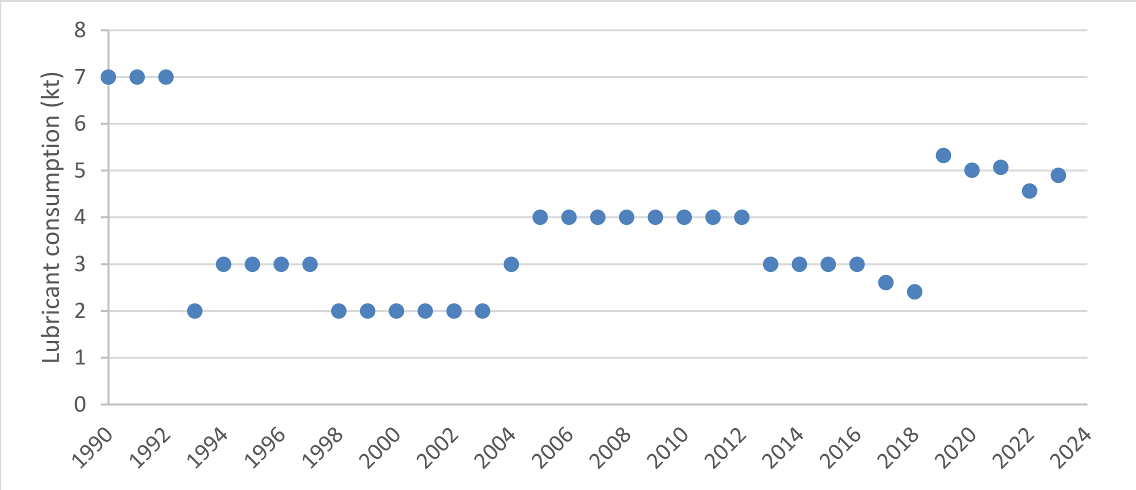


**Figure 4.7. Lubricant consumption 1990–2023 (kt)**

#### 4.4.2.2. Paraffin Wax Use (2D2)

$CO_2$ emissions from use of paraffin wax have been estimated using the Tier 1 methodology proposed by the 2006 IPCC guidelines (eqn. 5.4, pg. 5.11, vol.3, IPCC 2006 guidelines):

$CO_2$ Emissions = PW •CCWax •ODUWax • 44 /12

Where:
$CO_2$ Emissions = $CO_2$ emissions from waxes, tonne $CO_2$;
PW = total wax consumption, TJ;
CCWax = carbon content of paraffin wax (20; default, 2006 IPCC guidelines, vol.2, pg.1.21), tonne C/TJ (= kg C/GJ) and
ODUWax = Oxidised During Use factor for paraffin wax, fraction (0.2; default, 2006 IPCC guidelines, vol.3, pg.5.12).

Activity data (Table 4.15) was obtained in kg from the imports' statistics of the Statistical Service. It was assumed that all imported quantities have been consumed in the year the import has taken place. Imports data was converted to TJ using the default NCV for paraffin wax of 40.2, as proposed by the 2006 IPCC guidelines (vol.2, pg.1.18).

**Table 4.15. Imports of paraffin wax in Cyprus (kt)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| Imports of paraffin wax (kt) | 0.108 | 0.179 | 0.252 | 0.354 | 0.362 | 0.134 | 0.159 |
| | | | | | | | |
| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
| Imports of paraffin wax (kt) | 0.117 | 0.147 | 0.179 | 0.111 | 0.178 | 0.155 | 0.185 |
| | | | | | | | |
| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Imports of paraffin wax (kt) | 0.150 | 0.005 | 0.028 | 0.095 | 0.060 | 0.099 | 0.049 |
| | | | | | | | |
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| Imports of paraffin wax (kt) | 0.035 | 0.071 | 0.074 | 0.099 | 0.131 | 0.320 | 0.100 |
| | | | | | | | |
| | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| Imports of paraffin wax (kt) | 0.105 | 0.120 | 0.113 | 0.086 | 0.163 | 0.130 | |

#### 4.4.2.3. Other Non-energy Products from Fuels and Solvent Use (2.D.3)

The use of solvents manufactured using fossil fuels as feedstocks can lead to evaporative emissions of various non-methane volatile organic compounds (NMVOC), which are subsequently further oxidised in the atmosphere.

Emissions of NMVOCs are reported in this category. NMVOCs are indirect greenhouse gases which result from the use of solvents and various other volatile compounds. The indirect $CO_2$ emissions associated with these NMVOC emissions are reported under this category. Previously, these estimates were reported in the CRT Tables as direct $CO_2$ and included in Cyprus' national total.

Methodologies for estimating these NMVOC emissions can be found in the EMEP/EEA Emission Inventory Guidebook (EEA, 2016). Further information on emissions of NMVOCs and indirect $CO_2$ emissions can be found in Chapter 9 of this report.

#### 4.4.2.4. Other: Urea used as a catalyst (2.D.3)

Emissions of $CO_2$ are estimated from consumption of urea by road vehicles with relevant types of catalytic converters for control of pollutant emissions and are reported under 2D3. Selective catalytic reduction (SCR) technology was introduced in modern vehicles in order to ensure compliance with the EU regulations on air pollution reduction. The SCR technology injects urea solution into the exhaust line as a percentage of fuel use of a vehicle to curb $NO_x$ emissions. The urea solution then releases small amounts of $CO_2$ and of $NH_3$ to make a reaction with $NO_x$ to break it down into $N_2$ and $H_2O$. However, this small amount of $CO_2$ from this process causes an additional amount of $CO_2$ in the exhaust system.

The report considers SCR from Euro IV technologies and thus urea solution as an additive has been estimated for different years according to the penetration of technologies from Euro IV onwards for different categories of vehicles in Cyprus. Euro IV and V Coaches/Buses and HDV penetrated the Cypriot market in 2007 and 2008 respectively. Urea additive for passenger cars and LDVs have been included from 2015 onwards for Euro 6 vehicles.

The 2006 IPCC Guidelines specify two approaches for estimating $CO_2$ emissions from urea consumption. This is either from statistics on total urea sales or by estimating urea consumption as a proportion of the amount of fuel consumed. There are no statistics on urea sales in Cyprus, so the approach based on fuel consumption is used. Not all diesel vehicles use urea so it is necessary to know the amount of fuel consumed specifically from those vehicles with the relevant exhaust after treatment technology that require urea injection.

Urea is used by HGVs and buses in Cyprus manufactured to Euro IV, V and VI standards. An assumption was made that 75% of Euro IV and V buses and HGVs and 100% of Euro VI vehicles are equipped with SCR. Fuel consumption was calculated using the proportionality of these types of vehicles to the total Cypriot diesel fleet and diesel consumption from road transport data from the Energy Balance. Following the EMEP/EEA Guidebook, urea consumption is assumed to be 4% of fuel consumption for a Euro IV bus or HGV, 6% for Euro V and 3.5% for Euro VI.

Then the recommended equation by the 2006 IPCC guidelines was used:

$$Emissions = Activity * \frac{12}{60} * Purity * \frac{44}{12}$$

Here, Activity means amount of urea-based additive consumed for use in SCR; Purity means the mass fraction of Urea in the urea additive; and the Default value for Purity (if country specific value is not available) is 0.325.

The diesel consumption used is the same as presented in Table 3.18. The resulting activity data used is presented in Table 4.16.

**Table 4.16. Activity data used for estimation of emissions from Urea used as a catalyst**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|---|---|---|---|
| Activity (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|
| Activity (kt) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.079 | 0.112 | 0.154 |

| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|---|---|---|---|
| Activity (kt) | 0.181 | 0.197 | 0.184 | 0.142 | 0.122 | 0.432 | 0.725 | 1.060 | 1.280 | 1.621 |

| | **2020** | **2021** | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Activity (kt) | 1.605 | 1.805 | 1.661 | 1.686 | | | | | | |

### 4.4.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 4.4.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

### 4.4.5. Category-specific recalculations

Emissions for 2D3 Other: Urea used as a catalyst category have been recalculated for the time period 2020-2022 due to updated values of diesel consumption by vehicles using urea from COPERT.

The impact of recalculations is presented in the following table.

**Table 4.17. 2D3 Other: Urea used as a catalyst category recalculation**

| **2D3 (Gg $CO_2$)** | **2020** | **2021** | **2022** | | | |
|---|---|---|---|---|---|---|
| 2024 submission | 0.3789 | 0.4380 | 0.4384 | | | |
| 2025 submission | 0.3825 | 0.4301 | 0.3959 | | | |
| *change* | 0.95% | -1.80% | -9.71% | | | |

### 4.4.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 4.5. Electronic Industry Emissions (2.E)

This source category is not occurring in Cyprus.

## 4.6. Product uses as substitutes for ozone depleting substances (2.F)

Hydrofluorocarbons (HFCs) and, to a very limited extent, perfluorocarbons (PFCs), are serving as alternatives to ozone depleting substances (ODS) being phased out under the Montreal Protocol. Current and expected application areas of HFCs and PFCs include: refrigeration and air conditioning, fire suppression and explosion protection, aerosols, solvent cleaning, foam blowing; and other applications. HFCs and PFCs are not controlled by the Montreal Protocol because they do not contribute to depletion of the stratospheric ozone layer. HFCs are chemicals containing only hydrogen, carbon, and fluorine. HFCs and PFCs have high global warming potentials (GWPs) and, in the case of PFCs, long atmospheric residence times.

### 4.6.1. Category description

Emissions have been estimated for the following source categories of 2.F: 2F1 (Refrigeration and air conditioning), 2F2 (Foam Blowing Agents), 2F3 (Fire Protection), and 2F4 (Aerosols). Due to data unavailability, emissions have been estimated using a country-specific methodology for source categories 2F2, 2F3 and 2F4, while for source category 2F1 the calculation of emissions is based on Tier 2a methodology (see next section). According to the available information, manufacturing of refrigeration and air-conditioning equipment does not occur in Cyprus, therefore the activity is reported NO. Moreover, Solvents (2F5) and Other Applications (2F6) are also not occurring in Cyprus. The total emissions by gas and source for the period 1990–2021 are presented in Table 4.18 and Figure 4.8.

**Table 4.18. Emissions from consumption of halocarbons 1990–2023 (Gg $CO_2$ eq.)**

| | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| **F. Product uses as substitutes for ODS** | **NO** | **61.52** | **121.85** | **198.03** | **216.05** | **220.76** | **224.32** |
| 1. Refrigeration and air conditioning | NO | 58.74 | 114.66 | 185.48 | 202.41 | 206.48 | 210.55 |
| 2. Foam blowing agents | NO | 0.08 | 0.46 | 0.92 | 1.01 | 1.08 | 1.02 |
| 3. Fire protection | NO | 0.53 | 2.17 | 7.01 | 8.17 | 8.68 | 8.82 |
| 4. Aerosols | NO | 2.18 | 4.56 | 4.62 | 4.46 | 4.52 | 3.93 |
| 5. Solvents | NO | NO | NO | NO | NO | NO | NO |
| 6. Other applications | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| HFC-32 (t) | NO | 4.43 | 10.88 | 18.80 | 22.21 | 22.90 | 23.13 |
| HFC-125 (t) | NO | 4.98 | 12.42 | 21.37 | 25.09 | 25.98 | 26.31 |
| HFC-134a (t) | NO | 30.40 | 50.30 | 75.36 | 76.45 | 76.35 | 77.69 |
| HFC-143a (t) | NO | 0.56 | 1.57 | 2.62 | 2.90 | 3.12 | 3.22 |
| HFC-227ea (t) | NO | 0.16 | 0.65 | 2.09 | 2.44 | 2.59 | 2.63 |
| **Total (Gg $CO_2$ eq.)** | **NO** | **61.52** | **121.85** | **198.03** | **216.05** | **220.76** | **224.32** |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| **F. Product uses as substitutes for ODS** | **231.73** | **243.96** | **264.78** | **285.96** | **305.83** | **330.00** | **336.65** |
| 1. Refrigeration and air conditioning | 217.86 | 231.58 | 251.92 | 272.12 | 292.59 | 316.98 | 323.04 |
| 2. Foam blowing agents | 1.03 | 1.05 | 1.07 | 1.10 | 1.14 | 1.20 | 1.21 |
| 3. Fire protection | 9.32 | 8.21 | 8.90 | 9.57 | 8.80 | 8.57 | 9.31 |
| 4. Aerosols | 3.52 | 3.12 | 2.89 | 3.17 | 3.29 | 3.26 | 3.10 |
| 5. Solvents | NO | NO | NO | NO | NO | NO | NO |
| 6. Other applications | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| HFC-32 (t) | 24.11 | 26.45 | 29.88 | 33.06 | 36.37 | 40.59 | 41.43 |
| HFC-125 (t) | 27.41 | 30.03 | 33.96 | 37.51 | 41.07 | 45.59 | 46.31 |
| HFC-134a (t) | 79.34 | 80.97 | 83.25 | 87.37 | 91.97 | 96.56 | 99.57 |
| HFC-143a (t) | 3.34 | 3.62 | 4.12 | 4.48 | 4.72 | 4.98 | 4.80 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HFC-227ea (t) | 2.78 | 2.45 | 2.66 | 2.86 | 2.63 | 2.56 | 2.78 |
| **Total (Gg $CO_2$ eq.)** | **231.73** | **243.96** | **264.78** | **285.96** | **305.83** | **330.00** | **336.65** |

| | 2021 | 2022 | 2023 | | | | |
|---|---|---|---|---|---|---|---|
| **F. Product uses as substitutes for ODS** | **364.61** | **394.92** | **414.96** | | | | |
| 1. Refrigeration and air conditioning | 351.18 | 381.40 | 401.36 | | | | |
| 2. Foam blowing agents | 1.25 | 1.27 | 1.28 | | | | |
| 3. Fire protection | 9.40 | 9.27 | 9.35 | | | | |
| 4. Aerosols | 2.79 | 2.98 | 2.96 | | | | |
| 5. Solvents | NO | NO | NO | | | | |
| 6. Other applications | NO | NO | NO | | | | |
| | | | | | | | |
| HFC-32 (t) | 47.53 | 52.88 | 55.80 | | | | |
| HFC-125 (t) | 52.79 | 58.57 | 62.08 | | | | |
| HFC-134a (t) | 100.92 | 106.05 | 108.99 | | | | |
| HFC-143a (t) | 5.10 | 5.48 | 6.11 | | | | |
| HFC-227ea (t) | 2.80 | 2.77 | 2.79 | | | | |
| **Total (Gg $CO_2$ eq.)** | **364.61** | **394.92** | **414.96** | | | | |

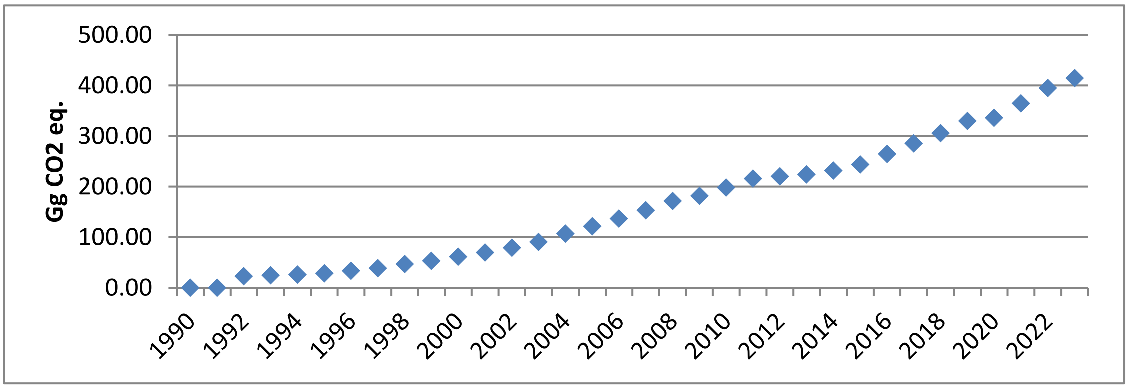


**Figure 4.8. Emissions from consumption of halocarbons 1990–2023**

## 4.6.2. Methodological issues

Due to insufficient information for a long period of time, it was decided to use a country-specific methodology for the estimation of the emissions from the sources 2F2, 2F3 and 2F4.

**2F1**

The calculation of GHG emissions from Refrigeration and Air Condition (RAC) systems is based on Tier 2a methodology suggested by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). The Tier 2a methodology:

a) Considers the phase out or the phase down of CFCs and HCFCs depending on the Montreal Protocol schedule and possible national or regional regulations, in order to establish the refrigerant choice for all applications;
b) Defines the typical refrigerant charge and the equipment lifetime per sub-application;
c) Defines the emission factors for refrigerant charge, during operation, at servicing and at end-of-life.

RAC systems have been classified into six sub-application categories, listed below:

i. Domestic refrigeration,

ii. Commercial refrigeration including different types of equipment, from vending machines to centralised refrigeration systems in supermarkets,
iii. Industrial refrigeration including food processing and cold storage,
iv. Transport refrigeration including equipment and systems used in refrigerated trucks, containers, reefers, and wagons,
v. Stationary air conditioning including air-to-air systems, heat pumps, and chillers for building and residential applications,
vi. Mobile air-conditioning systems used in passenger cars, truck cabins, buses, and trains.

Refrigerant emissions at a year **t** from each of the six sub-applications of RAC systems were calculated separately. These emissions result from:

$E_{containers,t}$ = emissions related to the management of refrigerant containers
$E_{charge,t}$ = emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged
$E_{lifetime,t}$ = annual emissions from the banks of refrigerants associated with the six sub-applications during operation (fugitive emissions and ruptures) and servicing
$E_{end\text{-}of\text{-}life,t}$ = emissions at system disposal

Equations for estimating average emission rates for the above-mentioned sectors are outlined below and were calculated on a refrigerant-by-refrigerant basis for all equipment.

***Refrigerant management of containers***

$$E_{containers,t} = RM_t * \frac{c}{100}$$

Where:
$E_{containers,\ t}$ = emissions from all HFC containers in year t, kg
$RM_t$ = HFC market for new equipment and servicing of all refrigeration application in year t, kg
c = emission factor of HFC container management of the current refrigerant market, percent

***Refrigerant charge emissions of new equipment***

$$E_{charge,t} = M_t * \frac{k}{100}$$

Where:
$E_{charge,\ t}$ = emissions during system manufacture/assembly in year t, kg
$M_t$ = amount of HFC charged into new equipment in year t (per sub-application), kg
k = emission factor of assembly losses of the HFC charged into new equipment (per sub-application), percent

***Emissions during lifetime (operation and servicing)***

$$E_{operation,2017} = B_{2017} * \frac{x}{100}$$

Where:
$E_{lifetime,\ t}$ = amount of HFC emitted during system operation in year t, kg
$B_t$ = amount of HFC banked in existing systems in year t (per sub-application), kg
x = annual emission rate (i.e., emission factor) of HFC of each sub-application bank during operation, accounting for average annual leakage and average annual emissions during servicing, percent

***Emissions at end-of-life***

$$E_{end-of-life,t} = M_{t-d} * \frac{p}{100} * (1 - \frac{n_{rec,d}}{100})$$

Where:

$E_{end\text{-}of\text{-}life,\,t}$ = amount of HFC emitted at system disposal in year t, kg
$M_{t\text{-}d}$ = amount of HFC initially charged into new systems installed in year (t-d), kg
p = residual charge of HFC in equipment being disposed of expressed in percentage of full charge, percent
$\eta_{rec,d}$ = recovery efficiency at disposal, which is the ratio of recovered HFC referred to the HFC contained in the system, percent

The emission factors used are predominately the defaults proposed by the IPCC guidelines. These default values reflect the current state of knowledge about the industry and are provided as ranges rather than point estimates.

Other data, assumptions and emission parameters used in preparation of RAC systems emissions inventory for each sub-category are listed below.

***Mobile Air Conditioning (MAC) systems***

| **Activity Data / Emission Factors** | **Source** |
|---|---|
| Registration of vehicles at the end of each year | Statistical Service of Cyprus |
| Container Heels (c)<br>• Heels from service containers are recovered, therefore $E_{containers,t} = 0$ | IPCC guidelines |
| Nominal charge of each MAC ($m_t$)<br>• For passenger cars $m_t$=0.7 kg,<br>• For trucks $m_t$=1.0 kg,<br>• For buses $m_t$=10 kg | IPCC guidelines |
| Assembly Losses (k)<br>• MAC systems are imported pre-charged, therefore $E_{charge,\,t} = 0$ | IPCC guidelines |
| Lifetime (d)<br>• d = 12 years | IPCC guidelines |
| Annual Emission Rate (x)<br>• This factor accounts for both leaks from equipment as well as any emissions during service<br>○ Annual Emissions Rate from leaks = 10%<br>○ Annual Emission Rate during servicing = 2%<br>○ x = 12% | IPCC guidelines |
| Residual Charge in MACs Disposed (p)<br>• p = 25% | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 25% | IPCC guidelines |
| | |
| **Other assumptions** | |
| • All new vehicles sold from January 2017 uses R1234yf or R774 as MAC refrigerant (MACs Directive 2006/40/EC[40])<br>• Introductory year of R134a as MAC refrigerant was 1992<br>• Vehicles with MAC systems for year 1996-2001 was 60%[41]. The same percentage (60%) was kept for years 1992-1995. For the following years, linear interpolation was used.<br>• MACs are serviced every 5 years | |

***Domestic Refrigeration (DR)***

| **Activity Data / Emission Factors** | **Source** |
|---|---|
| Number of households | Statistical Service of Cyprus |

[40] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006L0040

[41] Establishing the Leakage Rates of MACs, 2013, DG Environment (EC)

| | |
|---|---|
| Number of refrigerators per households<br>• 1.17 refrigerators per household | Demetriou, D., Polatides, H., Haralambopoulos, D, (2010). Integrated Energy Planning for the Residential Sector: The case-study of Cyprus. Energy Sources, Part B: Economics, Planning and Policy. |
| Number of freezers per households<br>• 0.30 freezers per household | Demetriou, D., Polatides, H., Haralambopoulos, D, (2010) |
| Container Heels (c)<br>• Generally refrigerators and freezers are not serviced during their lifetime, therefore $E_{containers,t} = 0$ | IPCC guidelines |
| Nominal charge of each refrigerator and freezer ($m_t$)<br>• m=0.3 kg | IPCC guidelines |
| Assembly Losses (k)<br>• Refrigerators and freezers are imported pre-charged, therefore $E_{charge,\ t} = 0$ | IPCC guidelines |
| Lifetime (d)<br>• d = 20 years | IPCC guidelines |
| Annual Emission Rate (x)<br>• x = 0.3% | IPCC guidelines |
| Residual Charge in Refrigerators and Freezers Disposed (p)<br>• p = 40% | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 35% | IPCC guidelines |
| | |
| **Other assumptions** | |
| • Refrigerants used for domestic refrigerators and freezers (with bold the refrigerants used for the calculation of the emissions): **R134a**, R600a, R12<br>• Introductory year of R134a as DR refrigerant was 1992 | |

***Transport Refrigeration (TR)***

| **Activity Data / Emission Factors** | **Source** |
|---|---|
| Number of TRs sold each year | Department of Road Transport, Cyprus |
| Container Heels (c)<br>• Heels from service containers are recovered, therefore $E_{containers,t} = 0$ | IPCC guidelines |
| Nominal charge of each TR ($m_t$)<br>• m=4.5 kg | IPCC guidelines |
| Assembly Losses (k)<br>• TR systems are imported pre-charged, therefore $E_{charge,\ t} = 0$ | IPCC guidelines |
| Lifetime (d)<br>• d = 15 years | IPCC guidelines |
| Annual Emission Rate (x)<br>• This factor accounts for both leaks from equipment as well as any emissions during service<br>    ○ Annual Emissions Rate from leaks = 15%<br>    ○ Annual Emission Rate during servicing = 10%<br>• x = 25% | IPCC guidelines |
| Residual Charge in TRs Disposed (p)<br>• p = 75% | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 25% | IPCC guidelines |
| | |
| **Other assumptions** | |
| • Refrigerants used for TRs: R134a, R404A<br>• TRs are serviced each year | |

*Industrial Refrigeration (IR)*

| Activity Data / Emission Factors | Source |
|---|---|
| Bank in Existing Equipment ($B_t$) for the year 2023 (using national GDP)<br>• 12435 kg (R404A)<br>• 108 kg (R134a)<br>• 959 kg (R507A) | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |
| Bank in Existing Equipment ($B_t$) for the year 2017<br>• 9016 kg (R404A)<br>• 341 kg (R134a)<br>• 360 kg (R507A) | Industrial and Commercial RAC Inventory 2017, Cyprus |
| Bank in Existing Equipment ($B_t$) for previous years<br>• The national GDP was used to determine the banks for previous years to complete the time-series | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |
| Container Heels (c)<br>• Heels from service containers are recovered, therefore $E_{containers,t} = 0$ | IPCC guidelines |
| Nominal charge of each IR ($m_t$)<br>• m=100 kg | IPCC guidelines |
| Assembly Losses (k)<br>• IR systems are imported pre-charged, therefore $E_{charge,\ t} = 0$ | IPCC guidelines |
| Lifetime (d)<br>• d = 20 years | IPCC guidelines |
| Annual Emission Rate (x)<br>• This factor accounts for both leaks from equipment as well as any emissions during service<br>  o Annual Emissions Rate from leaks = 10%<br>  o Annual Emission Rate during servicing =5%<br>• x = 15% | IPCC guidelines |
| Residual Charge in IRs Disposed (p)<br>• p = 75% | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 35% | IPCC guidelines |
| | |
| **Other assumptions** | |
| • Refrigerants used for IRs (with bold the refrigerants used for the calculation of the emissions): **R404A**, R22, **R134a**, **R507A**, R434A<br>• Introductory year of R404A as IR refrigerant was 1996<br>• Introductory year of R134a as IR refrigerant was 1992<br>• Introductory year of R507A as IR refrigerant was 2012<br>• IRs are serviced each year | |

*Commercial Refrigeration (CR)*

| Activity Data / Emission Factors | Source |
|---|---|
| Bank in Existing Equipment ($B_t$) for the year 2023 (using national GDP)<br>• 46358 kg for Stand-alone Commercial Applications (R404A)<br>• 11589 kg for Medium & Large Commercial Refrigeration (R404A)<br>• 3810 kg for Stand-alone Commercial Applications (R134A)<br>• 952 kg for Medium & Large Commercial Refrigeration (R134A) | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |

| | |
|---|---|
| • 2019 kg for Stand-alone Commercial Applications (R410A)<br>• 505 kg for Medium & Large Commercial Refrigeration (R410A)<br>• 3090 kg for Stand-alone Commercial Applications (R407C)<br>• 772 kg for Medium & Large Commercial Refrigeration (R407C)<br>• 3000 kg for Stand-alone Commercial Applications (R507A)<br>• 750 kg for Medium & Large Commercial Refrigeration (R507A) | |
| Bank in Existing Equipment ($B_t$) for the year 2017<br>• 37862 kg for Stand-alone Commercial Applications (R404A)<br>• 9465 kg for Medium & Large Commercial Refrigeration (R404A)<br>• 2851 kg for Stand-alone Commercial Applications (R134A)<br>• 713 kg for Medium & Large Commercial Refrigeration (R134A)<br>• 790 kg for Stand-alone Commercial Applications (R410A)<br>• 198 kg for Medium & Large Commercial Refrigeration (R410A)<br>• 1148 kg for Stand-alone Commercial Applications (R407C)<br>• 287 kg for Medium & Large Commercial Refrigeration (R407C)<br>• 1122 kg for Stand-alone Commercial Applications (R507A)<br>• 280 kg for Medium & Large Commercial Refrigeration (R507A) | Industrial and Commercial RAC Inventory 2017, Cyprus |
| Bank in Existing Equipment ($B_t$) for previous years<br>• The national GDP was used to determine the banks for previous years in order to complete the time-series | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |
| Container Heels (c)<br>• Heels from service containers are recovered, therefore $E_{containers,t} = 0$ | IPCC guidelines |
| Nominal charge of each CR ($m_t$)<br>• m=5 kg for Stand-alone Commercial Applications<br>• m= 100 kg for Medium & Large Commercial Refrigeration | IPCC guidelines |
| Assembly Losses (k)<br>• Stand-alone Commercial Applications systems are imported pre-charged, therefore $E_{charge,\ t} = 0$<br>• Medium & Large Commercial Refrigeration systems are charged on-site<br>  o Assembly Losses = 1.5% | IPCC guidelines |
| Lifetime (d)<br>• d = 12 years | IPCC guidelines |
| Annual Emission Rate (x)<br>• This factor accounts for both leaks from equipment as well as any emissions during service<br>• Stand-alone Commercial Applications<br>  o Annual Emissions Rate from leaks = 8% | IPCC guidelines |

| | |
|---|---|
| ○ Annual Emission Rate during servicing =2%<br>○ x = 10%<br>• Medium & Large Commercial Refrigeration<br>○ Annual Emissions Rate from leaks = 15%<br>○ Annual Emission Rate during servicing =5%<br>○ x = 20% | |
| Residual Charge in CRs Disposed (p)<br>• p = 40% for Stand-alone Commercial Applications<br>• p = 75% for Medium & Large Commercial Refrigeration | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 35% for Stand-alone Commercial Applications<br>• $n_{rec}$ = 35% for Medium & Large Commercial Refrigeration | IPCC guidelines |
| | |
| **Other assumptions** | |
| • Refrigerants used for IRs (with bold the refrigerants used for the calculation of the emissions): **R404A**, **R134A**, R22, **R410A**, **R407C**, **R507A** [Industrial and Commercial RAC Inventory 2017, Cyprus].<br>• Introductory year of R404A as CR refrigerant was 1996<br>• Introductory year of R134a as CR refrigerant was 1992<br>• Introductory year of R410A as CR refrigerant was 2012<br>• Introductory year of R407A as CR refrigerant was 2012<br>• Introductory year of R507A as CR refrigerant was 2012<br>• Stand-alone Commercial Applications accounts approximate 80% of the total CR systems [Industrial and Commercial RAC Inventory 2017, Cyprus]<br>• Medium & Large Commercial Refrigeration accounts approximate 20% of the total CR systems [Industrial and Commercial RAC Inventory 2017, Cyprus]<br>• Stand-alone Commercial Applications systems are serviced every 5 years<br>• Medium & Large Commercial Refrigeration systems are serviced each year | |

***Stationary Air Conditioning systems***

| **Residential A/C** | |
|---|---|
| **Activity Data / Emission Factors** | **Source** |
| Number of households | Statistical Service of Cyprus |
| Percentage of households having split A/C units<br>• 87% | Demetriou, D., Polatides, H., Haralambopoulos, D, (2010). Integrated Energy Planning for the Residential Sector: The case-study of Cyprus. Energy Sources, Part B: Economics, Planning and Policy. |
| Number of A/C units per households<br>• 2.65 A/C units per household | Demetriou, D., Polatides, H., Haralambopoulos, D, (2010). |
| Container Heels (c)<br>• Heels from service containers are recovered, therefore $E_{containers,t} = 0$ | IPCC guidelines |
| Nominal charge of each Residential A/C unit ($m_t$)<br>• m=3 kg | IPCC guidelines |
| Assembly Losses (k)<br>• A/C units are imported pre-charged, therefore $E_{charge,\ t} = 0$ | IPCC guidelines |
| Lifetime (d)<br>• d = 15 years | IPCC guidelines |
| • This factor accounts for both leaks from equipment as well as any emissions during service<br>○ Annual Emissions Rate from leaks = 5%<br>○ Annual Emission Rate during servicing =2%<br>• x = 7% | IPCC guidelines |

| | |
|---|---|
| Residual Charge in Residential A/C units Disposed (p)<br>• p = 40% | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 40% | IPCC guidelines |
| | |
| **Other assumptions** | |
| • Refrigerants used for Residential A/C units (with bold the refrigerants used for the calculation of the emissions): **R410A**, **R407C**, R22 [Based on results from Industrial and Commercial RAC Inventory 2017, Cyprus]<br>• Introductory year of R407A as refrigerant was 1996<br>• Introductory year of R407C as refrigerant was 1996<br>• Residential A/C units are serviced every 5 years | |
| | |
| **Commercial A/C, including heat pumps** | |
| **Activity Data / Emission Factors** | **Source** |
| Bank in Existing Equipment ($B_t$) for the year 2023 (using national GDP)<br>• 33838 kg (R410A)<br>• 23185 kg (R407C) | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |
| Bank in Existing Equipment ($B_t$) for the year 2017<br>• 29763 kg (R410A)<br>• 21923 kg (R407C) | Industrial and Commercial RAC Inventory 2017, Cyprus |
| Bank in Existing Equipment ($B_t$) for previous years<br>• The national GDP was used to determine the banks for previous years in order to complete the time-series | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |
| Container Heels (c)<br>• Heels from service containers are recovered, therefore $E_{containers,t}$ = 0 | IPCC guidelines |
| Nominal charge of each Commercial A/C unit ($m_t$)<br>• m=3 kg | IPCC guidelines |
| Assembly Losses (k)<br>• A/C units are imported pre-charged, therefore $E_{charge,\ t}$ = 0 | IPCC guidelines |
| Lifetime (d)<br>• d = 15 years | IPCC guidelines |
| • This factor accounts for both leaks from equipment as well as any emissions during service<br>  ○ Annual Emissions Rate from leaks = 5%<br>  ○ Annual Emission Rate during servicing =2%<br>• x = 7% | IPCC guidelines |
| Residual Charge in Commercial A/C units Disposed (p)<br>• p = 40% | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 40% | IPCC guidelines |
| | |
| **Other assumptions** | |
| • Refrigerants used for Commercial A/C units (with bold the refrigerants used for the calculation of the emissions): **R410A**, **R407C**, R22 [Industrial and Commercial RAC Inventory 2017, Cyprus]<br>• Introductory year of R407A as refrigerant was 1996<br>• Introductory year of R407C as refrigerant was 1996<br>• Commercial A/C units are serviced every 5 years | |
| | |
| **Chillers** | |
| **Activity Data / Emission Factors** | **Source** |

| | |
|---|---|
| Bank in Existing Equipment ($B_t$) for the year 2023 (using national GDP)<br>• 136626 kg (R410A)<br>• 49077 kg (R407C)<br>• 38836 kg (R134A) | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |
| Bank in Existing Equipment ($B_t$) for the year 2017<br>• 78313 kg (R410A)<br>• 28131 kg (R407C)<br>• 29063 kg (R134A) | Industrial and Commercial RAC Inventory 2017, Cyprus |
| Bank in Existing Equipment ($B_t$) for previous years<br>• The national GDP was used to determine the banks for previous years to complete the time-series | Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy |
| Container Heels (c)<br>• Heels from service containers are recovered, therefore $E_{containers,t} = 0$ | IPCC guidelines |
| Nominal charge of each chiller system ($m_t$)<br>• m=50 kg | IPCC guidelines |
| Assembly Losses (k)<br>• Chiller systems are imported pre-charged, therefore $E_{charge,t} = 0$ | IPCC guidelines |
| Lifetime (d)<br>• d = 20 years | IPCC guidelines |
| • This factor accounts for both leaks from equipment as well as any emissions during service<br>o Annual Emissions Rate from leaks = 5%<br>o Annual Emission Rate during servicing =5%<br>• x = 10% | IPCC guidelines |
| Residual Charge in Chiller systems Disposed (p)<br>• p = 90% | IPCC guidelines |
| Recovery Efficiency ($n_{rec}$) [%]<br>• $n_{rec}$ = 50% | IPCC guidelines |
| | |
| **Other assumptions** | |
| • Refrigerants used for Chiller systems (with bold the refrigerants used for the calculation of the emissions): **R410A**, **R407C**, **R134a**, R22 [Industrial and Commercial RAC Inventory 2017, Cyprus]<br>• Introductory year of R407A as refrigerant was 1996<br>• Introductory year of R407C as refrigerant was 1996<br>• Introductory year or R134a as refrigerant was 1992<br>• Chiller systems are serviced every year | |

The main deficiency identified in preparation of inventory is associated with the lack of reporting obligation for importers of bulk F-gases and F-gas equipment in the early years to establish the time-series for the categories of “Industrial Refrigeration”, “Commercial Refrigeration” and “Stationary A/C systems”. Data for these categories were established for each year going back to 1950 through a correlation to the annual national GDP.

**2F2, 2F3 and 2F4**

The methodology applied consisted of the following steps:

(a) The stock emissions from the four sources (2F2, 2F3 and 2F4) for Greece, Italy, Malta and Spain were obtained from the NIR2023 submissions to the UNFCCC for the years 1990-2021 (CRT – Table 2(II).B-H). The four countries were selected due to their similarity in social and economic conditions to Cyprus. Any fluorinated ozone-depleting substances (ODSs) not imported to Cyprus in bulk, as well as emissions other than those from stocks were disregarded in an effort to better historically match and appraise the situation. Therefore, only the following gases have been taken into account: HFC-32, HFC-125, HFC-134a, HFC-143a and HFC-227ea.

(b) The amounts of substitutes of ODSs used by the four model countries were tabulated in tonnes and modified by their 100-year global warming potential (GWP) to calculate the t $CO_2$ eq. emissions from each source. The substitutes of ODSs applicable to the estimation of emissions from stocks in Cyprus are listed in Table 1.4 (Section 1.4.3). The equivalent emissions are thus calculated as: substitute of ODS amount (t) × GWP (t $CO_2$eq/t).

(c) The t $CO_2$ eq. emissions from each substance and subcategories are, then, summed per year and divided by the average total population of each country obtained from EUROSTAT (Table 4.19) to provide for the annual per capita emissions (Table 4.20) for the years 1990-2020.

(d) The annual per capita emissions average of the four countries for 2F1 and only Spain, Italy and Greece for 2F2, 2F3 and 2F4 were, in turn, used to calculate the total t $CO_2$ equivalent annual emissions from stocks in Cyprus, based on the population of Cyprus for each corresponding year (Table 4.21).

(e) The following have been taken into account during the calculations:
- 2F2: According to the information submitted by the four countries and the imports of bulk gases in Cyprus, all emissions have been assumed to be HCF-134a and from closed cells.
- 2F3: According to the information submitted by the Greece, Italy and Malta, all emissions have been assumed to be HFC-227ea.
- 2F4: For the source MDI-aerosols, only the emissions from Metered Dose Inhalers have been taken into account, since Aerosols do not occur in Cyprus. Moreover, according to the information submitted by the four countries, all emissions have been assumed to be HFC-134a.

**Table 4.19. Average total population used for the estimation of per capita emissions from 2F (2F2, 2F3, 2F4) activities (EUROSTAT)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|---|---|
| Malta | 352430 | 361908 | 365781 | 369455 | 373161 | 376433 | 378404 |
| Spain | 38853227 | 38881416 | 39051336 | 39264034 | 39458489 | 39639726 | 39808374 |
| Italy | 56694360 | 56744119 | 56772923 | 56821250 | 56842392 | 56844408 | 56844197 |
| Greece | 10120892 | 10272691 | 10367163 | 10430958 | 10489871 | 10535973 | 10588332 |

| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
|---|---|---|---|---|---|---|---|
| Malta | 381405 | 384176 | 386397 | 388759 | 391415 | 394641 | 397296 |
| Spain | 39971329 | 40143449 | 40303568 | 40470182 | 40665545 | 41035278 | 41827838 |
| Italy | 56876364 | 56904379 | 56909109 | 56923524 | 56960692 | 56987507 | 57130506 |
| Greece | 10629267 | 10693250 | 10747768 | 10775627 | 10835989 | 10888274 | 10915770 |

| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|---|---|
| Malta | 399867 | 402668 | 404999 | 405616 | 407832 | 410926 | 414027 |
| Spain | 42547451 | 43296338 | 44009971 | 44784666 | 45668939 | 46239273 | 46486619 |
| Italy | 57495900 | 57874753 | 58064214 | 58223744 | 58652875 | 59000586 | 59190143 |
| Greece | 10940369 | 10969912 | 11004716 | 11036008 | 11060937 | 11094745 | 11119289 |

| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
|---|---|---|---|---|---|---|---|
| Malta | 414989 | 417546 | 422509 | 429424 | 439691 | 450415 | 460297 |
| Spain | 46667174 | 46818219 | 46727890 | 46512199 | 46449565 | 46440099 | 46528024 |
| Italy | 59364690 | 59394207 | 59685227 | 60782668 | 60795612 | 60665551 | 60589445 |
| Greece | 11123392 | 11086406 | 11003615 | 10926807 | 10858018 | 10783748 | 10768193 |

| | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
|---|---|---|---|---|---|---|---|
| Malta | 475701 | 493559 | 514564 | 516100 | 520971 | 542051 | |
| Spain | 46658447 | 46937060 | 47332614 | 47398695 | 47432893 | 48085361 | |
| Italy | 60483973 | 59816673 | 59641488 | 59236213 | 59030133 | 58997201 | |
| Greece | 10741165 | 10724599 | 10718565 | 10678632 | 10459782 | 10413982 | |

**Table 4.20. Per capital emissions by source from 2F (2F2, 2F3, 2F4) activities (kg $CO_2$ eq./cap)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |
| Malta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Spain | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Italy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Greece | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| AVERAGE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **2F3** | | | | | | | | |
| Malta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Spain | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 |
| Italy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Greece | 0.00 | 0.00 | 0.02 | 0.05 | 0.13 | 0.24 | 0.39 | 0.57 |
| AVERAGE | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 | 0.06 | 0.10 | 0.15 |
| **2F4** | | | | | | | | |
| Malta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Spain | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| Italy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Greece | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| AVERAGE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |

| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |
| Malta | 0.00 | 0.00 | 0.00 | 0.10 | 0.20 | 0.29 | 0.38 | 0.51 |
| Spain | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.06 |
| Italy | 0.00 | 0.09 | 0.21 | 0.36 | 0.54 | 0.78 | 1.09 | 1.47 |
| Greece | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.03 | 0.03 |
| AVERAGE | 0.00 | 0.02 | 0.05 | 0.11 | 0.19 | 0.27 | 0.37 | 0.52 |
| **2F3** | | | | | | | | |
| Malta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.02 | 0.00 |
| Spain | 0.07 | 0.11 | 0.12 | 0.18 | 0.23 | 0.29 | 0.36 | 0.43 |
| Italy | 0.00 | 0.31 | 0.42 | 0.58 | 0.75 | 0.96 | 1.26 | 1.60 |
| Greece | 1.47 | 1.97 | 2.53 | 3.42 | 4.63 | 6.12 | 7.85 | 9.83 |
| AVERAGE | 0.39 | 0.60 | 0.77 | 1.04 | 1.40 | 1.84 | 2.62 | 2.96 |
| **2F4** | | | | | | | | |
| Malta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.47 | 9.57 |
| Spain | 9.53 | 10.56 | 10.74 | 9.63 | 8.07 | 12.21 | 9.01 | 7.81 |
| Italy | 0.00 | 0.71 | 1.86 | 2.82 | 3.01 | 3.72 | 4.79 | 5.02 |
| Greece | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.46 |
| AVERAGE | 2.38 | 2.82 | 3.15 | 3.11 | 2.77 | 3.98 | 5.32 | 6.22 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |
| Malta | 0.58 | 0.63 | 0.68 | 0.99 | 1.13 | 1.28 | 1.38 | 1.42 |
| Spain | 0.15 | 0.18 | 0.21 | 0.21 | 0.22 | 0.23 | 0.24 | 0.24 |
| Italy | 2.18 | 2.47 | 2.72 | 2.94 | 3.12 | 3.26 | 3.37 | 3.43 |
| Greece | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.11 |
| AVERAGE | 0.73 | 0.83 | 0.91 | 1.04 | 1.13 | 1.20 | 1.25 | 1.30 |
| **2F3** | | | | | | | | |
| Malta | 0.00 | 4.14 | 0.04 | 5.23 | 4.73 | 7.02 | 6.26 | 4.90 |
| Spain | 0.50 | 0.60 | 0.70 | 0.80 | 0.91 | 1.03 | 1.16 | 1.26 |
| Italy | 1.95 | 2.32 | 2.68 | 9.52 | 10.49 | 11.41 | 12.21 | 12.94 |
| Greece | 11.71 | 13.50 | 15.11 | 16.64 | 18.12 | 19.44 | 20.66 | 21.64 |
| AVERAGE | 3.54 | 5.14 | 4.63 | 8.05 | 8.56 | 9.73 | 10.07 | 10.18 |
| **2F4** | | | | | | | | |
| Malta | 8.83 | 8.37 | 12.89 | 4.90 | 6.15 | 6.98 | 7.71 | 5.61 |
| Spain | 7.61 | 7.65 | 7.59 | 6.90 | 6.47 | 6.46 | 5.96 | 5.75 |
| Italy | 5.19 | 4.99 | 4.74 | 4.63 | 4.32 | 3.84 | 3.35 | 3.13 |
| Greece | 8.73 | 6.38 | 9.56 | 5.84 | 5.62 | 3.97 | 3.95 | 3.68 |
| AVERAGE | 7.59 | 6.85 | 8.69 | 5.57 | 5.64 | 5.31 | 5.24 | 4.54 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Malta | 1.44 | 1.50 | 1.51 | 1.55 | 1.67 | 1.79 | 1.82 | 2.00 |
| Spain | 0.25 | 0.26 | 0.26 | 0.26 | 0.26 | 0.27 | 0.26 | 0.26 |
| Italy | 3.41 | 3.43 | 3.45 | 3.44 | 3.42 | 3.42 | 3.37 | 3.33 |
| Greece | 0.18 | 0.25 | 0.33 | 0.40 | 0.47 | 0.55 | 0.55 | 0.54 |
| AVERAGE | 1.32 | 1.36 | 1.39 | 1.41 | 1.46 | 1.50 | 1.50 | 1.53 |
| **2F3** | | | | | | | | |
| Malta | 6.59 | 0.72 | 2.81 | 4.67 | 0.56 | 0.37 | 2.70 | 2.82 |
| Spain | 1.25 | 1.19 | 1.12 | 1.03 | 0.93 | 0.86 | 0.78 | 0.71 |
| Italy | 13.45 | 13.88 | 14.29 | 14.91 | 14.79 | 14.67 | 15.11 | 14.92 |
| Greece | 22.18 | 22.98 | 23.72 | 24.19 | 24.45 | 23.22 | 23.34 | 23.49 |
| AVERAGE | 10.87 | 9.69 | 10.49 | 11.20 | 10.18 | 9.78 | 10.48 | 10.49 |
| **2F4** | | | | | | | | |
| Malta | 3.77 | 3.69 | 1.85 | 2.19 | 1.61 | 1.30 | 1.19 | 1.04 |
| Spain | 5.76 | 4.55 | 5.56 | 5.79 | 6.07 | 5.92 | 5.62 | 5.07 |
| Italy | 3.07 | 2.67 | 2.35 | 3.01 | 3.75 | 3.85 | 3.31 | 2.52 |
| Greece | 3.79 | 3.81 | 3.86 | 3.83 | 3.82 | 3.83 | 3.81 | 3.81 |
| AVERAGE | 4.10 | 3.68 | 3.41 | 3.70 | 3.81 | 3.72 | 3.49 | 3.11 |
| | | | | | | | | |
| | **2022** | **2023** | | | | | | |
| **2F2** | | | | | | | | |
| Malta | 2.12 | 2.27 | | | | | | |
| Spain | 0.26 | 0.25 | | | | | | |
| Italy | 3.26 | 3.11 | | | | | | |
| Greece | 0.53 | 0.50 | | | | | | |
| AVERAGE | 1.54 | 1.53 | | | | | | |
| **2F3** | | | | | | | | |
| Malta | 2.33 | 2.12 | | | | | | |
| Spain | 0.65 | 0.58 | | | | | | |
| Italy | 14.61 | 14.71 | | | | | | |
| Greece | 23.39 | 23.22 | | | | | | |
| AVERAGE | 10.24 | 10.16 | | | | | | |
| **2F4** | | | | | | | | |
| Malta | 1.03 | 0.68 | | | | | | |
| Spain | 5.89 | 5.55 | | | | | | |
| Italy | 2.40 | 2.77 | | | | | | |
| Greece | 3.88 | 3.88 | | | | | | |
| AVERAGE | 3.30 | 3.22 | | | | | | |

**Table 4.21. Total population of Cyprus used for the estimation of emissions from 2F (2F2, 2F3, 2F4) activities**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** |
|---|---|---|---|---|---|---|---|---|---|
| Population | 572655 | 587141 | 603069 | 619231 | 632944 | 645399 | 656333 | 666313 | 675215 |

| | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
|---|---|---|---|---|---|---|---|---|---|
| Population | 682862 | 690497 | 697549 | 705539 | 713720 | 722893 | 733067 | 744013 | 757916 |

| | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** |
|---|---|---|---|---|---|---|---|---|---|
| Population | 776333 | 796930 | 819140 | 839751 | 862011 | 865878 | 858000 | 847008 | 848319 |

| | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | | |
|---|---|---|---|---|---|---|---|---|---|
| Population | 854802 | 864236 | 875899 | 888005 | 896007 | 904705 | 920701 | | |

**Table 4.22. Contribution of activities to 2F (2F2, 2F3, 2F4) emissions**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |
| Closed cells | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F3** | | | | | | | | |
| Fire protection | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F4** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Metered dose inhalers | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |
| Closed cells | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F3** | | | | | | | | |
| Fire protection | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F4** | | | | | | | | |
| Metered dose inhalers | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |
| Closed cells | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F3** | | | | | | | | |
| Fire protection | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F4** | | | | | | | | |
| Metered dose inhalers | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| **2F2** | | | | | | | | |
| Closed cells | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F3** | | | | | | | | |
| Fire protection | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **2F4** | | | | | | | | |
| Metered dose inhalers | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| | | | | | | | | |
| | **2022** | **2023** | | | | | | |
| **2F2** | | | | | | | | |
| Closed cells | 100% | 100% | | | | | | |
| **2F3** | | | | | | | | |
| Fire protection | 100% | 100% | | | | | | |
| **2F4** | | | | | | | | |
| Metered dose inhalers | 100% | 100% | | | | | | |

**Table 4.23. Total 2F (2F2, 2F3, 2F4) emissions from Stocks estimated for Cyprus (t $CO_2$ eq.)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|
| **2F2** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| **2F3** | 0 | 0 | 3 | 8 | 20 | 41 | 66 | 100 | 261 |
| **2F4** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 12 | 1610 |

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| **2F2** | 36 | 79 | 130 | 194 | 267 | 373 | 463 | 546 | 628 |
| **2F3** | 406 | 532 | 729 | 989 | 1314 | 1897 | 2173 | 2633 | 3893 |
| **2F4** | 1924 | 2175 | 2173 | 1956 | 2842 | 3843 | 4557 | 5647 | 5189 |

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| **2F2** | 706 | 830 | 922 | 1006 | 1080 | 1126 | 1132 | 1153 | 1176 |
| **2F3** | 3596 | 6416 | 7012 | 8168 | 8680 | 8818 | 9324 | 8209 | 8896 |
| **2F4** | 6750 | 4436 | 4618 | 4461 | 4518 | 3933 | 3516 | 3116 | 2890 |

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | | |
|---|---|---|---|---|---|---|---|---|---|
| **2F2** | 1208 | 1259 | 1317 | 1332 | 1374 | 1394 | 1412 | | |
| **2F3** | 9573 | 8798 | 8567 | 9310 | 9396 | 9267 | 9353 | | |
| **2F4** | 3165 | 3295 | 3261 | 3095 | 2786 | 2985 | 2965 | | |

### 4.6.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 4.6.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

### 4.6.5. Category-specific recalculations

Emissions for 2F category have been recalculated for:

i. Commercial Refrigeration (2F1a) due to updated GDP values from the Statistical Service for the period 2018-2022,
ii. Industrial Refrigeration (2F1c) due to updated GDP values from the Statistical Service for the period 2018-2022
iii. Stationary A/C Systems (2F1f) due to updated GDP values from the Statistical Service for the period 2018-2022,
iv. Updated data for categories 2F2, 2F3, 2F4 for 2021 and 2022.

The impact of recalculations is presented in the following table and figure.

**Table 4.24. 2F Recalculations**

| **2F (kt $CO_2$ eq.)** | **2018** | **2019** | **2020** | **2021** | **2022** | |
|---|---|---|---|---|---|---|
| 2024 submission | 304.75 | 328.20 | 334.51 | 359.20 | 383.73 | |
| 2025 submission | 305.83 | 330.00 | 336.65 | 364.61 | 394.92 | |
| *change* | 0.35% | 0.55% | 0.64% | 1.51% | 2.92% | |

### 4.6.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 4.7. Other Product Manufacture and Use (2G)

According to the 2006 IPCC Guidelines, the source category 2G should include emissions for the activities Electrical Equipment (2G1) (Manufacture, Use and Disposal of Electrical Equipment), $SF_6$ and PFCs from Other Product Uses (2G2) (Military Applications, Accelerators and other), $N_2O$ from Product Uses (2G3) (Medical Applications, Propellant for Pressure and Aerosol Products and other) and Other (2G4). According to the available information the activities that take place in Cyprus are Use of Electrical Equipment (2G1b), Medical Applications of $N_2O$ (2G3a) and Propellant for Pressure and Aerosol Products (2G3b). The total emissions by gas and source for the period 1990–2023 are presented in Table 4.25 and Figure 4.9.

**Table 4.25. Emissions from Other Product Manufacture and Use (2G)**

| | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| **G. Other product manufacture and use (Gg $CO_2$ eq.)** | **6.66** | **13.80** | **17.40** | **18.32** | **20.14** | **20.77** | **21.32** |
| 1. Electrical equipment | 2.73 | 9.13 | 12.42 | 12.70 | 14.36 | 14.97 | 15.58 |
| 2. $SF_6$ and PFCs from other product use | NO | NO | NO | NO | NO | NO | NO |
| 3. $N_2O$ from product uses | 3.93 | 4.67 | 4.98 | 5.62 | 5.77 | 5.80 | 5.75 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4. Other | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| $N_2O$ (t) | 14.84 | 17.63 | 18.80 | 21.22 | 21.78 | 21.88 | 21.68 |
| $SF_6$ (t) | 0.12 | 0.39 | 0.53 | 0.54 | 0.61 | 0.64 | 0.66 |
| **Total (Gg $CO_2$ eq.)** | **6.66** | **13.80** | **17.40** | **18.32** | **20.14** | **20.77** | **21.32** |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| **G. Other product manufacture and use (Gg $CO_2$ eq.)** | **21.86** | **22.47** | **21.33** | **21.59** | **22.76** | **21.39** | **24.74** |
| 1. Electrical equipment | 16.18 | 16.79 | 15.61 | 15.80 | 16.89 | 15.44 | 18.74 |
| 2. $SF_6$ and PFCs from other product use | NO | NO | NO | NO | NO | NO | NO |
| 3. $N_2O$ from product uses | 5.67 | 5.68 | 5.72 | 5.79 | 5.87 | 5.95 | 6.00 |
| 4. Other | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| $N_2O$ (t) | 21.40 | 21.44 | 21.60 | 21.84 | 22.13 | 22.44 | 22.64 |
| $SF_6$ (t) | 0.69 | 0.71 | 0.66 | 0.67 | 0.72 | 0.66 | 0.80 |
| **Total (Gg $CO_2$ eq.)** | **21.86** | **22.47** | **21.33** | **21.59** | **22.76** | **21.39** | **24.74** |

| | 2021 | 2022 | 2023 | | | | |
|---|---|---|---|---|---|---|---|
| **G. Other product manufacture and use (Gg $CO_2$ eq.)** | **23.64** | **24.00** | **24.09** | | | | |
| 1. Electrical equipment | 17.58 | 17.84 | 17.84 | | | | |
| 2. $SF_6$ and PFCs from other product use | NO | NO | NO | | | | |
| 3. $N_2O$ from product uses | 6.06 | 6.16 | 6.25 | | | | |
| 4. Other | NO | NO | 24.09 | | | | |
| | | | | | | | |
| $N_2O$ (t) | 22.86 | 23.25 | 23.59 | | | | |
| $SF_6$ (t) | 0.75 | 0.76 | 0.76 | | | | |
| **Total (Gg $CO_2$ eq.)** | **22.64** | **24.00** | **24.09** | | | | |

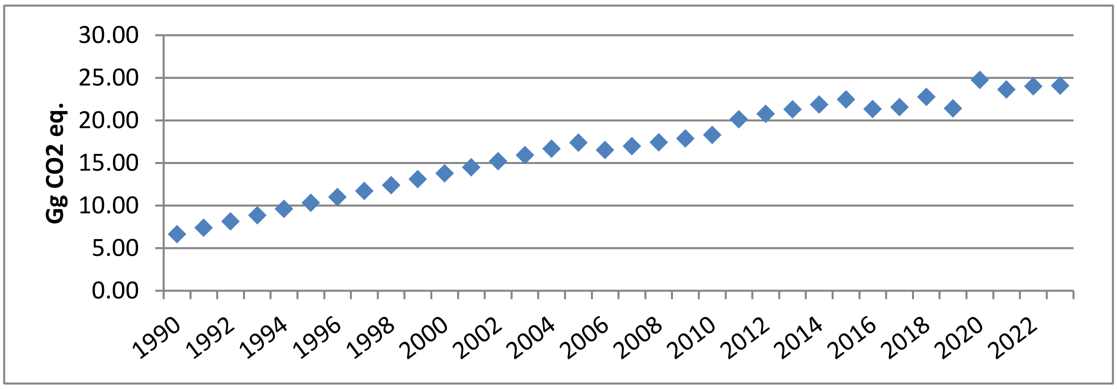


**Figure 4.9. Emissions from Other Product Manufacture and Use (2G)**

## 4.7.1. Electrical Equipment (2G1)

$SF_6$ is used for electrical insulation and for current interruption in equipment used in the transmission and distribution of electricity. The Electricity Authority of Cyprus (EAC) is the owner of both the high and low voltage distribution systems and the owner and operator of the medium and lower voltage distribution systems in Cyprus. $SF_6$ is used in equipment across all voltage ranges on both the Distribution and Transmission systems owned by EAC Networks.

Electrical equipment containing $SF_6$ is imported into Cyprus, and at time of purchase is added to the $SF_6$ installed inventory database. Quantities of $SF_6$ are needed for servicing and repair of existing equipment. There are no manufacturing emissions.

#### 4.7.1.1. Methodological issues

In the context of the present inventory, emissions are estimated using a Tier 1 method (the default emission-factor approach). In this method, emissions are estimated by multiplying default regional emission factors by the nameplate $SF_6$ capacity of the equipment at each life cycle stage beyond manufacturing in the country. The following equation was used for the emissions:

$$Total\ Emission = Manufacturing\ Emissions + Equipment\ Installation\ Emissions + Equipment\ Use\ Emissions + Equipment\ Disposal\ Emissions$$

Where:

*Manufacturing emissions* = Manufacturing Emission Factor * Total $SF_6$ consumption by equipment manufacturers (there are no manufacturing emissions in Cyprus)

*Equipment installation emissions* = Installation Emission Factor * Total nameplate capacity of new equipment filled on site (not at the factory).

*Equipment use emissions* = Use Emission Factor * Total nameplate capacity of installed equipment. The 'use emission factor' includes emissions due to leakage, servicing, and maintenance as well as failures

*Equipment disposal emissions* = Total nameplate capacity of retiring equipment * Fraction of $SF_6$ remaining at retirement

Default emissions factors are taken from Table 8.2 to 8.4 (IPCC Guidelines, pgs. 8.15 & 8.16, volume 3, chapter 8).

$SF_6$ emissions from electrical equipment are presented in Table 4.26.

**Table 4.26. $SF_6$ emissions (in t) from electrical equipment for the period 1990–2023**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $SF_6$ (t) | 0.12 | 0.14 | 0.17 | 0.20 | 0.23 | 0.25 | 0.28 | 0.31 | 0.33 | 0.36 | 0.39 |

| | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $SF_6$ (t) | 0.42 | 0.44 | 0.47 | 0.50 | 0.53 | 0.49 | 0.50 | 0.51 | 0.53 | 0.54 | 0.61 |

| | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $SF_6$ (t) | 0.64 | 0.66 | 0.69 | 0.71 | 0.66 | 0.67 | 0.72 | 0.66 | 0.80 | 0.75 | 0.76 |
| | | | | | | | | | | | |
| | **2023** | | | | | | | | | | |
| $SF_6$ (t) | 0.76 | | | | | | | | | | |

#### 4.7.1.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 4.7.1.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 4.7.1.4. Category-specific recalculations

No recalculations to report.

#### 4.7.1.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 4.7.2. $SF_6$ and PFCs from Other Product Uses (2G2)

No information is available to support that $SF_6$ and PFCs from Other Product Uses occurs in Cyprus.

## 4.7.3. $N_2O$ from Product Uses (2G3)

Evaporative emissions of nitrous oxide ($N_2O$) can arise from various types of product use, including: Medical applications (anaesthetic use, analgesic use and veterinary use), Use as a propellant in aerosol products, primarily in food industry (pressure-packaged whipped cream, etc.), etc. In general, medical applications and use as a propellant in aerosol products are likely to be larger sources than others. In Cyprus these are the two activities identified as consumers of $N_2O$.

#### 4.7.3.1. Methodological issues

Medical Applications (2G3a)

The necessary activity data is not available to estimate emissions according to the 2006 IPCC guidelines; therefore a country-specific methodology has been developed.

The method uses the total population of Cyprus and the emission factor of 0.00001532 t $N_2O$ per capita in the equation:

$$N_2O \text{ emissions (Gg)} = \text{population} * \text{emission factor per capita (t } N_2O/\text{capita)}$$

The emission factor is based on an average t $N_2O$/capita value from all EU Member States reporting country-specific data using amount of gas as activity data (0.00001532 t $N_2O$/capita in 2016).

Propellant for Pressure and Aerosol Products (2G3b)

The necessary activity data is not available to estimate emissions according to the 2006 IPCC guidelines; therefore a country specific methodology has been developed.

The method uses the total population of Cyprus and the emission factor of 0.00000995 t $N_2O$ per capita in the equation:

$$N_2O \text{ emissions (Gg)} = \text{population} * \text{emission factor per capita (t } N_2O/\text{capita)}$$

The emission factor is based on an average t $N_2O$/capita value from all EU Member States reporting country-specific data using amount of gas as activity data (0.00000995 t $N_2O$/capita in 2016).

The results as reported in CRTreporter for $N_2O$ emissions from Product Uses are presented in Table 4.27.

**Table 4.27. $N_2O$ emissions (Gg) from Product Uses**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|---|---|
| 2G3a | 0.0090 | 0.0092 | 0.0095 | 0.0097 | 0.0099 | 0.0101 | 0.0102 |
| 2G3b | 0.0058 | 0.0060 | 0.0062 | 0.0063 | 0.0064 | 0.0065 | 0.0066 |
| TOTAL | 0.0148 | 0.0152 | 0.0156 | 0.0160 | 0.0163 | 0.0166 | 0.0168 |
| | | | | | | | |
| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
| 2G3a | 0.0103 | 0.0105 | 0.0106 | 0.0107 | 0.0108 | 0.0109 | 0.0111 |
| 2G3b | 0.0067 | 0.0068 | 0.0069 | 0.0069 | 0.0070 | 0.0071 | 0.0072 |
| TOTAL | 0.0171 | 0.0173 | 0.0174 | 0.0176 | 0.0178 | 0.0180 | 0.0183 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
| 2G3a | 0.0112 | 0.0114 | 0.0116 | 0.0119 | 0.0122 | 0.0125 | 0.0129 |
| 2G3b | 0.0073 | 0.0074 | 0.0075 | 0.0077 | 0.0079 | 0.0082 | 0.0084 |
| TOTAL | 0.0185 | 0.0188 | 0.0192 | 0.0196 | 0.0201 | 0.0207 | 0.0212 |
| | | | | | | | |
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| 2G3a | 0.0132 | 0.0133 | 0.0131 | 0.0130 | 0.0130 | 0.0131 | 0.0132 |
| 2G3b | 0.0086 | 0.0086 | 0.0085 | 0.0084 | 0.0084 | 0.0085 | 0.0086 |
| TOTAL | 0.0218 | 0.0219 | 0.0217 | 0.0214 | 0.0214 | 0.0216 | 0.0218 |
| | | | | | | | |
| | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| 2G3a | 0.0134 | 0.0136 | 0.0137 | 0.0139 | 0.0141 | 0.0143 | |
| 2G3b | 0.0087 | 0.0088 | 0.0089 | 0.0090 | 0.0092 | 0.0093 | |
| TOTAL | 0.0221 | 0.0224 | 0.0226 | 0.0229 | 0.0233 | 0.0236 | |

#### 4.7.3.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 4.7.3.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 4.7.3.4. Category-specific recalculations

No recalculations to report.

#### 4.7.3.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

### 4.7.4. Other product manufacture and use (2G4)

Source category 2G4 in Cyprus includes the emissions associated with Tobacco combustion.

Emissions of NMVOCs are reported in this category. NMVOCs are indirect greenhouse gases which result from the use of tobacco. The indirect $CO_2$ emissions associated with these NMVOC emissions are reported under this category. Previously, these estimates were reported in the CRT Tables as direct $CO_2$ and included in Cyprus' national total.

#### 4.7.3.1. Methodological issues

Methodologies for estimating these NMVOC emissions can be found in the EMEP/EEA Emission Inventory Guidebook (EEA, 2016). Further information on emissions of NMVOCs and indirect $CO_2$ emissions can be found in Chapter 9 of this report.

#### 4.7.4.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 4.7.4.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and

verification activities are applied for this sector.

#### 4.7.4.4. Category-specific recalculations

No recalculations to report.

#### 4.7.4.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

# Chapter 5.
## Agriculture (CRT sector 3)

## 5.1. Overview of sector

In agricultural activities there are many processes leading to emissions and removals of greenhouse gases, which can be widely dispersed in space and highly variable in time. The factors governing emissions and removals can be natural and anthropogenic, direct and indirect, and it can be difficult to clearly distinguish between causal factors.

Livestock production can result in methane ($CH_4$) emissions from enteric fermentation and both $CH_4$ and nitrous oxide ($N_2O$) emissions from livestock manure management systems. Cattle are an important source of $CH_4$ in many countries because of their large population and high $CH_4$ emission rate due to their ruminant digestive system. Methane emissions from manure management tend to be smaller than enteric emissions, with the most substantial emissions associated with confined animal management operations where manure is handled in liquid-based systems. Nitrous oxide emissions from manure management vary significantly between the types of management system used and can also result in indirect emissions due to other forms of nitrogen loss from the system.

According to the 2006 IPCC Guidelines, the following source categories are included in this sector: Enteric fermentation (3.A), Manure management (3.B), Rice cultivation (3.C), Agricultural soils (3.D), Prescribed burning of savannas (3.E), Field burning of agricultural residues (3.F), Liming (3.G), Urea Application (3.H), Other Carbon-containing fertilizers (3.I). In Cyprus, rice cultivation (3.C), prescribed burning of savannas (3.E) and Liming (3.G) do not take place and are therefore reported as NO.

### 5.1.1. Emission trends

***The agricultural sector of Cyprus[42]***

Although abundant with fresh produce and a sunny climate, farming in Cyprus is faced with droughts and environmental challenges, as well as an ongoing struggle for economic relevance. In the early years of Cyprus' independence, the contribution of the agricultural sector to GDP was about 20%, whereas today it has dropped to around 1.7% and employs 4% of the workforce. However, the sector has tackled these trials and tribulations head-on by adopting new technologies, bringing new products to the market and widening its customer base.

Agriculture has shown remarkable resilience and production has remained at stable levels, despite recent macroeconomic challenges – proving there are positive future prospects for the sector if it continues to develop on a more professional, niche and scientific basis. New structural reforms are also set to increase competitiveness and productivity, allowing Cyprus to become more dynamic, export-oriented and most importantly to adopt a mentality of continuous modernisation.

Cyprus' agricultural share of total domestic exports is around 13.4%, and it is quintessentially Mediterranean with health-promoting foods such as citrus fruit, vegetables, grapes and potatoes. As for processed agricultural goods, Cyprus' key exports are halloumi, fruit and vegetable juices, meats and wines. The island's famous halloumi cheese has become one of the top export products for Cyprus.

The most important crops produced in Cyprus are: cereals (wheat, barley); melons (watermelons, sweet melons); vegetables (potatoes, carrots, tomatoes, cucumbers); and other fruit and tree crops, such as grapes, oranges, lemons, grapefruit, apples, pears, peaches, cherries, bananas, almonds, olives and

[42] Cyprus Profile, 2017, Green Growth and Niche Products, available at http://www.cyprusprofile.com/en/sectors/agriculture-and-food (accessed 19/12/2017)

carobs. An area of success has been the marketing of the Cyprus potato – one of the most important agricultural export products and easily recognisable by its reddish peel and extraordinary taste. Thanks to climatic conditions, fresh new Cyprus potatoes intended for export are available to European markets far before the traditional continental season.

***Emissions***

Emissions from Agriculture accounted for 6.0% of total emissions in 2023 (without LULUCF), compared to 8.3% in 1990. Emissions increased by 16.65% compared to 1990. Agriculture is responsible for mainly methane and nitrous oxide emissions. In 2023 agriculture contributed 38.1% to the total methane emissions and 69% to the total nitrous oxide emissions. The total emissions by gas and source from agricultural activities for the period 1990–2023 in Cyprus are presented in Table 5.1 and Figure 5.1.

**Table 5.1. GHG emissions from Agriculture, for the period 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| **3. Agriculture** | **454.74** | **542.91** | **525.54** | **514.80** | **506.90** | **484.68** | **449.17** |
| A. Enteric fermentation | 220.61 | 251.11 | 255.88 | 263.63 | 270.08 | 263.38 | 251.14 |
| B. Manure management | 172.45 | 231.25 | 212.23 | 193.35 | 181.91 | 165.66 | 149.33 |
| C. Rice cultivation | NO | NO | NO | NO | NO | NO | NO |
| D. Agricultural soils | 56.90 | 57.72 | 55.31 | 56.33 | 53.17 | 54.10 | 47.27 |
| E. Prescribed burning of savannas | NO | NO | NO | NO | NO | NO | NO |
| F. Field burning of agricultural residues | 2.96 | 1.16 | 1.15 | 0.76 | 0.83 | 0.98 | 0.64 |
| G. Liming | NO | NO | NO | NO | NO | NO | NO |
| H. Urea application | 1.82 | 1.67 | 0.97 | 0.74 | 0.91 | 0.55 | 0.79 |
| I. Other carbon-containing fertilizers | NO | NO | NO | NO | NO | NO | NO |
| J. Other | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| $CO_2$ (Gg) | 1.82 | 1.67 | 0.97 | 0.74 | 0.91 | 0.55 | 0.79 |
| $CH_4$ (Gg) | 12.03 | 14.70 | 14.24 | 13.87 | 13.70 | 13.01 | 12.17 |
| $N_2O$ (Gg) | 0.44 | 0.49 | 0.47 | 0.47 | 0.46 | 0.45 | 0.41 |
| **Total (Gg $CO_2$ eq.)** | **454.74** | **542.91** | **525.54** | **514.80** | **506.90** | **484.68** | **449.17** |

| **Gg $CO_2$ eq.** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| **3. Agriculture** | **437.26** | **441.85** | **462.39** | **476.12** | **481.80** | **495.53** | **531.55** |
| A. Enteric fermentation | 249.45 | 251.32 | 273.00 | 286.37 | 292.99 | 303.26 | 329.63 |
| B. Manure management | 143.31 | 140.11 | 141.35 | 139.59 | 139.50 | 140.83 | 148.96 |
| C. Rice cultivation | NO | NO | NO | NO | NO | NO | NO |
| D. Agricultural soils | 43.84 | 49.03 | 47.38 | 49.28 | 48.71 | 50.54 | 52.01 |
| E. Prescribed burning of savannas | NO | NO | NO | NO | NO | NO | NO |
| F. Field burning of agricultural residues | 0.24 | 0.99 | 0.26 | 0.47 | 0.38 | 0.68 | 0.73 |
| G. Liming | NO | NO | NO | NO | NO | NO | NO |
| H. Urea application | 0.41 | 0.40 | 0.39 | 0.42 | 0.22 | 0.23 | 0.22 |
| I. Other carbon-containing fertilizers | NO | NO | NO | NO | NO | NO | NO |
| J. Other | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| $CO_2$ (Gg) | 0.41 | 0.40 | 0.39 | 0.42 | 0.22 | 0.23 | 0.22 |
| $CH_4$ (Gg) | 11.87 | 11.89 | 12.61 | 12.95 | 13.16 | 13.52 | 14.65 |
| $N_2O$ (Gg) | 0.39 | 0.41 | 0.41 | 0.43 | 0.43 | 0.44 | 0.46 |
| **Total (Gg $CO_2$ eq.)** | **437.26** | **441.85** | **462.39** | **476.12** | **481.80** | **495.53** | **531.55** |

| **Gg $CO_2$ eq.** | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| **3. Agriculture** | **546.27** | **528.61** | **530.45** | | | | |
| A. Enteric fermentation | 342.12 | 332.00 | 336.14 | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B. Manure management | 151.51 | 144.91 | 142.96 | | | | |
| C. Rice cultivation | NO | NO | NO | | | | |
| D. Agricultural soils | 51.71 | 50.76 | 50.55 | | | | |
| E. Prescribed burning of savannas | NO | NA | NA | | | | |
| F. Field burning of agricultural residues | 0.63 | 0.67 | 0.62 | | | | |
| G. Liming | NO | NO | NO | | | | |
| H. Urea application | 0.30 | 0.27 | 0.18 | | | | |
| I. Other carbon-containing fertilizers | NO | NO | NO | | | | |
| J. Other | NO | NA | NA | | | | |
| | | | | | | | |
| $CO_2$ (Gg) | 0.30 | 0.27 | 0.18 | | | | |
| $CH_4$ (Gg) | 15.14 | 14.61 | 14.70 | | | | |
| $N_2O$ (Gg) | 0.46 | 0.46 | 0.45 | | | | |
| **Total (Gg $CO_2$ eq.)** | **626.2** | **528.61** | **530.45** | | | | |

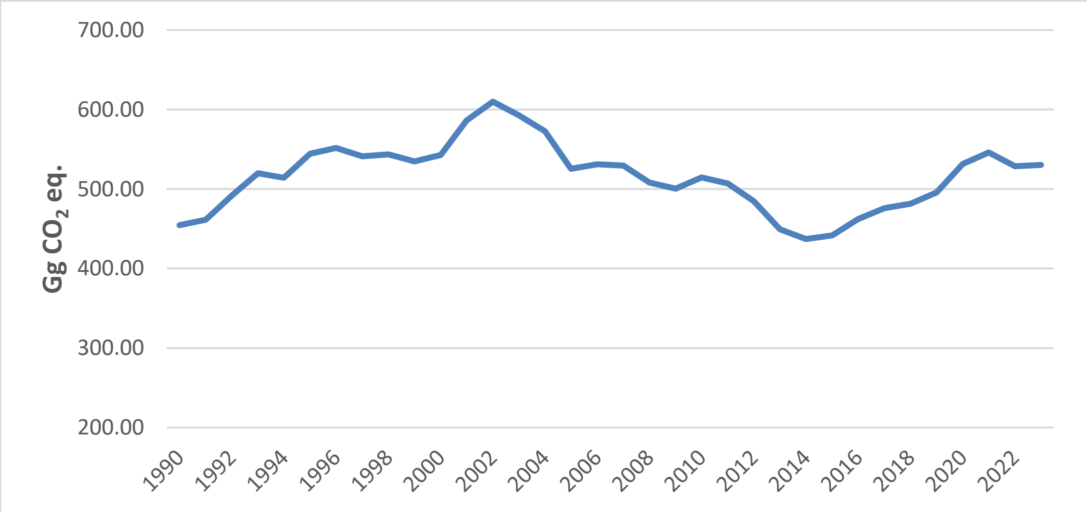


**Figure 5.1. Emissions from Agriculture, 1990–2023**

## 5.1.2. Methodology

The calculation of GHG emissions from Agriculture is based on the methodologies and emission factors suggested by the 2006 IPCC Guidelines. Data used for the estimation of the emissions was obtained from the National Statistical Service, the Department of Agriculture, the Veterinary services and other sources. Tier 1 method with default IPCC 2006 emission factors are used for all calculations except enteric fermentation emissions from cattle (3A1a), manure management of cattle (3B1.1) and swine (3B1.3) and direct $N_2O$ emissions from managed soils from inorganic fertilizers (3D1.1) and organic fertilizers (3D1.2a, 3D1.2b, 3D12c) that are estimated using Tier 2. The methodologies and emission factors used are summarised in Table 5.2.

**Table 5.2. Agriculture – methodologies and emission factors applied**

| **Category-Classification** | | **Gas** | **EF** | **Method** |
|---|---|---|---|---|
| 3A | Enteric Fermentation – Dairy Cattle | $CH_4$ | CS | T2 |
| 3A | Enteric Fermentation - Non-dairy cattle, sheep, goats, horses, mules and asses and swine | $CH_4$ | D | T1 |
| 3B1.1<br>3B1.3 | Manure Management – Dairy Cattle and Non-dairy cattle, swine (market & breeding) | $CH_4$ | D | T2 |
| 3B1.2 | Manure Management – sheep, goats, horses, mules and | $CH_4$ | D | T1 |

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 3B1.4 | asses, poultry | | | |
| 3B2.1<br>3B2.2<br>3B2.3<br>3B2.4 | Direct $N_2O$ emissions – Dairy and non-dairy cattle, Sheep, swine (market & breeding), goats, horses, poultry, mules and asses | $N_2O$ | D | T1 |
| 3B2.5 | Indirect $N_2O$ emissions | $N_2O$ | D | T1 |
| 3D1.1 | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils- Inorganic fertilizers | $N_2O$ | CS | T2 |
| 3D1.2a | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils - Organic N fertilizers - Animal manure used as fertilizers | $N_2O$ | CS | T2 |
| 3D1.2b | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils - Organic N fertilizers - Sewage sludge applied to soils | $N_2O$ | CS | T2 |
| 3D1.2c | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils - Organic N fertilizers – Other organic fertilizers applied to soils | $N_2O$ | CS | T2 |
| 3D1.4 | Agricultural soils- Direct $N_2O$ Emissions From Managed Soils - Crop residues | $N_2O$ | D | T1 |
| 3D2.1 | Indirect $N_2O$ emissions from managed soils – Atmospheric Deposition | $N_2O$ | D | T1 |
| 3D2.2 | Indirect $N_2O$ emissions from managed soils Nitrogen Leaching and run-off | $N_2O$ | D | T1 |
| 3F1 | Field Burning of Agricultural Residues – Cereals – Wheat, Barley, Oats | $N_2O/CH_4$ | D | T1 |
| 3F2 | Field Burning of Agricultural Residues – Pulses – Bean and Pulses | $N_2O/CH_4$ | D | T1 |
| 3F3 | Field Burning of Agricultural Residues –Tubers and Roots | $N_2O/CH_4$ | D | T1 |
| 3H | Urea Application | $CO_2$ | D | T1 |

T1, T2: IPCC methodology Tier 1, 2 respectively; D: IPCC default methodology and emission factor;

**Key categories**

The results of the key categories assessment are presented in Section 1.4.

**Uncertainty**

The uncertainty analysis is presented in Section 1.5.

**Completeness**

Table 5.3 gives an overview of the IPCC source categories included in this chapter and presents the status of emissions estimates from all sub-sources in agriculture. Methane emissions from agricultural soils are not estimated since appropriate methodologies have not been developed yet.

**Table 5.3. Agriculture – Inventory completeness**

| Source category | $CO_2$ | $CH_4$ | $N_2O$ |
|---|---|---|---|
| 3A. Enteric fermentation | | ✓ | |
| 3B. Manure management | | ✓ | ✓ |
| 3C. Rice cultivation | | NO | |
| 3D. Agricultural soils | | NE | ✓ |
| 3E. Prescribed burning of savannahs | | NO | NO |
| 3F. Field burning of agricultural residues | | ✓ | ✓ |
| 3G. Liming | NO | | |
| 3H. Urea Application | ✓ | | |
| 3I. Other Carbon – containing Fertilizers | NO | | |

NO: Not occurring; NE: Not estimated due to method unavailability

## 5.2. Enteric Fermentation (3A)

Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. The amount of methane that is released depends on the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed consumed. Ruminant livestock (e.g., cattle, sheep) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses). The ruminant gut structure fosters extensive enteric fermentation of their diet.

Methane emissions from enteric fermentation in 2023 accounted for 81.7% of total GHG emissions from Agriculture and 31.1% of the total methane emissions excluding LULUCF. Methane emissions from enteric fermentation are presented in Table 5.4 and Figure 5.2.

**Table 5.4. $CH_4$ emissions from Enteric Fermentation (3A) 1990–2023**

| Gg $CH_4$ | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| **A. Enteric fermentation** | **7.88** | **8.97** | **9.14** | **9.42** | 9.65 | 9.41 | 8.97 |
| 1. Cattle | 4.05 | 4.46 | 4.66 | 4.53 | 4.67 | 4.66 | 4.69 |
| Dairy cattle | 2.21 | 2.72 | 2.78 | 2.75 | 2.80 | 2.79 | 2.83 |
| Non-dairy cattle | 1.84 | 1.75 | 1.88 | 1.78 | 1.87 | 1.87 | 1.85 |
| 2. Sheep | 2.32 | 1.97 | 2.15 | 2.63 | 2.85 | 2.78 | 2.51 |
| 3. Swine | 0.42 | 0.61 | 0.64 | 0.70 | 0.66 | 0.59 | 0.54 |
| 4. Other livestock | 1.09 | 1.92 | 1.68 | 1.56 | 1.47 | 1.38 | 1.24 |
| Goats | 1.03 | 1.89 | 1.65 | 1.54 | 1.45 | 1.36 | 1.22 |
| Horses | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mules and Asses | 0.05 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total CH4** | **7.88** | **8.97** | **9.14** | **9.42** | **9.65** | **9.41** | **8.97** |

| Gg $CH_4$ | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| **A. Enteric fermentation** | **8.91** | **8.98** | **9.75** | **10.23** | **10.46** | **10.83** | **11.77** |
| 1. Cattle | 4.87 | 4.88 | 5.54 | 5.82 | 6.16 | 6.44 | 7.29 |
| Dairy cattle | 2.92 | 3.01 | 3.49 | 3.74 | 3.94 | 4.22 | 4.82 |
| Non-dairy cattle | 1.95 | 1.86 | 2.05 | 2.09 | 2.22 | 2.21 | 2.47 |
| 2. Sheep | 2.34 | 2.38 | 2.43 | 2.57 | 2.49 | 2.60 | 2.62 |
| 3. Swine | 0.51 | 0.54 | 0.53 | 0.53 | 0.54 | 0.52 | 0.54 |
| 4. Other livestock | 1.18 | 1.18 | 1.25 | 1.31 | 1.27 | 1.28 | 1.32 |
| Goats | 1.16 | 1.17 | 1.23 | 1.29 | 1.25 | 1.26 | 1.30 |
| Horses | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mules and Asses | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total CH4** | **8.91** | **8.98** | **9.75** | **10.23** | **10.46** | **10.83** | **11.77** |

| Gg $CH_4$ | 2021 | 2022 | 2023 | | | | |
|---|---|---|---|---|---|---|---|
| **A. Enteric fermentation** | **12.22** | **11.94** | **12.00** | | | | |
| 1. Cattle | 7.56 | 7.31 | 7.52 | | | | |
| Dairy cattle | 5.00 | 4.85 | 5.04 | | | | |
| Non-dairy cattle | 2.80 | 2.46 | 2.48 | | | | |
| 2. Sheep | 0.54 | 2.79 | 2.83 | | | | |
| 3. Swine | 1.31 | 0.50 | 0.46 | | | | |
| 4. Other livestock | 1.29 | 1.33 | 1.20 | | | | |
| Goats | 0.01 | 1.31 | 1.17 | | | | |
| Horses | 0.01 | 0.01 | 0.01 | | | | |
| Mules and Asses | 2.80 | 0.01 | 0.01 | | | | |
| **Total CH4** | **12.22** | **11.94** | **12.00** | | | | |

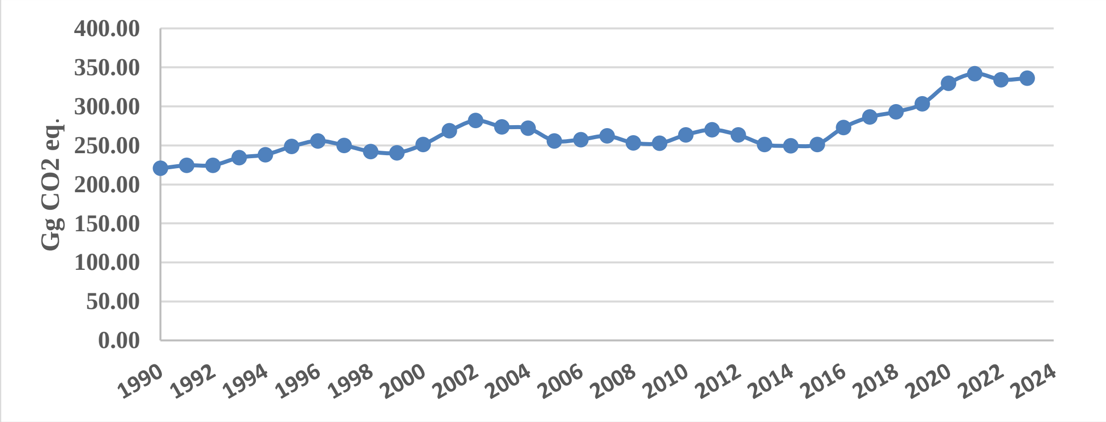


**Figure 5.2.** **$CH_4$ emissions from Enteric Fermentation (3A) 1990–2023 in Gg $CO_2$ eq.**

## 5.2.1. Methodological issues

Tier 1 methodology is applied and the default emission factors suggested by the IPCC Guidelines are used for the estimation of methane emissions from enteric fermentation for non-dairy cattle, sheep, goats, horses, mules and asses and swine. The emissions from dairy cattle are estimated using Tier 2 methodology. Poultry emissions were not estimated, since an emission factor is not available in the IPCC guidelines.

### 5.2.1.1. Activity data

The animal population used for the calculation of methane emissions from enteric fermentation is the annual average and it is presented in Table 5.5. The source of animal population is the Department of Agriculture, except for horses, mules and asses. Following a recommendation of the ERT in the Saturday Paper prepared during the in-country review of the 2016 submission to the UNFCCC, the population for horses, mules and asses was obtained from the Agricultural Censuses of the Statistical Service for the years 1985, 1994, 2002 and 2010 and linearly interpolated to complete the time series. Information after 2010 was available for the mules and asses by the Veterinary Services but was not available for the horses, therefore the decreasing trend that exists between 2003 and 2010 is used to extrapolate population for 2011–2016 using equation $y=-58.571x+1220.6$. Population for the years 2016–2022 was obtained by the veterinary services.

**Table 5.5.** **Animal population for 1990–2023 (in 1000s)**

| | Dairy cattle | Other cattle | Sheep | Breeding swine[a] | Market swine[b] | Horses | Mules and Asses | Goats | Poultry |
|---|---|---|---|---|---|---|---|---|---|
| **1990** | 22.4 | 32.3 | 290.0 | 33.8 | 244.2 | 0.46 | 5.03 | 205.0 | 3694 |
| **1991** | 23.1 | 31.9 | 295.0 | 37.6 | 258.7 | 0.43 | 4.44 | 205.0 | 3403 |
| **1992** | 23.9 | 31.9 | 285.0 | 42.4 | 299.5 | 0.41 | 3.85 | 200.0 | 3838 |
| **1993** | 25.6 | 35.5 | 275.0 | 43.6 | 325.8 | 0.38 | 3.26 | 198.0 | 4551 |
| **1994** | 27.6 | 36.8 | 255.0 | 48.0 | 308.2 | 0.35 | 2.67 | 210.0 | 4313 |
| **1995** | 29.5 | 38.6 | 250.0 | 48.4 | 325.7 | 0.44 | 2.53 | 220.0 | 4460 |
| **1996** | 27.3 | 42.8 | 252.0 | 48.9 | 350.7 | 0.53 | 2.39 | 240.0 | 4749 |
| **1997** | 25.5 | 36.9 | 245.0 | 53.3 | 361.5 | 0.62 | 2.26 | 302.0 | 4816 |
| **1998** | 23.8 | 32.0 | 240.0 | 49.8 | 381.5 | 0.71 | 2.12 | 322.0 | 4894 |
| **1999** | 24.1 | 30.2 | 233.0 | 44.2 | 374.3 | 0.80 | 1.98 | 346.0 | 4823 |
| **2000** | 23.5 | 30.7 | 246.0 | 52.1 | 356.3 | 0.89 | 1.84 | 378.6 | 4830 |
| **2001** | 24.4 | 29.1 | 296.6 | 55.7 | 395.6 | 0.98 | 1.70 | 427.1 | 4873 |
| **2002** | 26.2 | 31.9 | 294.0 | 56.3 | 435.1 | 1.07 | 1.56 | 459.5 | 5037 |
| **2003** | 26.6 | 31.9 | 264.6 | 55.6 | 432.5 | 1.16 | 1.42 | 407.9 | 5015 |
| **2004** | 26.1 | 34.2 | 279.0 | 51.7 | 418.8 | 1.10 | 1.29 | 378.0 | 4547 |
| **2005** | 24.6 | 33.0 | 268.9 | 50.6 | 379.1 | 1.04 | 1.16 | 329.3 | 4419 |
| **2006** | 23.9 | 32.2 | 272.2 | 53.0 | 399.7 | 0.99 | 1.03 | 344.9 | 3775 |

| | Dairy cattle | Other cattle | Sheep | Breeding swine[a] | Market swine[b] | Horses | Mules and Asses | Goats | Poultry |
|---|---|---|---|---|---|---|---|---|---|
| **2007** | 23.7 | 31.2 | 292.2 | 54.0 | 396.3 | 0.93 | 0.90 | 368.1 | 3978 |
| **2008** | 23.6 | 32.0 | 267.3 | 48.3 | 416.6 | 0.87 | 0.78 | 318.4 | 3892 |
| **2009** | 23.2 | 30.9 | 300.2 | 47.0 | 416.2 | 0.81 | 0.65 | 280.8 | 3793 |
| **2010** | 23.4 | 31.3 | 328.9 | 46.3 | 417.4 | 0.75 | 0.52 | 307.4 | 3793 |
| **2011** | 24.1 | 32.8 | 355.9 | 40.5 | 398.7 | 0.69 | 0.63 | 290.2 | 3678 |
| **2012** | 24.1 | 32.8 | 346.8 | 36.3 | 358.4 | 0.64 | 0.70 | 271.2 | 3488 |
| **2013** | 24.7 | 32.5 | 313.5 | 35.1 | 322.8 | 0.58 | 0.84 | 243.1 | 3091 |
| **2014** | 25.3 | 34.2 | 293.0 | 31.8 | 326.2 | 0.52 | 0.91 | 232.0 | 3677 |
| **2015** | 26.2 | 32.7 | 296.9 | 32.1 | 326.2 | 0.46 | 0.96 | 233.9 | 3154 |
| **2016** | 28.5 | 34.5 | 304.2 | 32.6 | 319.6 | 0.40 | 1.00 | 246.6 | 3261 |
| **2017** | 30.1 | 36.6 | 321.5 | 33.2 | 317.0 | 0.40 | 1.16 | 257.6 | 3360 |
| **2018** | 31.9 | 38.9 | 311 | 33.8 | 328.2 | 0.43 | 1.20 | 250.4 | 3475 |
| **2019** | 35.0 | 38.85 | 324.4 | 32.7 | 312.9 | 0.71 | 1.31 | 251.0 | 3604 |
| **2020** | 39.5 | 43.4 | 328.1 | 32.4 | 327.0 | 0.61 | 1.15 | 260.8 | 3588 |
| **2021** | 38.9 | 45.0 | 350.6 | 31.0 | 329.6 | 0.66 | 1.23 | 257.1 | 3625 |
| **2022** | 38.2 | 43.2 | 343.7 | 26.9 | 303.9 | 0.71 | 1.32 | 254.2 | 3553 |
| **2023** | 38.6 | 43.5 | 353.5 | 26.3 | 283.3 | 0.71 | 1.32 | 233.9 | 3639 |

[a] sows; [b] all except sows

### 5.2.1.2. Methodological issues

Dairy cattle, Tier 2

Methane emissions from the enteric fermentation of dairy cattle are estimated according to the Tier 2 IPCC methodology, as it is described in the IPCC Guidelines (pg. 10.31, volume 4). The calculation of the $CH_4$ emission factor for is based on the following equation (eqn 10.21, pg. 10.30, volume 4):

$$EF = [[(GE * (YM/100) * 365\ days/yr] / 55.65\ MJ/kg\ CH_4]$$

where EF is the estimated emission factor for $CH_4$ (kg $CH_4$/head/yr), GE is the gross energy intake (MJ/head/day) and Ym is the methane conversion rate which is the fraction of the gross energy in feed converted to $CH_4$.

The calculation of gross energy is based on the following equation (eqn 10.16, pg. 10.21, volume 4):

$$GE = \{[(NE_m + NE_a + NE_l + NE_{work} + NE_p) / REM] + [(NE_g + NE_{wool}) / REG]\} / (DE\% / 100)$$

where $NE_m$ is the net energy required for animal maintenance in MJ/day, $NE_a$ is the net energy for animal activity in MJ/day, $NE_l$ is the net energy for lactation in MJ/day, $NE_{work}$ is the net energy for work, $NE_p$ is the net energy required for pregnancy in MJ/day, REM is the ratio of the net energy available in a diet for maintenance to digestible energy consumed, $NE_g$ is the net energy for growth in MJ/day, $NE_{wool}$ is the net energy required to produce a year of wool, REG is the ratio of net energy available for growth in a diet to digestible energy consumed and DE% is the digestible energy expressed as a percentage of gross energy.

The dairy cattle population used for the calculation of methane emissions from enteric fermentation is presented in Table 5.6. Information for average weight (W), live body weight (BW), mature body weight (MW) and milk production has been obtained from the Department of Agriculture[43]. The digestibility of feed was obtained after a recommendation of the review expert of the TERT (comment no. CY-3A-2016-0002). The remaining parameters use the default value proposed by the IPCC GPG. The fat percentage in milk is assumed to be 3.5%, based on the suggestion that was made during the volunteer participation of Cyprus in the Effort Sharing Decision review (ESD review) that took place in 2014. Table 5.6 presents the values used for the calculations, while Table 5.7 presents the daily milk production and the % pregnant population. The resulting Gross energy (GE) and the emissions factors (EFs) for the period

[43]Mr. George Papaioannou, Agricultural Officer, Department of Agriculture, tel. no. +357 22408566

1990–2020 are presented in Table 5.8.

There is an ongoing survey conducted by the department of Agriculture regarding dairy cattle, pregnancy rates, feed and farming. It is expected that once the results available, there will be an upgrade in the methodology.

**Table 5.6. Information for the application of Tier 2 methodology for dairy cattle**

| Parameter | Value | Source |
|---|---|---|
| Average weight (W), kg | 550 | Department of Agriculture |
| Net energy maintenance coefficient ($Cf_i$) | 0.386 | IPCC Guidelines (cattle, Table 10.4, pg. 10.16, vol. 4) |
| Activity coefficient ($C_a$) | 0.00 | IPCC Guidelines (stall, Table 10.5, pg. 10.17, vol. 4) |
| Live body weight (BW), kg | 550 | Department of Agriculture |
| Growth coefficient (C) | 0.8 | IPCC Guidelines (eqn.10.6, pg. 10.17, vol. 4) |
| Mature body weight of an adult animal (MW), kg | 550 | Department of Agriculture |
| Daily weight gain (WG), kg/day | 0 | IPCC Guidelines (footnote 1, pg. 10.12,vol.4) |
| Fat in milk | 3.5% | Recommendation which was identified by technical Expert review team during the Review 2014 |
| Hours of work / day | 0 | Department of Agriculture |
| $C_{pregnancy}$ | 0.10 | IPCC Guidelines (table 10.7, pg.10.20, vol.4) |
| Digestibility of feed, DE | 68 | Recommendation of the review expert of the TERT (comment no. CY-3A-2016-0002) |
| $CH_4$ conversion rate (Ym) | 0.065 | IPCC Guidelines (table 10.12, pg.10.30, vol.4) |

**Table 5.7. Daily milk production per dairy cow (kg) and per cent pregnant population of cows in Cyprus**

| **Year** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| Milk production (kg/day/cow) | 12.22 | 12.30 | 12.25 | 12.60 | 12.49 | 12.90 | 13.84 | 14.30 |
| % pregnant population* | 81.3 | 81.3 | 81.3 | 81.3 | 81.3 | 81.3 | 81.3 | 81.3 |

| **Year** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| Milk production (kg/day/cow) | 15.40 | 15.07 | 17.07 | 15.89 | 14.77 | 16.71 | 15.86 | 16.41 |
| % pregnant population | 81.3 | 81.3 | 81.3 | 81.3 | 81.3 | 81.3 | 81.3 | 80.3 |

| **Year** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| Milk production (kg/day/cow) | 15.89 | 14.77 | 16.71 | 17.95 | 17.64 | 17.42 | 17.29 | 16.96 |
| % pregnant population | 81.3 | 81.3 | 81.3 | 76.3 | 76.3 | 72.2 | 72.2 | 72.2 |

| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| Milk production (kg/day/cow) | 17.18 | 17.08 | 19.26 | 19.68 | 19.60 | 18.68 | 19.08 | 20.99 |
| % pregnant population | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 |

| **Year** | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Milk production (kg/day/cow) | 20.56 | 21.54 | | | | | | |
| % pregnant population | 72.2 | 72.2 | | | | | | |

* No data available for 1990–2003, 2010 and 2011. 1990–2003 assumed that is equal to 2004, 2010 assumed equal to 2009 and 2011, 2013 to 2020 assumed equal to 2012.

**Table 5.8. Gross energy (GE) and emissions factor (EF) for dairy cattle for the period 1990–2023**

| **Year** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| GE (MJ/head/day) | 231.8 | 232.4 | 232.0 | 234.9 | 234.0 | 237.3 | 244.8 | 248.6 |
| EF (kg $CH_4$/head/yr) | 98.8 | 99.1 | 98.9 | 100.1 | 99.8 | 101.2 | 104.4 | 106.0 |

| **Year** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| GE (MJ/head/day) | 257.4 | 254.7 | 270.9 | 261.4 | 252.3 | 268.0 | 261.2 | 265.5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EF (kg $CH_4$/head/yr) | 109.7 | 108.6 | 115.5 | 111.4 | 107.6 | 114.3 | 111.3 | 113.2 |

| **Year** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| GE (MJ/head/day) | 270.4 | 267.3 | 275.1 | 277.3 | 274.9 | 272.6 | 271.5 | 268.9 |
| EF (kg $CH_4$/head/yr) | 115.3 | 114.0 | 117.3 | 118.2 | 117.2 | 116.2 | 115.8 | 114.6 |

| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| GE (MJ/head/day) | 270.7 | 269.9 | 287.5 | 290.8 | 290.2 | 282.8 | 286.1 | 301.4 |
| EF (kg $CH_4$/head/yr) | 115.4 | 115.1 | 122.5 | 124.0 | 123.7 | 120.5 | 122.0 | 128.5 |

| **Year** | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| GE (MJ/head/day) | 297.9 | 305.8 | | | | | | |
| EF (kg $CH_4$/head/yr) | 127.0 | 130.4 | | | | | | |

Non-dairy cattle, sheep, goats, horses, mules and asses and swine; Tier 1

The methane emission factors used for enteric fermentation of non-dairy cattle, sheep, goats, horses, mules and asses and swine for the application of the Tier 1 methodology are as defined in the IPCC 2006 guidelines (volume 4, pg. 10.29, Table 10.11) and are presented in Table 5.9. Poultry emissions were not estimated, since an emission factor is not available in the IPCC guidelines (volume 4, pg.10.28, Table 10.10). The animal populations used are presented in Table 5.5. Non-dairy cattle and sheeps are identified as key categories but no data are available currently in order to implement a Tier 2 methodology. After discussions with the Agricultural Research Institute in Cyprus, it will be attempted to improve the methodology for non-dairy-cattle. Unfortunately, regarding sheep it was considered unfeasible at the moment. We are keeping in mind to apply higher tiers when data will be available.

**Table 5.9. Methane emission factor applied for enteric fermentation, according to animal**

| | **Emission factor (kg $CH_4$/head)** | **Source** |
|---|---|---|
| Non-dairy cattle | 57 | IPCC 2006, pg. 10.29, volume 4, western Europe* |
| Sheep | 8 | IPCC 2006, pg. 10.28, volume 4, developed |
| Swine | 1.5 | IPCC 2006, pg. 10.28, volume 4, developed |
| Horses | 18 | IPCC 2006, pg. 10.28, volume 4, developed |
| Mules and asses | 10 | IPCC 2006, pg. 10.28, volume 4, developed |
| Goats | 5 | IPCC 2006, pg. 10.28, volume 4, developed |

* Milk production closer to North America but production system as Western Europe

## 5.2.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

## 5.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. Animal population is compared between four data sources: Statistical Service, DLI, EUROSTAT and Department of Agriculture.

## 5.2.4. Category-specific recalculations

There are minor recalculations for the year 2022 due to the updating number of sheep, swine and goat. These results in a decrease in emissions by 0.01%.

## 5.2.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

# 5.3. Manure Management (3B)

The term ‘manure’ is used here collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock. The decomposition of manure under anaerobic conditions (i.e., in the absence of oxygen) during storage and treatment, produces $CH_4$. Emissions of $CH_4$ related to manure handling and storage are reported under ‘Manure Management.’ The main factors affecting $CH_4$ emissions are the amount of manure produced and the portion of the manure that decomposes anaerobically. The former depends on the rate of waste production per animal and the number of animals, and the latter on how the manure is managed.

Direct $N_2O$ emissions occur via combined nitrification and denitrification of nitrogen contained in the manure. The emission of $N_2O$ from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment. The production and emission of $N_2O$ from managed manures requires the presence of either nitrites or nitrates in an anaerobic environment preceded by aerobic conditions necessary for the formation of these oxidized forms of nitrogen.

## 5.3.1. Category description

### 5.3.1.1. Animal waste management in Cyprus[44]

Most small-scale pig farms in Cyprus use mechanical separation for the treatment of their waste. The separated liquid is sent to evaporation lagoons or is used for irrigation, and the solid fraction is used as soil improver. Nine large pig farms have installed a combination of anaerobic/aerobic treatment plants (Anaerobic digestion). The treated liquid fraction is used for irrigation, washing the housing areas or is placed in evaporation lagoons. The produced biogas is combusted onsite by Combined Heat Power generators for the production of heat and electricity. Both heat and electricity are consumed at the farms. Any excess electricity is sold to the electricity provider and directed to the electricity distribution network. Heat is not distributed outside the farm because there is no heat distribution network in Cyprus. The emissions from the electrical energy from the biogas used onsite and offsite has been taken into account in the energy sector according to the national energy balance.

The waste from cattle, sheep, goats, horses, mules and asses are collected and left to dry before being applied on land for soil improver (Solid storage and dry lot). Poultry waste is characterised by high content of solids (almost dry) and it is collected, left to dry and then used as soil improver (Solid storage and dry lot).

Manure management is responsible for methane and nitrous oxide emissions. Methane is produced during the anaerobic decomposition of manure, while nitrous oxide is produced during the storage and treatment of manure before its use as fertilizer.

Emissions from manure management in 2023 accounted for 6.95% of the total methane emissions without LULUCF. $CH_4$ and $N_2O$ from manure management in 2023 accounted for 18.2% and 57.3% of GHG emissions from Agriculture respectively. Total emissions in 2023 decreased by 17.1% compared to 1990 levels because of the improvement of waste management practices. $CH_4$ and $N_2O$ emissions from manure management for the period 1990–2023 are presented in Table 5.10 and Figure 5.3.

[44] Kythreotou, N., G. Florides, S.A. Tassou, 2010. Production and management of biodegradable waste in Cyprus a paper published in the proceedings of SEEP2010 Conference Proceedings, June 29th– July 2nd 2010, Bari, Italy.

**Table 5.10. $CH_4$ and $N_2O$ emissions from manure management for 1990–2023**

| Gg $CO_2$ eq. | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| **B. Manure management** | **172.45** | **231.25** | **212.23** | **193.35** | **181.91** | **165.66** | **149.33** |
| 1. Cattle | 26.76 | 28.94 | 30.28 | 28.61 | 28.78 | 28.63 | 28.18 |
| Dairy cattle | 16.14 | 19.00 | 19.56 | 18.71 | 18.67 | 18.64 | 18.52 |
| Non-dairy cattle | 10.61 | 9.94 | 10.71 | 9.90 | 10.11 | 9.99 | 9.66 |
| 2. Sheep | 14.45 | 12.26 | 13.40 | 16.39 | 17.74 | 17.28 | 15.62 |
| 3. Swine | 89.28 | 131.70 | 113.69 | 97.16 | 85.89 | 73.34 | 63.27 |
| 4. Other livestock | 18.95 | 29.28 | 26.02 | 22.78 | 21.67 | 20.26 | 18.07 |
| Goats | 9.12 | 16.85 | 14.66 | 13.68 | 12.92 | 12.07 | 10.82 |
| Horses | 0.08 | 0.16 | 0.18 | 0.13 | 0.12 | 0.11 | 0.10 |
| Mules and Asses | 0.40 | 0.15 | 0.09 | 0.05 | 0.05 | 0.06 | 0.07 |
| Poultry | 9.35 | 12.13 | 11.08 | 8.91 | 8.58 | 8.03 | 7.08 |
| Other | NO | NO | NO | NO | NO | NO | NO |
| 5. Indirect $N_2O$ emissions | 23.02 | 29.07 | 28.85 | 28.42 | 27.82 | 26.14 | 24.20 |
| | | | | | | | |
| $CH_4$ (Gg) | 4.07 | 5.69 | 5.07 | 4.43 | 4.03 | 3.58 | 3.18 |
| $N_2O$ (Gg) | 0.22 | 0.27 | 0.27 | 0.26 | 0.26 | 0.25 | 0.23 |
| **Total (Gg $CO_2$ eq.)** | **172.45** | **231.25** | **212.23** | **193.35** | **181.91** | **165.66** | **149.33** |

| Gg $CO_2$ eq. | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| **B. Manure management** | **143.31** | **140.11** | **141.35** | **139.59** | **139.50** | **140.83** | **148.96** |
| 1. Cattle | 29.27 | 28.72 | 32.36 | 33.17 | 35.14 | 36.96 | 41.84 |
| Dairy cattle | 19.09 | 19.22 | 21.92 | 22.81 | 24.09 | 25.95 | 29.52 |
| Non-dairy cattle | 10.18 | 9.50 | 10.43 | 10.36 | 11.05 | 11.00 | 12.31 |
| 2. Sheep | 14.60 | 14.79 | 15.16 | 16.02 | 15.50 | 16.16 | 16.35 |
| 3. Swine | 56.07 | 54.89 | 50.64 | 45.87 | 43.87 | 41.92 | 43.42 |
| 4. Other livestock | 18.72 | 17.58 | 18.26 | 18.91 | 18.70 | 19.10 | 19.43 |
| Goats | 10.33 | 10.41 | 10.98 | 11.47 | 11.15 | 11.17 | 11.61 |
| Horses | 0.09 | 0.08 | 0.07 | 0.07 | 0.07 | 0.12 | 0.11 |
| Mules and Asses | 0.07 | 0.08 | 0.08 | 0.09 | 0.10 | 0.10 | 0.09 |
| Poultry | 8.23 | 7.01 | 7.13 | 7.28 | 7.38 | 7.70 | 7.62 |
| Other | NO | NO | NO | NO | NO | NO | NO |
| 5. Indirect $N_2O$ emissions | 24.65 | 24.14 | 24.95 | 25.62 | 26.29 | 26.69 | 27.93 |
| | | | | | | | |
| $CH_4$ (Gg) | 2.96 | 2.89 | 2.85 | 2.71 | 2.68 | 2.67 | 2.85 |
| $N_2O$ (Gg) | 0.23 | 0.22 | 0.23 | 0.24 | 0.24 | 0.25 | 0.26 |
| **Total (Gg $CO_2$ eq.)** | **143.31** | **140.11** | **141.35** | **139.59** | **139.50** | **140.83** | **148.96** |

| Gg $CO_2$ eq. | 2021 | 2022 | 2023 | | | | |
|---|---|---|---|---|---|---|---|
| **B. Manure management** | **151.51** | **144.91** | **142.96** | | | | |
| 1. Cattle | 43.0 | 41.8 | 42.8 | | | | |
| Dairy cattle | 30.3 | 29.5 | 30.4 | | | | |
| Non-dairy cattle | 12.7 | 12.3 | 12.5 | | | | |
| 2. Sheep | 17.5 | 17.1 | 17.6 | | | | |
| 3. Swine | 43.5 | 39.8 | 37.3 | | | | |
| 4. Other livestock | 19.4 | 19.1 | 18.4 | | | | |
| Goats | 11.4 | 11.3 | 10.4 | | | | |
| Horses | 0.1 | 0.1 | 0.1 | | | | |
| Mules and Asses | 0.1 | 0.1 | 0.1 | | | | |
| Poultry | 7.7 | 7.5 | 7.7 | | | | |
| Other | NO | NO | NO | | | | |
| 5. Indirect $N_2O$ emissions | 28.2 | 27.1 | 26.9 | | | | |
| | | | | | | | |
| $CH_4$ (Gg) | 2.90 | 2.73 | 2.68 | | | | |
| $N_2O$ (Gg) | 0.26 | 0.26 | 0.26 | | | | |

| Total (Gg $CO_2$ eq.) | 151.51 | 144.91 | 142.96 | | | |
|---|---|---|---|---|---|---|

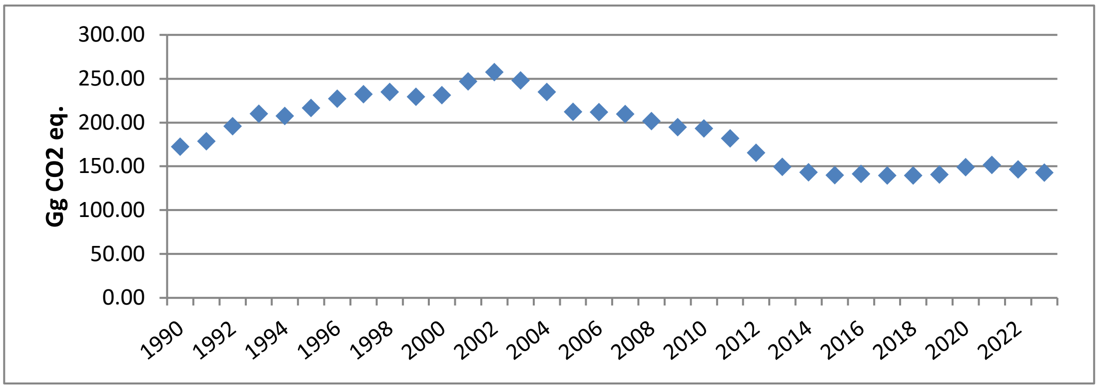


**Figure 5.3. Emissions from manure management, 1990–2023**

## 5.3.2. Methodological issues

#### 5.3.2.1. $CH_4$ emissions (3B1)

The best way to determine emission factors is to conduct non-invasive or non-disturbing measurements of emissions in actual systems representative of those in use in the country. These field results can be used to develop models to estimate emission factors (Tier 3). Such measurements are difficult to conduct, and require significant resources and expertise, and equipment that may not be available. However, attempts will be made in order to carry out such surveys in the following years. There are two alternatives for developing emission factors, with the selection of emission factors depending on the method (i.e., Tier 1 or Tier 2) chosen for estimating emissions. Tier 2 methodology is applied for swine, dairy and other cattle, and Tier 1 applied for sheep, horses, goats, poultry mules and asses.

Tier 1: When using the Tier 1 method, methane emission factors by livestock category or subcategory are used (Table 5.11). The EFs for manure management were chosen according to the manure management practices that are applied in Cyprus for the particular specie[45]. The animal population used is presented in Table 5.5.

**Table 5.11. Emission factors used for the estimation of methane emissions from manure management**

| Animal | kg $CH_4$/head/yr | Source |
|---|---|---|
| Sheep | 0.28 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate |
| Goats | 0.20 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4– developed countries, temperate |
| Horses | 2.34 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate |
| Mules and asses | 1.10 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate |
| Laying chicken | 0.03 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate/dry |
| Broiler chicken | 0.02 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate |
| Turkeys | 0.09 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate |
| Other Poultry | 0.03 | Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate/ducks |

[45]The choice for the EFs was based on personal communication with Mr. Antis Athanasiades, the responsible officer for manure management at the Department of Environment (Pollution Prevention Unit, aathanasiades@environment.moa.gov.cy, +35722408935).

Tier 2: The Tier 2 method relies on two primary types of inputs that affect the calculation of methane emission factors from manure: Manure characteristics and Manure management system characteristics. Manure characteristics includes the amount of volatile solids (VS) produced in the manure and the maximum amount of methane able to be produced from that manure (Bo). Volatile substance excretion (VS) and Bo are as recommended for Eastern Europe by 2006 IPCC Guidelines in Annex 10A.2 (Table 5.12) except for Dairy cattle where it is calculated after the 2006 IPCC Guidelines, after the TERT recommendation CY_3B_2022_0005. Manure management system characteristics includes the types of systems used to manage manure and a system-specific methane conversion factor (MCF) that reflects the portion of Bo that is achieved. For the development of the EF equation 10.23 (pg. 10.41, vol. 4, 2006 IPCC guidelines) is applied. Waste management practices applied according to animal type is presented in Table 5.13. Information on waste management practices has been obtained from personal communication with Mr. Antis Athanasiades (Environment Officer, Pollution Control Unit[46]), due to the unavailability of any other references on distribution of animal waste to waste management practice. The emissions are estimated by multiplying the developed EF by the animal population (Table 5.5).

**Table 5.12. Volatile substance excretion (VS) and Bo for T2 methodology (2006 IPCC Guidelines, vol. 4, Annex 10A.2)**

| Animal | VS (kg/hd/day) | Bo ($m^3$ $CH_4$/kg VS) | Table |
|---|---|---|---|
| Dairy cows | CS | 0.24 | 10A-4 |
| Other cattle | 2.7 | 0.17 | 10A-5 |
| Market swine | 0.3 | 0.45 | 10A-7 |
| Breeding swine | 0.5 | 0.45 | 10A-8 |

**Table 5.13. Waste management per technology contribution**

| Animal | 1990–2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|
| Dairy Cattle | | | | | | | |
| Liquid system | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Solid storage and dry lot | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| Anaerobic digestion | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Non-Dairy Cattle | | | | | | | |
| Liquid system | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Solid storage and dry lot | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| Anaerobic digestion | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Sheep | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Goats | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Horses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mules and asses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Market Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Aerobic treatment | 90% | 87% | 83% | 80% | 77% | 73% | 70% |
| Anaerobic digestion | 0% | 3% | 7% | 10% | 13% | 17% | 20% |
| Breading Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Aerobic treatment | 90% | 87% | 83% | 80% | 77% | 73% | 70% |
| Anaerobic digestion | 0% | 3% | 7% | 10% | 13% | 17% | 20% |
| Poultry | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 98% |
| Anaerobic digestion | 0% | 0% | 0% | 0% | 0% | 0% | 2% |
| | | | | | | | |
| **Animal** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Dairy Cattle | | | | | | | |
| Liquid system | 20% | 20% | 19% | 19% | 18% | 18% | 17% |
| Solid storage and dry lot | 80% | 80% | 80% | 80% | 80% | 80% | 80% |

[46] 15/11/2017, Tel. +357 22 408935, email aathanasiades@environment.moa.gov.cy

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Anaerobic digestion | 0% | 0% | 1% | 1% | 2% | 2% | 3% |
| Non-Dairy Cattle | | | | | | | |
| Liquid system | 20% | 20% | 19% | 19% | 18% | 18% | 17% |
| Solid storage and dry lot | 100% | 80% | 99% | 99% | 99% | 97% | 97% |
| Anaerobic digestion | 0% | 0% | 1% | 1% | 2% | 2% | 3% |
| Sheep | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Goats | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Horses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mules and asses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Market Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Aerobic treatment | 67% | 63% | 60% | 57% | 53% | 50% | 47% |
| Anaerobic digestion | 23% | 27% | 30% | 33% | 37% | 40% | 43% |
| Breading Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Aerobic treatment | 67% | 63% | 60% | 57% | 53% | 50% | 47% |
| Anaerobic digestion | 23% | 27% | 30% | 33% | 37% | 40% | 43% |
| Poultry | | | | | | | |
| Solid storage and dry lot | 97% | 95% | 94% | 92% | 91% | 89% | 88% |
| Anaerobic digestion | 3% | 5% | 6% | 8% | 9% | 11% | 12% |
| | | | | | | | |
| **Animal** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
| Dairy Cattle | | | | | | | |
| Liquid system | 16% | 16% | 15% | 15% | 15% | 15% | 15% |
| Solid storage and dry lot | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| Anaerobic digestion | 4% | 4% | 5% | 5% | 5% | 5% | 5% |
| Non-Dairy Cattle | | | | | | | |
| Liquid system | 16% | 16% | 15% | 15% | 15% | 15% | 15% |
| Solid storage and dry lot | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| Anaerobic digestion | 4% | 4% | 5% | 5% | 5% | 5% | 5% |
| Sheep | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Goats | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Horses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mules and asses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Market Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Aerobic treatment | 53% | 50% | 47% | 43% | 40% | 40% | 40% |
| Anaerobic digestion | 47% | 50% | 53% | 57% | 60% | 60% | 60% |
| Breading Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Aerobic treatment | 43% | 40% | 37% | 33% | 30% | 30% | 30% |
| Anaerobic digestion | 47% | 50% | 53% | 57% | 60% | 60% | 60% |
| Poultry | | | | | | | |
| Solid storage and dry lot | 86% | 85% | 83% | 82% | 80% | 80% | 80% |
| Anaerobic digestion | 16% | 15% | 17% | 18% | 20% | 20% | 20% |
| | | | | | | | |
| **Animal** | **2021** | **2022** | **2023** | | | | |
| Dairy Cattle | | | | | | | |
| Liquid system | 15% | 15% | 15% | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Solid storage and dry lot | 80% | 80% | 80% | | | | |
| Anaerobic digestion | 5% | 5% | 5% | | | | |
| Non-Dairy Cattle | | | | | | | |
| Liquid system | 15% | 15% | 15% | | | | |
| Solid storage and dry lot | 80% | 80% | 80% | | | | |
| Anaerobic digestion | 5% | 5% | 5% | | | | |
| Sheep | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | | | | |
| Goats | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | | | | |
| Horses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | | | | |
| Mules and asses | | | | | | | |
| Solid storage and dry lot | 100% | 100% | 100% | | | | |
| Market Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | | | | |
| Aerobic treatment | 30% | 30% | 30% | | | | |
| Anaerobic digestion | 60% | 60% | 60% | | | | |
| Breading Swine | | | | | | | |
| Solid storage and dry lot | 10% | 10% | 10% | | | | |
| Aerobic treatment | 30% | 30% | 30% | | | | |
| Anaerobic digestion | 60% | 60% | 60% | | | | |
| Poultry | | | | | | | |
| Solid storage and dry lot | 80% | 80% | 80% | | | | |
| Anaerobic digestion | 20% | 20% | 20% | | | | |

#### 5.3.2.2. $N_2O$ emissions (3B2)

The level of detail and methods chosen for estimating $N_2O$ emissions from manure management systems depend upon national circumstances. Tier 2 methodology is applied for calculating direct $N_2O$ emissions from manure management systems, and is described below.

Tier 2 entails multiplying the total amount of N excretion (from all livestock species/categories) in each type of manure management system by an emission factor for that type of manure management system (Equation 10.25, pg. 10.54, vol. 4, 2006 IPCC Guidelines). Emissions are then summed over all manure management systems. IPCC default $N_2O$ emission factors and default nitrogen excretion data, whereas manure management system data is country-specific.

The annual nitrogen excretion rate per animal type using the nitrogen excretion rates (kg N ex/animal/year) is shown in Table 5.14. These are the defaults proposed by the IPCC methodologies. The Nitrogen excretion rate has been determined by using the IPPC 2006 Guidelines equation 10.30, pg. 10.57. The animal population used is presented in Table 5.5. It should be noted that Cyprus has used Western Europe default values for N excretion and Eastern Europe default values for $CH_4$ for manure management. The reason for the different approach is that manure management practices for cattle waste used in Cyprus are more appropriately categorised as Eastern European. However, for the calculation of the $N_2O$ emissions from manure management, the high milk production resulted in the factor being changed to that of Western Europe, based on the comment received by the UNFCCC review team in 2013.

**Table 5.14. Default values for Nitrogen excretion rate (IPCC 2006 guidelines, volume 4, table 10.19, pg. 10.59)**

| Animal | Default values for Nitrogen excretion rate (kg N /animal/day) |
|---|---|
| Dairy Cattle | 0.48 |
| Non-Dairy Cattle | 0.33 |
| Market swine | 0.51 |
| Breading swine | 0.42 |
| Sheep | 0.85 |
| Poultry | 0.83 |

| | |
|---|---|
| Goats | 1.28 |
| Horses | 0.26 |
| Mules and asses | 0.26 |

The annual nitrogen excretion per waste management system is estimated by multiplying the % of waste allocated to a particular system by the estimated annual nitrogen excretion per animal type. The total annual nitrogen excretion per waste management system (regardless animal type) is then multiplied by the kg$N_2O$-N/kg Nex coefficient, to estimate the $N_2O$ emissions. The kg$N_2O$-N/kg N ex coefficients used are presented in Table 5.15. After the TERT CY-3B-2023-0004, aerobic treatment for swine is considered without crust.

**Table 5.15. kg $N_2O$-N/kg N ex coefficients per technology used**

| Animal | kg$N_2O$-N/kg N ex | Source |
|---|---|---|
| Solid storage | 0.005 | 2006 IPCC Guidelines, volume 4, pg. 10.62, table 10.21 |
| Aerobic treatment (forced aeration) | 0.005 | |
| Liquid System without crust | 0.000 | |
| Anaerobic digestion | 0.000 | |

3B2.5. Indirect $N_2O$ emissions from Manure Management

**I. Indirect $N_2O$ emissions from volatilisation of N from Manure Management**

To estimate the indirect $N_2O$ emissions from manure management four steps were applied, according to the Tier 1 methodology: (a) Estimation of annual nitrogen excretion per animal type (kg N ex/year), (b) Allocation of waste to waste management system used, (c) Estimation of amount of manure nitrogen that is lost due to volatilisation, and (d) Estimation of $N_2O$ emissions using the totals volatilisation N-losses (kg N/yr). The indirect $N_2O$ emissions were estimated using the equation 10.27 (pg. 10.56, volume 4 2006 IPCC guidelines), as outlined below.

The annual nitrogen excretion per animal type using the nitrogen excretion rates (kg N ex/animal/year) is shown in Table 5.14. These are the defaults proposed by the IPCC methodologies. The animal population used is presented in Table 5.5.

The distribution of waste to the waste management systems has been estimated based on the information presented in Table 5.13.

The annual amount of manure nitrogen that is lost due to volatilisation ($N_{volatilisation -MMS}$) is estimated by multiplying the % of waste allocated to a particular waste management system by the annual nitrogen excretion per animal estimated in step (a) and by multiplying the % of managed manure nitrogen for livestock category T in the manure system S ($Frac_{GASMS}$ (%)). The percent of managed manure nitrogen for livestock is presented in Table 5.16.

The total annual amount of manure nitrogen that is lost due to volatilisation ($N_{vol.atilization-MMS}$) is multiplied by the emission factor for $N_2O$ emissions from atmospheric deposition of nitrogen on soils and water surfaces ($EF_4$) to estimate the $N_2O$ emissions. The emission factor used is 0.01 kg $N_2O$-N (default value). The equation used to estimate the indirect $N_2O$ emissions from volatilisation are summarised in the equation $N_2O_{G(mm)} = (N_{volatilisation -MMS} * EF_4) * 44/28$.

**Table 5.16. Default values for volatilisation N losses.**

| Animal | Manure management system | N volatilisation losses | Source |
|---|---|---|---|
| Dairy cattle | Solid storage | 30% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| | Liquid system | 40% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| | Anaerobic digestion | 40% | Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared |

| | | | |
|---|---|---|---|
| | | | by EU experts in Oct 2018 |
| Non-dairy cattle | Solid storage | 45% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| | Liquid system | 40% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| | Anaerobic digestion | 40% | Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared by EU experts in Oct 2018 |
| Market swine | Anaerobic digestion | 48% | Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared by EU experts in Oct 2018 |
| | Solid storage | 45% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| | Aerobic treatment | 48% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| Breeding swine | Anaerobic digestion | 48% | Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared by EU experts in Oct 2018 |
| | Solid storage | 45% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| | Aerobic treatment | 48% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines |
| Sheep | Solid storage | 12% | No default available for this animal - use other. IPCC guidelines, volume 4, pg. 10.65, table 10.22 |
| Goats | Solid storage | 12% | |
| Horses | Solid storage | 12% | |
| Mules and Asses | Solid storage | 12% | |
| Poultry | Solid storage | 40% | Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines: Poultry with litter |
| | Anaerobic digestion | 40% | Assume same as solid storage: based on recommendation from review during EU review 2018* |

*anaerobic digestion decreases the N losses from the poultry manure in form of $NH_3$. The time of the pre-storage is not too long and the digestate is stored covered.

**II. Indirect $N_2O$ emissions from leaching and runoff of nitrogen from manure management**

The Tier 2 calculation of N volatilisation in forms of $NH_3$ and $NO_x$ from manure management systems is based on multiplication of the amount of nitrogen excreted (from all livestock categories) and managed in each manure management system by a fraction of volatilised nitrogen (see Equation 10.26, pg. 10.54, vol. 4, 200 IPCC Guidelines). N losses are then summed over all manure management systems. The Tier 2 method is applied using default nitrogen excretion data, default fractions of N losses and country-specific manure management system data.

Indirect $N_2O$ emissions from leaching and runoff of nitrogen from manure management have been estimated using eqns. 10.28 and 10.29 (pg. 10.56–10.57, vol. 4) of the IPCC 2006 guidelines. The annual nitrogen excretion per animal type using the nitrogen excretion rates (kg N ex/animal/year) is shown in Table 5.13. These are the defaults proposed by the IPCC methodologies. The animal population used is presented in Table 5.5.

Due to fact that CY has (a) low precipitation during very little time period in a year, and (b) uncovered solid manure storage (therefore some leaching takes place), it was decided to change the Frac(leachMS) from 10% to the lowest recommended from the typical range of 1–20% proposed by the guidelines (pg.

10.56, vol. 4); i.e. 1%.

The default emission factor for $N_2O$ emissions from nitrogen leaching and runoff, kg $N_2O$-N/kg N leached and runoff (EF5) proposed by the IPCC guidelines is used, 0.0075 kg $N_2O$-N (kg N leaching/runoff)-1 (vol. 4, Chapter 11, Table 11.3).

### 5.3.3. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 5.3.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. Animal population is compared between four data sources: Statistical Service, DLI, EUROSTAT and Department of Agriculture.

### 5.3.5. Category-specific recalculations

There are minor recalculations for the year 2022 due to the updating number of sheep, swine and goat. These results in a decrease in emissions of 1.05%.

### 5.3.6. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 5.4. Rice cultivation (CRT source category 3C)

Not occurring.

## 5.5. Agricultural soils (3D)

Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. Nitrification is the aerobic microbial oxidation of ammonium to nitrate, and denitrification is the anaerobic microbial reduction of nitrate to nitrogen gas ($N_2$). Nitrous oxide is a gaseous intermediate in the reaction sequence of denitrification and a by-product of nitrification that leaks from microbial cells into the soil and ultimately into the atmosphere. One of the main controlling factors in this reaction is the availability of inorganic N in the soil. This methodology, therefore, estimates $N_2O$ emissions using human-induced net N additions to soils (e.g., synthetic or organic fertilizers, deposited manure, crop residues, sewage sludge). Direct emissions of $N_2O$ from managed soils are estimated separately from indirect emissions, though using a common set of activity data.

Total emissions from agricultural soils in 2023 contributed 9.5% to the emissions from agriculture and 0.6% to the total emissions of the country (excluding LULUCF). Agricultural soils also contributed 29.4% to the $N_2O$ emissions of the country excluding LULUCF. Total emissions from agricultural soils in 2023 reduced by 11.2% compared to 1990. Emissions from agricultural soils for the period 1990–2023 are presented in Table 5.17 and Figure 5.5.

**Table 5.17. $N_2O$ emissions from agricultural soils for 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** |
|---|---|---|---|---|---|---|
| 3D1. Direct $N_2O$ emissions from managed soils | **40.25** | **39.09** | **37.75** | **38.06** | **35.82** | **36.98** |
| 1. Inorganic N fertilizers | 15.52 | 13.16 | 10.74 | 11.70 | 8.92 | 10.39 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. Organic N fertilizers | 17.21 | 21.37 | 20.96 | 21.55 | 21.55 | 20.47 |
| a. Animal manure applied to soils | 17.19 | 21.31 | 20.83 | 21.30 | 21.32 | 20.28 |
| b. Sewage sludge applied to soils | 0.02 | 0.06 | 0.13 | 0.20 | 0.15 | 0.10 |
| c. Other organic fertilizers applied to soils | NO | NO | NO | 0.04 | 0.08 | 0.09 |
| 3. Urine and dung deposited by grazing animals | NO | NO | NO | NO | NO | NO |
| 4. Crop residues | 7.52 | 4.55 | 6.05 | 4.79 | 5.33 | 6.09 |
| 5. Mineralization/ immobilization associated with loss/gain of soil organic matter | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.03 |
| 6. Cultivation of organic soils | NO | NO | NO | NO | NO | NO |
| 7. Other | NO | NO | NO | NO | NO | NO |
| 3D2. Indirect $N_2O$ Emissions from managed soils | **16.65** | **18.64** | **17.55** | **18.27** | **17.34** | **17.12** |
| 1. Atmospheric deposition | 16.65 | 18.64 | 17.55 | 18.26 | 17.34 | 17.11 |
| 2. Nitrogen leaching and run-off | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| | | | | | | |
| **Total (Gg$N_2O$)** | **0.21** | **0.22** | **0.21** | **0.21** | **0.20** | **0.20** |
| **Total (Gg $CO_2$ eq.)** | **56.90** | **57.72** | **55.31** | **56.33** | **53.17** | **54.10** |

| **Gg $CO_2$ eq.** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
|---|---|---|---|---|---|---|
| 3D1. Direct $N_2O$ emissions from managed soils | **31.83** | **28.83** | **33.72** | **31.33** | **32.83** | **32.26** |
| 1. Inorganic N fertilizers | 8.81 | 8.36 | 9.41 | 10.09 | 9.80 | 9.77 |
| 2. Organic N fertilizers | 18.75 | 18.33 | 18.25 | 18.98 | 19.74 | 19.74 |
| a. Animal manure applied to soils | 18.57 | 18.23 | 18.15 | 18.84 | 19.61 | 19.59 |
| b. Sewage sludge applied to soils | 0.11 | 0.05 | 0.04 | 0.06 | 0.04 | 0.04 |
| c. Other organic fertilizers applied to soils | 0.06 | 0.05 | 0.07 | 0.09 | 0.09 | 0.12 |
| 3. Urine and dung deposited by grazing animals | NO | NO | NO | NO | NO | NO |
| 4. Crop residues | 4.24 | 2.09 | 6.00 | 2.20 | 3.22 | 2.66 |
| 5. Mineralization/ immobilization associated with loss/gain of soil organic matter | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.08 |
| 6. Cultivation of organic soils | NO | NO | NO | NO | NO | NO |
| 7. Other | NO | NO | NO | NO | NO | NO |
| 3D2. Indirect $N_2O$ Emissions from managed soils | **15.44** | **15.02** | **15.32** | **16.04** | **16.44** | **16.44** |
| 1. Atmospheric deposition | 15.43 | 15.01 | 15.30 | 16.02 | 16.43 | 16.42 |
| 2. Nitrogen leaching and run-off | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| | | | | | | |
| **Total (Gg$N_2O$)** | **0.18** | **0.17** | **0.19** | **0.18** | **0.19** | **0.18** |
| **Total (Gg $CO_2$ eq.)** | **47.27** | **43.84** | **49.03** | **47.37** | **49.27** | **48.70** |

| **Gg $CO_2$ eq.** | **2019** | **2020** | **2021** | **2022** | **2023** | |
|---|---|---|---|---|---|---|
| 3D1. Direct $N_2O$ emissions from managed soils | **33.85** | **34.84** | **34.41** | **33.85** | **33.66** | |
| 1. Inorganic N fertilizers | 9.37 | 9.37 | 8.94 | 8.84 | 9.11 | |
| 2. Organic N fertilizers | 20.29 | 21.04 | 21.44 | 20.91 | 20.71 | |
| a. Animal manure applied to soils | 20.08 | 20.85 | 21.26 | 20.72 | 20.50 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| b. Sewage sludge applied to soils | 0.05 | 0.04 | 0.03 | 0.03 | 0.05 | |
| c. Other organic fertilizers applied to soils | 0.16 | 0.15 | 0.14 | 0.16 | 0.17 | |
| 3. Urine and dung deposited by grazing animals | NO | NO | NO | NO | NO | |
| 4. Crop residues | 4.10 | 4.33 | 3.92 | 3.98 | 3.72 | |
| 5. Mineralization/ immobilization associated with loss/gain of soil organic matter | 0.09 | 0.10 | 0.11 | 0.12 | 0.11 | |
| 6. Cultivation of organic soils | NO | NO | NO | NO | NO | |
| 7. Other | NO | NO | NO | NO | NO | |
| 3D2. Indirect $N_2O$ Emissions from managed soils | **16.67** | **17.17** | **17.30** | **16.92** | **16.87** | |
| 1. Atmospheric deposition | 16.65 | 17.15 | 17.27 | 16.89 | 16.84 | |
| 2. Nitrogen leaching and run-off | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | |
| | | | | | | |
| **Total (Gg$N_2O$)** | **0.19** | **0.20** | **0.20** | **0.19** | **0.19** | |
| **Total (Gg $CO_2$ eq.)** | **50.53** | **52.01** | **51.71** | **50.76** | **50.53** | |

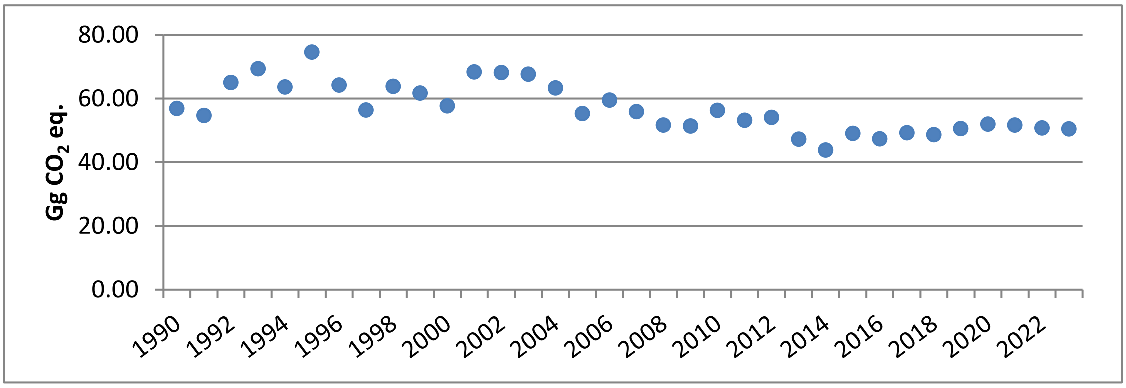


**Figure 5.4. $N_2O$ emissions from agricultural soils 1990–2023 (Gg $CO_2$ eq.)**

## 5.5.1. Direct $N_2O$ emissions from managed soils (3D1)

In most soils, an increase in available N enhances nitrification and denitrification rates which then increase the production of $N_2O$. Increases in available N can occur through human-induced N additions or change of land-use. The following N sources are included in the methodology for estimating direct $N_2O$ emissions from managed soils: synthetic N fertilizers (FSN); organic N applied as fertiliser (e.g., animal manure, compost, sewage sludge, rendering waste) (FON); urine and dung N deposited on pasture, range and paddock by grazing animals (FPRP); N in crop residues (above-ground and below-ground), including from N-fixing crops and from forages during pasture renewal (FCR); and for the first time in this inventory, N mineralisation associated with loss of soil organic matter resulting from change of land use or management of mineral soils (FSOM).

Drainage/management of organic soils (FOS) is not considered for the GHG inventory of Cyprus, as there is no management of organic soils in Cyprus.

### 5.5.1.1. Methodological issues

In its most basic form, direct $N_2O$ emissions from managed soils are estimated using Equation 11.1 in the 2006 IPCC Guidelines (vol. 4, pg. 11.7), as described below.

<u>Inorganic N fertilizers (3D1.1)</u>

$N_2O$ emissions from the use of inorganic N fertilizers were estimated using Tier 2 methodology suggested by the 2006 IPCC Guidelines. Country specific emission factor EF (kg $N_2O$-N/kg N) is assumed 0.003 after the publication "The effect of chemical and organic N inputs on N2O emission from rain-fed crops in Eastern Mediterranean" in the Elsevier Journal[47]. Activity data is obtained from the Department of Agriculture[48].

**Table 5.18. N input from application of inorganic fertilizers for the period (in kt) 1990–2023**

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| Inorganic fertilizers (kg N) | 12.426 | 12.169 | 14.760 | 16.189 | 14.289 | 20.526 | 13.628 | 11.126 |
| **Year** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| Inorganic fertilizers (kg N) | 14.601 | 11.561 | 10.537 | 12.359 | 10.579 | 11.198 | 10.738 | 8.593 |
| **Year** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Inorganic fertilizers (kg N) | 11.291 | 8.198 | 7.499 | 7.674 | 9.369 | 7.138 | 8.319 | 7.051 |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Inorganic fertilizers (kg N) | 6.693 | 7.533 | 8.073 | 7.841 | 7.824 | 7.500 | 7.500 | 7.157 |
| **Year** | **2022** | **2023** | | | | | | |
| Inorganic fertilizers (kg N) | 7.075 | 7.289 | | | | | | |

Organic N fertilizers - Animal Manure applied to soils (3D1.2a)

The Tier 2 methodology of the 2006 IPCC Guidelines is applied. The estimate of managed manure nitrogen available for application to managed soils is based on the equation 10.34 in the 2006 IPCC Guidelines (vol. 4, pg. 10.56). Animal population used is as presented in Table 5.5, annual average N excretion per animal of species/ category T in the country is based on defaults proposed by the 2006 IPCC Guidelines (Table 5.14 above), while the fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country is as presented in Table 5.19. The amount of managed manure nitrogen for livestock category T that is lost in the manure management system S $Frac_{LossMS}$ (%) is shown in Table 5.19: Defaults recommended by the 2006 IPCC Guidelines (Table 10.22, pg. 10.65, vol. 4). The amount of estimated volatilisation N-losses is presented in Table 5.20. The values are recalculated for the whole timeseries due to the manure management recalculations described in the previous section. The amount of nitrogen from bedding is not known therefore assumed 0.

Managed manure nitrogen available for application to managed soils is then multiplied by the country-specific emission factor for $N_2O$ emissions from N inputs EF (0.003 kg $N_2O$-N/kg N) after the publication "The effect of chemical and organic N inputs on $N_2O$ emission from rain-fed crops in Eastern Mediterranean" in the Elsevier Journal[47], and converted to $N_2O$ by multiplication with 44/28.

**Table 5.19. Default values for nitrogen loss due to volatilisation of $NH_3$ and $NO_x$ from manure management**

| Animal | Manure management system | N loss due to volatilisation of $NH_3$ and $NO_x$ from manure management |
|---|---|---|
| Dairy cattle | Solid storage | 60% |
| | Liquid system | 60% |
| | Anaerobic digestion | 60% |
| Non-dairy cattle | Solid storage | 50% |

[47] Michalis Omirou, Ioannis Anastopoulos, Dionysia A. Fasoula, Ioannis M. Ioannides,The effect of chemical and organic N inputs on N2O emission from rain-fed crops in Eastern Mediterranean, Journal of Environmental Management, Volume 270, 2020, 110755,ISSN 0301-4797,https://doi.org/10.1016/j.jenvman.2020.110755.

[48] George Theophanous, Agriculture Officer, Department of Agriculture (tel. +357 22464028, gtheophanous@da.moa.gov.cy) – Fertilizer Control Board

| | | |
|---|---|---|
| | Liquid system | 60% |
| | Anaerobic digestion | 60% |
| Market swine | Anaerobic digestion | 52% |
| | Solid Storage | 50% |
| | Aerobic treatment | 52% |
| Breeding swine | Anaerobic digestion | 52% |
| | Solid storage | 50% |
| | Aerobic treatment | 52% |
| Sheep | Solid storage | 85% |
| Goats | Solid storage | 85% |
| Horses | Solid storage | 85% |
| Mules and Asses | Solid storage | 85% |
| Poultry | Solid storage | 50% |
| | Anaerobic digestion | 50% |

**Table 5.20. Volatilisation N-losses (kg N)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| **Volatilisation N-losses (kg N)** | 13761 | 13869 | 14125 | 14552 | 14398 | 14779 | 15366 | 16126 |

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| **Volatilisation N-losses (kg N)** | 16236 | 16306 | 17059 | 19002 | 19909 | 18561 | 18000 | 16677 |

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| **Volatilisation N-losses (kg N)** | 16768 | 17538 | 16279 | 16129 | 17053 | 17067 | 16236 | 14869 |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| **Volatilisation N-losses (kg N)** | 14593 | 14528 | 15079 | 15698 | 15680 | 16067 | 16686 | 17022 |
| | | | | | | | | |
| | **2022** | **2023** | | | | | | |
| **Volatilisation N-losses (kg N)** | 16589 | 16406 | | | | | | |

Organic N fertilizers - Sewage sludge applied to soils (3D1.2b)

The Tier 2 methodology of the 2006 IPCC Guidelines is applied. The treated sewage sludge applied to land data was obtained from the national statistics and the relevant reports from the Department of Environment[49]. Data was available for all wastewater treatment plants for the years 2004 and 2005. Data for the public waste water treatment plants was available for 2004–2012. All data was available in tonnes of dry matter. The sewage sludge used in agriculture during 1990–2003 and 2006–2014 was estimated using (a) the ratio of the public treatment plants compared to all treatment plants for 2004 and 2005, and (b) the percentage of the population served by a sewer system data for 1997 to 2004. The resulting data is presented in Table 5.21.

Nitrogen content per kg dry sludge was assumed to be 3% for all years and was obtained from S. Perikenti[50]. The resulting nitrogen in sewage sludge applied on land is presented in Table 5.23. The fraction of N input converted to $N_2O$ (EF) is assumed to be 0.003 kg $N_2O$-N/kg sewage-N produced, after the publication “The effect of chemical and organic N inputs on $N_2O$ emission from rain-fed crops in Eastern Mediterranean” in the Elsevier Journal[47].

**Table 5.21. Dry sludge applied to soils and nitrogen in sewage sludge (kg)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|

[49] Perikenti, S. 2011&2013. Questionnaire according to Commission Decision 94/741/EC for the report of the Member States on the transposition and implementation of Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture, amended by Directive 91/692/EEC. Department of Environment

[50] Environment Officer responsible for sewage treatment plants, email dated 18/10/2013

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dry sludge (kg) | 517390 | 583589 | 704000 | 748000 | 737000 | 891000 | 1232000 |
| N in sewage sludge (kg) | 15522 | 17508 | 21120 | 22440 | 22110 | 26730 | 36960 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| Dry sludge (kg) | 1320000 | 1408000 | 1463000 | 1573000 | 1749000 | 2013000 | 2530000 |
| N in sewage sludge (kg) | 39600 | 42240 | 43890 | 47190 | 52470 | 60390 | 75900 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Dry sludge (kg) | 3135000 | 3427000 | 3116000 | 5745000 | 6515000 | 7903000 | 5294000 |
| N in sewage sludge (kg) | 94050 | 102810 | 93480 | 172350 | 195450 | 237090 | 158820 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Dry sludge (kg) | 3912000 | 2756000 | 2924000 | 1391000 | 936000 | 1436000 | 1075000 |
| N in sewage sludge (kg) | 117360 | 82680 | 87720 | 41730 | 28080 | 43080 | 32250 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| Dry sludge (kg) | 937000 | 1015000 | 1014000 | 867000 | 745000 | 1375000 | |
| N in sewage sludge (kg) | 28110 | 30450 | 30420 | 26010 | 22350 | 41250 | |

Other organic fertilizers applied to soils (3D1.2c)

Even though there is overproduction of compost in Cyprus, all produced compost is stored as there is no demand for application on land.[51] Nevertheless, to exclude the possibility of underestimating emissions, it was assumed that all compost produced from waste management activities is consumed in-country by agriculture, for the purposes of estimation of emissions from this source. Data on composting in Cyprus was first collected in 2010 (Table 5.22). Composting started in 2010 in specific municipal waste management plants and in a compost plan. As a result, there is no data before 2010 available. Information on other qualitative parameters of the compost applied on land and used for the calculations has been obtained from one of the largest green waste management companies of Cyprus, indicating 96% dry matter and 1.0187% N. $N_2O$ emissions are estimated by multiplying the calculated Ncomp by EF (0.003 after the publication "The effect of chemical and organic N inputs on N2O emission from rain-fed crops in Eastern Mediterranean" in the Elsevier Journal[47]) and then by 44/28.

**Table 5.22. Activity data used for the calculation of $N_2O$ emissions from Other organic fertilizers applied to soils (3D1.2c)**

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| TOTAL composting (1000t wet mass) | 7.89 | 14.95 | 16.20 | 11.67 | 8.72 | 12.05 |
| wet compost (kg) | 7890000 | 14950000 | 16200000 | 11670000 | 8720000 | 12050000 |
| Dry compost (kg) | 3156000 | 5980000 | 6480000 | 4668000 | 3488000 | 4820000 |
| N COMP (kg N) | 34306 | 65003 | 70438 | 50741 | 37915 | 52393 |

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| TOTAL composting (1000t wet mass) | 16.77 | 16.62 | 22.24 | 30.30 | 28.40 | 25.61 |

[51] Personal communication with Constantinos Ioannides (10/11/2017), Waste management permitting officer, Pollution Prevention Unit, Department of Environment (tel. +357 22408958, cioannides@environment.moa.gov.cy).

| | | | | | | |
|---|---|---|---|---|---|---|
| wet compost (kg) | 16770000 | 16620000 | 36520000 | 30300000 | 28404000 | 25610000 |
| Dry compost (kg) | 670800 | 6648000 | 14608000 | 12120000 | 11361600 | 10244000 |
| N COMP (kg N) | 72916 | 72264 | 158789 | 131744 | 123501 | 111352 |

| | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|
| TOTAL composting (1000t wet mass) | 29.28 | 30.75 | | | | |
| wet compost (kg) | 29284000 | 30746000 | | | | |
| Dry compost (kg) | 11713600 | 12298400 | | | | |
| N COMP (kg N) | 127327 | 133684 | | | | |

Urine and dung deposited by grazing animals (3D1.3)

Not occurring: A very small percentage of the sheep and goats are grazing; however, no information is available to make an estimation of or an assumption for the grazing population[52].

Crop residues (3D1.4)

The term FCR refers to the amount of N in crop residues (above-ground and below-ground) that is returned to soils annually, including N-fixing crops. The FCR is estimated from crop yield statistics, default factors for above-/below-ground residue to yield ratios, and residue N contents. In addition, the method accounts for the effect of residue burning or other removal of residues. Because different crop types vary in residue to yield ratios, renewal time and N contents, separate calculations are performed for major crop types, and then N values from all crop types are summed up. Equation 11.6 in the 2006 IPCC Guidelines (pg. 11.14, vol. 4) provides the equation to estimate N from crop residues and forage/pasture renewal, for a Tier 1 approach.

Crop production (t/yr) and cultivated area (ha) data per crop is obtained from Statistical Service (Table 5.23). Crop yield is estimated by dividing the crop production by the area; the results are tabulated in Table 5.23. Harvested annual dry matter yield per crop (Crop(T)) is estimated by multiplying the 2006 IPCC Guidelines default dry matter fraction (DRY) (Table 5.24 obtained from table 11.2, pg.11.17, vol.4) with the estimated Crop yield (YieldFresh) (eqn 11.7, pg.11.15, vol.4, 2006 IPCC Guidelines). Using the defaults values shown in Table 5.24 for Slope, Intercept, NAGT, RBGT and NBGT (table 11.2, pg.11.17, vol.4) above ground residue dry matter AGDM_T (kg/ha) and ratio of above-ground residues dm to harvested crop RAGT (kg/dm) are estimated.

FracBURN (kg N/kg crop-N), shown in Table 5.25, is considered as the default for developing countries (0.25) in 1990, then is linearly declined to the default for developed countries (0.1) in 2008. After that year, this factor has been kept constant. This assumption was based on general knowledge of the sector, and on the fact that a normative banning crop residues burning came into place in 2003. The relevant legislation is the Fire Prevention of Outdoors Law of 1988 (220/1988) as amended by 109(I)2002. 0.1 is used because according to the expert judgement of firefighters and their observations in the field, there is illegal burning of agricultural residues taking place, based. There are no statistics on this type of fires. No details are available to support any deviation from the 10% default.

The resulting estimations of area burnt are presented in Table 5.23. For the calculation of FCR, FracRenewT and FracRemoveT are assumed 1 and 0 respectively, as according to the defaults proposed by 2006 Guidelines (pg.11.14, vol.4).

Due to the unavailability of proposed defaults for Combustion factor ($C_f$) for Crops other than wheat in the 2006 IPCC Guidelines, a desk study was performed for the values used by countries with similar climatic conditions with Cyprus; i.e. Greece, Spain, Malta and Italy. Malta and Spain report $C_f$ as NO. Values for Cf used are presented in Table 5.28. The values used by Greece were used for Barley and Oats, while for Beans & pulses (legumes) and Potatoes (tubers) 0.40 was used, based on the expert

[52] Personal communication with Dr. Petros Mavromatis (22/11/2017), head of sheep and goat farming division, Department of Agriculture (tel. +357 22408555, pmavrommatis@da.moa.gov.cy)

judgement of Dr. Michalis Omirou[53].

$N_2O$ emissions are estimated by multiplying the calculated FCR by EF1 (0.01 default, table 11.1, pg. 11.11, vol.4, 2006 IPCC guidelines) and then by 44/28.

**Table 5.23. Crop production (t/yr), cultivated area (ha), Crop yield (kg/ha), CropT (kg dm/ha), above ground residue dry matter $AGDM_T$ (kg/ha), ratio of above-ground residues dm to harvested crop RAGT (kg/dm), Area Burnt (ha/yr) and FCR (kg N/yr) per crop**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|---|---|
| Crop production (t/yr) | | | | | | | |
| Wheat | 10400 | 5600 | 10500 | 11700 | 8000 | 12297 | 13000 |
| Barley | 98000 | 59500 | 171000 | 193000 | 154000 | 133818 | 128000 |
| Oats | 100 | 80 | 145 | 100 | 150 | 174 | 190 |
| Beans & pulses (legumes) | 3505 | 3000 | 3629 | 3607 | 3157 | 3992 | 3700 |
| Potatoes (tubers) | 185900 | 179650 | 195400 | 199000 | 135000 | 207699 | 228000 |
| Cultivated area (ha) | | | | | | | |
| Wheat | 5100 | 4900 | 5000 | 5000 | 3300 | 3500 | 3700 |
| Barley | 52330 | 43790 | 60000 | 64000 | 60000 | 57500 | 55000 |
| Oats | 100 | 100 | 110 | 140 | 200 | 220 | 240 |
| Beans & pulses (legumes) | 1350 | 1173 | 1145 | 1103 | 810 | 1039 | 857 |
| Potatoes (tubers) | 8000 | 8690 | 9625 | 8080 | 7500 | 8313 | 9125 |
| Crop yield (YieldFresh), kg/ha | | | | | | | |
| Wheat | 2039 | 1143 | 2100 | 2340 | 2424 | 3514 | 3514 |
| Barley | 1873 | 1359 | 2850 | 3016 | 2567 | 2327 | 2327 |
| Oats | 1000 | 800 | 1318 | 714 | 750 | 792 | 792 |
| Beans & pulses (legumes) | 2596 | 2558 | 3169 | 3270 | 3898 | 3842 | 4317 |
| Potatoes (tubers) | 23238 | 20673 | 20301 | 24629 | 18000 | 24986 | 24986 |
| CropT (kg dm/ha) | | | | | | | |
| Wheat | 1815 | 1017 | 1869 | 2083 | 2158 | 3127 | 3127 |
| Barley | 1667 | 1209 | 2537 | 2684 | 2284 | 2071 | 2071 |
| Oats | 890 | 712 | 1173 | 636 | 668 | 705 | 705 |
| Beans & pulses (legumes) | 2363 | 2327 | 2884 | 2976 | 3547 | 3496 | 3929 |
| Potatoes (tubers) | 5112 | 4548 | 4466 | 5418 | 3960 | 5497 | 5497 |
| above ground residue dry matter AGDM_T (kg/ha) | | | | | | | |
| Wheat | 3261 | 2056 | 3342 | 3665 | 3778 | 5242 | 5242 |
| Barley | 2223 | 1775 | 3076 | 3220 | 2829 | 2620 | 2620 |
| Oats | 1700 | 1538 | 1958 | 1469 | 1497 | 1531 | 1531 |
| Beans & pulses (legumes) | 3520 | 3480 | 4109 | 4213 | 4858 | 4801 | 5290 |
| Potatoes (tubers) | 1571 | 1515 | 1507 | 1602 | 1456 | 1610 | 1610 |
| Area Burnt (ha/yr) | | | | | | | |
| Wheat | 1275 | 1184 | 1167 | 1125 | 715 | 729 | 740 |
| Barley | 13083 | 10583 | 14000 | 14400 | 13000 | 11979 | 11000 |
| Oats | 25 | 24 | 26 | 32 | 43 | 46 | 48 |
| Beans & pulses (legumes) | 338 | 283 | 267 | 248 | 176 | 216 | 171 |
| Potatoes (tubers) | 2000 | 2100 | 2246 | 1818 | 1625 | 1732 | 1825 |
| FCR (kg N/yr) | | | | | | | |
| Wheat | 133233 | 79822 | 135491 | 149750 | 102525 | 152707 | 162306 |
| Barley | 1260233 | 829608 | 2060702 | 2317592 | 1903818 | 1689766 | 1623779 |
| Oats | 1443 | 1295 | 1883 | 1740 | 2558 | 2905 | 3188 |
| Beans & pulses (legumes) | 46283 | 39853 | 46298 | 45880 | 39098 | 49683 | 45372 |
| Potatoes (tubers) | 364653 | 373456 | 410779 | 382605 | 303234 | 398454 | 438331 |
| TOTAL | 1805846 | 1324033 | 2655153 | 2897566 | 2351234 | 2293515 | 2272975 |
| | | | | | | | |

[53] Personal Communication 16/11/2017 Dr. Michalis Omirou, Agricultural Research Officer, Agricultural Research Institute (Tel. +357-22403146, michalis.omirou@ari.gov.cy)

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|
| Crop production (t/yr) | | | | | | | |
| Wheat | 13000 | 11500 | 11500 | 14000 | 10000 | 10500 | 12900 |
| Barley | 128000 | 36000 | 54000 | 112700 | 37600 | 116500 | 128400 |
| Oats | 190 | 280 | 320 | 400 | 350 | 380 | 500 |
| Beans & pulses (legumes) | 3700 | 3558 | 3684 | 3764 | 3308 | 3383 | 3358 |
| Potatoes (tubers) | 228000 | 81500 | 138092 | 161500 | 117000 | 121000 | 148500 |
| Cultivated area (ha) | | | | | | | |
| Wheat | 3700 | 5250 | 5800 | 6600 | 6150 | 5400 | 5900 |
| Barley | 55000 | 37500 | 53000 | 52000 | 45000 | 50200 | 51300 |
| Oats | 240 | 270 | 290 | 340 | 330 | 370 | 400 |
| Beans & pulses (legumes) | 857 | 890 | 893 | 913 | 832 | 832 | 847 |
| Potatoes (tubers) | 9125 | 7000 | 7500 | 6800 | 6500 | 5715 | 5700 |
| Crop yield (YieldFresh), kg/ha | | | | | | | |
| Wheat | 3514 | 2190 | 1983 | 2121 | 1626 | 1944 | 2186 |
| Barley | 2327 | 960 | 1019 | 2167 | 836 | 2321 | 2503 |
| Oats | 792 | 1037 | 1103 | 1176 | 1061 | 1027 | 1250 |
| Beans & pulses (legumes) | 4317 | 3998 | 4125 | 4123 | 3976 | 4066 | 3965 |
| Potatoes (tubers) | 24986 | 11643 | 18412 | 23750 | 18000 | 21172 | 26053 |
| CropT (kg dm/ha) | | | | | | | |
| Wheat | 3127 | 1950 | 1765 | 1888 | 1447 | 1731 | 1946 |
| Barley | 2071 | 854 | 907 | 1929 | 744 | 2065 | 2228 |
| Oats | 705 | 923 | 982 | 1047 | 944 | 914 | 1113 |
| Beans & pulses (legumes) | 3929 | 3638 | 3754 | 3752 | 3618 | 3700 | 3608 |
| Potatoes (tubers) | 5497 | 2561 | 4051 | 5225 | 3960 | 4658 | 5732 |
| above ground residue dry matter AGDM_T (kg/ha) | | | | | | | |
| Wheat | 3464 | 3185 | 3371 | 2705 | 3133 | 3458 | 3464 |
| Barley | 1427 | 1479 | 2480 | 1319 | 2614 | 2773 | 1427 |
| Oats | 1730 | 1784 | 1843 | 1749 | 1722 | 1902 | 1730 |
| Beans & pulses (legumes) | 4961 | 5092 | 5089 | 4938 | 5031 | 4927 | 4961 |
| Potatoes (tubers) | 1316 | 1465 | 1583 | 1456 | 1526 | 1633 | 1316 |
| Area Burnt (ha/yr) | | | | | | | |
| Wheat | 740 | 1006 | 1063 | 1155 | 1025 | 855 | 885 |
| Barley | 11000 | 7188 | 9717 | 9100 | 7500 | 7948 | 7695 |
| Oats | 48 | 52 | 53 | 60 | 55 | 59 | 60 |
| Beans & pulses (legumes) | 171 | 171 | 164 | 160 | 139 | 132 | 127 |
| Potatoes (tubers) | 1825 | 1342 | 1375 | 1190 | 1083 | 905 | 855 |
| FCR (kg N/yr) | | | | | | | |
| Wheat | 151675 | 154544 | 187423 | 140009 | 143778 | 174771 | 151675 |
| Barley | 574295 | 848472 | 1468404 | 639644 | 1512694 | 1652986 | 574295 |
| Oats | 4144 | 4634 | 5668 | 5218 | 5782 | 7027 | 4144 |
| Beans & pulses (legumes) | 44246 | 45718 | 46840 | 41500 | 42409 | 42369 | 44246 |
| Potatoes (tubers) | 237627 | 309294 | 319762 | 266399 | 254137 | 283800 | 237627 |
| TOTAL | 1011987 | 1362662 | 2028096 | 1092771 | 1958800 | 2160952 | 1011987 |

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| Crop production (t/yr) | | | | | | | |
| Wheat | 14280 | 9930 | 9249 | 7520 | 10712 | 24720 | 14690 |
| Barley | 150000 | 100990 | 60286 | 58372 | 52007 | 34960 | 40092 |
| Oats | 410 | 490 | 650 | 943 | 814 | 373 | 2038 |
| Beans & pulses (legumes) | 2410 | 3280 | 3291 | 3348 | 3318 | 3312 | 3312 |
| Potatoes (tubers) | 127500 | 131650 | 152500 | 127500 | 155500 | 115000 | 112500 |
| Cultivated area (ha) | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Wheat | 7225 | 7450 | 5264 | 5389 | 5287 | 4990 | 5761 |
| Barley | 65007 | 58448 | 52517 | 48914 | 34019 | 30680 | 22444 |
| Oats | 513 | 808 | 4368 | 4919 | 4250 | 3034 | 2950 |
| Beans & pulses (legumes) | 834 | 808 | 796 | 855 | 737 | 554 | 614 |
| Potatoes (tubers) | 5511 | 5380 | 6190 | 4290 | 6290 | 5110 | 4970 |
| Crop yield (YieldFresh), kg/ha | | | | | | | |
| Wheat | 1976 | 1333 | 1757 | 1395 | 2026 | 4954 | 2550 |
| Barley | 2307 | 1728 | 1148 | 1193 | 1193 | 1140 | 1786 |
| Oats | 799 | 606 | 149 | 192 | 192 | 123 | 691 |
| Beans & pulses (legumes) | 2890 | 4059 | 4134 | 3916 | 3916 | 5978 | 5394 |
| Potatoes (tubers) | 23136 | 24470 | 24637 | 29720 | 29720 | 22505 | 22636 |
| CropT (kg dm/ha) | | | | | | | |
| Wheat | 1759 | 1186 | 1564 | 1242 | 1803 | 4409 | 2269 |
| Barley | 2054 | 1538 | 1022 | 1062 | 1361 | 1014 | 1590 |
| Oats | 711 | 540 | 132 | 171 | 170 | 109 | 615 |
| Beans & pulses (legumes) | 2630 | 3694 | 3762 | 3563 | 4097 | 5440 | 4909 |
| Potatoes (tubers) | 5090 | 5383 | 5420 | 6538 | 5439 | 4951 | 4980 |
| above ground residue dry matter AGDM_T (kg/ha) | | | | | | | |
| Wheat | 3176 | 2311 | 2881 | 2395 | 3243 | 7178 | 3947 |
| Barley | 2603 | 2097 | 1591 | 1631 | 1923 | 1584 | 2148 |
| Oats | 1537 | 1381 | 1011 | 1045 | 1045 | 990 | 1450 |
| Beans & pulses (legumes) | 3821 | 5024 | 5101 | 4877 | 5479 | 6998 | 6397 |
| Potatoes (tubers) | 1569 | 1598 | 1602 | 1714 | 1604 | 1555 | 1558 |
| Area Burnt (ha/yr) | | | | | | | |
| Wheat | 1024 | 993 | 658 | 629 | 573 | 499 | 576 |
| Barley | 9209 | 7793 | 6565 | 5707 | 3685 | 3068 | 2244 |
| Oats | 73 | 108 | 546 | 574 | 460 | 303 | 295 |
| Beans & pulses (legumes) | 118 | 108 | 100 | 100 | 80 | 55 | 61 |
| Potatoes (tubers) | 781 | 717 | 774 | 501 | 681 | 511 | 497 |
| FCR (kg N/yr) | | | | | | | |
| Wheat | 197152 | 147198 | 131305 | 111657 | 150467 | 320440 | 201501 |
| Barley | 1967237 | 1410504 | 942529 | 906124 | 757952 | 555379 | 565824 |
| Oats | 7131 | 9989 | 37445 | 44216 | 38427 | 25815 | 39448 |
| Beans & pulses (legumes) | 32230 | 41452 | 41586 | 42768 | 41635 | 40246 | 40715 |
| Potatoes (tubers) | 257728 | 259843 | 300697 | 232303 | 307409 | 238036 | 232217 |
| TOTAL | 2461477 | 1868987 | 1453562 | 1337068 | 1295890 | 1179916 | 1079705 |

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| Crop production (t/yr) | | | | | | | |
| Wheat | 18889 | 23740 | 22923 | 15181 | 4445 | 35356 | 6902 |
| Barley | 46062 | 45716 | 67028 | 36006 | 2720 | 52175 | 2907 |
| Oats | 781 | 739 | 796 | 736 | 197 | 596 | 352 |
| Beans & pulses (legumes) | 4319 | 4204 | 4374 | 4428 | 4205 | 4905 | 4000 |
| Potatoes (tubers) | 82000 | 126080 | 82200 | 105480 | 114997 | 95921 | 122803 |
| Cultivated area (ha) | | | | | | | |
| Wheat | 7833 | 10592 | 8550 | 6921 | 6135 | 11969 | 8386 |
| Barley | 24150 | 24955 | 28853 | 23534 | 18939 | 20560 | 14536 |
| Oats | 909 | 369 | 419 | 305 | 229 | 317 | 367 |
| Beans & pulses (legumes) | 523 | 618 | 727 | 654 | 639 | 715 | 498 |
| Potatoes (tubers) | 4255 | 5065 | 4550 | 4638 | 4912 | 4735 | 5041 |
| Crop yield (YieldFresh), kg/ha | | | | | | | |
| Wheat | 2411 | 2241 | 2681 | 2193 | 725 | 2954 | 823 |
| Barley | 1907 | 1832 | 2323 | 1530 | 144 | 2538 | 200 |
| Oats | 859 | 2003 | 1900 | 2413 | 860 | 1880 | 959 |
| Beans & pulses (legumes) | 8258 | 6803 | 6017 | 6771 | 6581 | 6860 | 8032 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Potatoes (tubers) | 19271 | 24892 | 18066 | 22743 | 23411 | 20258 | 24361 |
| CropT (kg dm/ha) | | | | | | | |
| Wheat | 2146 | 1995 | 2386 | 1952 | 645 | 2629 | 733 |
| Barley | 1698 | 1630 | 2068 | 1362 | 128 | 2259 | 178 |
| Oats | 765 | 1782 | 1691 | 2148 | 766 | 1673 | 854 |
| Beans & pulses (legumes) | 7515 | 6190 | 5475 | 6161 | 5988 | 6243 | 7309 |
| Potatoes (tubers) | 4240 | 5476 | 3975 | 5003 | 5151 | 4457 | 5359 |
| above ground residue dry matter AGDM_T (kg/ha) | | | | | | | |
| Wheat | 3761 | 3532 | 4123 | 3468 | 1494 | 4490 | 1626 |
| Barley | 2254 | 2188 | 2616 | 1924 | 715 | 2803 | 764 |
| Oats | 1586 | 2512 | 2429 | 2844 | 1587 | 2413 | 1667 |
| Beans & pulses (legumes) | 9342 | 7845 | 7037 | 7812 | 7617 | 7904 | 9109 |
| Potatoes (tubers) | 1484 | 1608 | 1457 | 1560 | 1575 | 1506 | 1596 |
| Area Burnt (ha/yr) | | | | | | | |
| Wheat | 783 | 1059 | 855 | 692 | 614 | 1197 | 839 |
| Barley | 2415 | 2496 | 2885 | 2353 | 1894 | 2056 | 1454 |
| Oats | 91 | 37 | 42 | 31 | 23 | 32 | 37 |
| Beans & pulses (legumes) | 52 | 62 | 73 | 65 | 64 | 72 | 50 |
| Potatoes (tubers) | 426 | 507 | 455 | 464 | 491 | 474 | 504 |
| FCR (kg N/yr) | | | | | | | |
| Wheat | 260783 | 330717 | 312689 | 212069 | 78373 | 477458 | 117177 |
| Barley | 640951 | 641640 | 897600 | 527002 | 135564 | 688099 | 113052 |
| Oats | 13466 | 9080 | 9941 | 8577 | 3395 | 7468 | 5751 |
| Beans & pulses (legumes) | 50923 | 50419 | 53115 | 53130 | 50594 | 58779 | 47269 |
| Potatoes (tubers) | 183365 | 248987 | 190160 | 217239 | 233617 | 209089 | 244916 |
| TOTAL | 1149488 | 1280844 | 1463505 | 1018017 | 501544 | 1440893 | 528165 |

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|
| Crop production (t/yr) | | | | | | | |
| Wheat | 16592 | 14991 | 28412 | 33555 | 25139 | 30150 | 27850 |
| Barley | 18754 | 7727 | 29243 | 25664 | 25478 | 23817 | 21490 |
| Oats | 490 | 396 | 209 | 347 | 379 | 415 | 410 |
| Beans & pulses (legumes) | 4389 | 3307 | 2786 | 3209 | 2865 | 2665 | 2952 |
| Potatoes (tubers) | 109923 | 105325 | 82100 | 91880 | 98984 | 85160 | 83226 |
| Cultivated area (ha) | | | | | | | |
| Wheat | 8678 | 10197 | 10589 | 12970 | 12321 | 13314 | 12700 |
| Barley | 10953 | 12795 | 11576 | 12524 | 12833 | 10683 | 10000 |
| Oats | 248 | 219 | 223 | 334 | 303 | 248 | 300 |
| Beans & pulses (legumes) | 528 | 460 | 416 | 453 | 412 | 435 | 406 |
| Potatoes (tubers) | 4219 | 4536 | 3883 | 3797 | 3991 | 3786 | 3700 |
| Crop yield (YieldFresh), kg/ha | | | | | | | |
| Wheat | 1912 | 1470 | 2683 | 2587 | 2040 | 2265 | 2193 |
| Barley | 1712 | 604 | 2526 | 2049 | 1985 | 2229 | 2149 |
| Oats | 1976 | 1808 | 937 | 1039 | 1251 | 1673 | 1367 |
| Beans & pulses (legumes) | 8313 | 7189 | 6695 | 7084 | 6954 | 6126 | 7279 |
| Potatoes (tubers) | 26054 | 23220 | 21143 | 24198 | 24802 | 22493 | 22493 |
| CropT (kg dm/ha) | | | | | | | |
| Wheat | 1702 | 1308 | 2388 | 2303 | 1816 | 2015 | 1952 |
| Barley | 1524 | 537 | 2248 | 1824 | 1767 | 1984 | 1913 |
| Oats | 1758 | 1609 | 834 | 925 | 1113 | 1489 | 1216 |
| Beans & pulses (legumes) | 7564 | 6542 | 6092 | 6446 | 6328 | 5575 | 6624 |
| Potatoes (tubers) | 5732 | 5108 | 4652 | 5324 | 5456 | 4949 | 4949 |
| above ground residue dry matter AGDM_T (kg/ha) | | | | | | | |
| Wheat | 3089 | 2496 | 4126 | 3997 | 3262 | 3563 | 3467 |
| Barley | 2083 | 1117 | 2793 | 2377 | 2322 | 2535 | 2464 |
| Oats | 2490 | 2354 | 1649 | 1731 | 1903 | 2245 | 1997 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Beans & pulses (legumes) | 9398 | 8243 | 7734 | 8134 | 8001 | 7150 | 8335 |
| Potatoes (tubers) | 1633 | 1571 | 1525 | 1592 | 1606 | 1555 | 1555 |
| Area Burnt (ha/yr) | | | | | | | |
| Wheat | 868 | 1020 | 1059 | 1297 | 1232 | 1331 | 1270 |
| Barley | 1095 | 1280 | 1158 | 1252 | 1283 | 1068 | 1000 |
| Oats | 25 | 22 | 22 | 33 | 30 | 25 | 30 |
| Beans & pulses (legumes) | 53 | 46 | 42 | 45 | 41 | 44 | 41 |
| Potatoes (tubers) | 422 | 454 | 388 | 380 | 399 | 379 | 370 |
| FCR (kg N/yr) | | | | | | | |
| Wheat | 236193 | 222739 | 387529 | 459519 | 354584 | 419467 | 389060 |
| Barley | 267213 | 156308 | 385956 | 351916 | 351596 | 321346 | 291963 |
| Oats | 6046 | 5024 | 3451 | 5462 | 5505 | 5403 | 5748 |
| Beans & pulses (legumes) | 51721 | 39457 | 33465 | 38339 | 34289 | 32300 | 35183 |
| Potatoes (tubers) | 212688 | 214797 | 175176 | 183810 | 195801 | 176314 | 172309 |
| TOTAL | 773860 | 638325 | 985576 | 1039046 | 941775 | 954831 | 894263 |

**Table 5.24. Default dry matter fraction (DRY), Slope, Intercept, NAGT, RBGT, NBGT per crop**

| Crop | DRY | Slope | Intercept | NAGT | RBGT | NBGT |
|---|---|---|---|---|---|---|
| Wheat | 0.89 | 1.51 | 0.52 | 0.006 | 0.24 | 0.009 |
| Barley | 0.89 | 0.98 | 0.59 | 0.007 | 0.22 | 0.014 |
| Oats | 0.89 | 0.91 | 0.89 | 0.007 | 0.25 | 0.008 |
| Beans & pulses (legumes) | 0.91 | 1.13 | 0.85 | 0.008 | 0.19 | 0.008 |
| Potatoes (tubers) | 0.22 | 0.10 | 1.06 | 0.019 | 0.20 | 0.014 |

**Table 5.25. Crop residue that is burned (FracBURN)**

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| FracBURN | 0.25 | 0.24 | 0.23 | 0.23 | 0.22 | 0.21 | 0.20 | 0.19 |

| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| FracBURN | 0.18 | 0.18 | 0.17 | 0.16 | 0.15 | 0.14 | 0.13 | 0.13 |

| Year | 2006 | 2007 | 2008 | | | | | |
|---|---|---|---|---|---|---|---|---|
| FracBURN | 0.12 | 0.11 | 0.10 | | | | | |

**Table 5.26. Combustion factor ($C_f$)**

| Crop | $C_f$ | Source |
|---|---|---|
| Wheat | 0.90 | default - table 2.6, pg.2.49, vol.4, IPCC 2006 |
| Barley | 0.89 | Greece - NIR2017 |
| Oats | 0.89 | Greece - NIR2017 |
| Beans & pulses (legumes) | 0.40 | expert judgement - Michalis Omirou tel. 16/11/2017 |
| Potatoes (tubers) | 0.40 | expert judgement - Michalis Omirou tel. 16/11/2017 |

<u>Mineralization/immobilization associated with loss/gain of soil organic matter (3D1.5)</u>

Cyprus reported in 2023 for the first time direct $N_2O$ emissions associated with N mineralised in mineral soils resulting from carbon losses in mineral soils in cropland remaining cropland due to management changes. The carbon losses in mineral soils in cropland remaining cropland are reported in the LULUCF sector, however the associated $N_2O$ emissions are to be reported in CRT table 3.D. The Tier 1 method of the 2006 IPCC guidelines with default parameters were used to estimate direct $N_2O$ emissions. More specifically, for the direct $N_2O$ emissions, the C/N ratio equal to 10 and the emission factor of 0.01 kg $N_2O$–N/kg N were used.

<u>Cultivation of organic soils (3D1.6)</u>

Not Occurring

<u>Other (3D1.7)</u>

Not Occurring

#### 5.5.1.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 5.5.1.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 5.5.1.4. Category-specific recalculations

Please refer to paragraph 5.5.2.4 below.

#### 5.5.1.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 5.5.2. Indirect $N_2O$ emissions from managed soils (3D2)

In addition to the direct emissions of $N_2O$ from managed soils that occur through a direct pathway, emissions of $N_2O$ also take place through two indirect pathways. The first of these pathways is the volatilisation of N as NH3 and oxides of N ($NO_x$), and the deposition of these gases and their products $NH_4^+$ and $NO_3^-$ onto soils and the surface of lakes and other waters. The second pathway is the leaching and runoff from land of N from synthetic and organic fertiliser additions, crop residues, mineralisation of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals.

The methodology described in this section addresses the following N sources of indirect $N_2O$ emissions from managed soils arising from agricultural inputs of N: synthetic N fertilizers (FSN); organic N applied as fertiliser (e.g., applied animal manure, compost, sewage sludge, rendering waste and other organic amendments) (FON); urine and dung N deposited on pasture, range and paddock by grazing animals (FPRP); N in crop residues (above- and below-ground), including N-fixing crops and forage/pasture renewal returned to soils (FCR). N mineralisation associated with loss of soil organic matter resulting from change of land use or management on mineral soils (FSOM) because it does not occur in Cyprus.

#### 5.5.2.1. Methodological issues

For both Atmospheric deposition (3D2.1) and Leaching/Runoff (3D2.2) the Tier 1 methodology according to 2006 IPCC Guidelines is applied.

Atmospheric deposition (3D2.1)

The $N_2O$ emissions from atmospheric deposition of N volatilised from managed soil are estimated with Equation 11.9 in the 2006 IPCC Guidelines (pg. 11.21, vol.4), using the following data and parameters:

- FSN, annual amount of synthetic fertiliser N applied to soils (kg N/yr): same as presented in Table 5.18;
- FracGASF, fraction of synthetic fertiliser N that volatilises as $NH_3$ and $NO_x$, kg N volatilised/kg of N applied: default of 0.1 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4);
- FON, annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N/yr: the total nitrogen input to the soil from the categories animal manure applied to soils and sewage sludge, as estimated for category Organic N fertilizers (3D1.2) – total FON presented in Table 5.27.
- FPRP, annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr): considered 0 for Cyprus. A very small percentage of the sheep and goats are grazing; however, no information is available to make an estimation or an assumption on the

population grazing[54]

- FracGASM, fraction of applied organic N fertiliser materials (FON) and of urine and dung N deposited by grazing animals (FPRP) that volatilises as $NH_3$ and $NO_x$, kg N volatilised/kg of N applied or deposited: default of 0.2 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4);
- EF4, emission factor for $N_2O$ emissions from atmospheric deposition of N on soils and water surfaces, kg N–$N_2O$/kg $NH_3$–N + $NO_x$–N volatilized: default of 0.01 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4, IPCC 2006)

The resulting $N_2O$(ATD) –N is presented in Table 5.27. $N_2O$(ATD) –N is converted to $N_2O$ by multiplication with 44/28.

**Table 5.27. FON and $N_2O$(ATD) –N (kg N/yr)**

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|
| FON | 13776101 | 13886045 | 14146482 | 14574230 | 14420441 | 14805742 |
| $N_2O$(ATD) –N | 39978 | 39941 | 43053 | 45337 | 43130 | 50137 |
| **Year** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| FON | 15403224 | 16165623 | 16277873 | 16349470 | 17106399 | 19054024 |
| $N_2O$(ATD) –N | 44434 | 43457 | 47157 | 44260 | 44750 | 50467 |
| **Year** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
| FON | 19968932 | 18637054 | 18094102 | 16779359 | 16861458 | 17709868 |
| $N_2O$(ATD) –N | 50517 | 48472 | 46926 | 42152 | 45014 | 43618 |
| **Year** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| FON | 16474832 | 16365643 | 17245915 | 17249039 | 16385200 | 15005878 |
| $N_2O$(ATD) –N | 40449 | 40405 | 43861 | 41636 | 41089 | 37063 |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| FON | 14672154 | 14608032 | 15201961 | 15801430 | 15806903 | 16244042 |
| $N_2O$(ATD) –N | 36037 | 36749 | 38477 | 39444 | 39438 | 39988 |
| | | | | | | |
| **Year** | **2020** | **2021** | **2022** | **2023** | | |
| FON | 16839529 | 17158882 | 16739009 | 16580673 | | |
| $N_2O$(ATD) –N | 41179 | 41475 | 40553 | 40450 | | |

Leaching/Runoff (3D2.2)

Cyprus reported in 2023 for the first time indirect $N_2O$ emissions associated with N mineralised in mineral soils resulting from carbon losses in mineral soils in cropland remaining cropland due to management changes. The carbon losses in mineral soils in cropland remaining cropland are reported in the LULUCF sector, however the associated $N_2O$ emissions are to be reported in CRT table 3.D. The Tier 1 method of the 2006 IPCC guidelines with default parameters were used to estimate indirect $N_2O$ emissions. More specifically, for the indirect $N_2O$ emissions, the emission factor of 0.0075 kg $N_2O$–N/kg N and the fraction of 0.30 for the N mineralised that is lost through leaching/runoff were used.

### 5.5.2.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 5.5.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and

[54] Personal communication with Dr. Petros Mavromatis (22/11/2017), head of sheep and goat farming division, Department of Agriculture (tel. +357 22408555, pmavrommatis@da.moa.gov.cy).

verification activities are applied for this sector.

#### 5.5.2.4. Category-specific recalculations

There have been recalculations for the category 3D (Direct $N_2O$ emissions from managed soils (3D1) and Indirect Direct $N_2O$ emissions from managed soils (3D2)) for the period 2016-2019 and the year 2022 due to:

i. Updated data of dry sludge applied on land for the period 2016-2019 and 2022;
ii. Updated data of animal manure applied to soils for 2022; and
iii. Updated data of crop production and cultivated area per crop for 2022.

The impact is presented in Table 5.28 below:

**Table 5.28. Impact of recalculations on $N_2O$ emissions from managed soils (3D) (1990-2021)**

| Gg CO2 eq. | 2016 | 2017 | 2018 | 2019 | 2022 |
|---|---|---|---|---|---|
| **NIR 2025** | 47.37 | 49.27 | 48.70 | 50.53 | 50.76 |
| **NIR 2024** | 47.38 | 49.28 | 48.71 | 50.54 | 51.68 |
| **Difference (%)** | -0.02% | -0.004% | -0.01% | -0.01% | -1.78% |

#### 5.5.2.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

### 5.5.3. Prescribed burning of savannas (3E)

Not Occurring in Cyprus.

### 5.5.4. Field burning of agricultural residues (3F)

Large quantities of agricultural wastes are produced from farming systems world-wide, in the form of crop residue. Burning of crop residues is not thought to be a net source of carbon dioxide ($CO_2$) because the carbon released to the atmosphere during burning is reabsorbed during the next growing season. However, crop residue burning is a net source of $CH_4$, CO, $NO_x$, and $N_2O$. This section accounts for emissions of these non-$CO_2$ gases from field burning of agricultural crop residues. Burning of agricultural wastes in the fields is a common practice in the developing world; it is used primarily to clear remaining straw and stubble after harvest and to prepare the field for the next cropping cycle. In Cyprus, field burning of agricultural residues was a widespread practice until 2003, when a normative banning crop residues burning came into place (Fire Prevention of Outdoors Law of 1988 [220/1988] as amended by 109(I)/2002). Total emissions from field burning of agricultural residues for the period 1990–2023 are presented in Table 5.29 and Figure 5.5.

**Table 5.29. Field burning of agricultural residues emissions, 1990–2023**

| Gg $CO_2$ eq. | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| **3F** | **2.96** | **1.16** | **1.15** | **0.76** | **0.83** | **0.98** | **0.64** |
| 3.F.1 Cereals | 2.79 | 1.07 | 1.08 | 0.72 | 0.78 | 0.94 | 0.59 |
| 3.F.2 Pulses | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| 3.F.3 Tubers and Roots | 0.12 | 0.06 | 0.05 | 0.02 | 0.03 | 0.02 | 0.03 |
| | | | | | | | |
| $CH_4$ (t) | 84.78 | 33.18 | 32.92 | 21.79 | 23.84 | 28.22 | 18.26 |
| $N_2O$ (t) | 2.20 | 0.86 | 0.85 | 0.56 | 0.62 | 0.73 | 0.47 |
| **Total (Gg $CO_2$ eq.)** | **2.96** | **1.16** | **1.15** | **0.76** | **0.83** | **0.98** | **0.64** |

| Gg $CO_2$ eq. | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **3F** | **0.24** | **0.99** | **0.26** | **0.47** | **0.38** | **0.68** | **0.73** |
| 3.F.1 Cereals | 0.19 | 0.94 | 0.21 | 0.42 | 0.34 | 0.64 | 0.69 |
| 3.F.2 Pulses | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 |
| 3.F.3 Tubers and Roots | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 |
| | | | | | | | |
| $CH_4$ (t) | 6.93 | 28.47 | 7.49 | 13.43 | 10.92 | 19.46 | 20.94 |
| $N_2O$ (t) | 0.18 | 0.74 | 0.19 | 0.35 | 0.28 | 0.50 | 0.54 |
| **Total (Gg $CO_2$ eq.)** | **0.24** | **0.99** | **0.26** | **0.47** | **0.38** | **0.68** | **0.73** |

| **Gg $CO_2$ eq.** | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| **3F** | **0.63** | **0.67** | **0.62** | | | | |
| 3.F.1 Cereals | 0.60 | 0.63 | 0.58 | | | | |
| 3.F.2 Pulses | 0.01 | 0.01 | 0.01 | | | | |
| 3.F.3 Tubers and Roots | 0.02 | 0.02 | 0.02 | | | | |
| | | | | | | | |
| $CH_4$ (t) | 18.1 | 19.1 | 17.7 | | | | |
| $N_2O$ (t) | 0.47 | 0.50 | 0.46 | | | | |
| **Total (Gg $CO_2$ eq.)** | **0.63** | **0.67** | **0.62** | | | | |

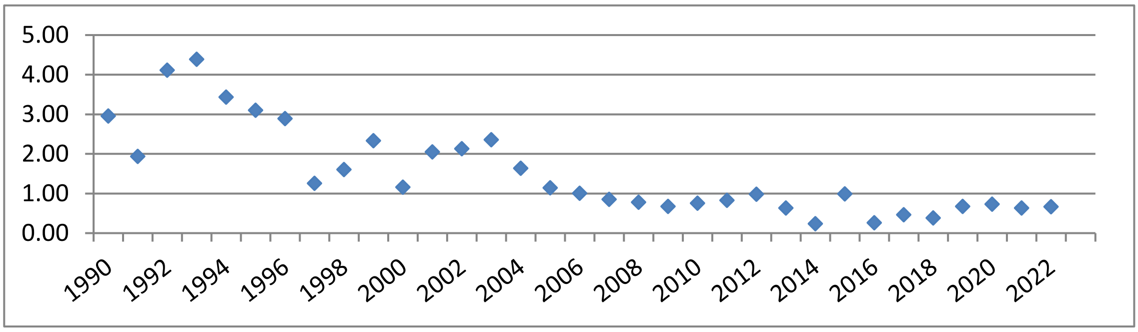


**Figure 5.5. Field burning of agricultural residues emissions, 1990–2023 (Gg $CO_2$ eq.)**

### 5.5.4.1. Methodological issues

A generic methodology to estimate the emissions of individual greenhouse gases for any type of fire is summarised in Equation 2.27 (pg. 2.42, vol. 4, 2006 IPCC Guidelines) using the following:

- A, area burnt, ha: data already presented in Table 5.2
- $M_B$, mass of fuel available for combustion, tonnes/ha: data already presented in Table 5.25 (above ground residue dry matter AGDM_T)
- $C_f$, combustion factor, dimensionless: data already presented in Table 5.29
- $G_{ef}$, emission factor, g/ kg dry matter burnt: 2.7 g $CH_4$/kg DM burnt, 0.07 g $N_2O$/kg DM burnt (according to default values in Table 2.5, pg. 2.47, vol. 4, 2006 IPCC Guidelines). According to the 2006 IPCC guidelines for combustion of non-woody biomass in Grassland and Cropland, $CO_2$ emissions do not need to be estimated and reported, because it is assumed that annual $CO_2$ removals (through growth) and emissions (whether by decay or fire) by biomass are in balance.

### 5.5.4.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

### 5.5.4.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 5.5.4.4. Category-specific recalculations

Recalculations were made because of recalculations in 3.D.1.4 (updated values for production and cultivated area of crops for 2022). This results in an increase in emissions of 0.071 kt$CO_2$eq. or 10.6%.

#### 5.5.4.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 5.5.5. Liming (3G)

Soils on Cyprus vary between lithosols, leptosols, regosols, gypsisols, solonchaks, solonetz, vertisols, and cambisols, as according to the World Reference Base of Food and Agriculture Organization of the United Nations soil classification system[55]. All of these soils have a pH of 7 or above. Additionally, according to information provided by the Department of Agriculture[56], there is no information, data or documents to support that liming does take place in Cyprus. The expert judgement of Mr. Mousouliotis is to report liming activities as NO.

## 5.5.6. Urea application (3H)

Adding urea to soils during fertilisation leads to a loss of $CO_2$ that was fixed in the industrial production process. Urea ($CO(NH_2)_2$) is converted into ammonium ($NH_4^+$), hydroxyl ion ($OH^-$), and bicarbonate ($HCO_3^-$) in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, bicarbonate that is formed evolves into $CO_2$ and water. This source category is included because the $CO_2$ removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector (IPPU Sector). The GHG inventory is developed using a Tier 1 approach.Total emissions from urea application for the period 1990–2023 are presented in Table 5.30 and Figure 5.6.

**Table 5.30. Urea application emissions, 1990–2023**

| Urea application (Gg $CO_2$) | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| | 1.82 | 1.67 | 0.97 | 0.74 | 0.91 | 0.55 | 0.79 |

| Urea application (Gg $CO_2$) | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| | 0.41 | 0.40 | 0.39 | 0.42 | 0.22 | 0.23 | 0.22 |

| Urea application (Gg $CO_2$) | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| | 0.30 | 0.27 | 0.18 | | | | |

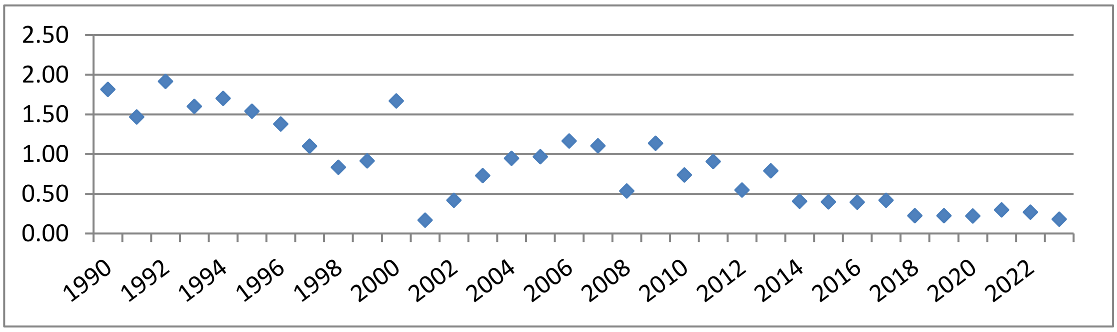


**Figure 5.6. Urea application emissions, 1990–2023 (Gg $CO_2$ eq.)**

#### 5.5.6.1. Methodological issues

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[55] Zomeni A., Camera C., Bruggeman A., Zissimos A., Christoforou I., Noller J., 2014, Digital soil map of Cyprus (1:25,000); AGWATER - Options for sustainable agricultural production and water use in Cyprus under global change; Scientific Report 6; Deliverable D15, D16. The Cyprus Institute, Nicosia, p.15.

[56] Andreas Mousouliotis, Agriculture Officer, Department of Agriculture (tel. +357 22464016, amousouliotis@da.moa.gov.cy).

The steps for estimating $CO_2$–C emissions from urea applications are:

Step 1: Estimate the total amount of urea applied annually to a soil in the country (M); Data of urea sales in Cyprus is obtained from the Department of Agriculture[57] (Table 5.31). Activity data assumes that all sold urea in a given year is consumed in the same year.

Step 2: Apply an overall emission factor (EF) of 0.20 for urea, which is equivalent to the carbon content of urea on an atomic weight basis (20% for $CO(NH_2)_2$).

Step 3: Estimate the total $CO_2$–C emission based on the product of the amount of urea applied, the emission factor, and Equation 11.13 in 2006 IPCC Guidelines (pg. 11.32, vol. 4). Total $CO_2$–C emission estimated in presented in Table 5.34.

Step 4: Multiply by 44/12 to convert $CO_2$–C emissions into $CO_2$.

**Table 5.31. Urea consumption in Cyprus (t) and total $CO_2$–C emission (tC/yr)**

| **Year** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| Urea consumption (t) | 2475 | 2000 | 2615 | 2185 | 2323 | 2101 | 1879 | 1502 |
| $CO_2$–C emission (tC/yr) | 495 | 400 | 523 | 437 | 465 | 420 | 376 | 300 |

| **Year** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| Urea consumption (t) | 1140 | 1250 | 2280 | 227 | 572 | 997 | 1291 | 1318 |
| $CO_2$–C emission (tC/yr) | 228 | 250 | 456 | 45 | 114 | 199 | 258 | 264 |

| **Year** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| Urea consumption (t) | 1590 | 1508 | 732 | 1553 | 1006 | 1239 | 748.4 | 1078 |
| $CO_2$–C emission (tC/yr) | 318 | 302 | 146 | 311 | 201 | 248 | 150 | 216 |

| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| Urea consumption (t) | 555 | 543 | 538 | 570 | 305 | 308 | 300 | 408 |
| $CO_2$–C emission (tC/yr) | 111 | 109 | 108 | 114 | 61 | 62 | 60 | 82 |

| **Year** | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Urea consumption (t) | 370 | 249.6 | | | | | | |
| $CO_2$–C emission (tC/yr) | 74 | 50 | | | | | | |

#### 5.5.6.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 5.5.6.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 5.5.6.4. Category-specific recalculations

No recalculations to report for this category.

#### 5.5.6.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

[57] George Theophanous, Agriculture Officer, Department of Agriculture (tel. +357 22464028, gtheophanous@da.moa.gov.cy) – Fertilizer Control Board.

### 5.5.7. Other carbon-containing fertilizers (3I)

NO

### 5.5.8. Other (please specify) (3J)

NO

# Chapter 6.
# Land use, land-use change and forestry (CRT sector 4)

## 6.1. Overview of sector

Cyprus is an island in the Mediterranean Sea. It measures 240 kilometers long from end to end and 100 kilometers wide at its widest point. It lies between latitudes 34° and 36° N, and longitudes 32° and 35° E. Since 1974 the northern part of Cyprus has been under occupation by Türkiye and **beyond the effective control of the Cyprus Government**. For comparability purposes with the rest of the National Inventory sectors of this report, following the recommendations of the UNFCCC Expert Review Team (September 2016 Saturday Paper Report), GHG emissions/removals are reported only for the lands under the effective control of the Government as managed land. The rest of the island is considered to be "unmanaged" and no GHG emissions/removals estimates are included in this report, even though the whole country land area is tracked and reported.

### 6.1.1. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Land areas are represented using the IPCC approach 2 (total land-use area, including changes between categories). The essential feature of approach 2 is that it provides an assessment of both the net losses or gains in the area of specific land-use categories and what these conversions represent (i.e., gross changes both from and to a land-use category) but without spatially-explicit location data. The final result of this approach is presented as a non-spatially explicit land-use conversion matrix covering the period 1990 until the latest reported year.

Land use area data for Cyprus are sourced from the CORINE land cover (CLC) inventory[58] data (for details see Chapter 6.2.3). Five CORINE data sets covering the years 1990, 2000, 2006, 2012 and 2018 were considered in the preparation of this inventory. In order to retain consistency among GHG estimates reported for different years the total land area from the 2018 data set was taken as the total country area, and for the previous data sets a proportional approach was used to adjust the areas to the total country area. The complete data sets allowed for the establishment of the respective land use matrices for the periods 1990-2000, 2000–2006, 2006–2012 and 2012-2018. All matrices were linearly interpolated/extrapolated to obtain annual land use change data for all individual years within these periods. Due to the lack of measured data before 1990, it was assumed that for all reported lands the pre-1990 land uses were not different from the land use in 1990. From 2018 onward, the same land-use changes that occurred (type and magnitude) in the period 2012–2018 were assumed in order to complete the land representation up to the latest reported year. Once a new CORINE land cover data set becomes available the land-use matrix from 2018 onward will be revised accordingly.

The surface area of the smallest unit mapped in the CORINE project is 25 hectares. However, the sensitivity for land cover change is 5 ha. As a first approximation, it is assumed that the possible overestimation and underestimation of the individual land use categories and land use changes among these land use categories within the smallest units mapped in the CORINE nullify within the reporting unit. This assumption will be checked against other data of sensitivity comparable to the threshold area used in the definition of forest when the data are available.

[58] http://land.copernicus.eu/pan-european/corine-land-cover/view

It should be noted, that in the current submission several QC checks have been implemented, regarding the land representation. More specifically, in the current submission the consistency in land representation and thus in the emissions/removals reported is ensured. This is verified by the fact that:

- The total managed and unmanaged areas remain constant throughout the time series, respectively, and therefore, the total country area remains constant for all inventory years as well.
- For every land-use category X, the final area reported in the year t-1 in CRT 4.1 equals the initial area reported in the year t in CRT 4.1 for the same land-use category X;
- For every land-use category X, and for every year Y in the inventory time series, the total area reported in the background CRTs 4.A-4.F equals the final area reported in CRT 4.1 for the same land-use category X in year Y.
- The 2006 IPCC guidelines default 20 years conversion and transition period is applied in all land-use categories.

## 6.1.2. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The 2006 IPCC guidelines identify six broad land-use categories for the purpose of estimating and reporting greenhouse gas emissions and removals from land use and land-use conversions: (i) forest land; (ii) cropland; (iii) grassland; (iv) wetlands; (v) settlements; and (vi) other land. In the preparation of this inventory the generic definitions of the categories referred to in the 2006 IPCC guidelines were implemented in a country-specific way, described below based on the national definition of forest.

### 6.1.2.1. Definition of forest

Cyprus adopted the following definition of forest for GHG reporting under the Convention (and the Kyoto Protocol in the past):

***Forest*** *comprises of land covered by forest trees which covers at least 0.3 hectares, where the tree crown cover is at least 10 per cent and the minimum tree height is of 5 meters (at maturity).*

The forest definition adopted by Cyprus is in line with the Forest National Law of 2012 (25 (I)/2012) and in accordance with the definition used for its reporting for the Global Forest Resource assessment under the Food and Agriculture Organization of the United Nations (FAO FRA 2015). This definition is also consistent with the guidance of the national definition of forest contained in Decision 16/CMP.1.

It should be noted that the Department of Forests (Department of Forests, CY-1414 Nicosia, Cyprus) applied the following definition of forest in its reporting under the FRA 2015[59]: Forest comprises land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds at maturity in situ. It does not include land that is predominantly under agricultural or urban land use.

It should also be noted that according to the Forest National Law of 2012 (25 (I)/2012), the area threshold of 0.3 hectare is to be implemented in all future reports covering any period since the year 2012.

### 6.1.2.2. The land-use categories for greenhouse gas inventory reporting

Subsequent to the guidance contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the following national definitions of land-use categories were developed for the purpose of preparation of the GHG inventories:

<u>(i) Forest land</u>

This category contains all lands that meet the definition of forest. It also includes forest roads, cleared tracts, firebreaks and other small open areas within the forest as well as reforested areas or burnt areas or

[59] Forest Data Reporting Package for 2015, FAO, page 12, Table 1.2.1 Data sources.

other areas that temporarily have low plant cover due to human intervention or natural causes, but does not include municipal parks and gardens. Forest land contains only areas covered with trees that are considered as forest trees under the Forest National Law of 2012 (25 (I)/2012).

The forest land is further divided into two subcategories: coniferous forest and broadleaved forest, based on the dominant tree species.

(ii) Cropland

This category contains cropped land, including lands with woody vegetation (i.e. fruit trees) where the vegetation does not meet the definition of forest. In particular, this category includes land principally occupied by agriculture, including: arable land, annual and permanent crops as well as vineyards, fruit trees and berry plantations, olive groves and other similar types of cultivation.

The cropland is further divided into two subcategories: annual cropland and woody (perennial) cropland, based on the dominant type of cultivated vegetation.

(iii) Grassland

This category includes rangelands and pasture land that are not considered cropland. It also includes systems with woody vegetation and other non-grass vegetation such as bushes and sclerophyllous vegetation that fall below the threshold values used in the forest land category. The category also includes all pastures, natural grassland and scarcely vegetated areas.

The grassland is further divided into two subcategories: grass and woody (perennial) grassland, based on the dominant type of land cover.

(iv) Wetlands

This category contains areas of land that is covered or saturated by water for all or part of the year and that does not fall into the forest land, cropland, grassland or settlements categories. In particular, it contains: inland and salt marshes, water courses and water bodies.

(v) Settlements

This category contains all developed land, including transportation infrastructure and human settlements of any size. In particular, it contains: industrial and commercial units, urban areas, port areas, airports, construction, mineral extraction and waste dump sites.

(vi) Other land

This category includes bare soil, rock, beaches, dunes and sand plains and all land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, i.e. to retain the entire Cyprus area constant among the reported years.

Table 6.1 presents the correspondence (mapping) of the CORINE land cover (CLC) data[60] to the land-use categories based on the 2006 IPCC guidelines.

**Table 6.1. The correspondence between the CORINE land cover categories identified in Cyprus and the 2006 IPCC land-use categories as implemented in the Cyprus' conditions.**

| LULUCF Land-Use Categories | CORINE land cover | CLC code |
|---|---|---|
| Forest land/Broadleaved forest | Broad leaved forest | 311 |
| Forest land/Coniferous forest | Coniferous forest | 312 |
| Forest land/Coniferous forest | Mixed forest | 313 |
| Forest land/Coniferous forest | Transitional woodland/shrub | 324 |
| Cropland/Woody (Woody CL) | Vineyards | 221 |
| Cropland/Woody (Woody CL) | Fruit trees and berry plantations | 222 |

[60] http://land.copernicus.eu/pan-european/corine-land-cover/view

| LULUCF Land-Use Categories | CORINE land cover | CLC code |
|---|---|---|
| Cropland/Woody (Woody CL) | Olive groves | 223 |
| Cropland/Woody (Woody CL) | Complex cultivation | 242 |
| Cropland/Woody (Woody CL) | Land principally occupied by agriculture, with significant areas of natural vegetation | 243 |
| Cropland/Annual (Annual CL) | Non-irrigated arable land | 211 |
| Cropland/Annual (Annual CL) | Permanently irrigated land | 212 |
| Cropland/Annual (Annual CL) | Annual crops associated with permanent crops | 241 |
| Grassland/Woody (Woody GL) | Sclerophyllous vegetation | 323 |
| Grassland/Grass (Grass GL) | Pastures | 231 |
| Grassland/Grass (Grass GL) | Natural grassland | 321 |
| Grassland/Grass (Grass GL) | Scarcely vegetated areas | 333 |
| Settlements (SL) | Continuous urban fabric | 111 |
| Settlements (SL) | Discontinuous urban fabric | 112 |
| Settlements (SL) | Industrial or commercial units | 121 |
| Settlements (SL) | Road and rail networks and associated land | 122 |
| Settlements (SL) | Port areas | 123 |
| Settlements (SL) | Airports | 124 |
| Settlements (SL) | Mineral extraction sites | 131 |
| Settlements (SL) | Dump sides | 132 |
| Settlements (SL) | Construction sites | 133 |
| Settlements (SL) | Green urban areas | 141 |
| Settlements (SL) | Sport and leisure facilities | 142 |
| Wetlands (WL) | Inland marshes | 411 |
| Wetlands (WL) | Salt marshes | 421 |
| Wetlands (WL) | Water courses | 511 |
| Wetlands (WL) | Water bodies | 512 |
| Other land (OL) | Beaches, dunes and sand plains | 331 |
| Other land (OL) | Bare rock | 332 |
| | Burnt areas* | 334 |

*Burned areas were distributed among the remaining land use categories based on the previous land use. In Cyprus, burning of vegetation does not lead to land use change.

The CORINE land cover (CLC) categories listed in Table 6 above exhaust all land uses existing in Cyprus. This ensures that the land categories system implemented in this inventory is complete, hence all country land area is classified into one of these categories in a unique way avoiding duplication.

All lands subject to the effective control of the Republic of Cyprus are considered as managed, whereas the rest of the land area is considered unmanaged. However unmanaged land area is tracked throughout time and reported in CRT 4.1 and therefore the total country area is reported annually.

Table 6.2 presents the areas of the 2006 IPCC land-use categories and sub-categories based on the different CORINE data sets.

**Table 6.2. Land-use categories and sub-categories area data based on the CORINE data sets. The resolution for detection of individual land use categories is 25 ha. The data cover the areas under the effective control of the Cyprus Government (managed land) and the area which is not under the effective control of the Cyprus Government (unamanaged land).**

| | Year 1990 | Year 2000 | Year 2006 | Year 2012 | Year 2018 |
|---|---|---|---|---|---|
| | kha | | | | |
| **Land-use categories** | | | | | |
| Forest land/broadleaved | 0.63 | 0.63 | 0.62 | 0.62 | 0.62 |
| Forest land/coniferous | 157.49 | 157.58 | 157.73 | 157.81 | 158.17 |
| Cropland/annual | 132.62 | 129.64 | 127.72 | 127.33 | 127.16 |
| Cropland/woody | 123.65 | 124.95 | 123.77 | 122.89 | 122.44 |
| Grassland/grass | 24.62 | 26.35 | 25.03 | 24.66 | 25.72 |
| Grassland/woody | 107.00 | 106.52 | 104.95 | 104.81 | 103.35 |

| | | | | | |
|---|---|---|---|---|---|
| Wetlands | 3.98 | 3.98 | 3.96 | 4.01 | 4.06 |
| Settlements | 48.90 | 49.20 | 55.07 | 56.72 | 57.36 |
| Other land | 2.92 | 2.96 | 2.96 | 2.96 | 2.94 |
| **Total managed land** | **601.82** | **601.82** | **601.82** | **601.82** | **601.82** |
| **Total unmanaged land** | **322.35** | **322.35** | **322.35** | **322.35** | **322.35** |
| **Total land** | **924.17** | **924.17** | **924.17** | **924.17** | **924.17** |

## 6.1.3. GHG emissions and removals in the LULUCF sector

The emissions and removals from the LULUCF sector by main land-use category for the whole inventory period are presented in Table 6.3.

**Table 6.3. Emissions and removals (+/-) from LULUCF categories (kt $CO_2$ eq).**

| Year | Total | FL | CL | GL | WL | SL | OL | HWP |
|---|---|---|---|---|---|---|---|---|
| **1990** | -153.07 | 1.51 | -134.23 | -23.05 | NO,NE | 0.46 | 0.11 | 2.14 |
| **1991** | -166.98 | -18.24 | -134.77 | -23.53 | NO,NE | 0.45 | 0.14 | 8.97 |
| **1992** | -172.65 | -23.54 | -135.31 | -24.01 | NO,NE | 0.43 | 0.18 | 9.60 |
| **1993** | -174.80 | -11.81 | -135.84 | -24.49 | NO,NE | 0.41 | 0.21 | -3.28 |
| **1994** | -183.35 | -23.10 | -136.38 | -24.96 | NO,NE | 0.39 | 0.24 | 0.46 |
| **1995** | -180.03 | -18.77 | -136.92 | -25.44 | NO,NE | 0.37 | 0.27 | 0.45 |
| **1996** | -185.36 | -22.26 | -137.46 | -25.92 | NO,NE | 0.36 | 0.30 | -0.38 |
| **1997** | -184.22 | -29.88 | -138.00 | -26.40 | NO,NE | 0.34 | 0.34 | 9.38 |
| **1998** | -190.49 | -27.93 | -138.53 | -26.87 | NO,NE | 0.32 | 0.37 | 2.15 |
| **1999** | -198.38 | -33.17 | -139.07 | -27.35 | NO,NE | 0.30 | 0.40 | 0.51 |
| **2000** | -142.51 | 9.92 | -139.61 | -27.83 | NO,NE | 0.29 | 0.44 | 14.30 |
| **2001** | -168.60 | -46.21 | -139.59 | -28.81 | NO,NE | 23.11 | 0.36 | 22.54 |
| **2002** | -201.94 | -81.47 | -139.52 | -28.75 | NO,NE | 23.59 | 0.36 | 23.86 |
| **2003** | -214.02 | -94.33 | -139.45 | -28.69 | NO,NE | 24.06 | 0.36 | 24.02 |
| **2004** | -214.55 | -95.72 | -139.37 | -28.63 | NO,NE | 24.53 | 0.36 | 24.29 |
| **2005** | -220.83 | -102.58 | -139.30 | -28.57 | NO,NE | 25.00 | 0.36 | 24.27 |
| **2006** | -222.49 | -103.97 | -139.23 | -28.52 | NO,NE | 25.45 | 0.36 | 23.42 |
| **2007** | -182.89 | -42.13 | -140.95 | -28.50 | 0.44 | 9.08 | 0.36 | 18.81 |
| **2008** | -249.84 | -108.26 | -140.77 | -28.50 | 0.45 | 9.23 | 0.36 | 17.64 |
| **2009** | -277.65 | -141.28 | -140.58 | -28.50 | 0.47 | 9.38 | 0.36 | 22.51 |
| **2010** | -265.04 | -130.19 | -140.00 | -28.02 | 0.48 | 9.54 | 0.32 | 22.82 |
| **2011** | -300.78 | -168.10 | -139.43 | -27.53 | 0.50 | 9.70 | 0.29 | 23.79 |
| **2012** | -293.62 | -162.14 | -138.85 | -27.05 | 0.52 | 9.85 | 0.26 | 23.78 |
| **2013** | -297.29 | -171.08 | -131.99 | -23.62 | 0.45 | 5.23 | 0.23 | 23.50 |
| **2014** | -299.11 | -173.38 | -131.39 | -23.07 | 0.46 | 5.16 | 0.19 | 22.91 |
| **2015** | -296.11 | -171.27 | -130.78 | -22.51 | 0.47 | 5.09 | 0.16 | 22.73 |
| **2016** | -190.89 | -66.95 | -130.22 | -21.97 | 0.47 | 5.07 | 0.13 | 22.57 |
| **2017** | -307.03 | -183.98 | -129.65 | -21.43 | 0.47 | 5.05 | 0.10 | 22.41 |
| **2018** | -302.31 | -180.14 | -129.09 | -20.89 | 0.47 | 5.03 | 0.06 | 22.24 |
| **2019** | -297.04 | -175.66 | -128.47 | -20.33 | 0.49 | 4.94 | 0.03 | 21.96 |
| **2020** | -298.54 | -177.58 | -127.88 | -19.78 | 0.50 | 4.89 | NO | 21.32 |
| **2021** | -235.33 | -112.90 | -127.57 | -19.73 | 0.50 | 4.46 | NO | 19.92 |
| **2022** | -299.39 | -177.18 | -127.26 | -19.68 | 0.50 | 4.02 | NO | 20.21 |
| **2023** | -310.58 | -187.42 | -126.95 | -19.62 | 0.50 | 3.59 | NO | 19.33 |

## 6.1.4. Emission Trends

The total LULUCF sector represents a GHG sink during the entire period 1990–2023. While the sink generally follows an upward trend, in years of exceptional extent of forest fires (2000, 2007, 2016 and

2021) the trend is visibly broken (see Figure 6.1). Overall, the sink in the total LULUCF increases from -153.1 kt $CO_2$ eq in 1990 to -310.6 kt $CO_2$ eq in 2023, representing an increase in net removals of 102.9%.

The forest land category is an important contributor to the sink in the LULUCF sector. The land converted to forest land represents a net sink for all inventoried years, while forest land remaining forest land represents sinks for all years, except some specific years in which represents a net source, primarily due to significant forest fire impacts.

The cropland remaining cropland and grassland remaining grassland categories are sinks over the entire period 1990–2023. For cropland remaining cropland national data are limited to area only, hence all emission/removal factors used in calculations of the GHG sources/sinks estimates are default data.

During the entire period 1990–2023, the wetlands category (land converted to wetlands) represents a minor source as well as the settlements category (land converted to settlements) does. Finally, the other land category represents a net source of emissions for the whole inventory period, except the last four years (2020-2023) in which emissions do not occur.

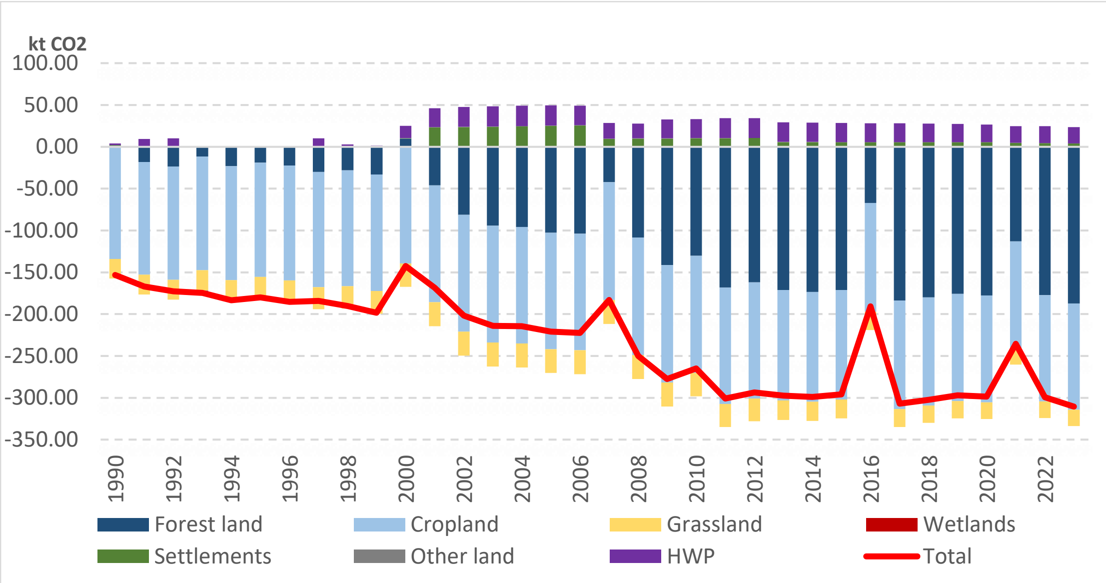


**Figure 6.1. Emissions/removals trend in the LULUCF sector in the period 1990–2023**

## 6.2. Forest land (4A)

### 6.2.1. Description

#### Area and ownership of Cyprus forest

The total forest land area in 2023 amounts to 159,08 ha covering approximately 26.4% of the total managed land area. Conifers represent the vast majority of the total managed forest land area, namely 99.6% while broadleaf forests are found only on 0.4% of the total managed forest land area in the country. Furthermore, according to a last survey, private forests and other forested State land cover 24.74% of the total area of Cyprus. Private forests are small holdings scattered all over Cyprus and are mainly located in distant mountainous and rural areas.

#### Floristic composition of Cyprus forests

Nearly half the area of the island is covered by tree vegetation that has been degraded by human activities. Forest is composed mainly of coniferous species like the Calabrian pine (*Pinus brutia*), the black pine (*Pinus nigra*), the Cedar (*Cedrus brevifolia*) and the Cypress (*Cypressus sempervirens*). Maquis vegetation includes species like Lentisk *(Pistacia lentiscus*), Juniper (*Juniperus phoenicea*), Maple (*Acer obtusifolium*) and Strawberry tree (*Arbutus andrachne*), while garigue lands consist of the Rock rose (*Cistus spp.*), Thyme (*Thymus capitatus*), Thorny-broom (*Calycotome villosa*), Thorny gorse (*Genista fasselata*) and Spiny burnet (*Sarcopoterium spinosum*). There are also minor areas consisting of young coniferous plantations (source: Forest Department, Ministry of Agriculture, Rural Development and Environment, Cyprus).

### 6.2.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The approach for representing land areas and land use databases is described in Chapter 6.1.1, "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

### 6.2.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting".

Table 6.4 below presents the area data on land remaining and converted to the broadleaved forest subcategory. Note that there are no conversions to broadleaved within the land converted to forest land category.

**Table 6.4. Areas of land remaining in the same land use subcategory (broadleaved remaining broadleaved forests) and of land converted to broadleaved forests from other land-use sub-categories.**

| Year | Broadleaved remaining broadleaved | Land converted to broadleaved forest from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Conif. FL | Annual CL | Woody CL | Grass GL | Woody GL | WL | SL | OL | |
| | kha | | | | | | | | | |
| 1990 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1991 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1992 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1993 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1994 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1995 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1996 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1997 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1998 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 1999 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 2000 | 0.631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.631 |
| 2001 | 0.630 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.630 |
| 2002 | 0.628 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.628 |
| 2003 | 0.627 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.627 |
| 2004 | 0.626 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.626 |
| 2005 | 0.624 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.624 |
| 2006 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2007 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2008 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2009 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2010 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2011 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2012 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2013 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2014 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2015 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2016 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2018 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2019 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2020 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2021 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2022 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |
| 2023 | 0.623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.623 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

Table 6.5 presents the same kind of information for the case of the coniferous forest subcategory. As explained in section 6.1.1, in all land-use categories the 20 years conversion period is applied in the current inventory, namely, any piece of land remains in the 'conversion' subcategory for 20 years before transferred to the remaining subcategory.

**Table 6.5. Areas of land remaining in the same land use subcategory (coniferous remaining coniferous forests) and of land converted to coniferous forests from other land-use sub-categories.**

| Year | Coniferous remaining coniferous | Land converted to coniferous forest from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Broad. FL | Annual CL | Woody CL | Grass GL | Woody GL | WL | SL | OL | |
| | kha | | | | | | | | | |
| 1990 | 157.486 | 0 | 0.000 | 0 | 0 | 0.009 | 0 | 0 | 0 | 157.495 |
| 1991 | 157.486 | 0 | 0.001 | 0 | 0 | 0.017 | 0 | 0 | 0 | 157.504 |
| 1992 | 157.485 | 0 | 0.001 | 0 | 0 | 0.026 | 0 | 0 | 0 | 157.512 |
| 1993 | 157.485 | 0 | 0.001 | 0 | 0 | 0.034 | 0 | 0 | 0 | 157.521 |
| 1994 | 157.485 | 0 | 0.002 | 0 | 0 | 0.043 | 0 | 0 | 0 | 157.530 |
| 1995 | 157.484 | 0 | 0.002 | 0 | 0 | 0.052 | 0 | 0 | 0 | 157.538 |
| 1996 | 157.484 | 0 | 0.003 | 0 | 0 | 0.060 | 0 | 0 | 0 | 157.547 |
| 1997 | 157.484 | 0 | 0.003 | 0 | 0 | 0.069 | 0 | 0 | 0 | 157.556 |
| 1998 | 157.484 | 0 | 0.003 | 0 | 0 | 0.078 | 0 | 0 | 0 | 157.564 |
| 1999 | 157.483 | 0 | 0.004 | 0 | 0 | 0.086 | 0 | 0 | 0 | 157.573 |
| 2000 | 157.483 | 0 | 0.004 | 0 | 0 | 0.095 | 0 | 0 | 0 | 157.582 |
| 2001 | 157.474 | 0 | 0.004 | 0 | 0.008 | 0.095 | 0 | 0.025 | 0 | 157.606 |
| 2002 | 157.466 | 0 | 0.004 | 0 | 0.016 | 0.095 | 0 | 0.049 | 0 | 157.630 |
| 2003 | 157.457 | 0 | 0.004 | 0 | 0.024 | 0.095 | 0 | 0.074 | 0 | 157.654 |
| 2004 | 157.449 | 0 | 0.004 | 0 | 0.032 | 0.095 | 0 | 0.099 | 0 | 157.678 |
| 2005 | 157.440 | 0 | 0.004 | 0 | 0.040 | 0.095 | 0 | 0.123 | 0 | 157.702 |
| 2006 | 157.431 | 0 | 0.004 | 0 | 0.048 | 0.095 | 0 | 0.148 | 0 | 157.726 |
| 2007 | 157.425 | 0 | 0.004 | 0 | 0.050 | 0.095 | 0 | 0.167 | 0 | 157.741 |
| 2008 | 157.419 | 0 | 0.004 | 0 | 0.052 | 0.095 | 0 | 0.186 | 0 | 157.756 |
| 2009 | 157.414 | 0 | 0.004 | 0 | 0.054 | 0.095 | 0 | 0.205 | 0 | 157.770 |
| 2010 | 157.417 | 0 | 0.004 | 0 | 0.056 | 0.086 | 0 | 0.223 | 0 | 157.785 |
| 2011 | 157.420 | 0 | 0.003 | 0 | 0.057 | 0.078 | 0 | 0.242 | 0 | 157.800 |
| 2012 | 157.423 | 0 | 0.003 | 0 | 0.059 | 0.069 | 0 | 0.261 | 0 | 157.815 |
| 2013 | 157.403 | 0 | 0.006 | 0.046 | 0.059 | 0.085 | 0 | 0.273 | 0 | 157.873 |
| 2014 | 157.383 | 0 | 0.010 | 0.092 | 0.059 | 0.102 | 0 | 0.286 | 0 | 157.931 |
| 2015 | 157.363 | 0 | 0.013 | 0.138 | 0.059 | 0.118 | 0 | 0.298 | 0 | 157.990 |
| 2016 | 157.343 | 0 | 0.017 | 0.184 | 0.059 | 0.135 | 0 | 0.310 | 0 | 158.048 |
| 2017 | 157.323 | 0 | 0.020 | 0.230 | 0.059 | 0.151 | 0 | 0.323 | 0 | 158.107 |
| 2018 | 157.303 | 0 | 0.023 | 0.276 | 0.059 | 0.168 | 0 | 0.335 | 0 | 158.165 |
| 2019 | 157.283 | 0 | 0.027 | 0.323 | 0.059 | 0.185 | 0 | 0.347 | 0 | 158.224 |
| 2020 | 157.264 | 0 | 0.030 | 0.369 | 0.059 | 0.201 | 0 | 0.359 | 0 | 158.282 |
| 2021 | 157.267 | 0 | 0.034 | 0.415 | 0.051 | 0.226 | 0 | 0.347 | 0 | 158.341 |
| 2022 | 157.271 | 0 | 0.038 | 0.461 | 0.043 | 0.251 | 0 | 0.335 | 0 | 158.399 |
| 2023 | 157.275 | 0 | 0.042 | 0.507 | 0.035 | 0.276 | 0 | 0.322 | 0 | 158.457 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

## 6.2.4. Methodological issues

Forest area is an area with vegetation cover that meets the national definition of forest. It includes stands of different ages, including areas transiently deprived of vegetation which are expected to revert to forest and lands recently afforested and reforested. All data collected by the Forest Department refer to the entire forest area. It also includes areas converted to forest, as defined by the 2006 IPCC guidelines in the 2006 IPCC sense. Consequently, all calculations involving biomass growth and losses are performed on the basis of the entire forest area. However, estimates relating specifically to the conversion process (e.g. accumulation/release of carbon from soil) are calculated specifically for the relevant conversion areas.

The growing stock and annual increment for all subcategories included in this category are defined as follows[61]:

**Growing stock** = Volume over bark of all living trees more than 12 cm in diameter at breast height. Includes the stem from stump height up to a top diameter of 7 cm. It does not include branches.

**Annual increment** = Average annual volume of increment over the given reference period net of natural losses on all trees, measured to minimum diameters as defined for "Growing stock". The annual increment is expressed on the per hectare basis.

National data on growing stock and annual increment are presented in Table 6.6.

**Table 6.6. National data on growing stock and annual increment**

| Year | Growing stock | Coniferous forest | Broadleaved forest |
|---|---|---|---|
| | $m^3$/ha | $m^3$/ha/yr | $m^3$/ha/yr |
| 1990 | 45.96 | 0.58 | 2 |
| 1991 | 45.96 | 0.58 | |
| 1992 | 45.95 | 0.57 | |
| 1993 | 45.94 | 0.57 | |
| 1994 | 45.94 | 0.56 | |
| 1995 | 45.93 | 0.56 | |
| 1996 | 45.92 | 0.56 | |
| 1997 | 45.92 | 0.55 | |
| 1998 | 45.91 | 0.55 | |
| 1999 | 45.90 | 0.54 | |
| 2000 | 45.90 | 0.54 | |
| 2001 | 46.42 | 0.59 | |
| 2002 | 46.94 | 0.65 | |
| 2003 | 47.46 | 0.70 | |
| 2004 | 47.98 | 0.70 | |
| 2005 | 48.50 | 0.70 | |
| 2006 | 50.28 | 0.70 | |
| 2007 | 52.05 | 0.70 | |
| 2008 | 53.83 | 0.84 | |
| 2009 | 55.61 | 0.94 | |
| 2010 | 57.39 | 0.94 | |
| 2011 | 59.22 | 1.17 | |
| 2012 | 61.06 | 1.17 | |
| 2013 | 62.89 | 1.17 | |
| 2014 | 64.73 | 1.17 | |
| 2015 | 66.57 | 1.17 | |
| 2016 | 66.57 | 1.17 | |
| 2017 | 66.57 | 1.17 | |
| 2018 | 66.57 | 1.17 | |

[61] FAO. Forest Data Reporting Package for 2015. Cyprus

| | | | |
|---|---|---|---|
| 2019 | 68.80 | 1.17 | |
| 2020 | 69.90 | 1.17 | |
| 2021 | 69.90 | 1.20 | |
| 2022 | 69.90 | 1.20 | |
| 2023 | 69.90 | 1.20 | |

National data on the growing stock and volume increment are averaged over the entire net area of forest in the current year (that is the area of forest remaining forest plus the areas converted to forest minus areas converted from forest to other uses in that year).

National data on the volume of harvest is expressed as volume under bark. The volume of bark is assumed as 12% of the harvested volume based on forest expert advice. The annual harvest is provided for the total forest land area for each year (that is the area of forest remaining forest plus the areas converted to forest minus areas converted from forest to other uses in that year).

In Cyprus, salvage logging is part of the forest harvest. However, data on salvage logging are also published separately from data on forest harvest, and it is included in calculation of emissions from harvest.

**Table 6.7. Annual harvest in forest land**

| Year | Coniferous forest | | Broadleaved forest | |
|---|---|---|---|---|
| | Roundwood | Fuelwood | Roundwood | Fuelwood |
| | $m^3$ | | | |
| 1990 | 46,305 | 14,194 | 1,518 | 465 |
| 1991 | 35,341 | 10,831 | 1,506 | 462 |
| 1992 | 32,339 | 10,550 | 1,511 | 493 |
| 1993 | 36,529 | 11,910 | 1,433 | 467 |
| 1994 | 31,395 | 5,397 | 1,449 | 249 |
| 1995 | 34,216 | 8,866 | 1,505 | 390 |
| 1996 | 32,366 | 6,460 | 1,508 | 301 |
| 1997 | 26,984 | 4,683 | 1,437 | 249 |
| 1998 | 18,840 | - | 1,158 | - |
| 1999 | 26,780 | 7,497 | 1,590 | 445 |
| 2000 | 15,859 | 3,524 | 1,442 | 320 |
| 2001 | 11,919 | 4,723 | 1,246 | 494 |
| 2002 | 9,997 | 3,174 | 1,290 | 409 |
| 2003 | 6,981 | 2,060 | 1,252 | 369 |
| 2004 | 5,756 | 1,004 | 1,320 | 230 |
| 2005 | 4,388 | 725 | 1,065 | 176 |
| 2006 | 2,879 | - | 1,063 | - |
| 2007 | 11,794 | 5,124 | 1,132 | 492 |
| 2008 | 13,585 | 4,161 | 1,163 | 356 |
| 2009 | 4,483 | 586 | 1,536 | 201 |
| 2010 | 5,636 | 3,007 | 537 | 287 |
| 2011 | 5,015 | 2,802 | 683 | 382 |
| 2012 | 4,121 | 5,571 | 971 | 1,313 |
| 2013 | 3,020 | 4,191 | 1,159 | 1,609 |
| 2014 | 3,419 | 3,644 | 1,062 | 1,131 |
| 2015 | 3,050 | 7,30 | 820 | 1,966 |
| 2016 | 1,923 | 4,955 | 227 | 584 |
| 2017 | 579 | 4,324 | 72 | 540 |
| 2018 | 1,727 | 4,012 | 248 | 575 |
| 2019 | 2,401 | 7,417 | 74 | 1,772 |
| 2020 | 2,758 | 6,503 | 64 | 1,407 |
| 2021 | 1,964 | 5,904 | 192 | 575 |
| 2022 | 2,524 | 12,640 | 392 | 1,344 |

| | | | | |
|---|---|---|---|---|
| 2023 | 1,928 | 6,482 | 385 | 1,295 |

The root/shoot ratio for all forest types is 0.28 (Table 4.4, of 2006 IPCC guidelines for subtropical dry forest, based on a previous ERT's advice).

The carbon fraction of wood is 0.47 t C/t d.m. for the whole inventory (based on a previous ERT's advice).

The biomass conversion and expansion factors used are the default ones from Table 4.5 of the 2006 IPCC guidelines, for the Mediterranean dry tropical, subtropical climatic zone, and for growing stock level 41–100 $m^3$/ha. These factors are presented in Table 6.8 below

**Table 6.8. BCEF values used in carbon stock changes estimation in living biomass.**

| Forest type | BCEF | Value used |
|---|---|---|
| Broadleaved forest | $BCEF_S$ | 0.80 t biomass/$m^3$ wood volume |
| | $BCEF_I$ | 0.55 t biomass/$m^3$ wood volume |
| | $BCEF_R$ | 0.89 t biomass/$m^3$ wood volume |
| Coniferous forest | $BCEF_S$ | 0.60 t biomass/$m^3$ wood volume |
| | $BCEF_I$ | 0.45 t biomass/$m^3$ wood volume |
| | $BCEF_R$ | 0.67 t biomass/$m^3$ wood volume |

**Forest fires**

All emissions from forest fires were attributed to the forest land remaining forest land category. The areas affected by fires are provided annually by the Forest Department of Cyprus. $CO_2$ emissions from forest fires in living biomass are estimated as part of the living biomass losses (equation 2.14, 2006 IPCC guidelines) and reported in CRT 4.A (carbon losses), aggregated with the losses from harvestings. In CRT 4(IV) however, non-$CO_2$ emissions from biomass burning in forest land are reported, applying equation 2.27 of the 2006 IPCC guidelines, with default emission factors (table 2.5 for extra tropical forest) for $CH_4$ and $N_2O$. Furthermore, the default combustion factor (Cf=0.45) from 2006 IPCC guidelines is used in all calculations relating to forest fires (Table 2.6 for all other temperate forests).

**Land converted to forest land**

Due to the lack of country-specific information on annual increment in above-ground biomass for land converted to forest land, the country specific values of growing stock that were presented previously were used to approximate the above-ground biomass growth. The 20 years default conversion and transition period was applied, while the BCEF, root-shoot ratio, and carbon fraction values used are the same as in the case of forest land remaining forest land.

With regard to carbon losses due to forest fires, as explained previously, all emissions from biomass burning are attributed to forest land remaining forest land, thus in CRT 4(IV) the 'IE' notation key is used for land converted to forest land and relevant information is reported in CRT 9.

**Change in carbon in dead organic matter**

In forest land remaining forest land, the tier 1 assumption from 2006 IPCC guidelines, that carbon stock changes in the dead organic matter (DOM) pool are zero is followed. In land converted to forest land, carbon stock changes in the DOM pool have been estimated and reported. For the whole inventory, carbon stocks in DOM pool in all non-forest land-use categories are taken equal to zero. For the litter carbon stocks in forest land, the default values from the 2006 IPCC guidelines are used for broadleaved and coniferous forests, namely, 2.8 t C/ha and 4.1 t C/ha (Table 2.2, for subtropical climate), respectively. In the current inventory, carbon stock changes in dead wood in land converted to forest land are reported for the first time. In the absence of default values for carbon stocks in dead wood in the 2006 IPCC guidelines, the default values from the 2019 Refinement to the 2006 IPCC Guidelines are used instead. More specifically, a unique value of 64.4 t C/ha (subtropical desert climate) for both broadleaved and coniferous forests is used.

The methodology applied is in accordance with equation 2.23 of the 2006 IPCC guidelines. Furthermore, the assumptions that DOM stocks are entirely lost in the year of conversion in the cases of forest land conversions to the other land-use categories, while DOM gains occur linearly from zero over the 20 years transition period in the cases of DOM buildup (i.e., land conversions to forest land) are applied.

**Change in carbon stocks in soils**

The reference carbon stock in mineral soils used in all land-use categories is the default one suggested by the 2006 IPCC Guidelines. More specifically, the whole country area in Cyprus is considered to be mineral high activity clay soils with a default reference carbon stock of 38 t C/ha (table 2.3, for tropical, dry climate).

In forest land remaining forest land, the tier 1 assumption from 2006 IPCC guidelines, that carbon stock changes in mineral soil (SOM) pool are zero is followed. In land converted to forest land, carbon stock changes were estimated applying formulation B of equation 2.25 of the 2006 IPCC guidelines with the default 20 years transition period. For forest land, the stock change factors for land use, management and input were taken equal to 1, thus the carbon stocks at equilibrium in forest land equal the reference soil carbon stocks. Similarly, all three stock change factors were taken equal to 1 in the case of woody cropland ($F_{LU}$ for perennial/tree crop, $F_{MG}$ for full tillage, $F_I$ for medium input), grass and woody grassland ($F_{LU}$ for all grassland, $F_{MG}$ for nominal managed grassland, $F_I$ for medium input). In the case of annual cropland, the $F_{LU}$ for long-term cultivated (tropical dry climate) equal to 0.58 is applied, together with the same $F_{MG}$, $F_I$ used for woody cropland. For settlements, the default 0.8 product of all three stock change factors is applied, and for the other land category the carbon stocks in mineral soils are taken equal to zero.

## 6.2.5. Uncertainties and time-series consistency

In the previous submission for the first time the uncertainty analysis included the LULUCF sector.

Uncertainties for the whole inventory period (1990-2023) have been assessed following the error propagation (approach 1) and equations 3.1, 3.2 contained in volume 1 of the 2006 IPCC guidelines. Input uncertainties related to activity data and emission factors have been assessed on the basis of information provided in the 2006 IPCC guidelines and country specific information.

The uncertainties associated with the input data for forest land remaining forest land and land converted to forest land are presented in the table below.

**Table 6.9. Input data uncertainties.**

| Input data | % |
|---|---|
| Area | 15 |
| Net annual increment (conifers) | 65 |
| Net annual increment (broadleaved) | 20 |
| BCEF (coniferous) | 38 |
| BCEF (broadleaved) | 40 |
| Annual roundwood, fuelwood | 20 |
| Area affected by wildfires | 10 |
| Litter stocks | 20 |
| Dead wood stocks | 81 |
| Reference soil carbon stocks | 90 |
| Annual & woody cropland biomass carbon stocks & biomass accumulation rate for woody CL | 75 |
| $FL_U$ in annual cropland | 61 |
| $FL_U$ in woody cropland | 50 |
| $FL_U$*$FL_{MG}$*$FL_I$ in settlements | 61 |
| Average forest growing stock | 20 |

| | |
|---|---|
| Average above-ground growing stock in woody grassland | 50 |
| MB*Cf (biomass burning) | 213 |
| Root-shoot ratio (R) | 2 |
| Carbon fraction (CF) | 2 |
| $CH_4$ EF for biomass burning | 81 |
| $N_2O$ EF for biomass burning | 54 |

The overall uncertainty for forest land remaining forest land is equal to 62%, 230%, 220% for $CO_2$, $CH_4$, $N_2O$ emissions respectively, while for land converted to forest land associated uncertainties equal to 43% for $CO_2$ emissions. A more detailed description of the results of the uncertainty analysis is reported in Annex 2.

The time series of emissions/removals for the land-use categories forest land remaining forest land and land converted to forest land (for coniferous and broadleaved forest together) is presented in figure 6.2 and figure 6.3.

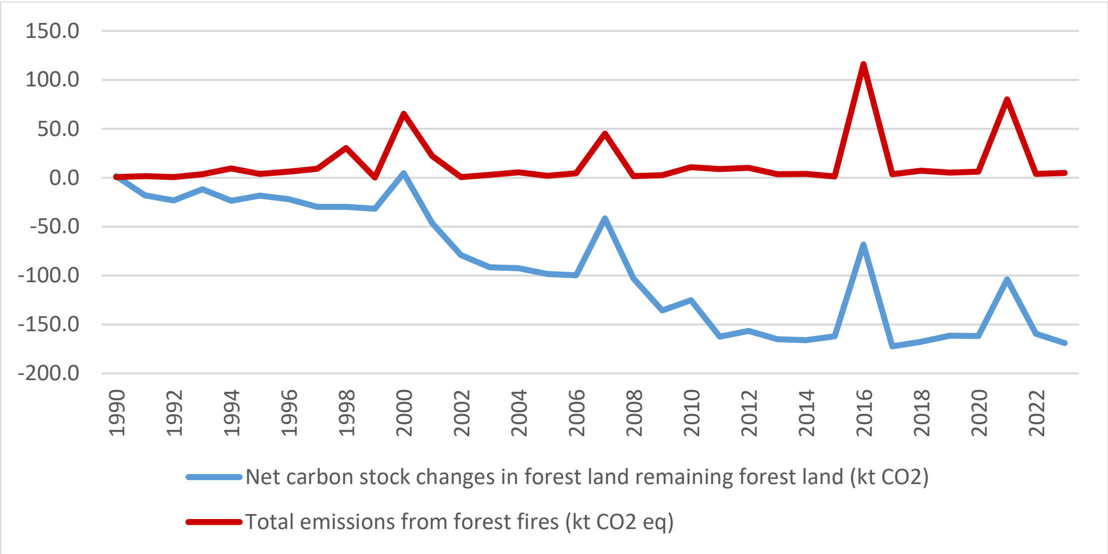


**Figure 6.2. Forest land remaining forest land: Net carbon stock changes (blue line) and emissions from forest fires (red line) during the period 1990 – 2023.**

In figure 6.2 the trend of an increasing sink in forest land remaining forest land is evident. The trend is transiently broken in years of exceptional forest fire events.

Figure 6.3 presents the increasing sink trend in land converted to forest land reflecting the increasing trend in areas under land converted to forest land. In land converted to forest land there are not any peaks/valleys due to disturbances, since all emissions from forest fires are included in forest land remaining forest land.

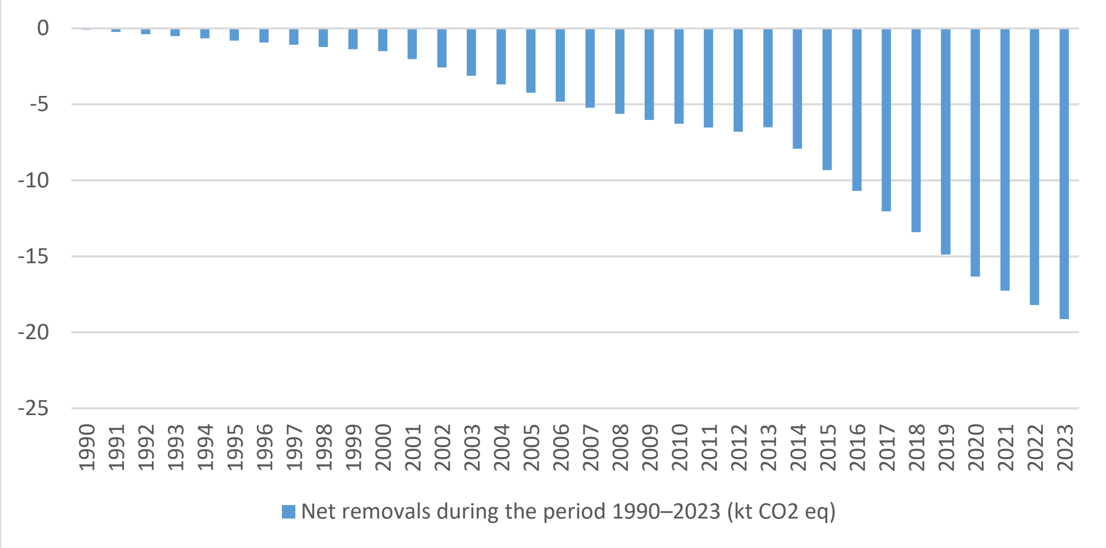


**Figure 6.3. Land converted to forest land: Net removals during the period 1990–2023**

Figure 6.4 presents the total contribution of the forest land remaining forest land and land converted to forest land categories to the GHG emissions/sources in the LULUCF sector.

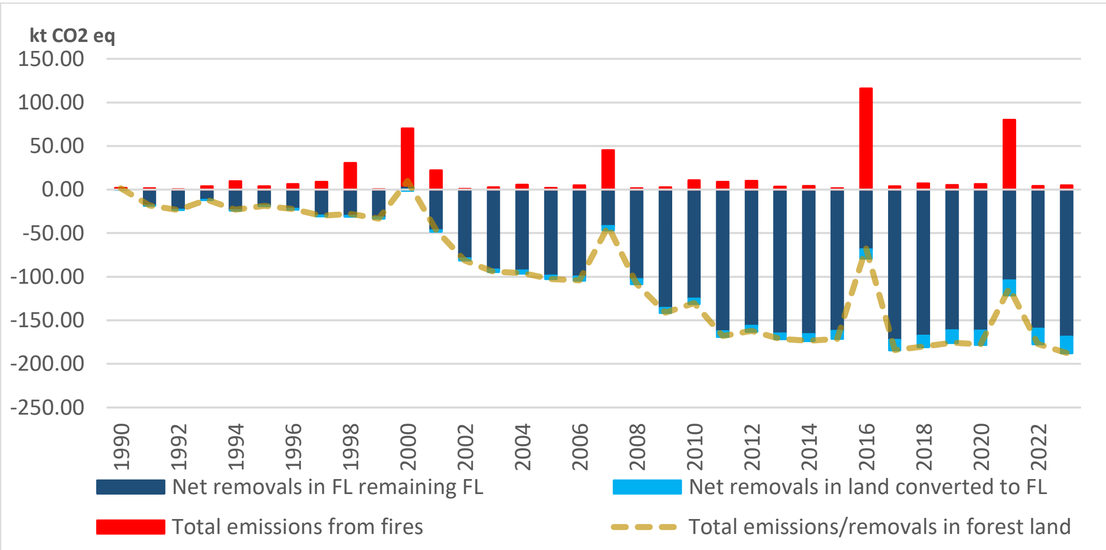


**Figure 6.4. Forest land remaining forest land and land converted to forest land contribution: net $CO_2$ emissions/removals during the period 1990 – 2023**

## 6.2.6. Category-specific QA/QC and verification

The following category specific QA/QC and verification approaches were implemented during preparation of this NID:

- Check of correctness/plausibility of the land representation, activity data and emission factors used in calculations and their units;
- Check of plausibility of input data;
- Check of completeness of data;
- Check of correctness of the methodologies applied and plausibility of results;
- Check of references and assumptions applied in processing of the data;

- Check of the consistency of the total area of the lands under the effective control of the Republic of Cyprus in all years of the reported period.
- Check of the correct use of notation keys in CRT tables and the complete and correct filling of the CRT tables.

### 6.2.7. Category-specific recalculations

No recalculations were implemented.

### 6.2.8. Category-specific planned improvements

The improvements considered related to this category include:

- Investigate options for developing more accurate net annual increment values for land conversions to forest land.
- Analyse further the CORINE data sets together with additional country data sources in order to refine equilibrium carbon stocks in mineral soils in cropland, grassland and settlements, to be used in land converted to forest land.
- An approach should be developed to obtain a numerical assessment of land use changes involving individual areas from 0.3 ha to 5 ha and their impact on the numerical estimates of land use changes obtained at the 5 ha resolution. The national definition of forest requires assessment of land use changes at the resolution of 0.3 ha. This may be achieved by means of establishing a correlation between the area of land use changes detected at the resolution of 5 ha and "true" area of land use changes estimated based on the threshold of 0.3 ha.
- Collect further information in order to distinguish forest land areas affected by fires between forest land remaining forest land and land converted to forest land, and between the forest types.
- Assess the appropriateness of the IPCC default dead wood stock value used for both broadleaved and coniferous forests and identify more accurate one.

## 6.3. Cropland (4B)

### 6.3.1. Description

### 6.3.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

### 6.3.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting". Table 6.10 presents data on lands converted to annual cropland. Note that the only conversions to annual cropland are from coniferous forests, perennial cropland, woody and grass grassland, and settlements. Similarly, table 6.11 presents data on lands converted to woody cropland.

**Table 6.10. Areas of land remaining in the same land use subcategory (annual cropland remaining annual cropland) and of land converted to annual cropland from other land-use sub-categories.**

| Year | Annual cropland remaining annual cropland | Land converted to annual cropland from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Woody CL | Broad. FL | Conif . FL | Grass GL | Woody GL | WL | SL | OL | |
| | kha | | | | | | | | | |
| 1990 | 132.596 | 0.001 | 0 | 0 | 0 | 0.025 | 0 | 0 | 0 | 132.622 |
| 1991 | 132.273 | 0.001 | 0 | 0 | 0 | 0.050 | 0 | 0 | 0 | 132.324 |
| 1992 | 131.950 | 0.002 | 0 | 0 | 0 | 0.074 | 0 | 0 | 0 | 132.026 |
| 1993 | 131.626 | 0.003 | 0 | 0 | 0 | 0.099 | 0 | 0 | 0 | 131.728 |
| 1994 | 131.303 | 0.004 | 0 | 0 | 0 | 0.124 | 0 | 0 | 0 | 131.430 |
| 1995 | 130.979 | 0.004 | 0 | 0 | 0 | 0.149 | 0 | 0 | 0 | 131.132 |
| 1996 | 130.656 | 0.005 | 0 | 0 | 0 | 0.174 | 0 | 0 | 0 | 130.835 |
| 1997 | 130.333 | 0.006 | 0 | 0 | 0 | 0.198 | 0 | 0 | 0 | 130.537 |
| 1998 | 130.009 | 0.006 | 0 | 0 | 0 | 0.223 | 0 | 0 | 0 | 130.239 |
| 1999 | 129.686 | 0.007 | 0 | 0 | 0 | 0.248 | 0 | 0 | 0 | 129.941 |
| 2000 | 129.362 | 0.008 | 0 | 0 | 0 | 0.273 | 0 | 0 | 0 | 129.643 |
| 2001 | 128.953 | 0.009 | 0 | 0 | 0.088 | 0.273 | 0 | 0 | 0 | 129.322 |
| 2002 | 128.543 | 0.010 | 0 | 0 | 0.175 | 0.273 | 0 | 0 | 0 | 129.001 |
| 2003 | 128.134 | 0.011 | 0 | 0 | 0.263 | 0.273 | 0 | 0 | 0 | 128.681 |
| 2004 | 127.724 | 0.013 | 0 | 0 | 0.350 | 0.273 | 0 | 0 | 0 | 128.360 |
| 2005 | 127.315 | 0.014 | 0 | 0 | 0.438 | 0.273 | 0 | 0 | 0 | 128.039 |
| 2006 | 126.905 | 0.015 | 0 | 0 | 0.525 | 0.273 | 0 | 0 | 0 | 127.718 |
| 2007 | 126.828 | 0.026 | 0 | 0 | 0.525 | 0.273 | 0 | 0.001 | 0 | 127.654 |
| 2008 | 126.750 | 0.038 | 0 | 0 | 0.525 | 0.273 | 0 | 0.002 | 0 | 127.589 |
| 2009 | 126.673 | 0.050 | 0 | 0 | 0.525 | 0.273 | 0 | 0.003 | 0 | 127.524 |
| 2010 | 126.621 | 0.061 | 0 | 0 | 0.525 | 0.248 | 0 | 0.004 | 0 | 127.459 |
| 2011 | 126.569 | 0.071 | 0 | 0 | 0.525 | 0.223 | 0 | 0.005 | 0 | 127.395 |
| 2012 | 126.517 | 0.082 | 0 | 0 | 0.525 | 0.198 | 0 | 0.007 | 0 | 127.330 |
| 2013 | 126.471 | 0.111 | 0 | 0.010 | 0.525 | 0.177 | 0 | 0.007 | 0 | 127.301 |
| 2014 | 126.424 | 0.140 | 0 | 0.020 | 0.525 | 0.156 | 0 | 0.007 | 0 | 127.272 |
| 2015 | 126.378 | 0.169 | 0 | 0.029 | 0.525 | 0.136 | 0 | 0.007 | 0 | 127.244 |
| 2016 | 126.332 | 0.198 | 0 | 0.039 | 0.525 | 0.115 | 0 | 0.007 | 0 | 127.215 |
| 2017 | 126.285 | 0.226 | 0 | 0.049 | 0.525 | 0.094 | 0 | 0.007 | 0 | 127.186 |
| 2018 | 126.239 | 0.255 | 0 | 0.059 | 0.525 | 0.073 | 0 | 0.007 | 0 | 127.157 |
| 2019 | 126.192 | 0.284 | 0 | 0.068 | 0.525 | 0.052 | 0 | 0.007 | 0 | 127.129 |
| 2020 | 126.146 | 0.313 | 0 | 0.078 | 0.525 | 0.031 | 0 | 0.007 | 0 | 127.100 |
| 2021 | 126.163 | 0.341 | 0 | 0.088 | 0.438 | 0.035 | 0 | 0.007 | 0 | 127.071 |
| 2022 | 126.179 | 0.370 | 0 | 0.098 | 0.350 | 0.039 | 0 | 0.007 | 0 | 127.042 |
| 2023 | 126.196 | 0.398 | 0 | 0.107 | 0.263 | 0.042 | 0 | 0.007 | 0 | 127.014 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

**Table 6.11. Areas of land remaining in the same land use subcategory (woody cropland remaining woody cropland) and of land converted to woody cropland from other land-use sub-categories.**

| Year | Woody cropland remaining woody cropland | Land converted to woody cropland from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Annua l CL | Broad. FL | Conif . FL | Grass GL | Woody GL | WL | SL | OL | |
| | kha | | | | | | | | | |
| 1990 | 123.514 | 0.137 | 0 | 0 | 0 | 0.002 | 0 | 0 | 0 | 123.653 |
| 1991 | 123.504 | 0.274 | 0 | 0 | 0 | 0.004 | 0 | 0 | 0 | 123.782 |
| 1992 | 123.495 | 0.411 | 0 | 0 | 0 | 0.006 | 0 | 0 | 0 | 123.912 |
| 1993 | 123.486 | 0.548 | 0 | 0 | 0 | 0.008 | 0 | 0 | 0 | 124.041 |
| 1994 | 123.477 | 0.685 | 0 | 0 | 0 | 0.010 | 0 | 0 | 0 | 124.171 |
| 1995 | 123.467 | 0.821 | 0 | 0 | 0 | 0.012 | 0 | 0 | 0 | 124.300 |
| 1996 | 123.458 | 0.958 | 0 | 0 | 0 | 0.014 | 0 | 0 | 0 | 124.430 |
| 1997 | 123.449 | 1.095 | 0 | 0 | 0 | 0.016 | 0 | 0 | 0 | 124.560 |
| 1998 | 123.439 | 1.232 | 0 | 0 | 0 | 0.018 | 0 | 0 | 0 | 124.689 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1999 | 123.430 | 1.369 | 0 | 0 | 0 | 0.020 | 0 | 0 | 0 | 124.819 |
| 2000 | 123.421 | 1.506 | 0 | 0 | 0 | 0.022 | 0 | 0 | 0 | 124.948 |
| 2001 | 123.024 | 1.598 | 0 | 0 | 0.007 | 0.087 | 0 | 0.036 | 0 | 124.752 |
| 2002 | 122.627 | 1.689 | 0 | 0 | 0.014 | 0.153 | 0 | 0.073 | 0 | 124.555 |
| 2003 | 122.230 | 1.781 | 0 | 0 | 0.020 | 0.219 | 0 | 0.109 | 0 | 124.359 |
| 2004 | 121.833 | 1.872 | 0 | 0 | 0.027 | 0.284 | 0 | 0.145 | 0 | 124.162 |
| 2005 | 121.436 | 1.964 | 0 | 0.001 | 0.034 | 0.350 | 0 | 0.182 | 0 | 123.965 |
| 2006 | 121.038 | 2.055 | 0 | 0.001 | 0.041 | 0.416 | 0 | 0.218 | 0 | 123.769 |
| 2007 | 120.884 | 2.059 | 0 | 0.001 | 0.041 | 0.419 | 0 | 0.218 | 0 | 123.622 |
| 2008 | 120.730 | 2.063 | 0 | 0.001 | 0.041 | 0.422 | 0 | 0.218 | 0 | 123.475 |
| 2009 | 120.576 | 2.066 | 0 | 0.001 | 0.041 | 0.426 | 0 | 0.218 | 0 | 123.328 |
| 2010 | 120.560 | 1.933 | 0 | 0.001 | 0.041 | 0.427 | 0 | 0.218 | 0 | 123.180 |
| 2011 | 120.545 | 1.800 | 0 | 0.001 | 0.041 | 0.429 | 0 | 0.218 | 0 | 123.033 |
| 2012 | 120.529 | 1.667 | 0 | 0.001 | 0.041 | 0.430 | 0 | 0.218 | 0 | 122.886 |
| 2013 | 120.567 | 1.534 | 0 | 0.010 | 0.041 | 0.438 | 0 | 0.218 | 0.003 | 122.811 |
| 2014 | 120.605 | 1.402 | 0 | 0.018 | 0.042 | 0.447 | 0 | 0.218 | 0.005 | 122.737 |
| 2015 | 120.642 | 1.269 | 0 | 0.027 | 0.042 | 0.455 | 0 | 0.218 | 0.008 | 122.662 |
| 2016 | 120.680 | 1.136 | 0 | 0.036 | 0.042 | 0.464 | 0 | 0.218 | 0.011 | 122.587 |
| 2017 | 120.718 | 1.003 | 0 | 0.045 | 0.043 | 0.472 | 0 | 0.218 | 0.014 | 122.512 |
| 2018 | 120.755 | 0.870 | 0 | 0.054 | 0.043 | 0.481 | 0 | 0.218 | 0.016 | 122.438 |
| 2019 | 120.793 | 0.738 | 0 | 0.062 | 0.043 | 0.489 | 0 | 0.218 | 0.019 | 122.363 |
| 2020 | 120.831 | 0.605 | 0 | 0.071 | 0.044 | 0.497 | 0 | 0.218 | 0.022 | 122.288 |
| 2021 | 120.930 | 0.518 | 0 | 0.080 | 0.037 | 0.442 | 0 | 0.182 | 0.024 | 122.213 |
| 2022 | 121.029 | 0.430 | 0 | 0.088 | 0.031 | 0.387 | 0 | 0.145 | 0.027 | 122.138 |
| 2023 | 121.129 | 0.343 | 0 | 0.097 | 0.024 | 0.332 | 0 | 0.109 | 0.030 | 122.064 |

The decreasing tendency in the area of cropland in Cyprus is consistent with international data provided, i.e., by the World Bank[62].

## 6.3.4. Methodological issues

The tier 1 method following the guidance contained in the 2006 IPCC Guidelines was applied due to the lack of national data (except activity data). In particular, all stock change factors are the default provided by the 2006 IPCC Guidelines.

**Annual cropland remaining annual cropland**

By definition this land-use category contains no woody vegetation. Due to the lack of data on changes in management in annual cropland, it is assumed that the management has remained constant since before 1990, hence the annual vegetation component does not affect the GHG sinks and sources on annual basis. It is further assumed that dead wood, litter and soil organic carbon stocks remain unchanged due to the lack of changes in the management of these lands.

Use of fire is not a part of management in lands classified as annual cropland.

**Land converted to annual cropland**

Lands converted to annual cropland are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. The tier 2 method was implemented to calculate carbon stock changes in living biomass (equation 2.15 of the 2006 IPCC guidelines) and the tier 1 method for the DOM and SOM mineral pools. It should be noted that in the current inventory, carbon stock changes in mineral soils in cropland remaining cropland associated with woody cropland conversions to annual cropland are reported for the first time.

Use of fire is not a part of management in lands classified as lands converted to annual cropland.

[62] http://www.factfish.com/statistic-country/cyprus/permanent+crops+area+of+total+area

**Woody cropland remaining woody cropland**

Woody cropland differs from annual cropland due to the presence of the woody vegetation (as detected using the CORINE land cover data). However, there is no national data on stock and net annual increment of this type of vegetation. Consequently, the default data provided in Table 5.1 of the 2006 IPCC Guidelines have been used in the GHG sink/source estimation for this land-use sub-category, namely 9 t C $ha^{-1}$ and 1.8 t C $ha^{-1}yr^{-1}$ for above-ground biomass carbon stock and biomass accumulation rate, respectively.

It is further assumed that dead wood, litter and soil organic carbon stocks remain unchanged due to the lack of changes in the management of these lands.

Use of fire is not a part of management in lands classified as woody cropland. Due to the lack of data it is assumed that wild fires do not occur in woody cropland (this assumption is further justified by the fact that woody vegetation is sparse in this land that prevents initiation and propagation of fire).

**Land converted to woody cropland**

Lands converted to woody cropland are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. The tier 2 method was implemented to calculate carbon stock changes in living biomass (equation 2.15 of the 2006 IPCC guidelines) and the tier 1 method for the DOM and SOM mineral pools. As explained previously, the DOM pool carbon stocks in all non-forest land-use categories were taken equal to zero. It should be noted that in the current inventory, carbon stock changes in mineral soils in cropland remaining cropland associated with annual cropland conversions to woody cropland are reported for the first time.

Use of fire is not a part of management in lands classified as lands converted to woody cropland.

**Organic carbon in soil**

For estimating carbon stock changes in both cropland remaining cropland and land converted to cropland, formulation B of equation 2.25 of the 2006 IPCC guidelines with the default 20 years transition period was applied. The 2006 IPCC default reference carbon stock for mineral soils and the stock change factors presented in section 6.2.4 were applied, which are also noted in table 6.12 below.

**Table 6.12. The IPCC default relative soil organic carbon stock change factors.**

| Sub-category | Carbon stock change factor | Description |
|---|---|---|
| Annual CL & woody CL | Reference $SOC_{REF}$ = 38 t C/ha | High activity soils in tropical dry climate |
| Annual CL | Land use $F_{LU}$= 0.58 | tropical dry moisture regime, long term annual cultivation |
| | Tillage $F_{MG}$= 1.0 | full level tillage |
| | Input $F_I$= 1.0 | medium level residue return for tropical dry climate |
| Woody CL | Land use $F_{LU}$= 1.0 | all temperature regimes, perennial tree crops |
| | Tillage $F_{MG}$= 1.0 | full level tillage |
| | Input $F_I$= 1.0 | medium level residue return for tropical dry climate |

**$N_2O$ emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils**

In the current submission, $N_2O$ emissions from N mineralization associated with mineral soil carbon loss as a result of land-use change to cropland are reported for the first time. These emissions are a consequence of the enhanced mineralisation (conversion to inorganic form) of soil organic matter (SOM) that normally takes place as a result of that conversion.

Both direct and indirect $N_2O$ emissions are reported following the tier 1 method of the 2006 IPCC guidelines with default emission factors. More specifically equations 11.1, 11.8 and 11.10 from chapter

11 were applied. The C/N ratio equal to 15 for forest land, grassland and settlements conversions to cropland, the emission factor (EF1) equal to 0.01 kg $N_2O$-N/kg N for direct $N_2O$ emissions, and the emission factor (EF5) equal to 0.0075 kg $N_2O$-N/kg N and the $Frac_{LEACH}$ equal to 0.3 for indirect $N_2O$ emissions are applied. $N_2O$ emissions from N mineralization occur due to land conversions to annual cropland only.

## 6.3.5. Uncertainties and time-series consistency

Uncertainties for the whole inventory period (1990-2023) have been assessed following the error propagation (approach 1) and equations 3.1, 3.2 contained in volume 1 of the 2006 IPCC guidelines. Input uncertainties related to activity data and emission factors have been assessed on the basis of information provided in the 2006 IPCC guidelines and country specific information.

The associated uncertainties with the input data for cropland remaining cropland and land converted to cropland are presented in table 6.9 above and in table 6.13.

**Table 6.13. Input data uncertainties.**

| Input data | % |
|---|---|
| EF1 (direct $N_2O$ from N mineralization) | 82 |
| EF5 (indirect $N_2O$ from leaching/run off) | 96 |
| $Frac_{LEACH}$ (indirect $N_2O$ from leaching/run off) | 78 |

The overall uncertainty for cropland land remaining cropland is equal to 67% for $CO_2$, while for land converted to cropland associated uncertainties equal to 96% and 176% for $CO_2$ and $N_2O$ emissions, respectively. A more detailed description of the results of the uncertainty analysis is reported in Annex 2.

The time series of GHG emissions/removals for the land-use categories cropland remaining cropland, land converted to annual cropland and land converted to woody cropland is presented in figure 6.5.

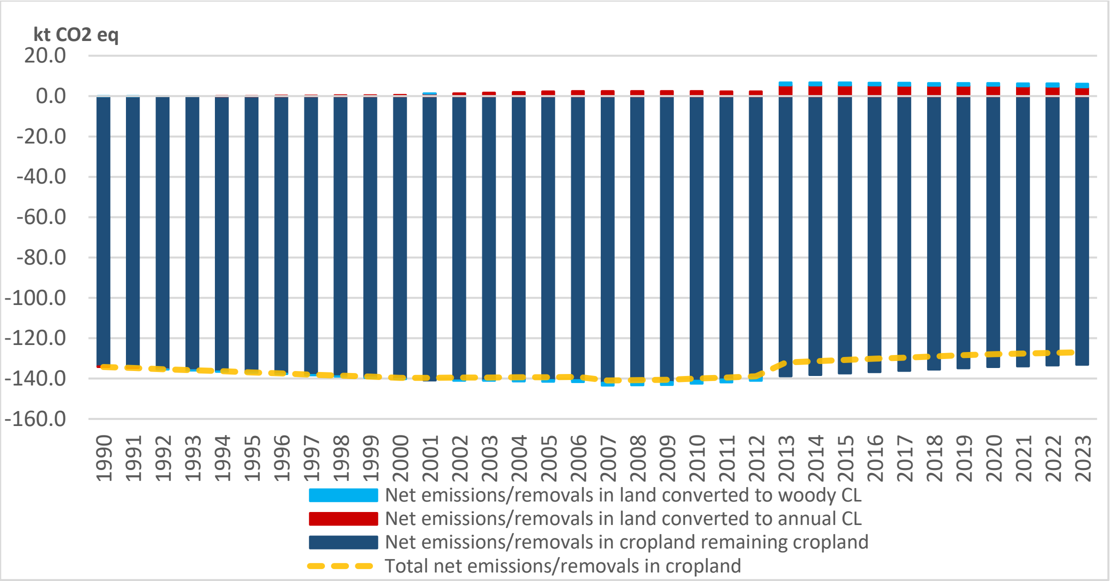

**Figure 6.5. Net emissions/removals in cropland category and its subcategories during the period 1990 – 2023 (note: indirect $N_2O$ emissions are included in the net emissions).**

### 6.3.6. Category-specific QA/QC and verification

See paragraph 6.2.6 above.

### 6.3.7. Category-specific recalculations

No recalculations were implemented.

### 6.3.8. Category-specific planned improvements

The improvements considered related to this category include:

- The applicability of default biomass data for woody cropland (stocks and growth) provided in the 2006 IPCC Guidelines should be further examined. In particular, the default data result in carbon stock changes comparable to those of forest land, which is unlikely for the national circumstances. Therefore, it is needed to either investigate options for developing national data or using regional data that represent more accurately the national circumstances.
- Investigate options for developing data on management and management changes in cropland areas (annual cropland and woody cropland), such as tillage and input application, rotation cycles, etc.
- Analyse further the CORINE data sets together with additional country data sources in order to refine equilibrium carbon stocks in mineral soils in cropland.

## 6.4. Grassland (4C)

### 6.4.1. Description

### 6.4.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The approach for representing land areas and land use databases is described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

### 6.4.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting".

Table 6.14 presents numerical data on the area of grass grassland remaining grass grassland and of land converted to grass grassland in the period 1990–2023. Note that no conversions from broadleaved forests, wetlands, settlements and other land to grass grassland occur during the whole inventory period.

**Table 6.14. Areas of land remaining in the same land use subcategory (grass grassland remaining grass grassland) and of land converted to grass grassland from other land-use sub-categories.**

| Year | Grass grassland remaining grass grassland | Land converted to grass grassland from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Woody GL | Broad. FL | Conif. FL | Annual CL | Woody CL | WL | SL | OL | |
| | kha | | | | | | | | | |
| 1990 | 24.451 | 0.040 | 0 | 0 | 0.132 | 0.000 | 0 | 0 | 0 | 24.623 |
| 1991 | 24.451 | 0.081 | 0 | 0 | 0.264 | 0.001 | 0 | 0 | 0 | 24.796 |
| 1992 | 24.451 | 0.121 | 0 | 0 | 0.395 | 0.001 | 0 | 0 | 0 | 24.968 |
| 1993 | 24.451 | 0.161 | 0 | 0 | 0.527 | 0.001 | 0 | 0 | 0 | 25.141 |
| 1994 | 24.451 | 0.202 | 0 | 0 | 0.659 | 0.002 | 0 | 0 | 0 | 25.313 |
| 1995 | 24.451 | 0.242 | 0 | 0 | 0.791 | 0.002 | 0 | 0 | 0 | 25.485 |
| 1996 | 24.451 | 0.282 | 0 | 0 | 0.923 | 0.002 | 0 | 0 | 0 | 25.658 |
| 1997 | 24.451 | 0.323 | 0 | 0 | 1.054 | 0.003 | 0 | 0 | 0 | 25.830 |
| 1998 | 24.451 | 0.363 | 0 | 0 | 1.186 | 0.003 | 0 | 0 | 0 | 26.003 |
| 1999 | 24.451 | 0.403 | 0 | 0 | 1.318 | 0.003 | 0 | 0 | 0 | 26.175 |
| 2000 | 24.451 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 26.348 |
| 2001 | 24.232 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 26.129 |
| 2002 | 24.012 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 25.909 |
| 2003 | 23.793 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 25.690 |
| 2004 | 23.574 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 25.471 |
| 2005 | 23.355 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 25.252 |
| 2006 | 23.135 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 25.032 |
| 2007 | 23.073 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 24.970 |
| 2008 | 23.011 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 24.908 |
| 2009 | 22.949 | 0.444 | 0 | 0 | 1.450 | 0.004 | 0 | 0 | 0 | 24.846 |
| 2010 | 23.059 | 0.403 | 0 | 0 | 1.318 | 0.003 | 0 | 0 | 0 | 24.783 |
| 2011 | 23.169 | 0.363 | 0 | 0 | 1.186 | 0.003 | 0 | 0 | 0 | 24.721 |
| 2012 | 23.279 | 0.323 | 0 | 0 | 1.054 | 0.003 | 0 | 0 | 0 | 24.659 |
| 2013 | 23.431 | 0.476 | 0 | 0.005 | 0.923 | 0.002 | 0 | 0 | 0 | 24.836 |
| 2014 | 23.582 | 0.629 | 0 | 0.010 | 0.791 | 0.002 | 0 | 0 | 0 | 25.014 |
| 2015 | 23.733 | 0.782 | 0 | 0.015 | 0.659 | 0.002 | 0 | 0 | 0 | 25.191 |
| 2016 | 23.884 | 0.936 | 0 | 0.020 | 0.527 | 0.001 | 0 | 0 | 0 | 25.369 |
| 2017 | 24.036 | 1.089 | 0 | 0.025 | 0.395 | 0.001 | 0 | 0 | 0 | 25.546 |
| 2018 | 24.187 | 1.242 | 0 | 0.030 | 0.264 | 0.001 | 0 | 0 | 0 | 25.724 |
| 2019 | 24.338 | 1.396 | 0 | 0.035 | 0.132 | 0 | 0 | 0 | 0 | 25.901 |
| 2020 | 24.489 | 1.549 | 0 | 0.040 | 0 | 0 | 0 | 0 | 0 | 26.078 |
| 2021 | 24.468 | 1.743 | 0 | 0.045 | 0 | 0 | 0 | 0 | 0 | 26.256 |
| 2022 | 24.447 | 1.936 | 0 | 0.050 | 0 | 0 | 0 | 0 | 0 | 26.433 |
| 2023 | 24.426 | 2.130 | 0 | 0.055 | 0 | 0 | 0 | 0 | 0 | 26.611 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

Table 6.15 presents the same information for the case of woody grassland for the period 1990–2023. Note that no conversions from broadleaved forests, wetlands and other land to woody grassland occur during the whole inventory period.

**Table 6.15. Areas of land remaining in the same land use subcategory (woody grassland remaining woody grassland) and of land converted to woody grassland from other land-use sub-categories.**

| Year | Woody grassland remaining woody grassland | Land converted to woody grassland from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Grass GL | Broad. FL | Conif . FL | Annua l CL | Woody CL | W L | SL | OL | |
| | kha | | | | | | | | | |
| 1990 | 106.959 | 0 | 0 | 0.000 | 0.035 | 0.003 | 0 | 0 | 0 | 106.997 |
| 1991 | 106.873 | 0 | 0 | 0.001 | 0.070 | 0.007 | 0 | 0 | 0 | 106.950 |
| 1992 | 106.787 | 0 | 0 | 0.001 | 0.105 | 0.010 | 0 | 0 | 0 | 106.903 |
| 1993 | 106.701 | 0 | 0 | 0.001 | 0.140 | 0.014 | 0 | 0 | 0 | 106.856 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 106.615 | 0 | 0 | 0.001 | 0.175 | 0.017 | 0 | 0 | 0 | 106.808 |
| 1995 | 106.529 | 0 | 0 | 0.002 | 0.209 | 0.021 | 0 | 0 | 0 | 106.761 |
| 1996 | 106.443 | 0 | 0 | 0.002 | 0.244 | 0.024 | 0 | 0 | 0 | 106.714 |
| 1997 | 106.357 | 0 | 0 | 0.002 | 0.279 | 0.028 | 0 | 0 | 0 | 106.667 |
| 1998 | 106.272 | 0 | 0 | 0.003 | 0.314 | 0.031 | 0 | 0 | 0 | 106.619 |
| 1999 | 106.186 | 0 | 0 | 0.003 | 0.349 | 0.034 | 0 | 0 | 0 | 106.572 |
| 2000 | 106.100 | 0 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0 | 0 | 106.525 |
| 2001 | 105.837 | 0 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0 | 0 | 106.263 |
| 2002 | 105.575 | 0 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0 | 0 | 106.000 |
| 2003 | 105.312 | 0 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0 | 0 | 105.738 |
| 2004 | 105.050 | 0 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0 | 0 | 105.475 |
| 2005 | 104.788 | 0 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0 | 0 | 105.213 |
| 2006 | 104.525 | 0 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0 | 0 | 104.950 |
| 2007 | 104.452 | 0.043 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0.006 | 0 | 104.927 |
| 2008 | 104.379 | 0.086 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0.013 | 0 | 104.903 |
| 2009 | 104.306 | 0.129 | 0 | 0.003 | 0.384 | 0.038 | 0 | 0.019 | 0 | 104.879 |
| 2010 | 104.272 | 0.171 | 0 | 0.003 | 0.349 | 0.034 | 0 | 0.025 | 0 | 104.855 |
| 2011 | 104.238 | 0.214 | 0 | 0.003 | 0.314 | 0.031 | 0 | 0.032 | 0 | 104.832 |
| 2012 | 104.203 | 0.257 | 0 | 0.002 | 0.279 | 0.028 | 0 | 0.038 | 0 | 104.808 |
| 2013 | 103.967 | 0.278 | 0 | 0.002 | 0.244 | 0.036 | 0 | 0.038 | 0 | 104.566 |
| 2014 | 103.731 | 0.299 | 0 | 0.002 | 0.209 | 0.044 | 0 | 0.038 | 0 | 104.323 |
| 2015 | 103.495 | 0.320 | 0 | 0.001 | 0.175 | 0.052 | 0 | 0.038 | 0 | 104.081 |
| 2016 | 103.259 | 0.340 | 0 | 0.001 | 0.140 | 0.060 | 0 | 0.038 | 0 | 103.839 |
| 2017 | 103.023 | 0.361 | 0 | 0.001 | 0.105 | 0.069 | 0 | 0.038 | 0 | 103.596 |
| 2018 | 102.787 | 0.382 | 0 | 0.001 | 0.070 | 0.077 | 0 | 0.038 | 0 | 103.354 |
| 2019 | 102.551 | 0.403 | 0 | 0.000 | 0.035 | 0.085 | 0 | 0.038 | 0 | 103.112 |
| 2020 | 102.315 | 0.424 | 0 | 0 | 0 | 0.093 | 0 | 0.038 | 0 | 102.870 |
| 2021 | 102.040 | 0.444 | 0 | 0 | 0 | 0.105 | 0 | 0.038 | 0 | 102.627 |
| 2022 | 101.765 | 0.465 | 0 | 0 | 0 | 0.117 | 0 | 0.038 | 0 | 102.385 |
| 2023 | 101.490 | 0.486 | 0 | 0 | 0 | 0.128 | 0 | 0.038 | 0 | 102.143 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

### 6.4.4. Methodological issues

A combination of tier 1 and tier 2 methods with country-specific information and default data following the guidance contained in the 2006 IPCC guidelines is applied in the grassland category.

**Grass grassland remaining grass grassland**

By definition this land-use category contains no woody vegetation, therefore biomass carbon stocks are taken equal to zero, and following the tier 1 method, carbon stock changes are assumed to be zero. The tier 1 method is applied for the DOM pool, thus carbon stock changes in litter and dead wood pools are considered to be zero. Regarding the SOM mineral pool, grassland areas in Cyprus do not experience significant management changes, consequently, carbon stock changes are assumed to be zero without introducing significant error.

The use of fire is not a part of management in lands classified as grass grassland.

**Land converted to grass grassland**

Lands converted to grass grassland are subject to changes in biomass when the land before the conversion had woody vegetation, dead wood, litter and soil organic carbon. The tier 2 method is implemented to calculate carbon stock changes in living biomass (equation 2.15 of the 2006 IPCC guidelines) and the tier 1 method for the DOM and SOM mineral pools. The living biomass carbon stocks of grass grassland after the conversion is taken equal to zero, and in the cases where woody vegetation existed in the previous land-use category (e.g., forest land), carbon stock changes are estimated by accounting the loss of total biomass stocks in the year of conversion. The total carbon loss in the year of conversion is applied in the DOM pool as well, where in the previous land-use category the DOM pool was not zero (e.g. forest land). It is noted, that in this submission dead wood carbon stock changes due to forest land conversion to grass grassland are estimated for the first time. Regarding the SOM pool, in the particular case of changes between grass grassland and woody grassland, carbon stock changes are estimated to be equal to zero since both sub-categories are associated with the same carbon stock equilibrium levels (i.e. 38 t C/ha). With regard to carbon stock changes in SOM in land-use conversions to grass grassland other than from woody grassland, these are estimated using the tier 1 method from 2006 IPCC guidelines by applying formulation B of equation 2.25 of the 2006 IPCC guidelines with the default 20 years transition period and the reference carbon stocks and stock change factors that have already been presented in section 6.2.4 and 6.3.4 for the respective land-use categories.

Use of fire is not a part of management in lands classified as lands converted to grass grassland.

**Woody grassland remaining woody grassland**

Woody grassland differs from the grass grassland due to the presence of the woody vegetation (as detected using the CORINE land cover data). A country-specific net annual increment value is applied in estimating carbon stock changes in living biomass equal to 0.2 $m^3 ha^{-1} yr^{-1}$ (for *Quercus alnifolia*) with default $BCEF_I$ (0.5 for hardwoods related to 21-40 growing stock level) and root-shoot ratio (i.e., 0.28) values. The tier 1 method is applied for the DOM pool, thus carbon stock changes in litter and dead wood pools are considered to be zero. Regarding the SOM mineral pools, grassland areas in Cyprus do not experience significant management changes, consequently, carbon stock changes are assumed to be zero.

Use of fire is not a part of management in lands classified as woody grassland. Furthermore, due to the lack of data, it is further assumed that wild fires do not occur on woody grassland (this assumption is further justified by the fact that woody vegetation is sparse in this land that prevents initiation and propagation of fire).

**Land converted to woody grassland**

Lands converted to woody grassland are subject to changes in biomass when the land before the conversion had woody vegetation, dead wood, litter and soil organic carbon. The tier 2 method is implemented to calculate carbon stock changes in living biomass (equation 2.15 of the 2006 IPCC guidelines) and the tier 1 method for the DOM and SOM mineral pools. In the cases where woody vegetation existed in the previous land-use category (e.g., forest land), carbon stock changes are estimated by accounting the loss of total biomass stocks in the year of conversion. The total carbon loss in the year of conversion is applied in the DOM pool as well, where in the previous land-use category the DOM pool was not zero (e.g. forest land). It is noted, that in this submission dead wood carbon stock changes due to forest land conversion to woody grassland are estimated for the first time. Regarding the SOM pool, in the particular case of changes between grass grassland and woody grassland, carbon stock changes are estimated to be equal to zero since both sub-categories are associated with the same carbon stock equilibrium levels (i.e. 38 t C/ha). With regard to carbon stock changes in SOM in land-use conversions to woody grassland other than from grass grassland, these are estimated using the tier 1 method from 2006 IPCC guidelines by applying formulation B of equation 2.25 of the 2006 IPCC guidelines with the default 20 years transition period and the reference carbon stocks and stock change factors that have already been presented in section 6.2.4 and 6.3.4 for the respective land-use categories

Use of fire is not a part of management in lands classified as lands converted to woody grassland.

## 6.4.5. Uncertainties and time-series consistency

Uncertainties for the whole inventory period (1990-2023) have been assessed following the error propagation (approach 1) and equations 3.1, 3.2 contained in volume 1 of the 2006 IPCC guidelines. Input uncertainties related to activity data and emission factors have been assessed on the basis of information provided in the 2006 IPCC guidelines and country specific information.

The associated uncertainties with the input data for grassland remaining grassland and land converted to grassland are presented in table 6.9 above.

The overall uncertainty for grassland remaining grassland is equal to 38% for $CO_2$, while for land converted to grassland associated uncertainties equal to 52% for $CO_2$. A more detailed description of the results of the uncertainty analysis is reported in Annex 2.

Figure 6.6 presents the emissions/removals time series for the grassland category for the period 1990–2023.

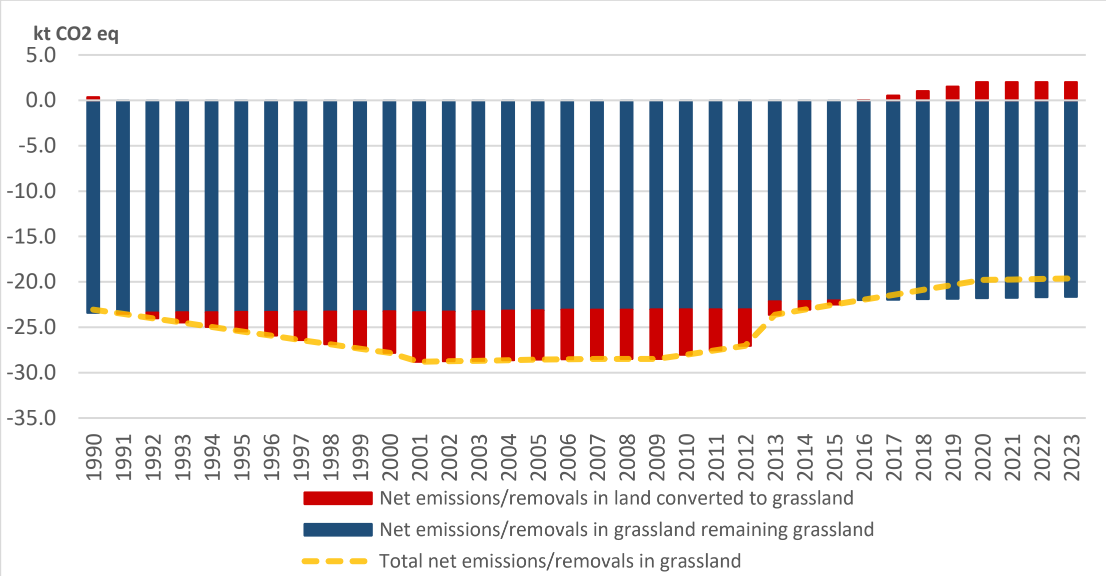


**Figure 6.6. Net emissions/removals in grassland remaining grassland and land converted to grassland subcategories during the period 1990 – 2023**

## 6.4.6. Category-specific QA/QC and verification

See paragraph 6.2.6 above.

## 6.4.7. Category-specific recalculations

No recalculations were implemented.

## 6.4.8. Category-specific planned improvements

The improvements considered related to this category include:

- Continue the land monitoring for detecting fires that may affect areas with woody grassland vegetation.
- Investigate further the net annual increment for woody grassland by exploring additional data sources.

## 6.5. Wetlands (4D)

### 6.5.1. Description[63]

Even though many wetlands in Cyprus are known to the public and can be visited, information about their condition and their total number was, until recently, scattered or even non-existent. In order to tackle this lack of knowledge and decentralised information, Terra Cypria, a local environmental NGO[64], conducted a complete Inventory of Cyprus Wetlands[65] using a Rapid Assessment methodology during a two-year period (2014–2015). This effort was funded by the MAVA Fondation pour la Nature. During the course of the project, all wetlands in Cyprus with an area >1.000 $m^2$ (0.1 ha) were visited and recorded – with the exception of those located within military zones, which were included in the inventory but not visited. The total number of 373 areas have been identified as meeting the qualification criteria set for wetlands outlined in the RAMSAR Convention and MedWet's guidelines; 315 wetlands are artificial and 58 natural (Figure 6.7).
Many of the island's wetlands are in continuous degradation, facing various pressures. The main causes that have been identified leading to degradation according to the team that conducted the research were: i) development pressures from the housing and tourist industry (especially on coastal areas), ii) dam construction halting water supply at downstream wetlands, iii) lack of specific legislation targeting the protection of wetland biodiversity, iv) unsatisfactory implementation of existing legislation which offers direct or indirect protection at specific wetlands and v) lack of knowledge from some government departments and citizens regarding the presence, importance and value of wetlands.

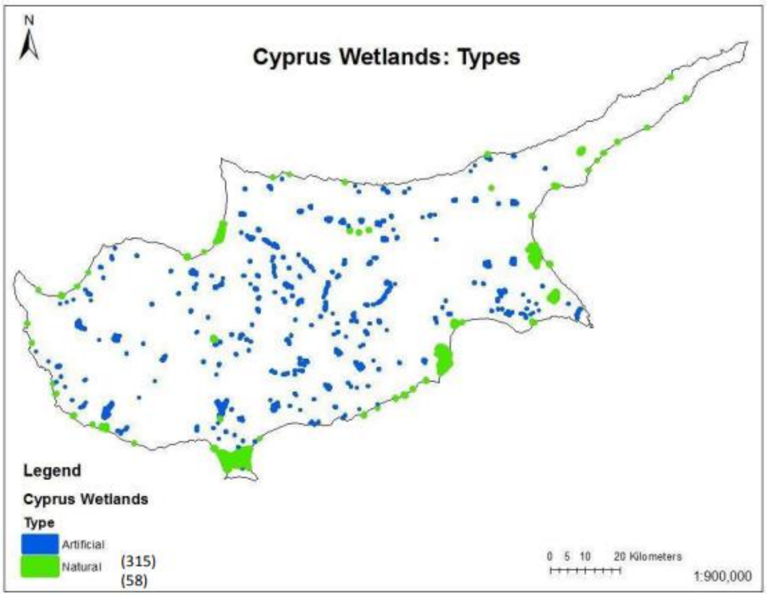


**Figure 6.7. Map of Cyprus, indicating the 373 wetlands identified and studied during the "Inventory of Cyprus Wetlands" project.**

Most of the natural wetlands are estuaries (68%) followed by marsh/swamps (16%). The rest of the natural wetlands (16%) are divided in four categories including wetlands systems, lakes, salt lakes and lagoons (Figure 6.8).

Almost half of artificial wetlands (48%) are river recharge barriers and reservoirs. One third (28%) are ponds (earth or concrete made). The rest of the artificial wetlands (24%) are divided into seven categories

[63] Zotos S., L. Sergides, A. Papatheodoulou; 2019. Conservation of the Island Wetlands of the Mediterranean Basin "Mediterranean Island Wetlands" project; The wetlands of Cyprus technical report; available on https://mava-foundation.org/wp-content/uploads/2020/07/Final-Inventory-Report-final-20.3.20-3-compressed.pdf (accessed 14/2/2021)
[64] https://terracypria.org/
[65] www.cypruswetlands.org

including mine ponds, membrane covered ponds, quarry ponds, tertiary treated waters, off-stream ponds, excavations ponds and wastewater treatment pools (figure 6.9).

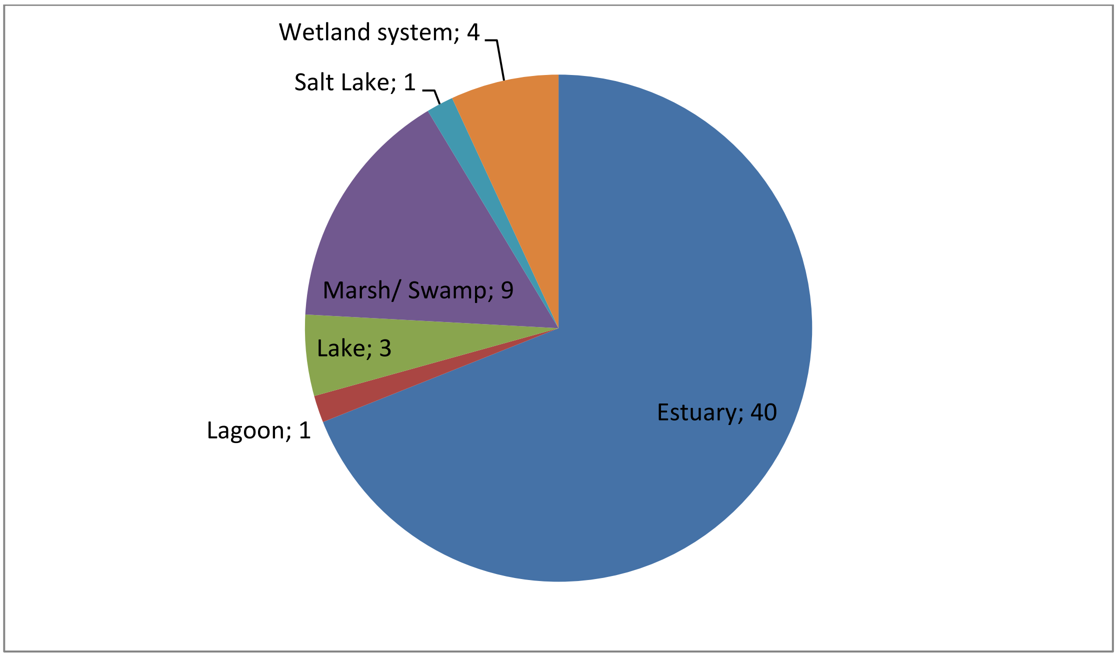


**Figure 6.8. Categories of natural wetlands in Cyprus**

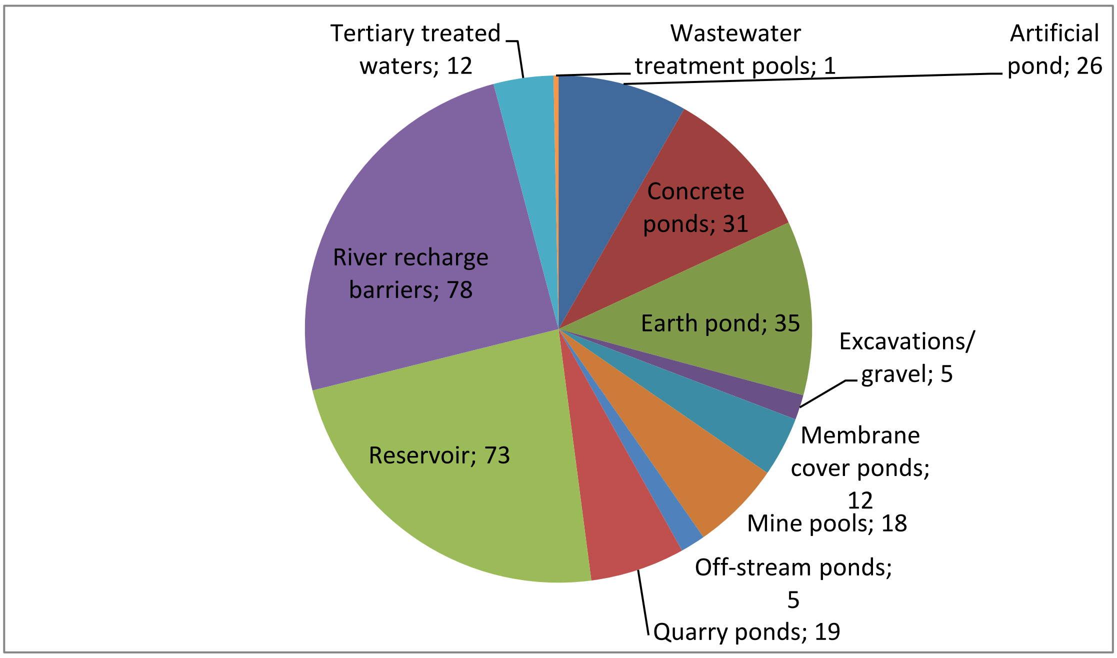


**Figure 6.9. Categories of artificial wetlands in Cyprus**

## 6.5.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases are described in Chapter 6.1.1 “Information on approaches used for representing land areas and on land-use databases used for the inventory preparation”.

## 6.5.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting".

Table 6.16 provides data on area of wetlands remaining wetlands and of lands converted to wetlands during the period 1990–2023.

**Table 6.16. Areas of land remaining in the same land use subcategory (wetlands remaining wetlands) and of land converted to wetlands from other land-use sub-categories.**

| Year | Wetlands remaining wetlands | Land converted to wetlands from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Broad. FL | Conif. FL | Annual CL | Woody CL | Grass GL | Woody GL | SL | OL | |
| | kha | | | | | | | | | |
| 1990 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1991 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1992 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1993 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1994 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1995 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1996 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1997 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1998 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 1999 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 2000 | 3.977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.977 |
| 2001 | 3.975 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.975 |
| 2002 | 3.972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.972 |
| 2003 | 3.970 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.970 |
| 2004 | 3.968 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.968 |
| 2005 | 3.966 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.966 |
| 2006 | 3.963 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.963 |
| 2007 | 3.957 | 0 | 0.006 | 0 | 0 | 0 | 0 | 0.009 | 0 | 3.972 |
| 2008 | 3.951 | 0 | 0.012 | 0 | 0 | 0 | 0 | 0.017 | 0 | 3.980 |
| 2009 | 3.945 | 0 | 0.018 | 0 | 0 | 0 | 0 | 0.026 | 0 | 3.989 |
| 2010 | 3.939 | 0 | 0.024 | 0 | 0 | 0 | 0 | 0.034 | 0 | 3.997 |
| 2011 | 3.933 | 0 | 0.030 | 0 | 0 | 0 | 0 | 0.043 | 0 | 4.005 |
| 2012 | 3.927 | 0 | 0.036 | 0 | 0 | 0 | 0 | 0.052 | 0 | 4.014 |
| 2013 | 3.927 | 0 | 0.041 | 0 | 0 | 0 | 0.001 | 0.053 | 0 | 4.021 |
| 2014 | 3.927 | 0 | 0.046 | 0 | 0 | 0 | 0.001 | 0.054 | 0 | 4.028 |
| 2015 | 3.927 | 0 | 0.051 | 0 | 0 | 0 | 0.002 | 0.055 | 0 | 4.035 |
| 2016 | 3.927 | 0 | 0.057 | 0 | 0 | 0 | 0.003 | 0.056 | 0 | 4.042 |
| 2017 | 3.927 | 0 | 0.062 | 0 | 0 | 0 | 0.004 | 0.057 | 0 | 4.049 |
| 2018 | 3.927 | 0 | 0.067 | 0 | 0 | 0 | 0.004 | 0.058 | 0 | 4.056 |
| 2019 | 3.927 | 0 | 0.073 | 0 | 0 | 0 | 0.005 | 0.059 | 0 | 4.063 |
| 2020 | 3.927 | 0 | 0.078 | 0 | 0 | 0 | 0.006 | 0.059 | 0 | 4.070 |
| 2021 | 3.927 | 0 | 0.083 | 0 | 0 | 0 | 0.006 | 0.060 | 0 | 4.077 |
| 2022 | 3.927 | 0 | 0.088 | 0 | 0 | 0 | 0.007 | 0.061 | 0 | 4.084 |
| 2023 | 3.927 | 0 | 0.094 | 0 | 0 | 0 | 0.008 | 0.062 | 0 | 4.091 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

## 6.5.4. Methodological issues

**Wetlands remaining wetlands**

In Cyprus, peat extraction does not occur.

2006 IPCC guidelines do not provide methodologies for estimating emissions/removals from wetlands remaining wetlands (other than peat extraction), thus associated emissions and removals have not been estimated and in this context the 'NE' notation key is used in CRT table 4.D for all carbon pools and relevant information is reported in CRT table 9.

**Land converted to wetlands**

For lands converted wetlands, the 2006 IPCC guidelines provide methodology for estimating carbon stock changes only in the living biomass pool, when land is converted to flooded land. The tier 1 method is followed, with the living biomass carbon stocks after the conversion assumed to be zero, and in the cases where woody vegetation existed in the previous land-use category (e.g., forest land), carbon stock changes are estimated by accounting a total loss of biomass stocks in the year of conversion.

For the DOM, and SOM mineral pools, the 2006 IPCC guidelines do not provide methodologies for estimating associated emissions/removals thus the 'NE' notation key is used in CRT table 4.D for these carbon pools and relevant information is reported in CRT table 9.

## 6.5.5. Uncertainties and time-series consistency

Uncertainties for the whole inventory period (1990-2023) have been assessed following the error propagation (approach 1) and equations 3.1, 3.2 contained in volume 1 of the 2006 IPCC guidelines. Input uncertainties related to activity data and emission factors have been assessed on the basis of information provided in the 2006 IPCC guidelines and country specific information.

The associated uncertainties with the input data for land converted to wetlands are presented in table 6.9 above.

The overall uncertainty for land converted to wetlands is equal to 52% for $CO_2$. A more detailed description of the results of the uncertainty analysis is reported in Annex 2.

Figure 6.10 presents the total net emissions/removals time series for the land converted to wetlands for the period 1990–2023.

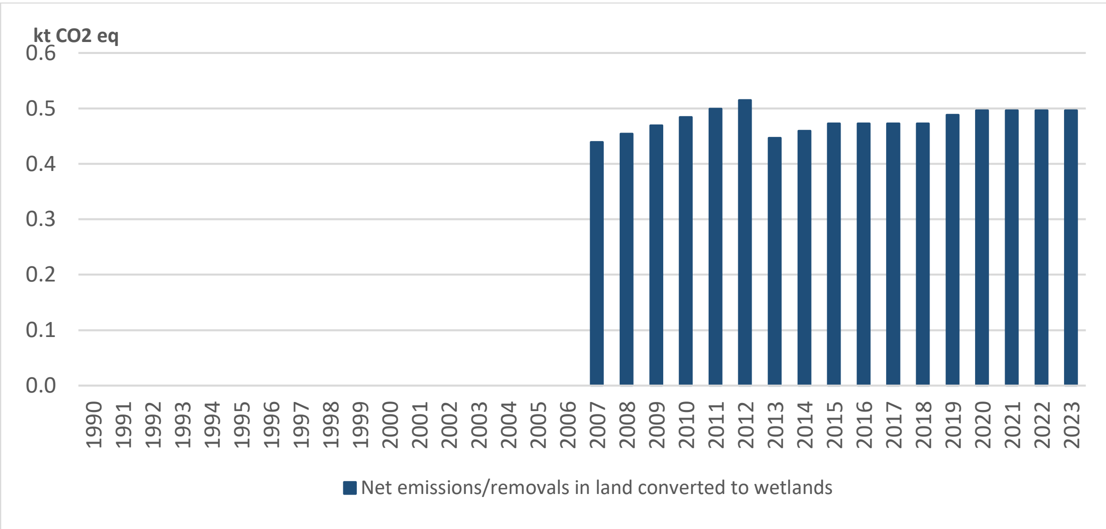


**Figure 6.10. Net emissions/removals in land converted to wetlands during the period 1990 – 2023.**

## 6.5.6. Category-specific QA/QC and verification

See para 6.2.6 above.

## 6.5.7. Category-specific recalculations

No recalculations were implemented.

## 6.5.8. Category-specific planned improvements

There are not any improvements planned for this category.

# 6.6. Settlements (4E)

## 6.6.1. Description

## 6.6.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

## 6.6.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting". Table 6.17 provides data on area of settlements remaining settlements and lands converted to settlements during the period 1990–2023.

**Table 6.17.Areas of land remaining in the same land use subcategory (settlements remaining settlements) and of land converted to settlements from other land-use sub-categories.**

| Year | Settlements remaining settlements | Land converted to settlements from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Broad. FL | Conif. FL | Annual CL | Woody CL | Grass GL | Woody GL | WL | OL | |
| | kha | | | | | | | | | |
| 1990 | 48.871 | 0 | 0 | 0.019 | 0.003 | 0 | 0.008 | 0 | 0 | 48.902 |
| 1991 | 48.871 | 0 | 0 | 0.039 | 0.005 | 0 | 0.016 | 0 | 0 | 48.932 |
| 1992 | 48.871 | 0 | 0 | 0.058 | 0.008 | 0 | 0.024 | 0 | 0 | 48.962 |
| 1993 | 48.871 | 0 | 0 | 0.078 | 0.011 | 0 | 0.033 | 0 | 0 | 48.992 |
| 1994 | 48.871 | 0 | 0 | 0.097 | 0.014 | 0 | 0.041 | 0 | 0 | 49.023 |
| 1995 | 48.871 | 0 | 0 | 0.117 | 0.016 | 0 | 0.049 | 0 | 0 | 49.053 |
| 1996 | 48.871 | 0 | 0 | 0.136 | 0.019 | 0 | 0.057 | 0 | 0 | 49.083 |
| 1997 | 48.871 | 0 | 0 | 0.155 | 0.022 | 0 | 0.065 | 0 | 0 | 49.113 |
| 1998 | 48.871 | 0 | 0 | 0.175 | 0.024 | 0 | 0.073 | 0 | 0 | 49.144 |
| 1999 | 48.871 | 0 | 0 | 0.194 | 0.027 | 0 | 0.081 | 0 | 0 | 49.174 |
| 2000 | 48.871 | 0 | 0 | 0.214 | 0.030 | 0 | 0.089 | 0 | 0 | 49.204 |
| 2001 | 48.810 | 0.001 | 0.008 | 0.532 | 0.426 | 0.117 | 0.286 | 0.002 | 0 | 50.183 |
| 2002 | 48.749 | 0.003 | 0.017 | 0.850 | 0.821 | 0.234 | 0.483 | 0.005 | 0 | 51.161 |
| 2003 | 48.688 | 0.004 | 0.025 | 1.168 | 1.217 | 0.350 | 0.680 | 0.007 | 0 | 52.139 |
| 2004 | 48.627 | 0.005 | 0.034 | 1.486 | 1.613 | 0.467 | 0.877 | 0.009 | 0 | 53.118 |
| 2005 | 48.566 | 0.006 | 0.042 | 1.804 | 2.009 | 0.584 | 1.073 | 0.011 | 0 | 54.096 |
| 2006 | 48.505 | 0.008 | 0.051 | 2.122 | 2.405 | 0.701 | 1.270 | 0.014 | 0 | 55.075 |
| 2007 | 48.470 | 0.008 | 0.051 | 2.195 | 2.548 | 0.718 | 1.340 | 0.020 | 0 | 55.350 |
| 2008 | 48.435 | 0.008 | 0.051 | 2.269 | 2.690 | 0.736 | 1.409 | 0.026 | 0 | 55.624 |
| 2009 | 48.400 | 0.008 | 0.051 | 2.343 | 2.833 | 0.754 | 1.479 | 0.032 | 0 | 55.899 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 48.396 | 0.008 | 0.051 | 2.397 | 2.973 | 0.771 | 1.540 | 0.038 | 0 | 56.174 |
| 2011 | 48.391 | 0.008 | 0.051 | 2.451 | 3.113 | 0.789 | 1.602 | 0.044 | 0 | 56.448 |
| 2012 | 48.387 | 0.008 | 0.051 | 2.505 | 3.253 | 0.806 | 1.663 | 0.050 | 0 | 56.723 |
| 2013 | 48.404 | 0.008 | 0.051 | 2.550 | 3.264 | 0.806 | 1.696 | 0.050 | 0 | 56.829 |
| 2014 | 48.421 | 0.008 | 0.051 | 2.594 | 3.275 | 0.806 | 1.729 | 0.050 | 0 | 56.934 |
| 2015 | 48.438 | 0.008 | 0.051 | 2.639 | 3.287 | 0.806 | 1.762 | 0.050 | 0 | 57.040 |
| 2016 | 48.455 | 0.008 | 0.051 | 2.684 | 3.298 | 0.806 | 1.795 | 0.050 | 0 | 57.146 |
| 2017 | 48.471 | 0.008 | 0.051 | 2.728 | 3.309 | 0.806 | 1.828 | 0.050 | 0 | 57.252 |
| 2018 | 48.488 | 0.008 | 0.051 | 2.773 | 3.320 | 0.806 | 1.860 | 0.050 | 0 | 57.357 |
| 2019 | 48.505 | 0.008 | 0.051 | 2.817 | 3.331 | 0.806 | 1.893 | 0.050 | 0 | 57.463 |
| 2020 | 48.522 | 0.008 | 0.051 | 2.862 | 3.343 | 0.806 | 1.926 | 0.050 | 0 | 57.569 |
| 2021 | 49.549 | 0.006 | 0.042 | 2.608 | 2.961 | 0.689 | 1.771 | 0.048 | 0 | 57.674 |
| 2022 | 50.575 | 0.005 | 0.034 | 2.354 | 2.579 | 0.573 | 1.615 | 0.046 | 0 | 57.780 |
| 2023 | 51.601 | 0.004 | 0.025 | 2.100 | 2.197 | 0.456 | 1.459 | 0.044 | 0 | 57.886 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

## 6.6.4. Methodological issues

In Cypriot conditions the settlements land-use category contains all developed land, including transportation infrastructure and human settlements of any size. In particular, it contains: industrial and commercial units, urban areas, port areas, airports, construction, mineral extraction and waste dump sites. Urban areas contain densely and sparsely populated areas (e.g. cities and villages). The category also includes lands covered with woody vegetation typical for inhabited areas that were not classified as forest, woody cropland and woody grassland. It also includes lands containing annual vegetation present in urban areas.

**Settlements remaining settlements**

The tier 1 assumption of the 2006 IPCC guidelines that carbon stock changes in living biomass, dead wood, litter and SOM mineral pools are zero is applied.

**Land converted to settlements**

Lands converted to settlements are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. The tier 2 method was implemented to calculate carbon stock changes in living biomass (equation 2.15 of the 2006 IPCC guidelines) and the tier 1 method for the DOM and SOM mineral pools. It should be noted that in the current inventory, carbon stocks in dead wood and litter in settlements after the conversion are taken equal to zero. Furthermore, both the living biomass and DOM stocks that were present before the conversion are assumed to be totally lost in the year of conversion as a result of the land-use change.

For estimating carbon stock changes in SOM mineral, formulation B of equation 2.25 of the 2006 IPCC guidelines with the default 20 years transition period was applied. In the current inventory, the carbon stock equilibrium level of settlements is taken equal to 80% of the reference carbon stocks, following the tier 1 assumption, while in the previous inventories the 83.4% of the reference carbon stocks was applied based on assumptions. However, until further analysis is done on these assumptions, it has been decided to use the tier 1 value instead. The stock change factors that are applied for the respective land-use categories converted to settlements are the ones presented in section 6.2.4.

Use of fire is not a part of management in lands classified as lands converted to settlements.

**$N_2O$ emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils**

In the current submission, $N_2O$ emissions from N mineralization associated with mineral soil carbon loss as a result of land-use change to settlements are reported for the first time. These emissions are a consequence of the enhanced mineralisation (conversion to inorganic form) of soil organic matter (SOM) that normally takes place as a result of that conversion.

Both direct and indirect $N_2O$ emissions are reported following the tier 1 method of the 2006 IPCC guidelines with default emission factors. More specifically equations 11.1, 11.8 and 11.10 from chapter 11 were applied. The C/N ratio equal to 15 for forest land and grassland conversions to settlements, the C/N ratio equal to 10 for cropland conversions to settlements, the emission factor (EF1) equal to 0.01 kg $N_2O$-N/kg N for direct $N_2O$ emissions, and the emission factor (EF5) equal to 0.0075 kg $N_2O$-N/kg N and the $Frac_{LEACH}$ equal to 0.3 for indirect $N_2O$ emissions are applied.

## 6.6.5. Uncertainties and time-series consistency

Uncertainties for the whole inventory period (1990-2023) have been assessed following the error propagation (approach 1) and equations 3.1, 3.2 contained in volume 1 of the 2006 IPCC guidelines. Input uncertainties related to activity data and emission factors have been assessed on the basis of information provided in the 2006 IPCC guidelines and country specific information.

The associated uncertainties with the input data for land converted to settlements are presented in table 6.9 and in table 6.13 above.

The overall uncertainty for land converted to settlements equals to 350% and 380% for $CO_2$ and $N_2O$ emissions, respectively. A more detailed description of the results of the uncertainty analysis is reported in Annex 2.

The time series of GHG emissions/removals for land converted to settlements is presented in figure 6.11.

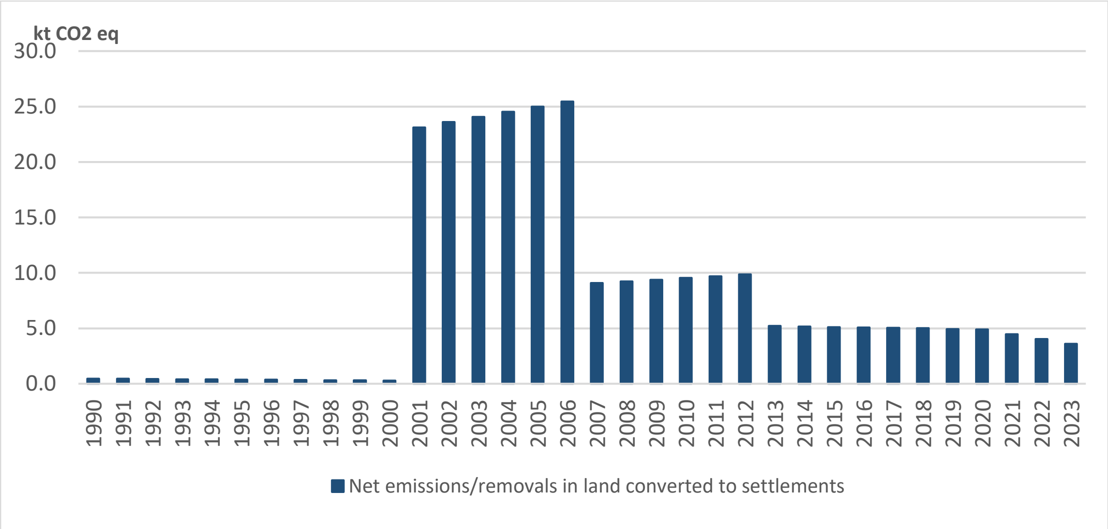


**Figure 6.11. Net emissions/removals in land converted to settlements during the period 1990 – 2023 (note: indirect $N_2O$ emissions are included in the net emissions)**

Figure 6.11 presents the total net emissions/removals time series for land converted to settlements during the period 1990–2023.

## 6.6.6. Category-specific QA/QC and verification

See para 6.2.6 above.

## 6.6.7. Category-specific recalculations

No recalculations were implemented.

## 6.6.8. Category-specific planned improvements

The improvements considered related to this category include:

- Investigate alternative data sources in order to refine the equilibrium carbon stocks in mineral soils in settlements.
- Investigate options for estimating carbon stock changes in living biomass in settlements remaining settlements and apply tier 2 of the 2006 IPCC guidelines.

# 6.7. Other land (4F)

## 6.7.1. Description

This land-use category includes bare soil, rock, beaches, dunes and sand plains and all land areas that couldn't be classified into any of the other five land-use categories by means of interpretation of the CORINE land cover data. It also allows the total of identified land areas to match the national area, i.e. to retain the entire Cyprus area unchanged among the reported years.

## 6.7.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

## 6.7.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting".

Table 6.18 presents numerical data on the area of other land remaining other land and of land converted to other land in the period 1990–2023.

**Table 6.18. Areas of land remaining in the same land use subcategory (other land remaining other land) and of land converted to other land from other land-use sub-categories.**

| Year | Other land remaining other land | Land converted to other land from: | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Broad. FL | Conif. FL | Annual CL | Woody CL | Grass GL | Woody GL | WL | SL | |
| | kha | | | | | | | | | |
| 1990 | 2.915 | 0 | 0 | 0 | 0.002 | 0 | 0.002 | 0 | 0 | 2.919 |
| 1991 | 2.915 | 0 | 0 | 0 | 0.004 | 0 | 0.004 | 0 | 0 | 2.923 |
| 1992 | 2.915 | 0 | 0 | 0 | 0.006 | 0 | 0.006 | 0 | 0 | 2.927 |
| 1993 | 2.915 | 0 | 0 | 0 | 0.008 | 0 | 0.008 | 0 | 0 | 2.931 |
| 1994 | 2.915 | 0 | 0 | 0 | 0.011 | 0 | 0.010 | 0 | 0 | 2.936 |
| 1995 | 2.915 | 0 | 0 | 0 | 0.013 | 0 | 0.012 | 0 | 0 | 2.940 |
| 1996 | 2.915 | 0 | 0 | 0 | 0.015 | 0 | 0.014 | 0 | 0 | 2.944 |
| 1997 | 2.915 | 0 | 0 | 0 | 0.017 | 0 | 0.017 | 0 | 0 | 2.948 |
| 1998 | 2.915 | 0 | 0 | 0 | 0.019 | 0 | 0.019 | 0 | 0 | 2.952 |
| 1999 | 2.915 | 0 | 0 | 0 | 0.021 | 0 | 0.021 | 0 | 0 | 2.957 |
| 2000 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2001 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2002 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2003 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2005 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2006 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2007 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2008 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2009 | 2.915 | 0 | 0 | 0 | 0.023 | 0 | 0.023 | 0 | 0 | 2.961 |
| 2010 | 2.919 | 0 | 0 | 0 | 0.021 | 0 | 0.021 | 0 | 0 | 2.961 |
| 2011 | 2.923 | 0 | 0 | 0 | 0.019 | 0 | 0.019 | 0 | 0 | 2.961 |
| 2012 | 2.927 | 0 | 0 | 0 | 0.017 | 0 | 0.017 | 0 | 0 | 2.961 |
| 2013 | 2.929 | 0 | 0 | 0 | 0.015 | 0 | 0.014 | 0 | 0 | 2.958 |
| 2014 | 2.930 | 0 | 0 | 0 | 0.013 | 0 | 0.012 | 0 | 0 | 2.955 |
| 2015 | 2.932 | 0 | 0 | 0 | 0.011 | 0 | 0.010 | 0 | 0 | 2.953 |
| 2016 | 2.933 | 0 | 0 | 0 | 0.008 | 0 | 0.008 | 0 | 0 | 2.950 |
| 2017 | 2.935 | 0 | 0 | 0 | 0.006 | 0 | 0.006 | 0 | 0 | 2.947 |
| 2018 | 2.936 | 0 | 0 | 0 | 0.004 | 0 | 0.004 | 0 | 0 | 2.944 |
| 2019 | 2.938 | 0 | 0 | 0 | 0.002 | 0 | 0.002 | 0 | 0 | 2.942 |
| 2020 | 2.939 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.939 |
| 2021 | 2.936 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.936 |
| 2022 | 2.934 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.934 |
| 2023 | 2.931 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.931 |

*FL = forest land, CL = cropland, GL = grassland, WL= wetlands, SL= settlements, OL = other land*

It is evident from the information in table 6.18 above that the conversions to other land are very limited in Cyprus, and they are associated only with changes from woody cropland and grassland land.

## 6.7.4 Methodological issues

**Other Land remaining Other land**

No guidance is provided in the 2006 IPCC guidelines for other land remaining other land.

**Land converted to other land**

Lands converted to other land are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. The tier 2 method was implemented to calculate carbon stock changes in living biomass (equation 2.15 of the 2006 IPCC guidelines) and the tier 1 method for the DOM and SOM mineral pools. It should be noted that carbon stocks in living biomass, dead wood and litter in other land after the conversion are taken equal to zero in accordance with the 2006 IPCC guidelines. Furthermore, both the living biomass and DOM stocks that were present before the conversion are assumed to be totally lost in the year of conversion as a result of the land-use change.

For estimating carbon stock changes in SOM mineral, formulation B of equation 2.25 of the 2006 IPCC guidelines with the default 20 years transition period is applied. In the current inventory, the carbon stock equilibrium level of other land is taken equal to zero, following the tier 1 assumption, while in the previous inventories mineral soil carbon stocks for other land were not taken equal to zero. The stock change factors that are applied for the respective land-use categories converted to other land are the ones presented in section 6.2.4.

**$N_2O$ emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils**

In the current submission, $N_2O$ emissions from N mineralization associated with mineral soil carbon loss as a result of land-use change to other land are reported for the first time. These emissions are a consequence of the enhanced mineralisation (conversion to inorganic form) of soil organic matter (SOM) that normally takes place as a result of that conversion.

Both direct and indirect $N_2O$ emissions are reported following the tier 1 method of the 2006 IPCC guidelines with default emission factors. More specifically equations 11.1, 11.8 and 11.10 from chapter 11 were applied. The C/N ratio equal to 15 (for grassland) and 10 (for cropland) conversions to other land, the emission factor (EF1) equal to 0.01 kg $N_2O$-N/kg N for direct $N_2O$ emissions, and the emission factor (EF5) equal to 0.0075 kg $N_2O$-N/kg N and the $Frac_{LEACH}$ equal to 0.3 for indirect $N_2O$ emissions are applied.

## 6.7.5. Uncertainties and time-series consistency

Uncertainties for the whole inventory period (1990-2023) have been assessed following the error propagation (approach 1) and equations 3.1, 3.2 contained in volume 1 of the 2006 IPCC guidelines. Input uncertainties related to activity data and emission factors have been assessed on the basis of information provided in the 2006 IPCC guidelines and country specific information.

The associated uncertainties with the input data for land converted to other land are presented in table 6.9 and in table 6.13 above.

The overall uncertainty for land converted to other land equals to 34% and 81% for $CO_2$ and $N_2O$ emissions, respectively. A more detailed description of the results of the uncertainty analysis is reported in Annex 2.

Figure 6.12 presents the total net emissions/removals associated with the land converted to other land during the period 1990–2023.

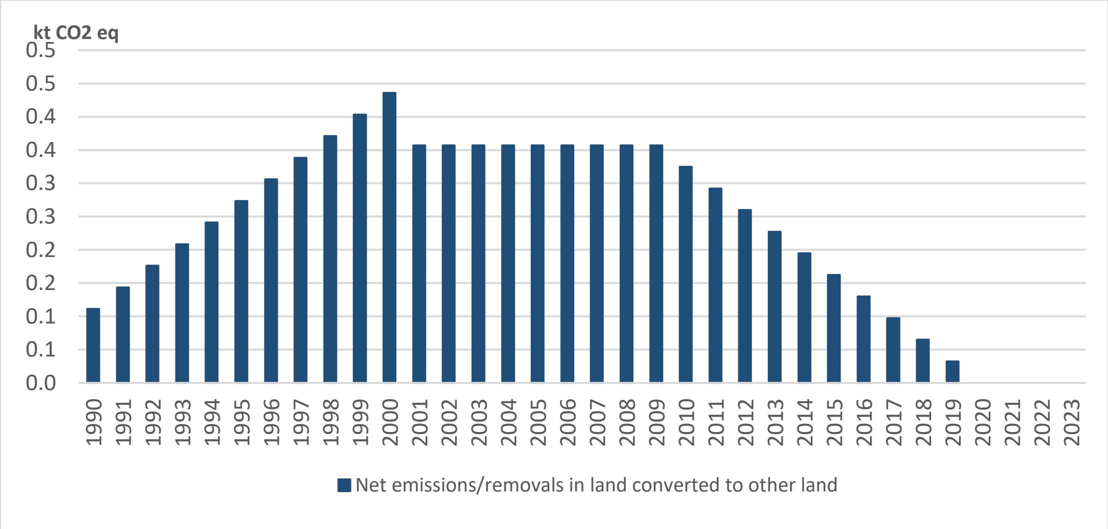


**Figure 6.12. Net emissions/removals in land converted to other land during the period 1990 – 2023 (note: indirect $N_2O$ emissions are included in the net emissions).**

## 6.7.6. Category-specific QA/QC and verification

See paragraph 6.2.6 above.

## 6.7.7. Category-specific recalculations

No recalculations were implemented.

## 6.7.8. Category-specific planned improvements

There are not any improvements planned for this category.

## 6.8. Harvested Wood Products (4G)

### 6.8.1. Description

Harvested Wood Products (HWP) include all wood material (including bark) that leaves harvest sites. Slash and other material left at harvest sites are regarded as dead organic matter in the associated land-use category.

In Cyprus, all domestically produced HWP originate only from harvest occurring in forest land category.

### 6.8.2. Information on approaches used and on databases used for the inventory preparation

Annual carbon stock changes in HWP pool are estimated following the production approach as it is described in the 2006 IPCC guidelines in order to estimate $CO_2$ emissions and removals from HWP originating from the country's land.

Three harvested wood products categories have been considered, namely sawnwood, wood-based panels, and paper and paperboard.

All relevant data were collected from the FAO database "Forestry Production and Trade".

### 6.8.3. Category specific definitions and the classification systems used

Definitions contained in "FAO Forest Products Definitions"[66] are used in this inventory.

### 6.8.4. Methodological issues

The tier 2 of the 2006 IPCC guidelines is applied for estimating the HWP contribution in the total net emissions/removals in the LULUCF sector. More specifically, the first order decay function presented in equation 12.6 is used.

Furthermore, the following elements of the 2006 IPCC guidelines are considered:

1. All $CO_2$ released/removed from HWP is included in the LULUCF sector;

2. $CO_2$ released from wood burnt for energy in the energy sector is not included in the energy sector totals (although $CO_2$ emissions from biofuels are reported as a memo item for QA/QC purposes). $CH_4$ and other gases from HWP used for energy is included in the energy sector;

3. $CO_2$ released from HWP in SWDS is not included in the waste sector totals although $CH_4$ emissions from HWP are included.

#### 6.8.4.1. Data for the calculation of an estimate of HWP Contribution under the Convention

The necessary activity data for all three categories, namely data for production, import and export, have been obtained from FAO statistics database "Forestry Production and Trade" (date of data download: 28 December 2022)[67]. Table 6.19 lists the FAO items and their codes that were the source of numerical data for all calculations in this chapter.

[66] available at: http://www.fao.org/forestry/34572-0902b3c041384fd87f2451da2bb9237.pdf
[67] available at http://www.fao.org/faostat/en/#data/FO

**Table 6.19. The FAO items and their codes that were the source of numerical data for all calculations relating to the HWP GHG contribution.**

| Item | Item Code |
|---|---|
| Sawnwood | 1872 |
| Wood-Based Panels | 1873 |
| Paper+Paperboard | 1876 |
| Wood Pulp | 1875 |
| Industrial Roundwood | 1865 |

In the current submission, the activity data used for estimating the HWP contribution are extrapolated back to 1900, in accordance with the 2006 IPCC guidelines. More specifically, equation 12.6 is applied with the estimated continuous rate of change equal to 0.0151 (that of industrial roundwood production increase). The carbon stocks in 1900 are assumed to be equal to zero. It is noted that for wood-based panels a complete time series for production is available only for the period 1982-2023 in FAOSTAT. Thus, the extrapolation back from 1982 to 1900 is approximated by means of equation 12.6.

As it has been already indicated, in the current submission the carbon stock changes for solid wood are disaggregated between sawnwood and wood panels compared to previous submission in which aggregated estimates only for solid wood were reported. The default half-lives used for the estimation of “products in use” and associated fraction retained each year are the disaggregated ones for the three HWP categories from the 2013 IPCC KP Supplement presented in table 6.20 below.

**Table 6.20. The default half-lives and associated decay rates for solid wood products and paper products**

| | Sawnwood | Wood-based panesl | Paper products |
|---|---|---|---|
| Half-life (years) | 35 yr | 25 | 2 yr |
| Decay rate k (k = ln(2)/ half-life) | 0.020 $yr^{-1}$ | 0.028 | 0.347 $yr^{-1}$ |

The conversion factors used in the calculation of the HWP contribution are taken from table 12.4 of the 2006 IPCC and are reported in CRT table 4.Gs2.

Figure 6.13 below presents the annual carbon stock changes in the period 1990-2023 for each HWP category.

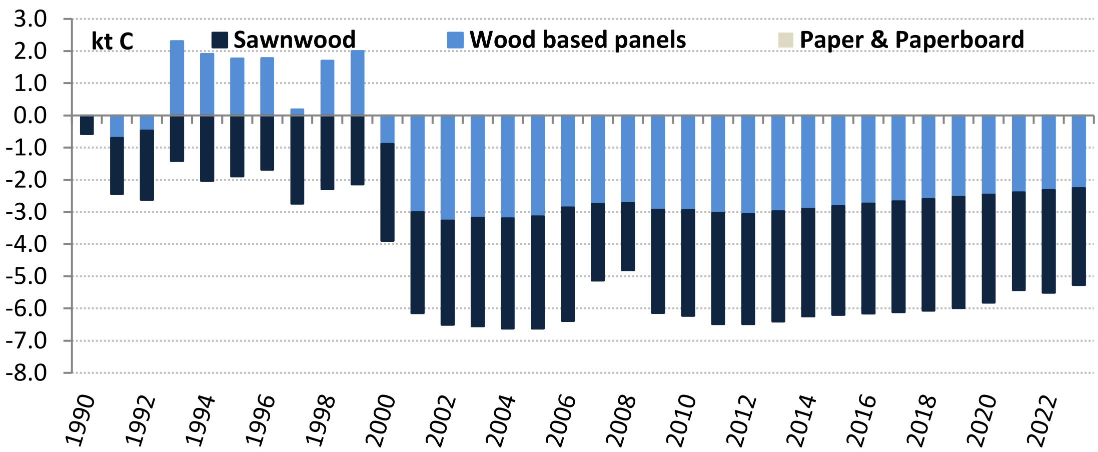


**Figure 6.13. Carbon stock changes in sawnwood, wood-based panels, paper and paperboard during the period 1990-2023.**

### 6.8.5. Uncertainties and time-series consistency

The uncertainty associated with this category is based on information provided by the 2006 IPCC guidelines, namely an overall uncertainty equal to 52% for $CO_2$. A more detailed description of the results of the uncertainty analysis is reported in Annex 2.

### 6.8.6. Category-specific QA/QC and verification

See paragraph 6.2.6 above.

### 6.8.7. Category-specific recalculations

No recalculations were implemented.

### 6.8.8. Category-specific planned improvements

There are not any improvements planned for this category.

# Chapter 7.
## Waste (CRT sector 5)

## 7.1. Overview of sector

Disposal and treatment of industrial and municipal wastes can produce emissions of GHG. Typically, $CH_4$ emissions from SWDS are the largest source of greenhouse gas emissions in the Waste Sector. $CH_4$ emissions from wastewater treatment and discharge may also be important.

Solid wastes can be disposed of through landfilling, recycling, incineration or waste-to-energy. Incineration and waste-to-energy technologies are not implemented for the management of municipal solid waste in Cyprus. This chapter will deal with $CH_4$ and $N_2O$ emissions resulting from solid waste disposal, biological treatment of solid waste and wastewater treatment and discharge. The most important gas produced in this source category is methane ($CH_4$). Emissions from incineration and open burning of waste are reported as NO as incineration does not take place in Cyprus.

### 7.1.1. Emissions trends

Emissions from the Waste Sector in 2023 contributed 7.5% of the total emissions without LULUCF, 59.7% to the total methane emissions of the country without LULUCF and 12.6% to the total $N_2O$ emissions without LULUCF. In 2023, 86.1% of the waste sector emissions are from solid waste disposal, 2.8% from biological treatment of solid waste and 11.1% from waste water treatment and discharge. The emissions from waste have changed considerably between 1990 and 2023 due to changes that are taking place in the waste and wastewater management practices of the country. Recycling and composting have been reducing the amount of waste disposal on land since 2010.

**Table 7.1. Total GHG emissions (in Gg $CO_2$ eq) from waste, 1990–2023**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| **Total waste** | **435.18** | **523.24** | **557.57** | **583.92** | **588.96** | **599.05** | **609.15** |
| A. Solid waste disposal | 295.37 | 369.73 | 420.35 | 482.17 | 494.71 | 506.10 | 518.69 |
| B. Biological treatment of solid waste | NO | NO | NO | 4.71 | 8.55 | 10.35 | 8.85 |
| C. Incineration and open burning of waste | NO | NO | NO | NO | NO | NO | NO |
| D. Wastewater treatment and discharge | 139.82 | 153.51 | 137.22 | 97.04 | 85.70 | 82.60 | 81.60 |
| E. Other | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| $CH_4$ (Gg) | 15.19 | 18.25 | 19.48 | 20.30 | 20.45 | 20.78 | 21.17 |
| $N_2O$ (Gg) | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 | 0.06 |
| **Total (Gg $CO_2$ eq.)** | **435.18** | **523.24** | **557.57** | **583.92** | **589.71** | **599.76** | **609.81** |

| **Gg $CO_2$ eq.** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| **Total waste** | **619.19** | **623.02** | **626.15** | **633.61** | **643.33** | **654.18** | **653.35** |
| A. Solid waste disposal | 527.87 | 533.77 | 540.47 | 547.74 | 554.51 | 561.03 | 567.35 |
| B. Biological treatment of solid | 10.55 | 11.48 | 11.63 | 11.88 | 15.11 | 17.94 | 17.26 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| waste | | | | | | | |
| C. Incineration and open burning of waste | NO | NO | NO | NO | NO | NO | NO |
| D. Wastewater treatment and discharge | 80.77 | 77.76 | 74.05 | 74.00 | 73.72 | 75.21 | 68.74 |
| E. Other | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| $CH_4$ (Gg) | 21.52 | 21.66 | 21.76 | 22.02 | 22.31 | 22.67 | 22.66 |
| $N_2O$ (Gg) | 0.07 | 0.07 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 |
| **Total (Gg $CO_2$ eq.)** | **620.38** | **624.81** | **627.76** | **635.25** | **644.93** | **656.42** | **656.09** |

| **Gg $CO_2$ eq.** | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| **Total waste** | **660.59** | **665.31** | **672.31** | | | | |
| A. Solid waste disposal | 571.59 | 574.88 | 578.85 | | | | |
| B. Biological treatment of solid waste | 17.89 | 18.67 | 19.19 | | | | |
| C. Incineration and open burning of waste | NO | NO | NO | | | | |
| D. Wastewater treatment and discharge | 71.11 | 71.76 | 74.27 | | | | |
| E. Other | NO | NO | NO | | | | |
| | | | | | | | |
| $CH_4$ (Gg) | 22.86 | 22.98 | 23.22 | | | | |
| $N_2O$ (Gg) | 0.08 | 0.08 | 0.08 | | | | |
| **Total (Gg $CO_2$ eq.)** | **662.56** | **665.31** | **672.31** | | | | |

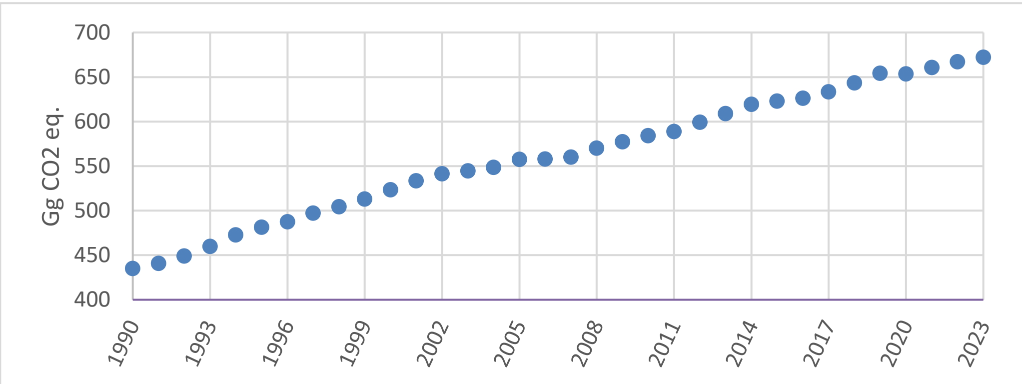


**Figure 7.1. GHG emissions from waste for the period 1990–2023**

## 7.1.2. Methodology

The calculation of GHG emissions from Waste is based on the methodologies and emission factors suggested by the IPCC Guidelines. Data used for the estimation of the emissions was obtained from the National Statistical Service. The Tier 2 method with default IPCC 2006 emission factors and parameters is implemented for Solid Waste Disposal (5A) and Tier 1 for Biological Treatment of Solid Waste (5B) and Wastewater Treatment and Discharge (5D).

The methodologies and emission factors used are summarised in Table 7.2.

**Table 7.2. Waste– methodologies and emission factors applied**

| Category-Classification | | Gas | EF | Method |
|---|---|---|---|---|
| 5A1.a | Solid Waste Disposal - Managed waste disposal sites- Anaerobic | $CH_4$ | D | T2 |
| 5A1.a | Solid Waste Disposal - Managed waste disposal sites- Anaerobic | $CO_2$ | NA | NA |
| 5A2. | Solid Waste Disposal - Unmanaged waste disposal sites | $CH_4$ | D | T2 |
| 5A2. | Solid Waste Disposal - Unmanaged waste disposal sites | $CO_2$ | NA | NA |
| 5B1a | Biological treatment of solid waste – Composting- municipal solid waste | $CH_4/N_2O$ | D | T1 |
| 5B2 | Anaerobic Digestion at Biogas Facilities | $CH_4$ | D | T1 |
| 5D1. | Wastewater Treatment and Discharge - Domestic wastewater | $CH_4/N_2O$ | CS | T1 |
| 5D2. | Wastewater Treatment and Discharge - Industrial wastewater | $CH_4$ | D | T1 |
| 5D2. | Wastewater Treatment and Discharge - Industrial wastewater | $N_2O$ | OTH | OTH |

T1: IPCC methodology Tier 1; D: IPCC default methodology and emission factor; OTH: other methodology – EMEP/CORINAIR 2007

**Key categories**

The results of the key categories assessment are presented in Section 1.4.

**Uncertainty**

The uncertainty analysis is presented in Section 1.5.

**Completeness**

Table 7.3 gives an overview of the IPCC source categories included in this chapter and presents the status of emissions estimates from all sub-sources in the sector of waste.

**Table 7.3. Waste – completeness**

| | $CO_2$ | $CH_4$ | $N_2O$ |
|---|---|---|---|
| 5A. Solid Waste Disposal | NA | ✓ | NA |
| 5B. Biological Treatment of Solid Waste | | ✓ | ✓ |
| 5D. Wastewater Treatment and Discharge | | ✓ | ✓ |

NA: Not applicable

## 7.2. Solid Waste Disposal (5A)

Treatment and disposal of municipal, industrial and other solid waste produces significant amounts of methane ($CH_4$). In addition to $CH_4$, solid waste disposal sites (SWDS) also produce biogenic carbon dioxide ($CO_2$) and non-methane volatile organic compounds (NMVOCs) as well as smaller amounts of nitrous oxide ($N_2O$), nitrogen oxides ($NO_x$) and carbon monoxide (CO). In Cyprus, as in many other industrialised countries, waste management has changed much over the last decade. Waste minimisation and recycling/reuse policies have been introduced to reduce the amount of waste generated, and increasingly, alternative waste management practices to solid waste disposal on land have been implemented to reduce the environmental impacts of waste management.

Decomposition of organic material derived from biomass sources (e.g., crops, wood) is the primary source of $CO_2$ released from waste. These $CO_2$ emissions are not included in national totals, because the carbon is of biogenic origin and net emissions are accounted for under the LULUCF Sector.

***Municipal solid waste management in Cyprus***

In Cyprus, household waste is collected by local authorities or individuals and disposed of in sites of different characteristics. In 2005[68] five disposal sites were in operation, of which none met the standards for landfills in accordance with the requirements of the relevant EU Directives. The landfills in Nicosia and Limassol operated with controlled drop while the other three sites operate under semi-controlled deposition conditions. These sites have been categorised as deep unmanaged for the purposes of inventory preparation.

Up until 2010, also in operation were 113 sites of uncontrolled disposal of household and other solid waste. These sites have been categorised as shallow unmanaged. Most active UWDS have been active for more than 25 years, while the smallest portion of the active UWDS were active for less than 5 years (Figure 7.2). Approximately half of UWDS (48%) started their operation during 1990-2000, while a significant number became operational during 1980–1990. Before 1970 only two sites operated, one of which was closed in the mid 1990s, while the other is still in operation (Figure 7.3).

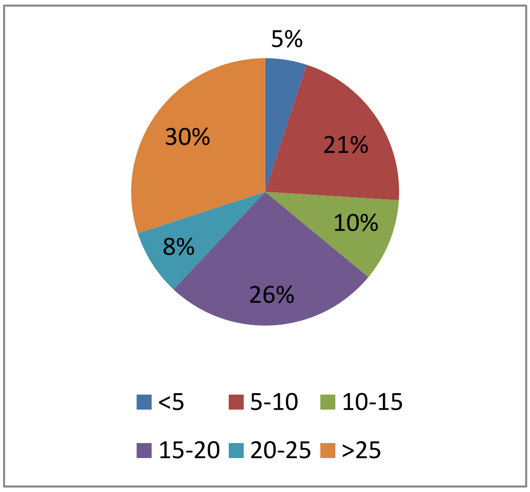


**Figure 7.2. Years of activity of active Uncontrolled Waste Disposal Sites**

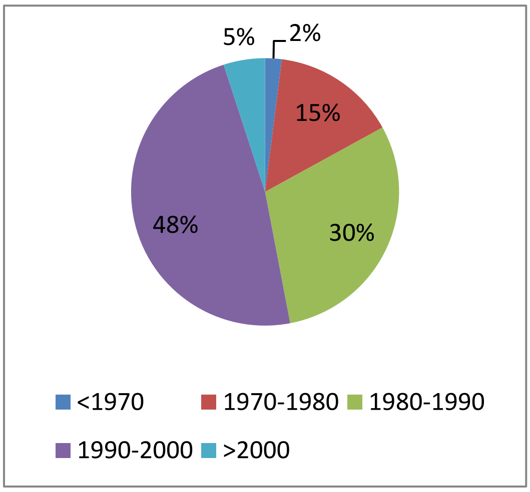


**Figure 7.3. Starting year of activity for all Uncontrolled Waste Disposal Sites**

The situation started changing in 2006 when the first managed waste disposal site started its operation in Pafos. Then the second managed waste disposal site started its operation in 2010, serving the districts of Larnaca and Ammochostos. For Limassol and Nicosia, the new facilities are under construction and all the municipal solid wastes produced are transferred to the existing deep unmanaged sites[69]. The national municipal waste Management Plant of 2015–2021 (MWMP) contains quantitative and qualitative targets and enumerates specific measures and actions to be taken in order for the EU targets to be reached. One of the quantitative targets is that no more than 95,000 tonnes of biodegradable waste is to be disposed in landfills (represents the 35% target of the 1999/31/EC directive). In addition, the Legal Measures will be focused on the:

- Development of local waste prevention and management schemes

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[68] In 2005 a census of all the solid waste disposal sites took place in Cyprus through the study "Παροχή συμβουλευτικών υπηρεσιών για την ετοιμασία στρατηγικού σχεδίου, περιβαλλοντικής και τεχνοοικονομικής μελέτης και εγγράφων προσφορών για την αποκατάσταση και μετέπειτα φροντίδα των χώρων ανεξέλεγκτης απόρριψης απορριμμάτων στην Κύπρο" ("Consultancy services for the preparation of the strategic plan, environmental and techno-economic studies and tender documents for the rehabilitation and aftercare of uncontrolled waste disposal sites in Cyprus").

[69] Athena Papanastasiou, Environment Officer, Waste Management Unit, Department of Environment, Tel.: +357 22 866231, E-mail: apapanastasiou@environment.moa.gov.cy

- Mandatory obligation for establishing separate collection systems by local authorities,
- Establishment of extended producer responsibility (EPR) in streams other than packaging waste,
- Establishment of a landfill tax/levy,
- Banning the disposal of certain waste streams from entering into landfills (e.g. green waste, high calorific value waste, etc.)

The adaptations of the strategy that are envisaged:

- One Sanitary Landfill and one Residual Sanitary Landfill (supplementing MBT unit at Koshi) were constructed and operated (both meet the requirements of directive 99/31/EC). The MBT unit was constructed and operated from 01/04/2010 servicing Larnaca-Ammochostos districts. The Plant was designed in a way that a high separation of recycled and biodegradable material is achieved. Another I.W.M.P (Integrated Waste Management Plant) servicing Limassol district is expected to be operated by the year 2018.
- The construction of the Green Point Network (22 collection points for the depositing of various waste streams out of households – bulky waste, green, textile, furniture, weee, etc.) is completed. The 4 Green Points servicing Paphos district are in operation and the rest are expected to be in operation by 2018.
- Separate collection at source was promoted at households, from the existing collective system for the packing waste servicing and also all types of paper created under the packaging directive, while the competent authority promotes the separate collection from other household streams such as other organic waste, eg. food and green waste.
- The construction works for the rehabilitation/restoration of the old non approved landfills, which are closed at Paphos and Larnaca-Ammochostos districts, were completed. The preparation of studies/documents regarding the rehabilitation/restoration of the 20 non sanitary landfills of Nicosia district and the 44 sanitary landfills of the Limassol district will be completed within 2018, and after that the construction works will begin.

A comprehensive study was undertaken in 2005 for the elaboration of a Strategic Plan, an Environmental study and a Feasibility study for the restoration and management of landfills. The purpose of the study was to record all landfills, assess their status and level of risk, create a restoration priority list based on pollution risk assessments, and undertake the appropriate environmental studies as well as feasibility studies for the restoration of the prioterized landfills. These studies were a necessary step for the restoration of all landfills recorded.

Two (2) landfills are still active in Cyprus but arrangements have been made in order for them to be closed and restored. According to recent data, these two landfills are fed with approximately 155,000 tonnes and 200,000 tonnes of municipality waste each year, respectively (reference year 2012).

Sixty-two (62) non sanitary landfills are planned to be restored appropriately within the following years. According to the preliminary study contacted in 2005, these landfills contain approximately 597,269 $m^3$ of solid waste, excluding 2 major landfills that have not been closed yet.

Fifty-three (53) landfills have been restored the last five years and are being monitored. During their restoration a total of 4,902,000 $m^3$ of solid waste were reallocated and properly buried using composite liners and leakage collection systems.

The EU landfill directive is fully harmonized in the national legislation but not fully implemented. Cyprus didn't manage to seize the operation of non-compliant landfills by 2009. Also, Cyprus has rehabilitated only 46% of its closed landfills.

***Emission trends***

Methane emissions were calculated using the Tier 2 method proposed by the IPCC 2006 guidelines using the IPCCWasteModel excel spreadsheet provided with the 2006 IPCC guidelines.

Carbon dioxide emissions occur during flaring of biogas released from the decomposition of waste. These emissions should not be included in the total GHG emissions of this source as they are of biogenic origin. Nevertheless, recovery and flaring of biogas do not occur in Cyprus and is therefore reported as NO.

$CH_4$ emissions from solid waste disposal on land in 2023 accounted for 86.4% of total GHG emissions from Waste sector, 6.5% of total national emissions without LULUCF and 53.3% of the total $CH_4$ emissions without LULUCF. Total emissions increased by 95.6% between 1990 and 2023. Emissions from Solid Waste Disposal Sites are presented in Table 7.4 and Figure 7.4.

**Table 7.4. Total GHG emissions from solid waste disposal sites for the period 1990–2023**

| **Gg $CH_4$** | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| **A. Solid waste disposal** | **10.55** | **13.20** | **15.01** | **17.22** | **17.67** | **18.07** | **18.52** |
| 1. Managed waste disposal sites | NO | NO | NO | 0.58 | 1.03 | 1.47 | 1.86 |
| 2. Unmanaged waste disposal sites | 10.55 | 13.20 | 15.01 | 16.64 | 16.63 | 16.61 | 16.66 |
| 3. Uncategorised waste disposal sites | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| **A. Solid waste disposal (Gg $CO_2$ eq.)** | **295.37** | **369.73** | **420.35** | **482.17** | **494.71** | **506.10** | **518.69** |

| **Gg $CH_4$** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| **A. Solid waste disposal** | **18.85** | **19.06** | **19.30** | **19.56** | **19.80** | **20.04** | **20.26** |
| 1. Managed waste disposal sites | 2.21 | 2.49 | 2.78 | 3.06 | 3.33 | 3.92 | 4.86 |
| 2. Unmanaged waste disposal sites | 16.65 | 16.57 | 16.52 | 16.50 | 16.47 | 16.12 | 15.40 |
| 3. Uncategorised waste disposal sites | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | |
| **A. Solid waste disposal (Gg $CO_2$ eq.)** | **527.87** | **533.77** | **540.47** | **547.74** | **554.51** | **561.03** | **567.35** |

| **Gg $CH_4$** | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| **A. Solid waste disposal** | **20.41** | **20.53** | **20.67** | | | | |
| 1. Managed waste disposal sites | 5.69 | 6.46 | 7.22 | | | | |
| 2. Unmanaged waste disposal sites | 14.72 | 14.07 | 13.45 | | | | |
| 3. Uncategorised waste disposal sites | NO | NO | NO | | | | |
| | | | | | | | |
| **A. Solid waste disposal (Gg $CO_2$ eq.)** | **571.59** | **574.88** | **578.76** | | | | |

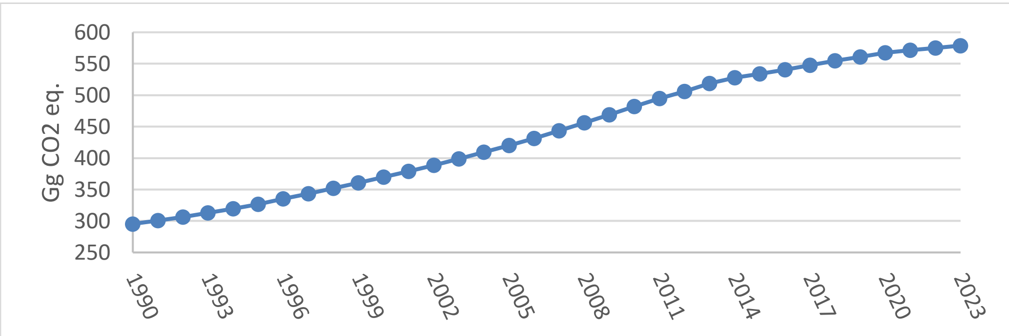


**Figure 7.4. Total GHG emissions from solid waste disposal sites for the period 1990–2023**

## 7.2.1. Methodological issues

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) outlines three methods to estimate $CH_4$ emissions from solid waste disposal sites: (a) the Tier 1 method based on the IPCC First Order Decay method (FOD), (b) the Tier 2 method using the IPCC FOD method, some default parameters and good quality country specific activity data and (c) the Tier 3 method using good quality country specific activity data and either the FOD IPCC FOD method with country specific key parameters or measurement derived county-specific parameters. According to the 2006 IPCC Guidelines, it is good practice to use the FOD method in order to account for time dependence of the emissions. The Tier 2 methodology was implemented for the estimation of emissions from land disposal of solid waste through the use of the IPCCWasteModel excel spreadsheet. The parameters are set to Southern Europe region, the DOC is calculated based on waste by composition and the methane generation constant is the default for dry temperate.

**Total municipal solid waste ($MSW_T$)**

Data on total MSW production and annual per capita production are available for the period 1996–2016 from the National Statistical Service. The data for the period 1990–1995 was obtained using the linear trend equation of 1996–2008 that was obtained from plotting the annual per capita production against time as shown in Figure 7.5. The years 2009 to 2016 were excluded from the trend, because during those years there are considerable changes in (a) the economy of the country and (b) the waste management practices of the country, which resulted in a decrease of the waste production. The total municipal solid waste production ($MSW_T$) was then estimated by multiplying the annual per capita production by the total population at the end of the year.

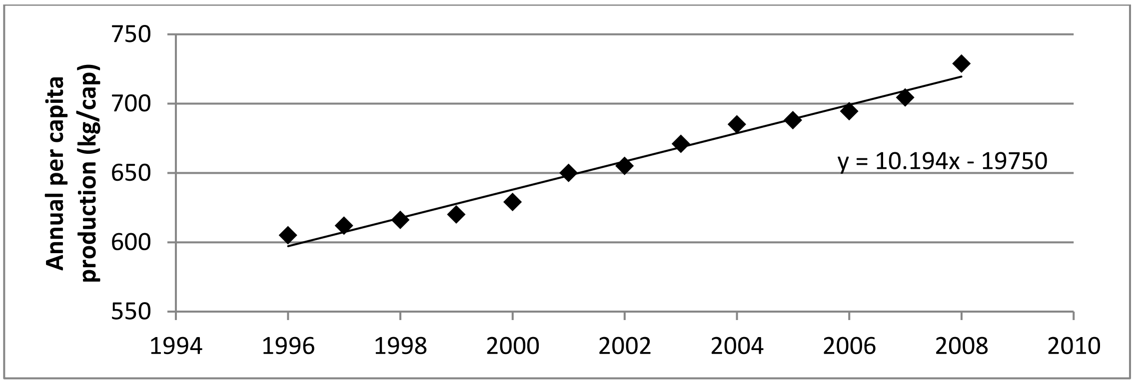


**Figure 7.5. Plot used to estimate the annual per capita production for 1990-1995 (kg/cap)**

The total population used, the annual per capita production and the resulting municipal solid waste production for the whole reporting period are presented in Table 7.5. Population data is according to national statistics published annually by the Statistical Service[70].

The population reported by the Statistical Service and used for the purposes of the GHG inventory of Cyprus is the population for the areas under the effective control of the Republic of Cyprus[71]. The reduction in population during the period 2012–2015 has been caused by negative net migration due to the economic crisis experienced during that period.

**Table 7.5. Total population, annual per capita production (kg/cap), total MSW production (1000t)**

| | Total population | Annual per capita production (kg/cap) | Total MSW production (1000t) |
|---|---|---|---|
| **1990** | 587100 | 536.1 | 314.7 |
| **1991** | 603100 | 546.3 | 329.4 |
| **1992** | 619200 | 556.4 | 344.6 |
| **1993** | 632900 | 566.6 | 358.6 |

[70] The 2017 publication, which includes data for the years 1996-2016 is available at http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/ACC6EE0E5A63FE79C225703C001EC792/$file/POP-DISTRICT-A96_16-EN-281117.xls?OpenElement; contact person for population statistics at the Statistical Service is Loukia Makri, +357 22602150, lmakri@cystat.mof.gov.cy

[71] http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/4756DB2E6CAEB256C22581E200378EA0?OpenDocument&sub=1&sel=1&e=&print

| | | | |
|---|---|---|---|
| **1994** | 645400 | 576.8 | 372.3 |
| **1995** | 656300 | 587.0 | 385.3 |
| **1996** | 666300 | 605.0 | 400.1 |
| **1997** | 675200 | 612.0 | 410.5 |
| **1998** | 682900 | 616.0 | 418.2 |
| **1999** | 690500 | 620.0 | 425.8 |
| **2000** | 697500 | 629.0 | 436.1 |
| **2001** | 705500 | 650.0 | 456.1 |
| **2002** | 713700 | 655.0 | 464.6 |
| **2003** | 722900 | 671.0 | 481.4 |
| **2004** | 733000 | 685.0 | 498.1 |
| **2005** | 744000 | 688.0 | 507.9 |
| **2006** | 757900 | 694 | 522.2 |
| **2007** | 776400 | 704 | 539.8 |
| **2008** | 796900 | 729 | 573.4 |
| **2009** | 819100 | 730 | 589.1 |
| **2010** | 839800 | 696 | 589.77 |
| **2011** | 862000 | 694 | 588.84 |
| **2012** | 865900 | 681 | 588.33 |
| **2013** | 858000 | 635 | 546.97 |
| **2014** | 847000 | 618 | 527.39 |
| **2015** | 848300 | 640 | 539.75 |
| **2016** | 854800 | 651 | 552.94 |
| **2017** | 864200 | 641 | 551.39 |
| **2018** | 875900 | 661 | 575.63 |
| **2019** | 888000 | 665 | 585.73 |
| **2020** | 896000 | 625 | 557.73 |
| **2021** | 904705 | 650 | 585.24 |
| **2022** | 920211 | 673 | 614.62 |
| **2023** | 933505 | 674 | 625.08 |

**Determining Historical Waste per Capita Data**

Please refer to Annex 3.2 for the methodology used to estimate Historical Waste per Capita Data.

**Fraction of MSW disposed at SWDS ($MSW_F$)**

Data on MSW disposed at SWDS is available for the period 1996–2019 from the National Statistical Service[72]. For the period 1990–1995 it was assumed that the fraction of waste disposed to SWDS is the same as 1996. The $MSW_F$ and the corresponding mass of MSW disposed to disposal sites are presented in Table 7.6. In Table 7.6 data on other waste management practices are also presented for years that data is available. MSW to disposal sites for 1950–1989 is assumed 100%.

**Table 7.6. Fraction of MSW disposed at SWDS ($MSW_F$), mass of MSW disposed to disposal sites (1000t) and other practices**

| | **Composting (1000t)*** | **Recycling (1000t)** | **MSW to disposal sites (1000t)** | **MSW to disposal sites** |
|---|---|---|---|---|
| **1990** | | | 305.97 | 97.2% |
| **1991** | | | 320.29 | 97.2% |
| **1992** | | | 334.98 | 97.2% |
| **1993** | | | 348.66 | 97.2% |
| **1994** | | | 361.94 | 97.2% |
| **1995** | | | 387.00 | 97.2% |
| **1996** | | 11.12 | 389.00 | 97.2% |
| **1997** | | 12.54 | 398.00 | 96.9% |

[72] The 2017 publication, which includes data for the years 1996-2016 is available at http://www.cystat.gov.cy/mof/cystat/statistics.nsf/energy_environment_82main_gr/energy_environment_82main_gr?OpenForm&sub=2&sel=2; contact person for population statistics at the Statistical Service is Marilena Kythreotou, +357 22602137, mkythreotou@cystat.mof.gov.cy

| | Composting (1000t)* | Recycling (1000t) | MSW to disposal sites (1000t) | MSW to disposal sites |
|---|---|---|---|---|
| **1998** | | 12.17 | 406.00 | 97.1% |
| **1999** | | 12.76 | 413.00 | 97.0% |
| **2000** | | 13.11 | 423.00 | 97.0% |
| **2001** | | 14.1 | 442.00 | 96.9% |
| **2002** | | 14.61 | 450.00 | 96.9% |
| **2003** | | 14.73 | 466.63 | 96.9% |
| **2004** | | 16.48 | 481.59 | 96.7% |
| **2005** | | 18.61 | 489.30 | 96.3% |
| **2006** | | 21.50 | 499.49 | 95.9% |
| **2007** | | 27.59 | 512.19 | 94.9% |
| **2008** | | 42.09 | 530.59 | 92.7% |
| **2009** | | 49.39 | 539.67 | 91.6% |
| **2010** | 26.31 | 63.72 | 497.86 | 84.4% |
| **2011** | 47.92 | 74.98 | 475.91 | 80.8% |
| **2012** | 57.77 | 72.20 | 467.48 | 79.5% |
| **2013** | 49.10 | 72.10 | 434.49 | 79.4% |
| **2014** | 58.79 | 72.38 | 398.67 | 75.6% |
| **2015** | 64.05 | 75.14 | 409.99 | 76.0% |
| **2016** | 64.83 | 80.43 | 424.44 | 76.8% |
| **2017** | 58.75 | 82.97 | 423.16 | 76.7% |
| **2018** | 73.89 | 82.99 | 392.86 | 68.2% |
| **2019** | 91.06 | 100.03 | 379.39 | 64.8% |
| **2020** | 86.41 | 93.70 | 364.14 | 65.3% |
| **2021** | 90.21 | 95.62 | 354.30 | 60.5% |
| **2022** | 93.34 | 97.41 | 363.34 | 59.1% |
| **2023** | 96.33 | 95.73 | 381.05 | 61.0% |

* includes Compost for backfilling

Assumptions for allocation have been based on the information provided by the Solid Waste Management Unit of the Department of Environment[73], presented below (Table 7.7). Managed-semi-aerobic is not used in Cyprus. The categorisation is based on the disposal of the waste according to their origin; i.e. urban or rural. Based on this categorisation, the amount of waste disposed per type of disposal site was estimated using the urban and rural population of each district at the end of the year (Table 7.8) and the waste generation per capita (Table 7.5). The resulting amount of waste generated per district and type of waste disposal site are presented in Table 7.9. The resulting total quantities of municipal solid waste disposed per type of waste disposal site and the population served per technology are presented in Table 7.10. Managed-semi-aerobic is not used in Cyprus and therefore not included in the table.

**Table 7.7. Allocation of waste to types waste disposal sites**

| | Deep unmanaged | Shallow unmanaged | Managed-anaerobic |
|---|---|---|---|
| **Nicosia** | all urban until 2011; all from 2012 to 2018 | all rural until 2011 | all from 2019 |
| **Ammochostos** | all urban until 2009 | all rural until 2009 | all from 2010 |
| **Larnaca** | all urban until 2009 | all rural until 2009 | all from 2010 |
| **Limassol** | all urban until 2011; all from 2012 to 2017 | all rural until 2011 | all from 2018 |
| **Pafos** | all urban until 2005 | all rural until 2005 | all from 2006 |

**Table 7.8. Urban and Rural population of Cyprus per district at the end of the year (1000s)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| Regional Population | | | | | | | | |
| Nicosia | 238.6 | 244.9 | 251.3 | 256.3 | 260.8 | 264.6 | 268 | 271 |
| Ammochostos | 30.3 | 31.0 | 31.7 | 32.7 | 33.6 | 34.4 | 35.1 | 35.8 |
| Larnaca | 98.0 | 100.8 | 103.5 | 105.8 | 107.8 | 109.6 | 111.2 | 112.6 |

[73] Mrs. Elena Christodoulidou, Environment Officer, Solid Waste Management Unit, Department of Environment, tel. +357 22866248, email echristodoulidou@environment.moa.gov.cy

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Limassol | 168.7 | 173.6 | 178.6 | 182.4 | 185.8 | 188.8 | 191.5 | 193.9 |
| Pafos | 51.5 | 52.8 | 54.1 | 55.7 | 57.4 | 58.9 | 60.5 | 61.9 |
| TOTAL | 587.1 | 603.1 | 619.2 | 632.9 | 645.4 | 656.3 | 666.3 | 675.2 |
| Urban Population | | | | | | | | |
| Nicosia | 171.6 | 177.0 | 182.5 | 186.4 | 189.9 | 193 | 195.7 | 198.2 |
| Ammochostos | 0.0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | 0 |
| Larnaca | 58.3 | 60.5 | 62.6 | 64.1 | 65.4 | 66.6 | 67.6 | 68.6 |
| Limassol | 130.6 | 135.4 | 140.3 | 143.6 | 146.6 | 149.2 | 151.7 | 153.8 |
| Pafos | 30.2 | 31.8 | 33.5 | 35.0 | 36.6 | 38.1 | 39.7 | 41.2 |
| TOTAL | 390.7 | 404.7 | 418.9 | 429.1 | 438.5 | 446.9 | 454.7 | 461.8 |
| Rural population | | | | | | | | |
| Nicosia | 67.0 | 67.9 | 68.8 | 69.9 | 70.9 | 71.6 | 72.3 | 72.8 |
| Ammochostos | 30.3 | 31.0 | 31.7 | 32.7 | 33.6 | 34.4 | 35.1 | 35.8 |
| Larnaca | 39.7 | 40.3 | 40.9 | 41.7 | 42.4 | 43.0 | 43.6 | 44.0 |
| Limassol | 38.1 | 38.2 | 38.3 | 38.8 | 39.2 | 39.6 | 39.8 | 40.1 |
| Pafos | 21.3 | 21.0 | 20.6 | 20.7 | 20.8 | 20.8 | 20.8 | 20.7 |
| TOTAL | 196.4 | 198.4 | 200.3 | 203.8 | 206.9 | 209.4 | 211.6 | 213.4 |
| | | | | | | | | |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| Regional Population | | | | | | | | |
| Nicosia | 273.4 | 275.8 | 277.9 | 280.3 | 283.5 | 286.2 | 289.7 | 293.5 |
| Ammochostos | 36.5 | 37.1 | 37.8 | 38.5 | 39.1 | 39.6 | 40.1 | 40.8 |
| Larnaca | 113.9 | 115.1 | 116.2 | 117.5 | 119.3 | 120.8 | 122.8 | 124.8 |
| Limassol | 195.8 | 197.8 | 199.5 | 201.6 | 204.6 | 205.7 | 208.1 | 210.8 |
| Pafos | 63.3 | 64.7 | 66.1 | 67.6 | 68.6 | 70.6 | 72.3 | 74.1 |
| TOTAL | 682.9 | 690.5 | 697.5 | 705.5 | 715.1 | 722.9 | 733.0 | 744.0 |
| Urban Population | | | | | | | | |
| Nicosia | 200.2 | 202.3 | 204.1 | 206.2 | 208.9 | 210.3 | 212.8 | 215.4 |
| Ammochostos | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 |
| Larnaca | 69.5 | 70.3 | 71.1 | 72.0 | 73.2 | 73.5 | 74.4 | 75.4 |
| Limassol | 155.7 | 157.5 | 159.2 | 161.2 | 163.9 | 163.1 | 164.3 | 165.7 |
| Pafos | 42.7 | 44.2 | 45.7 | 47.3 | 48.3 | 49.5 | 50.7 | 52 |
| TOTAL | 468.1 | 474.3 | 480.1 | 486.7 | 494.3 | 496.4 | 502.2 | 508.5 |
| Rural population | | | | | | | | |
| Nicosia | 73.2 | 73.5 | 73.8 | 74.1 | 74.6 | 75.9 | 76.9 | 78.1 |
| Ammochostos | 36.5 | 37.1 | 37.8 | 38.5 | 39.1 | 39.6 | 40.1 | 40.8 |
| Larnaca | 44.4 | 44.8 | 45.1 | 45.5 | 46.1 | 47.3 | 48.4 | 49.4 |
| Limassol | 40.1 | 40.3 | 40.3 | 40.4 | 40.7 | 42.6 | 43.8 | 45.1 |
| Pafos | 20.6 | 20.5 | 20.4 | 20.3 | 20.3 | 21.1 | 21.6 | 22.1 |
| TOTAL | 214.8 | 216.2 | 217.4 | 218.8 | 220.8 | 226.5 | 230.8 | 235.5 |
| | | | | | | | | |
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Regional Population | | | | | | | | |
| Nicosia | 298.4 | 305.1 | 312.6 | 320.6 | 328 | 336.0 | 336.9 | 333.8 |
| Ammochostos | 41.6 | 42.7 | 43.8 | 45.1 | 46.3 | 47.6 | 47.9 | 47.4 |
| Larnaca | 127.4 | 130.8 | 134.5 | 138.5 | 142.3 | 146.3 | 147.2 | 145.9 |
| Limassol | 214.3 | 219 | 224.4 | 230.2 | 235.5 | 241.3 | 241.9 | 239.7 |
| Pafos | 76.2 | 78.8 | 81.6 | 84.7 | 87.7 | 90.8 | 92 | 91.2 |
| TOTAL | 757.9 | 776.4 | 796.9 | 819.1 | 839.8 | 862.0 | 865.9 | 858 |
| Urban Population | | | | | | | | |
| Nicosia | 219 | 223.7 | 229.1 | 234.9 | 240.2 | 245.9 | 246.4 | 244.1 |
| Ammochostos | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Larnaca | 76.6 | 78.4 | 80.3 | 82.4 | 84.3 | 86.4 | 86.7 | 85.9 |
| Limassol | 167.7 | 170.7 | 174.1 | 177.8 | 181.1 | 184.6 | 184.1 | 182.4 |
| Pafos | 53.5 | 55.3 | 57.3 | 59.5 | 61.6 | 63.9 | 64.9 | 64.3 |
| TOTAL | 516.8 | 528.1 | 540.8 | 554.6 | 567.2 | 580.8 | 582.1 | 576.7 |
| Rural population | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Nicosia | 79.4 | 81.4 | 83.5 | 85.7 | 87.8 | 90.1 | 90.5 | 89.7 |
| Ammochostos | 41.6 | 42.7 | 43.8 | 45.1 | 46.3 | 47.6 | 47.9 | 47.4 |
| Larnaca | 50.8 | 52.4 | 54.2 | 56.1 | 58.0 | 59.9 | 60.5 | 60 |
| Limassol | 46.6 | 48.3 | 50.3 | 52.4 | 54.4 | 56.7 | 57.8 | 57.3 |
| Pafos | 22.7 | 23.5 | 24.3 | 25.2 | 26.1 | 26.9 | 27.1 | 26.9 |
| TOTAL | 241.1 | 248.3 | 256.1 | 264.5 | 272.6 | 281.2 | 283.8 | 281.3 |
| | | | | | | | | |
| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | | |
| Regional Population | | | | | | | | |
| Nicosia | 329.5 | 330 | 332.2 | 335.9 | 341.7 | 346.4 | | |
| Ammochostos | 46.8 | 46.9 | 47 | 47.5 | 48.2 | 48.9 | | |
| Larnaca | 144 | 144.2 | 144.9 | 146.5 | 147.0 | 149.0 | | |
| Limassol | 236.6 | 237 | 239.4 | 242.0 | 244.9 | 248.3 | | |
| Pafos | 90.1 | 90.2 | 91.3 | 92.3 | 94.1 | 95.4 | | |
| TOTAL | 847 | 848.3 | 854.8 | 864.2 | 875.9 | 888.0 | | |
| Urban Population | | | | | | | | |
| Nicosia | 241 | 241.4 | 244.2 | 246.9 | 252.9 | 256.4 | | |
| Ammochostos | 0 | 0 | 0 | 0 | 0 | 0.0 | | |
| Larnaca | 84.8 | 84.9 | 85.7 | 86.6 | 87.0 | 88.2 | | |
| Limassol | 180 | 180.3 | 182.6 | 184.6 | 187.0 | 189.6 | | |
| Pafos | 63.5 | 63.6 | 64.4 | 65.1 | 66.9 | 67.8 | | |
| TOTAL | 569.3 | 570.2 | 576.9 | 583.2 | 593.8 | 602.0 | | |
| Rural population | | | | | | | | |
| Nicosia | 88.5 | 88.6 | 88 | 89.0 | 88.8 | 90.0 | | |
| Ammochostos | 46.8 | 46.9 | 47 | 47.5 | 48.2 | 48.9 | | |
| Larnaca | 59.2 | 59.3 | 59.2 | 59.9 | 60.0 | 60.8 | | |
| Limassol | 56.6 | 56.7 | 56.8 | 57.4 | 57.9 | 58.7 | | |
| Pafos | 26.6 | 26.6 | 26.9 | 27.2 | 27.2 | 27.6 | | |
| TOTAL | 277.7 | 278.1 | 277.9 | 281.0 | 282.1 | 286.0 | | |

**Table 7.9. Amount of waste generated per district and type of waste disposal site (kt)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| Nicosia | | | | | | | | |
| deep unmanaged | 89.4 | 94.0 | 98.7 | 102.7 | 106.5 | 110.1 | 115.1 | 117.6 |
| shallow unmanaged | 34.9 | 36.1 | 37.2 | 38.5 | 39.8 | 40.9 | 42.5 | 43.2 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ammochostos | | | | | | | | |
| deep unmanaged | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| shallow unmanaged | 15.8 | 16.5 | 17.1 | 18.0 | 18.8 | 19.6 | 20.6 | 21.2 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Larnaca | | | | | | | | |
| deep unmanaged | 30.4 | 32.1 | 33.9 | 35.3 | 36.7 | 38.0 | 39.8 | 40.7 |
| shallow unmanaged | 20.7 | 21.4 | 22.1 | 23.0 | 23.8 | 24.5 | 25.6 | 26.1 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Limassol | | | | | | | | |
| deep unmanaged | 68.1 | 71.9 | 75.9 | 79.1 | 82.2 | 85.2 | 89.2 | 91.3 |
| shallow unmanaged | 19.9 | 20.3 | 20.7 | 21.4 | 22.0 | 22.6 | 23.4 | 23.8 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pafos | | | | | | | | |
| deep unmanaged | 15.7 | 16.9 | 18.1 | 19.3 | 20.5 | 21.7 | 23.4 | 24.4 |
| shallow unmanaged | 11.1 | 11.2 | 11.1 | 11.4 | 11.7 | 11.9 | 12.2 | 12.3 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| Nicosia | | | | | | | | |
| deep unmanaged | 119.7 | 121.7 | 124.5 | 129.9 | 132.5 | 136.8 | 140.9 | 142.8 |
| shallow unmanaged | 43.8 | 44.2 | 45.0 | 46.7 | 47.3 | 49.4 | 50.9 | 51.8 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ammochostos | | | | | | | | |
| deep unmanaged | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| shallow unmanaged | 21.8 | 22.3 | 23.1 | 24.3 | 24.8 | 25.8 | 26.6 | 27.0 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Larnaca | | | | | | | | |
| deep unmanaged | 41.6 | 42.3 | 43.4 | 45.4 | 46.4 | 47.8 | 49.3 | 50.0 |
| shallow unmanaged | 26.6 | 26.9 | 27.5 | 28.7 | 29.2 | 30.8 | 32.1 | 32.7 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Limassol | | | | | | | | |
| deep unmanaged | 93.1 | 94.7 | 97.1 | 101.5 | 104.0 | 106.1 | 108.8 | 109.8 |
| shallow unmanaged | 24.0 | 24.2 | 24.6 | 25.4 | 25.8 | 27.7 | 29.0 | 29.9 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pafos | | | | | | | | |
| deep unmanaged | 25.5 | 26.6 | 27.9 | 29.8 | 30.6 | 32.2 | 33.6 | 34.5 |
| shallow unmanaged | 12.3 | 12.3 | 12.4 | 12.8 | 12.9 | 13.7 | 14.3 | 14.6 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Nicosia | | | | | | | | |
| deep unmanaged | 145.4 | 149.4 | 154.5 | 157.1 | 144.4 | 137.8 | 182.2 | 168.3 |
| shallow unmanaged | 52.7 | 54.4 | 56.3 | 57.3 | 52.8 | 50.5 | 0 | 0 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ammochostos | | | | | | | | |
| deep unmanaged | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| shallow unmanaged | 27.6 | 28.5 | 29.5 | 30.2 | 0 | 0 | 0 | 0 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 27.8 | 26.7 | 25.9 | 23.9 |
| Larnaca | | | | | | | | |
| deep unmanaged | 50.8 | 52.4 | 54.2 | 55.1 | 0 | 0 | 0 | 0 |
| shallow unmanaged | 33.7 | 35.0 | 36.6 | 37.5 | 0 | 0 | 0 | 0 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 85.6 | 82.0 | 79.6 | 73.6 |
| Limassol | | | | | | | | |
| deep unmanaged | 111.3 | 114.0 | 117.4 | 118.9 | 108.9 | 103.5 | 130.8 | 120.9 |
| shallow unmanaged | 30.9 | 32.3 | 33.9 | 35.0 | 32.7 | 31.8 | 0 | 0 |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pafos | | | | | | | | |
| deep unmanaged | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| shallow unmanaged | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| managed-anaerobic | 50.6 | 52.6 | 55.0 | 56.6 | 52.7 | 50.9 | 49.8 | 46.0 |
| | | | | | | | | |
| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | | |
| Nicosia | | | | | | | | |
| deep unmanaged | 153.9 | 160.5 | 165.9 | 165.3 | 154.0 | 0 | | |
| shallow unmanaged | 0 | 0 | 0 | 0 | 0 | 0 | | |
| managed-anaerobic | 0 | 0 | 0 | 0 | 0 | 149.2 | | |
| Ammochostos | | | | | | | | |
| deep unmanaged | 0 | 0 | 0 | 0 | 0 | | | |
| shallow unmanaged | 0 | 0 | 0 | 0 | 0 | | | |
| managed-anaerobic | 21.9 | 22.8 | 23.5 | 23.4 | 21.7 | 21.1 | | |
| Larnaca | | | | | | | | |
| deep unmanaged | 0 | 0 | 0 | 0 | 0 | | | |
| shallow unmanaged | 0 | 0 | 0 | 0 | 0 | | | |
| managed-anaerobic | 67.3 | 70.1 | 72.4 | 72.1 | 66.3 | 64.2 | | |
| Limassol | | | | | | | | |
| deep unmanaged | 110.5 | 115.3 | 119.6 | 119.1 | 0 | | | |
| shallow unmanaged | 0 | 0 | 0 | 0 | 0 | | | |
| managed-anaerobic | 0 | 0 | 0 | 0 | 110.4 | 107.0 | | |
| Pafos | | | | | | | | |
| deep unmanaged | 0 | 0 | 0 | 0 | 0 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| shallow unmanaged | 0 | 0 | 0 | 0 | 0 | | | |
| managed-anaerobic | 42.1 | 43.9 | 45.6 | 45.4 | 42.4 | 41.1 | | |

**Table 7.10. Allocation of population and waste to types waste disposal sites**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| Population ($10^6$) | | | | | | | | |
| Un-managed, deep | 0.391 | 0.405 | 0.419 | 0.429 | 0.439 | 0.447 | 0.455 | 0.462 |
| Un-managed, shallow | 0.196 | 0.198 | 0.200 | 0.204 | 0.207 | 0.209 | 0.212 | 0.213 |
| Managed, anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0.587 | 0.603 | 0.619 | 0.633 | 0.645 | 0.656 | 0.666 | 0.675 |
| Waste production (Gg) | | | | | | | | |
| Un-managed, deep | 203.6 | 214.9 | 226.6 | 236.4 | 245.9 | 255.1 | 267.4 | 274.0 |
| Un-managed, shallow | 102.4 | 105.4 | 108.4 | 112.3 | 116.0 | 119.5 | 124.5 | 126.6 |
| Managed, anaerobic | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 306.0 | 320.3 | 335.0 | 348.7 | 361.9 | 374.6 | 391.9 | 400.6 |
| | | | | | | | | |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| Population ($10^6$) | | | | | | | | |
| Un-managed, deep | 0.468 | 0.474 | 0.480 | 0.487 | 0.494 | 0.496 | 0.502 | 0.509 |
| Un-managed, shallow | 0.215 | 0.216 | 0.217 | 0.219 | 0.221 | 0.227 | 0.231 | 0.236 |
| Managed, anaerobic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0.683 | 0.691 | 0.698 | 0.706 | 0.715 | 0.723 | 0.733 | 0.744 |
| Waste production (Gg) | | | | | | | | |
| Un-managed, deep | 280.0 | 285.3 | 292.9 | 306.6 | 313.6 | 322.9 | 332.6 | 337.0 |
| Un-managed, shallow | 128.5 | 130.0 | 132.6 | 137.8 | 140.1 | 147.3 | 152.9 | 156.1 |
| Managed, anaerobic | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 408.4 | 415.3 | 425.5 | 444.4 | 453.7 | 470.2 | 485.5 | 493.1 |
| | | | | | | | | |
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Population ($10^6$) | | | | | | | | |
| Un-managed, deep | 0.463 | 0.473 | 0.484 | 0.495 | 0.421 | 0.431 | 0.579 | 0.574 |
| Un-managed, shallow | 0.218 | 0.225 | 0.232 | 0.239 | 0.142 | 0.147 | 0 | 0 |
| Managed, anaerobic | 0.076 | 0.079 | 0.082 | 0.085 | 0.276 | 0.285 | 0.287 | 0.285 |
| TOTAL | 0.758 | 0.776 | 0.797 | 0.819 | 0.840 | 0.862 | 0.866 | 0.858 |
| Waste production (Gg) | | | | | | | | |
| Un-managed, deep | 307.6 | 315.8 | 326.1 | 331.1 | 253.3 | 241.3 | 313.0 | 289.2 |
| Un-managed, shallow | 145.0 | 150.2 | 156.4 | 160.0 | 85.5 | 82.3 | 0.0 | 0.0 |
| Managed, anaerobic | 50.6 | 52.6 | 55.0 | 56.6 | 166.1 | 159.6 | 155.3 | 143.5 |
| TOTAL | 503.1 | 518.6 | 537.5 | 547.8 | 504.9 | 483.1 | 468.3 | 432.7 |
| | | | | | | | | |
| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Population ($10^6$) | | | | | | | | |
| Un-managed, deep | 0.566 | 0.567 | 0.572 | 0.578 | 0.342 | 0 | 0 | 0 |
| Un-managed, shallow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Managed, anaerobic | 0.281 | 0.281 | 0.283 | 0.286 | 0.534 | 0.888 | 0.896 | 0.905 |
| TOTAL | 0.847 | 0.848 | 0.855 | 0.864 | 0.876 | 0.888 | 0.896 | 0.905 |
| Waste production (Gg) | | | | | | | | |
| Un-managed, deep | 264.5 | 275.7 | 285.5 | 284.2 | 154.1 | 0.0 | 0.0 | 0.0 |
| Un-managed, shallow | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Managed, anaerobic | 131.2 | 136.8 | 141.5 | 140.8 | 241.0 | 382.5 | 365.7 | 356.0 |
| TOTAL | 395.7 | 412.5 | 427.0 | 425.1 | 395.1 | 382.5 | 365.7 | 356.0 |
| | | | | | | | | |
| | **2022** | **2023** | | | | | | |
| Population ($10^6$) | | | | | | | | |
| Un-managed, deep | 0 | 0 | | | | | | |
| Un-managed, shallow | 0 | 0 | | | | | | |
| Managed, anaerobic | 0.920 | 0.934 | | | | | | |
| TOTAL | 0.920 | 0.934 | | | | | | |

| Waste production (Gg) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Un-managed, deep | 0.0 | 0 | | | | | | | |
| Un-managed, shallow | 0.0 | 0 | | | | | | | |
| Managed, anaerobic | 366.3 | 383.6 | | | | | | | |
| TOTAL | 366.3 | 383.6 | | | | | | | |

**Composition of MSW disposed at SWDS**

In previous inventories, the breakdown on composition of MSW to disposal sites was based on evaluations that took place years ago, hence not reflecting the implementation of the latest years' waste policy in Cyprus. In this report, an assumption of constant waste composition for the years 2005–2021 was reported based on the 2020 review. A new study is expected to take place this year to reflect on the implementation of waste policy in Cyprus and to provide more accurate results on composition of MSW to disposal sites.

**Table 7.11. Composition of MSW disposed at SWDS**

| | Paper | Textiles | Wood | Food waste | Garden | Plastics, other inert |
|---|---|---|---|---|---|---|
| **1990** | 38.58% | 6.28% | 27.58% | 2.31% | 6.39% | 18.86% |
| **1991** | 38.58% | 6.28% | 27.58% | 2.31% | 6.39% | 18.86% |
| **1992** | 38.58% | 6.28% | 27.58% | 2.31% | 6.39% | 18.86% |
| **1993** | 38.58% | 6.28% | 27.58% | 2.31% | 6.39% | 18.86% |
| **1994** | 38.58% | 6.28% | 27.58% | 2.31% | 6.39% | 18.86% |
| **1995** | 38.58% | 6.28% | 27.58% | 2.31% | 6.39% | 18.86% |
| **1996** | 38.58% | 6.28% | 27.58% | 2.31% | 6.39% | 18.86% |
| **1997** | 38.80% | 6.32% | 27.62% | 2.32% | 6.43% | 18.52% |
| **1998** | 38.68% | 6.30% | 27.41% | 2.31% | 6.41% | 18.89% |
| **1999** | 38.75% | 6.31% | 27.43% | 2.32% | 6.42% | 18.77% |
| **2000** | 38.76% | 6.31% | 27.34% | 2.32% | 6.42% | 18.85% |
| **2001** | 38.82% | 6.32% | 27.42% | 2.32% | 6.43% | 18.68% |
| **2002** | 38.81% | 6.32% | 27.42% | 2.32% | 6.43% | 18.70% |
| **2003** | 38.79% | 6.31% | 27.43% | 2.33% | 6.43% | 18.71% |
| **2004** | 38.77% | 6.31% | 27.43% | 2.33% | 6.42% | 18.73% |
| **2005** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2006** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2007** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2008** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2009** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2010** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2011** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2012** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2013** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2014** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2015** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2016** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2017** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2018** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2019** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2020** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2021** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2022** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |
| **2023** | 38.75% | 6.31% | 27.44% | 2.33% | 6.42% | 18.75% |

**Total non-municipal solid waste**

In addition to the municipal solid waste production data presented above, data has been obtained for the following additional solid waste categories: Animal and vegetal wastes, paper and cardboard wastes, Wood wastes, Textile wastes and Industrial effluent sludges. Data was obtained from the National

Statistical Service[74]. The Statistical Service has collected the data for the purposes of compliance with Regulation (EC) No 2150/2002 of 25 November 2002 on waste statistics, by the application of the methodologies presented in the relevant manuals published by EUROSTAT[75].

The available data for the pre-mentioned categories is presented in Table 7.12.

**Table 7.12. Total waste disposal – landfilled for non-municipal solid waste (in tonnes)**

| Category | 2010 | 2012 | 2014 | 2016 | 2018 | 2020 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|
| Industrial effluent sludges | 299 | 177 | 539 | 672 | 211 | 0 | 0 | 0 |
| Wood wastes | 17481 | 10589 | 8769 | 5415 | 4426 | 0 | 0 | 0 |
| Textile wastes | : | 14 | 13 | 13 | 12 | 0 | 0 | 0 |
| Animal and vegetal wastes | 201439 | 17941 | 11913 | 10434 | 9613 | 5476 | 3229 | 1933 |

The first reference year for which data for Generation and Treatment of Waste is available is 2004, in accordance with the provisions of the Waste Statistics Regulation (EC) No 2150/2002. No data are available for Cyprus before 2004. The methodology applied may differ between years, due to the amendment of the Regulation (data 2010 and onwards), and moreover due to improved methods of reporting waste following Eurostat's recommendations. Data revisions were applied from 2012 onwards.

An estimation of the activity data for the years 2013, 2015, 2017 and 2019 was made by obtaining the average of the years before and after; i.e. 2012 and 2014; 2014 and 2016; 2016 and 2018; 2018 and 2020 respectively.

The annual change of the Gross Domestic Product at Constant market prices of 2005 to estimate activity data for 2023.

To estimate the activity data for the years prior to 2012, going back to the year 1950 (see Annex 3.2), the annual change of the Gross Domestic Product at Constant market prices of 2005 was used, as published by the Statistical Service in the Statistical Abstract[76] (Table 7.13 for the period 1990–2011).

**Table 7.13. Gross Domestic Product (GDP) at Constant market prices of 2005 (1990–2011)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| GDP (€mn) | 7650 | 7704 | 8428 | 8487 | 8988 | 10191 | 10355 | 10603 |
| Annual change | | 0.7% | 9.4% | 0.7% | 5.9% | 13.4% | 1.6% | 2.4% |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| GDP (€mn) | 11139 | 11663 | 12330 | 12773 | 13186 | 13556 | 14180 | 14731 |
| Annual change | 5.1% | 4.7% | 5.7% | 3.6% | 3.2% | 2.8% | 4.6% | 3.9% |
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | | |
| GDP (€mn) | 15397 | 16156 | 16747 | 16407 | 16631 | 16698 | | |
| Annual change | 4.5% | 4.9% | 3.7% | -2.0% | 1.4% | 0.4% | | |

The resulting waste production per waste stream obtained from the application of the assumptions and methods presented above is presented in Table 7.14 for the complete time series.

**Table 7.14. Solid waste production per waste stream 1990–2023 (in tonnes)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| Industrial effluent sludges | 64 | 64 | 71 | 72 | 76 | 104 | 105 | 108 |
| Wood wastes | 3831 | 3858 | 4259 | 4289 | 4558 | 6217 | 6296 | 6466 |

[74] Ms. Marilena Kythreotou, Statistical Officer A', tel. +357 22 602317, mkythreotou@cystat.mof.gov.cy
[75] Manual on waste statistics, available at http://ec.europa.eu/eurostat/product?code=KS-RA-13-015&language=en; Waste generation and treatment (ESMS metadata file — env_wasgt_esms), available at http://ec.europa.eu/eurostat/cache/metadata/en/env_wasgt_esms.htm
[76] Available at http://www.cystat.gov.cy/mof/cystat/statistics.nsf/All/9707F78B64756B8AC225809700377869/$file/ABSTRACT-2014-EN-281215.pdf?OpenElement

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Textile wastes | 5 | 5 | 6 | 6 | 6 | 8 | 8 | 9 |
| Animal and vegetal wastes | 6491 | 6537 | 7216 | 7267 | 7722 | 10534 | 10667 | 10956 |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| Industrial effluent sludges | 115 | 121 | 129 | 134 | 139 | 143 | 151 | 158 |
| Wood wastes | 6887 | 7250 | 7710 | 8027 | 8337 | 8562 | 9015 | 9475 |
| Textile wastes | 9 | 10 | 10 | 11 | 11 | 11 | 12 | 13 |
| Animal and vegetal wastes | 11669 | 12283 | 13062 | 13600 | 14126 | 14506 | 15274 | 16053 |
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Industrial effluent sludges | 166 | 175 | 182 | 178 | 182 | 183 | 177 | 358 |
| Wood wastes | 9943 | 10478 | 10874 | 10659 | 10908 | 10954 | 10589 | 9679 |
| Textile wastes | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Animal and vegetal wastes | 16847 | 17752 | 18424 | 18060 | 18482 | 18559 | 17941 | 14927 |
| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Industrial effluent sludges | 539 | 605.5 | 672 | 442 | 211 | 106 | 0 | 0 |
| Wood wastes | 8769 | 7092 | 5415 | 4921 | 4426 | 2213 | 0 | 0 |
| Textile wastes | 13 | 13 | 13 | 13 | 12 | 6 | 0 | 0 |
| Animal and vegetal wastes | 11913 | 11173.5 | 10434 | 10024 | 9613 | 7545 | 5476 | 4525 |
| | **2022** | **2023** | | | | | | |
| Industrial effluent sludges | 0.0 | 0 | | | | | | |
| Wood wastes | 0.0 | 0 | | | | | | |
| Textile wastes | 0.0 | 0 | | | | | | |
| Animal and vegetal wastes | 3229 | 1933 | | | | | | |

**Reservations and reflections on the methodology applied**

(a) The backcasting of the waste production using a purely economic indicator shows the weakness that it does not represent the changes in the waste management practices that have been occurring after 2004, when Cyprus joined the European Union.

(b) During the period 1990–2000 Cyprus had considerably higher industrial activity than today, which started decreasing during the late 1990s. During the start of 2000s and especially after Cyprus joined the European Union, the economy of Cyprus focused more on services. These conditions cannot be represented in the backcasting with the GDP applied.

However, given the information available, this is the only methodology that can be applied to complete the series. Attempts will be made to improve the estimation of waste production through the examination of other available data and methods for future submission.

**Allocation of waste to types of waste disposal sites**

For the allocation of solid waste estimated to different types of waste disposal sites, it was decided to use the Number of Establishments by Economic Activity NACE (Rev. 2) and District for the year 2017, published by the Statistical Service in 2018[77] (Table 7.15).

[77] Available at https://www.mof.gov.cy/mof/cystat/statistics.nsf/All/8E65F57AC6EB3259C22583590036DE1F/$file/ESTABLISMENTS_NACE2_DISTRICT-2017-041218.pdf?OpenElement

**Table 7.15. Number of Establishments by Economic Activity NACE (Rev. 2) and District for the year 2017 associated with the production Industrial effluent sludges, Wood wastes, Textile wastes and Animal and vegetal wastes**

| Number of Establishments by Economic Activity NACE (Rev. 2) and District (2017) | Nicosia | Ammochostos | Larnaca | Limassol | Pafos | TOTAL |
|---|---|---|---|---|---|---|
| **WOOD WASTES** | | | | | | |
| 16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials | 264 | 51 | 164 | 297 | 85 | |
| 31091 Manufacture of wooden furniture | 80 | 5 | 25 | 29 | 10 | |
| 43321 Installation of non self-manufactured doors, windows, kitchens, frames and the like of wood or other materials | 25 | 6 | 9 | 29 | 9 | |
| 46731 Wholesale of wood | 28 | 4 | 8 | 16 | 5 | |
| 47524 Retail sale of wood | 10 | 2 | 4 | 7 | 2 | |
| **TOTAL wood** | **407** | **68** | **210** | **378** | **111** | **1174** |
| **contribution of district to total** | **35%** | **6%** | **18%** | **32%** | **9%** | |
| **TEXTILE WASTES** | | | | | | |
| 13 Manufacture of textiles | 52 | 4 | 23 | 22 | 7 | |
| 46161 Agents involved in the sale of textiles, clothing, fur, footwear and leather goods | 8 | 0 | 4 | 8 | 0 | |
| 4641 Wholesale of textiles | 32 | 1 | 7 | 18 | 0 | |
| 4751 Retail sale of textiles in specialized stores | 43 | 6 | 19 | 48 | 13 | |
| 46411 Wholesale of textiles (e.g fabrics, yarn, household linen, sewing thread, etc.) | 32 | 1 | 7 | 18 | 0 | |
| 47511 Retail sale of fabrics | 13 | 1 | 3 | 15 | 4 | |
| **TOTAL textile** | **180** | **13** | **63** | **129** | **24** | **409** |
| **contribution of district to total** | **44%** | **3%** | **15%** | **32%** | **6%** | |
| **ANIMAL AND VEGETAL WASTES** | | | | | | |
| 014 Animal production | 343 | 70 | 363 | 190 | 110 | |
| 0162 Support activities for animal production | 2 | 0 | 0 | 2 | 0 | |
| 104 Manufacture of vegetable and animal oils and fats | 13 | 3 | 10 | 3 | 6 | |
| 103 Processing and preserving of fruit and vegetables | 14 | 1 | 8 | 18 | 4 | |
| 104 Manufacture of vegetable and animal oils and fats | 13 | 3 | 10 | 3 | 6 | |
| 105 Manufacture of dairy products | 30 | 7 | 25 | 33 | 9 | |
| 10611 Production of flour from cereals and vegetables | 4 | 1 | 1 | 2 | 0 | |
| 4631 Wholesale of fruit and vegetables | 57 | 18 | 39 | 46 | 18 | |
| 4721 Retail sale of fruit and vegetables in specialized stores | 58 | 8 | 36 | 35 | 10 | |
| 0113 Growing of vegetables and melons, roots and tubers | 155 | 387 | 321 | 134 | 117 | |
| **TOTAL Animal and vegetal products** | **689** | **498** | **813** | **466** | **280** | **2746** |
| **contribution of district to total** | **25%** | **18%** | **30%** | **17%** | **10%** | |
| **INDUSTRIAL EFFLUENT SLUDGES** | | | | | | |
| **total establishments** | **39966** | **6865** | **16308** | **30444** | **11436** | **105019** |
| **contribution of district to total** | **38%** | **7%** | **16%** | **29%** | **11%** | |

Assumptions for allocation have been based on the information provided by the Solid Waste Management Unit of the Department of Environment, which is the same as for municipal solid waste (see Table 7.7). The categorization is based on the disposal of the waste according to their origin; i.e. urban or rural. All waste generated by industrial activities are assumed as urban waste that is transferred to either deep unmanaged of managed-anaerobic sites.

The resulting amount of waste generated per district is presented in Table 7.16, while the total quantities of solid waste disposed per type of waste and waste disposal site are presented in Table 7.17.

**Table 7.16. Amount of non-municipal solid waste generated per district (tonnes)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| **Nicosia** | | | | | | | | |
| Industrial effluent sludges | 24.4 | 24.5 | 27.1 | 27.3 | 29.0 | 39.5 | 40.0 | 41.1 |
| Wood wastes | 1328.2 | 1337.6 | 1476.4 | 1486.9 | 1580.0 | 2155.3 | 2182.6 | 2241.8 |
| Textile wastes | 2.2 | 2.2 | 2.5 | 2.5 | 2.7 | 3.6 | 3.7 | 3.8 |
| Animal and vegetal wastes | 1628.8 | 1640.3 | 1810.5 | 1823.3 | 1937.5 | 2643.0 | 2676.4 | 2749.0 |
| | | | | | | | | |
| **Ammochostos** | | | | | | | | |
| Industrial effluent sludges | 4.2 | 4.2 | 4.7 | 4.7 | 5.0 | 6.8 | 6.9 | 7.1 |
| Wood wastes | 221.9 | 223.5 | 246.7 | 248.4 | 264.0 | 360.1 | 364.7 | 374.5 |
| Textile wastes | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 |
| Animal and vegetal wastes | 1177.3 | 1185.6 | 1308.6 | 1317.9 | 1400.4 | 1910.3 | 1934.5 | 1986.9 |
| | | | | | | | | |
| **Larnaca** | | | | | | | | |
| Industrial effluent sludges | 9.9 | 10.0 | 11.1 | 11.1 | 11.8 | 16.1 | 16.3 | 16.8 |
| Wood wastes | 685.3 | 690.2 | 761.8 | 767.2 | 815.2 | 1112.1 | 1126.1 | 1156.7 |
| Textile wastes | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 | 1.3 | 1.3 | 1.3 |
| Animal and vegetal wastes | 1921.9 | 1935.5 | 2136.3 | 2151.4 | 2286.2 | 3118.6 | 3158.1 | 3243.7 |
| | | | | | | | | |
| **Limassol** | | | | | | | | |
| Industrial effluent sludges | 18.6 | 18.7 | 20.6 | 20.8 | 22.1 | 30.1 | 30.5 | 31.3 |
| Wood wastes | 1233.6 | 1242.3 | 1371.2 | 1380.9 | 1467.4 | 2001.7 | 2027.0 | 2082.0 |
| Textile wastes | 1.6 | 1.6 | 1.8 | 1.8 | 1.9 | 2.6 | 2.6 | 2.7 |
| Animal and vegetal wastes | 1101.6 | 1109.4 | 1224.5 | 1233.2 | 1310.4 | 1787.6 | 1810.2 | 1859.3 |
| | | | | | | | | |
| **Pafos** | | | | | | | | |
| Industrial effluent sludges | 7.0 | 7.0 | 7.8 | 7.8 | 8.3 | 11.3 | 11.5 | 11.8 |
| Wood wastes | 362.2 | 364.8 | 402.7 | 405.5 | 430.9 | 587.8 | 595.2 | 611.4 |
| Textile wastes | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 |
| Animal and vegetal wastes | 661.9 | 666.6 | 735.8 | 741.0 | 787.4 | 1074.1 | 1087.6 | 1117.2 |

| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| **Nicosia** | | | | | | | | |
| Industrial effluent sludges | 43.8 | 46.1 | 49.0 | 51.1 | 53.0 | 54.5 | 57.3 | 60.3 |
| Wood wastes | 2387.7 | 2513.3 | 2672.7 | 2782.7 | 2890.3 | 2968.2 | 3125.3 | 3284.7 |
| Textile wastes | 4.0 | 4.2 | 4.5 | 4.7 | 4.9 | 5.0 | 5.2 | 5.5 |
| Animal and vegetal wastes | 2927.9 | 3081.9 | 3277.5 | 3412.3 | 3544.3 | 3639.8 | 3832.4 | 4027.9 |
| | | | | | | | | |
| **Ammochostos** | | | | | | | | |
| Industrial effluent sludges | 7.5 | 7.9 | 8.4 | 8.8 | 9.1 | 9.4 | 9.9 | 10.4 |
| Wood wastes | 398.9 | 419.9 | 446.5 | 464.9 | 482.9 | 495.9 | 522.2 | 548.8 |
| Textile wastes | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 |
| Animal and vegetal wastes | 2116.3 | 2227.6 | 2368.9 | 2466.4 | 2561.8 | 2630.8 | 2770.0 | 2911.3 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Larnaca** | | | | | | | | |
| Industrial effluent sludges | 17.9 | 18.8 | 20.0 | 20.8 | 21.6 | 22.2 | 23.4 | 24.6 |
| Wood wastes | 1232.0 | 1296.8 | 1379.0 | 1435.8 | 1491.3 | 1531.5 | 1612.5 | 1694.8 |
| Textile wastes | 1.4 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.9 |
| Animal and vegetal wastes | 3454.8 | 3636.6 | 3867.3 | 4026.5 | 4182.1 | 4294.8 | 4522.1 | 4752.8 |
| | | | | | | | | |
| **Limassol** | | | | | | | | |
| Industrial effluent sludges | 33.4 | 35.1 | 37.4 | 38.9 | 40.4 | 41.5 | 43.7 | 45.9 |
| Wood wastes | 2217.5 | 2334.2 | 2482.3 | 2584.4 | 2684.4 | 2756.7 | 2902.6 | 3050.6 |
| Textile wastes | 2.9 | 3.0 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 | 4.0 |
| Animal and vegetal wastes | 1980.3 | 2084.5 | 2216.7 | 2307.9 | 2397.1 | 2461.7 | 2592.0 | 2724.2 |
| | | | | | | | | |
| **Pafos** | | | | | | | | |
| Industrial effluent sludges | 12.5 | 13.2 | 14.0 | 14.6 | 15.2 | 15.6 | 16.4 | 17.2 |
| Wood wastes | 651.2 | 685.4 | 728.9 | 758.9 | 788.3 | 809.5 | 852.3 | 895.8 |
| Textile wastes | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 |
| Animal and vegetal wastes | 1189.9 | 1252.5 | 1331.9 | 1386.7 | 1440.3 | 1479.2 | 1557.4 | 1636.9 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| **Nicosia** | | | | | | | | |
| Industrial effluent sludges | 63.3 | 66.6 | 69.2 | 67.8 | 69.4 | 69.7 | 67.4 | 136.2 |
| Wood wastes | 3447.2 | 3632.3 | 3769.8 | 3695.3 | 3781.7 | 3797.5 | 3671.0 | 3355.5 |
| Textile wastes | 5.8 | 6.1 | 6.3 | 6.2 | 6.3 | 6.4 | 6.2 | 5.9 |
| Animal and vegetal wastes | 4227.1 | 4454.2 | 4622.8 | 4531.5 | 4637.4 | 4656.8 | 4501.6 | 3745.3 |
| | | | | | | | | |
| **Ammochostos** | | | | | | | | |
| Industrial effluent sludges | 10.9 | 11.4 | 11.9 | 11.6 | 11.9 | 12.0 | 11.6 | 23.4 |
| Wood wastes | 575.9 | 606.9 | 629.8 | 617.4 | 631.8 | 634.5 | 613.3 | 560.6 |
| Textile wastes | 0.4 | 0.4 | 0.5 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 |
| Animal and vegetal wastes | 3055.3 | 3219.4 | 3341.3 | 3275.3 | 3351.8 | 3365.9 | 3253.7 | 2707.1 |
| | | | | | | | | |
| **Larnaca** | | | | | | | | |
| Industrial effluent sludges | 25.8 | 27.2 | 28.2 | 27.7 | 28.3 | 28.4 | 27.5 | 55.6 |
| Wood wastes | 1778.6 | 1874.2 | 1945.1 | 1906.7 | 1951.2 | 1959.4 | 1894.1 | 1731.3 |
| Textile wastes | 2.0 | 2.1 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.1 |
| Animal and vegetal wastes | 4987.9 | 5255.8 | 5454.8 | 5347.0 | 5472.0 | 5494.9 | 5311.7 | 4419.4 |
| | | | | | | | | |
| **Limassol** | | | | | | | | |
| Industrial effluent sludges | 48.2 | 50.8 | 52.7 | 51.7 | 52.9 | 53.1 | 51.3 | 103.8 |
| Wood wastes | 3201.5 | 3373.5 | 3501.2 | 3432.0 | 3512.2 | 3526.9 | 3409.4 | 3116.4 |
| Textile wastes | 4.1 | 4.4 | 4.5 | 4.4 | 4.5 | 4.6 | 4.4 | 4.3 |
| Animal and vegetal wastes | 2859.0 | 3012.6 | 3126.6 | 3064.8 | 3136.4 | 3149.6 | 3044.6 | 2533.1 |
| | | | | | | | | |
| **Pafos** | | | | | | | | |
| Industrial effluent sludges | 18.1 | 19.1 | 19.8 | 19.4 | 19.9 | 19.9 | 19.3 | 39.0 |
| Wood wastes | 940.1 | 990.6 | 1028.1 | 1007.8 | 1031.4 | 1035.7 | 1001.2 | 915.1 |
| Textile wastes | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Animal and vegetal wastes | 1717.8 | 1810.1 | 1878.6 | 1841.5 | 1884.6 | 1892.4 | 1829.4 | 1522.1 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| **Nicosia** | | | | | | | | |
| Industrial effluent sludges | 205.1 | 230.4 | 255.7 | 168.0 | 80.3 | 40.1 | 0.0 | 0.0 |
| Wood wastes | 3040.0 | 2458.6 | 1877.3 | 1705.8 | 1534.4 | 767.2 | 0.0 | 0.0 |
| Textile wastes | 5.7 | 5.7 | 5.7 | 5.5 | 5.3 | 2.6 | 0.0 | 0.0 |
| Animal and vegetal wastes | 2989.1 | 2803.5 | 2618.0 | 2515.0 | 2412.0 | 1893.0 | 1374.0 | 1135.4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **Ammochostos** | | | | | | | | |
| Industrial effluent sludges | 35.2 | 39.6 | 43.9 | 28.9 | 13.8 | 6.9 | 0.0 | 0.0 |
| Wood wastes | 507.9 | 410.8 | 313.6 | 285.0 | 256.4 | 128.2 | 0.0 | 0.0 |
| Textile wastes | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0.0 | 0.0 |
| Animal and vegetal wastes | 2160.5 | 2026.4 | 1892.3 | 1817.8 | 1743.4 | 1368.2 | 993.1 | 820.7 |
| | | | | | | | | |
| **Larnaca** | | | | | | | | |
| Industrial effluent sludges | 83.7 | 94.0 | 104.4 | 68.6 | 32.8 | 16.4 | 0.0 | 0.0 |
| Wood wastes | 1568.6 | 1268.6 | 968.6 | 880.2 | 791.7 | 395.9 | 0.0 | 0.0 |
| Textile wastes | 2.0 | 2.0 | 2.0 | 1.9 | 1.8 | 0.9 | 0.0 | 0.0 |
| Animal and vegetal wastes | 3527.0 | 3308.1 | 3089.2 | 2967.6 | 2846.1 | 2233.7 | 1621.3 | 1339.8 |
| | | | | | | | | |
| **Limassol** | | | | | | | | |
| Industrial effluent sludges | 156.3 | 175.5 | 194.8 | 128.0 | 61.2 | 30.6 | 0.0 | 0.0 |
| Wood wastes | 2823.4 | 2283.5 | 1743.5 | 1584.3 | 1425.1 | 712.5 | 0.0 | 0.0 |
| Textile wastes | 4.1 | 4.1 | 4.1 | 3.9 | 3.8 | 1.9 | 0.0 | 0.0 |
| Animal and vegetal wastes | 2021.7 | 1896.2 | 1770.7 | 1701.0 | 1631.3 | 1280.3 | 929.3 | 767.9 |
| | | | | | | | | |
| **Pafos** | | | | | | | | |
| Industrial effluent sludges | 58.7 | 65.9 | 73.2 | 48.1 | 23.0 | 11.5 | 0.0 | 0.0 |
| Wood wastes | 829.1 | 670.5 | 512.0 | 465.2 | 418.5 | 209.2 | 0.0 | 0.0 |
| Textile wastes | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.4 | 0.0 | 0.0 |
| Animal and vegetal wastes | 1214.7 | 1139.3 | 1063.9 | 1022.1 | 980.2 | 769.3 | 558.4 | 461.4 |

| | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Nicosia** | | | | | | | | |
| Industrial effluent sludges | 0.0 | 0.0 | | | | | | |
| Wood wastes | 0.0 | 0.0 | | | | | | |
| Textile wastes | 0.0 | 0.0 | | | | | | |
| Animal and vegetal wastes | 810.3 | 485.1 | | | | | | |
| | | | | | | | | |
| **Ammochostos** | | | | | | | | |
| Industrial effluent sludges | 0.0 | 0.0 | | | | | | |
| Wood wastes | 0.0 | 0.0 | | | | | | |
| Textile wastes | 0.0 | 0.0 | | | | | | |
| Animal and vegetal wastes | 585.6 | 350.6 | | | | | | |
| | | | | | | | | |
| **Larnaca** | | | | | | | | |
| Industrial effluent sludges | 0.0 | 0.0 | | | | | | |
| Wood wastes | 0.0 | 0.0 | | | | | | |
| Textile wastes | 0.0 | 0.0 | | | | | | |
| Animal and vegetal wastes | 956.1 | 572.4 | | | | | | |
| | | | | | | | | |
| **Limassol** | | | | | | | | |
| Industrial effluent sludges | 0.0 | 0.0 | | | | | | |
| Wood wastes | 0.0 | 0.0 | | | | | | |
| Textile wastes | 0.0 | 0.0 | | | | | | |
| Animal and vegetal wastes | 548.0 | 328.1 | | | | | | |
| | | | | | | | | |
| **Pafos** | | | | | | | | |
| Industrial effluent sludges | 0.0 | 0.0 | | | | | | |
| Wood wastes | 0.0 | 0.0 | | | | | | |
| Textile wastes | 0.0 | 0.0 | | | | | | |
| Animal and vegetal wastes | 329.3 | 197.1 | | | | | | |

**Table 7.17. Total quantities of solid waste disposed per type of waste and waste disposal site (tonnes)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| **Deep unmanaged** | | | | | | | | |
| Industrial effluent sludges | 64.0 | 64.5 | 71.2 | 71.7 | 76.2 | 103.9 | 105.2 | 108.1 |
| Wood wastes | 3831.3 | 3858.4 | 4258.8 | 4288.9 | 4557.6 | 6217.1 | 6295.6 | 6466.4 |
| Textile wastes | 5.1 | 5.1 | 5.6 | 5.7 | 6.0 | 8.2 | 8.3 | 8.5 |
| Animal and vegetal wastes | 6491.5 | 6537.3 | 7215.7 | 7266.7 | 7722.0 | 10533.6 | 10666.7 | 10956.1 |
| **Managed anaerobic** | | | | | | | | |
| Industrial effluent sludges | NO | NO | NO | NO | NO | NO | NO | NO |
| Wood wastes | NO | NO | NO | NO | NO | NO | NO | NO |
| Textile wastes | NO | NO | NO | NO | NO | NO | NO | NO |
| Animal and vegetal wastes | NO | NO | NO | NO | NO | NO | NO | NO |

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| **Deep unmanaged** | | | | | | | | |
| Industrial effluent sludges | 115.1 | 121.2 | 128.9 | 134.2 | 139.4 | 143.1 | 150.7 | 158.4 |
| Wood wastes | 6887.3 | 7249.6 | 7709.5 | 8026.8 | 8337.1 | 8561.8 | 9014.9 | 9474.7 |
| Textile wastes | 9.1 | 9.6 | 10.2 | 10.6 | 11.0 | 11.3 | 11.9 | 12.5 |
| Animal and vegetal wastes | 11669.1 | 12283.1 | 13062.3 | 13599.8 | 14125.7 | 14506.2 | 15274.0 | 16053.0 |
| **Managed anaerobic** | | | | | | | | |
| Industrial effluent sludges | NO | NO | NO | NO | NO | NO | NO | NO |
| Wood wastes | NO | NO | NO | NO | NO | NO | NO | NO |
| Textile wastes | NO | NO | NO | NO | NO | NO | NO | NO |
| Animal and vegetal wastes | NO | NO | NO | NO | NO | NO | NO | NO |

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| **Deep unmanaged** | | | | | | | | |
| Industrial effluent sludges | 148.1 | 156.1 | 162.0 | 158.8 | 122.2 | 122.8 | 118.7 | 240.0 |
| Wood wastes | 9003.3 | 9486.9 | 9846.0 | 9651.5 | 7293.9 | 7324.5 | 7080.4 | 6471.9 |
| Textile wastes | 12.4 | 13.0 | 13.5 | 13.3 | 10.9 | 10.9 | 10.6 | 10.2 |
| Animal and vegetal wastes | 15129.3 | 15942.0 | 16545.5 | 16218.5 | 7773.8 | 7806.3 | 7546.2 | 6278.5 |
| **Managed anaerobic** | | | | | | | | |
| Industrial effluent sludges | 18.1 | 19.1 | 19.8 | 19.4 | 60.1 | 60.3 | 58.3 | 118.0 |
| Wood wastes | 940.1 | 990.6 | 1028.1 | 1007.8 | 3614.5 | 3629.6 | 3508.6 | 3207.1 |
| Textile wastes | 0.8 | 0.8 | 0.8 | 0.8 | 3.5 | 3.5 | 3.4 | 3.3 |
| Animal and vegetal wastes | 1717.8 | 1810.1 | 1878.6 | 1841.5 | 10708.3 | 10753.2 | 10394.8 | 8648.5 |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| **Deep unmanaged** | | | | | | | | |
| Industrial effluent sludges | 361.4 | 406.0 | 450.5 | 296.0 | 141.5 | 0 | 0 | 0 |
| Wood wastes | 5863.4 | 4742.1 | 3620.8 | 3290.1 | 1534.4 | 0 | 0 | 0 |
| Textile wastes | 9.8 | 9.8 | 9.8 | 9.4 | 5.3 | 0 | 0 | 0 |
| Animal and vegetal wastes | 5010.7 | 4699.7 | 4388.7 | 4216.0 | 2412.0 | 0 | 0 | 0 |
| **Managed anaerobic** | | | | | | | | |
| Industrial effluent sludges | 177.6 | 199.5 | 221.5 | 145.5 | 130.7 | 105.5 | 0.0 | 0.0 |
| Wood wastes | 2905.6 | 2349.9 | 1794.2 | 1630.4 | 2891.6 | 2213.0 | 0.0 | 0.0 |
| Textile wastes | 3.2 | 3.2 | 3.2 | 3.1 | 6.7 | 6.0 | 0.0 | 0.0 |
| Animal and vegetal wastes | 6902.3 | 6473.8 | 6045.3 | 5807.5 | 7201.0 | 7544.5 | 5476.0 | 4525.3 |

| | 2022 | 2023 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Deep unmanaged** | | | | | | | | |
| Industrial effluent sludges | 0 | 0 | | | | | | |
| Wood wastes | 0 | 0 | | | | | | |
| Textile wastes | 0 | 0 | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Animal and vegetal wastes | 0 | 0 | | | | | | |
| **Managed anaerobic** | | | | | | | | |
| Industrial effluent sludges | 0.0 | 0.0 | | | | | | |
| Wood wastes | 0.0 | 0.0 | | | | | | |
| Textile wastes | 0.0 | 0.0 | | | | | | |
| Animal and vegetal wastes | 3229.3 | 1933.3 | | | | | | |

**Estimation of $CH_4$ from waste disposal on land**

For the purpose of estimation of emissions, the default IPCC parameters have been used, assuming that waste streams have the same characteristics as the MSW component and the IPCC waste model excel template. Therefore, the quantities presented in Table 7.17 have been added to the quantities of the MSW in the model.

Degradable organic carbon (DOC) has been estimated using the following equation (equation 3.7, volume 5, pg. 3.13 of IPCC 2006 guidelines using default carbon content values (0.15 for food waste, 0.43 for wood, 0.24 for textiles and 0.05 for Sewage sludge)).

$$DOC = \Sigma_i (DOC_i * W_i)$$

Fraction of degradable organic carbon which decomposes ($DOC_F$) is assumed as 0.5, which is the default value proposed by the 2006 IPCC guidelines (pg. 3.13, volume 5).

The $CH_4$ fraction F value used is the default proposed by the IPCC guidelines, i.e. 0.5. The oxidation factors (OX) used are the defaults proposed by the IPCC guidelines (Table 3.2, pg. 3.15, vol. 5, 2006 IPCC guidelines); i.e. 0 for deep unmanaged and 0.1 for managed anaerobic. No methane is recovered from SWDS in Cyprus, therefore recovery (R) is assumed 0.

The defaults used by the IPCC waste model for Methane generation rate constant (k) are according to dry temperate climate; i.e. 0.06 for food waste, 0.02 for wood and straw and 0.04 for textiles.

According to the consultations with the Waste Management Unit of the Department of Environment, and according to the 2006 IPCC Guidelines, all SWDS not meeting the criteria of managed SWDS and which have depth smaller than 5m are classified as unmanaged disposal sites, and are therefore assumed to be shallow. The value for the methane correction factor for shallow unmanaged disposal sites is assumed to be 0.4, per the default from the IPCC 2006 guidelines (pg. 3.14, volume 5). Moreover, all SWDS not meeting the criteria of managed SWDS and which have depth greater than or equal to 5m are classified as unmanaged disposal sites, and assumed to be deep. The value for the methane conversion factor for deep unmanaged disposal sites is assumed to be 0.8, per the default from the IPCC 2006 guidelines (pg. 3.14, volume 5).

Other parameters used for the calculation of methane emissions by the IPCC waste model are Delay time of 6 months; Fraction of methane (F) in developed gas of 0.5; and Conversion factor, for C to CH, of 1.33.

The resulting $CH_4$ emissions for the total solid waste, including both municipal and non-municipal solid wastes as estimated by the IPCC Waste Model, are presented in Table 7.18.

## 7.2.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

## 7.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and

verification activities are applied for this sector.

### 7.2.4. Category-specific recalculations

There are not any improvements planned for this category.

### 7.2.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 7.3. Biological Treatment of Solid Waste (5B)

Composting and anaerobic digestion of organic waste, such as food waste, garden (yard) and park waste and sludge, is common both in developed and developing countries. Advantages of the biological treatment include: reduced volume in the waste material, stabilisation of the waste, destruction of pathogens in the waste material, and production of biogas for energy use. The end products of the biological treatment can, depending on its quality, be recycled as fertiliser and soil amendment, or be disposed in SWDS.

Emissions from biological treatment of solid waste in 2023 accounted for 2.8% of total GHG emissions from Waste sector, and 0.21% of total national emissions without LULUCF. 99.6% of the emissions are from composting (5B1) and 0.4% from anaerobic digestion at biogas facilities (5B2). The emissions from biological treatment of solid waste (5B) are presented in Table 7.18 and Figure 7.7.

**Table 7.18. Emissions from biological treatment of solid waste, 1990–2023**

| | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| $CH_4$ (Gg) | NO | NO | NO | 0.11 | 0.20 | 0.24 | 0.20 |
| $N_2O$ (Gg) | NO | NO | NO | 0.01 | 0.01 | 0.01 | 0.01 |
| Total (Gg $CO_2$ eq.) | NO | NO | NO | 4.71 | 8.55 | 10.35 | 8.85 |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| $CH_4$ (Gg) | 0.24 | 0.26 | 0.27 | 0.27 | 0.35 | 0.41 | 0.39 |
| $N_2O$ (Gg) | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Total (Gg $CO_2$ eq.) | 10.55 | 11.48 | 11.63 | 11.88 | 15.11 | 17.94 | 17.26 |

| | 2021 | 2022 | 2023 | | | | |
|---|---|---|---|---|---|---|---|
| $CH_4$ (Gg) | 0.41 | 0.43 | 0.44 | | | | |
| $N_2O$ (Gg) | 0.02 | 0.03 | 0.026 | | | | |
| Total (Gg $CO_2$ eq.) | 17.89 | 18.67 | 19.21 | | | | |

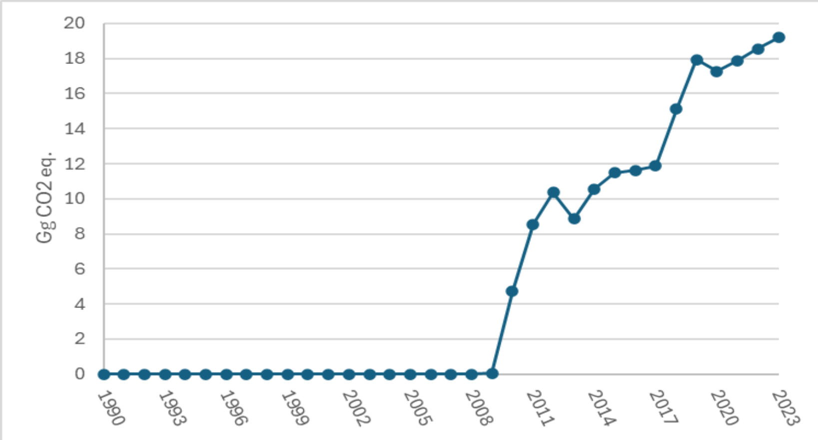


**Figure 7.6. Emissions from biological treatment of solid waste 1990–2023**

## 7.3.1. Composting (5B1)

Composting is an aerobic process and a large fraction of the degradable organic carbon (DOC) in the waste material is converted into carbon dioxide ($CO_2$). $CH_4$ is formed in anaerobic sections of the compost, but it is oxidised to a large extent in the aerobic sections of the compost. Composting can also produce emissions of $N_2O$.

### 7.3.1.1. Methodological issues

The estimation of $CH_4$ and $N_2O$ emissions from biological treatment of solid waste according to the 2006 IPCC Guidelines (chapter 4, vol. 5) involves the following steps:

**Step 1. Activity data**

Collect data on the amount and type of solid waste which is treated biologically. The amount of solid waste composted is presented in Table 7.19 and is according to the national statistics on production and management of municipal solid waste. Activity data includes the amount of composting material that is used for backfilling and sludge transported for composting.

**Table 7.19. The amount of solid waste composted for the period 2010–2023**

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Composting (1000t on a wet weight basis) | 0.00 | 0.00 | 6.78 | 7.95 | 16.03 | 17.89 |
| Compost from MTB Koshi (1000t on a wet weight basis) | 26.31 | 47.92 | 50.99 | 41.15 | 42.76 | 46.16 |
| Sludge transported for composting (1000t on a dry weight basis) | | | | | | |

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| Composting (1000t on a wet weight basis) | 16.20 | 7.56 | 9.30 | 8.08 | 5.77 | 6.87 |
| Compost from MTB Koshi (1000t on a wet weight basis) | 48.63 | 51.19 | 64.59 | 82.98 | 80.64 | 83.35 |
| Sludge transported for composting (1000t on a dry weight basis) | | 3.43 | 4.71 | 4.29 | 4.68 | 4.55 |

| | 2022 | 2023 | | | | |
|---|---|---|---|---|---|---|
| Composting (1000t on a wet weight basis) | 10.14 | 18.51 | | | | |
| Compost from MTB Koshi (1000t on a wet weight basis) | 83.20 | 77.82 | | | | |
| Sludge transported for composting (1000t on a dry weight basis) | 4.80 | 5.05 | | | | |

**Step 2. Estimation of emissions**

The $CH_4$ and $N_2O$ emissions of composting have been estimated using the default method, i.e. equations 4.1 and 4.2 of the 2006 IPCC guidelines (volume 5, page 4.5). The emission factor for $N_2O$ emissions is assumed to be 0.24 g/kg for wet waste and 0.6 g/kg for dry waste, while the $CH_4$ emission factor as 4 g/kg wet waste and 10 g/kg for dry waste (IPCC 2006, vol.5, pg. 4.6, table 4.1).

**Step 3. Subtraction of recovered gas**

According to the guidelines, the amount of recovered gas from the amount of $CH_4$ generated to estimate net annual $CH_4$ emissions should be subtracted. No recovery takes place in Cyprus therefore amount of recovered gas is 0.

**7.3.1.2. Uncertainties and time-series consistency**

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

**7.3.1.3. Category-specific QA/QC and verification**

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

**7.3.1.4. Category-specific recalculations**

Emissions from composting (5B1) were recalculated for the 2022 due to change of activity data.

The impact of recalculations is presented in the following table.

**Table 7.20. Composting (5B1) recalculations**

| **5B1 (Gg $CH_4$)** | **2022** | | | | | |
|---|---|---|---|---|---|---|
| 2024 submission | 5.00 | | | | | |
| 2025 submission | 4.81 | | | | | |
| *change* | *-3.8%* | | | | | |

**7.3.1.5. Category-specific planned improvements**

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 7.3.2 Anaerobic Digestion at Biogas Facilities (5B2)

Anaerobic digestion of organic waste expedites the natural decomposition of organic material without oxygen by maintaining the temperature, moisture content and pH close to their optimum values. Emissions of $CH_4$ from such facilities due to unintentional leakages during process disturbances or other unexpected events will generally be between 0 and 10 percent of the amount of $CH_4$ generated. In the absence of further information, use 5 percent as a default value for the $CH_4$ emissions. $N_2O$ emissions from the process are assumed to be negligible.

**7.3.2.1. Methodological issues**

The estimation of $CH_4$ emissions from biological treatment of solid waste as according to the 2006 IPCC Guidelines (chapter 4, vol. 5) involves the following steps:

**Step 1. Activity data**

Collect data on the amount of sludge transported for anaerobic treatment for biogas production. The amount of sludge transported for anaerobic treatment for biogas production is presented in Table 7.21 and is according to data provided by the Pollution Control Unit of Department of Environment under the provisions of the Urban Waste Water Treatment Directive 91/271/EEC.

**Table 7.21. The amount of sludge transported for anaerobic treatment for biogas production for the period 2009-2023**

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| Sludge transported for anaerobic treatment for biogas production (1000t on a dry weight basis) | 620 | 1549 | 2478 | 3682 | 4117 | 4061 |

| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Sludge transported for anaerobic treatment for biogas production (1000t on a dry weight basis) | 4221 | 4380 | 1044 | 1281 | 1192 | 508 |

| | 2021 | 2022 | 2023 | | | |
|---|---|---|---|---|---|---|
| Sludge transported for anaerobic treatment for biogas production (1000t on a dry weight basis) | 866 | 1110 | 1301 | | | |

**Step 2. Estimation of emissions**

The $CH_4$ emissions of anaerobic digestion at biogas facilities have been estimated using the default method, i.e. equations 4.1 and 4.2 of the 2006 IPCC guidelines (volume 5, page 4.5). The emission factor for $CH_4$ is assumed to be 2 g/kg dry waste (IPCC 2006, vol.5, pg. 4.6, table 4.1). The $N_2O$ emission factor for anaerobic digestion at biogas facilities is assumed as negligible.

#### 7.3.2.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 7.3.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 7.3.2.4. Category-specific recalculations

#### 7.3.2.5. Category-specific planned improvements

Please refer to Annex 7 for the National Inventory Improvement Plan.

## 7.4. Incineration and Open Burning of Waste (5C)

### 7.4.1. Incineration of waste (5C1)

According to data from Eurostat, there was an amount of waste for the period 2004-2014 that was incinerated without recovery. Following the recommendation FCCC/ARR/2019/CYP (W14) of the TERT review, Cyprus estimated the emissions from waste incineration without energy recovery for those years based on Eurostat AD, Equation 5.2 (IPCC 2006, vol.5, chap.5, pg. 5.7), Equation 5.4 (IPCC 2006, vol.5, chap.5, pg. 5.12), and Equation 5.5 (IPCC 2006, vol.5, chap.5, pg. 5.14), and default values for parameters related to EF (IPCC 2006, vol.5, chap.5, Table 5.2 and vol. 5, chap.2, Table 2.4). The estimated emissions increased by 0.0019-1.3555 kt CO2 eq., or 0.00002-0.0145 per cent of the national total, which is below the significance threshold of 0.05 per cent of the national total (3.90-4.93 kt CO2 eq), or 500 kt $CO_2$ eq. Cyprus decided, since the emissions are below the significance threshold, to report these emissions as "NE" due to the high uncertainties of both the activity data and emission factors accompanied the estimation of the emissions.

### 7.4.2. Open burning of waste (5C2)

Fire Prevention of Outdoors Law of 1988 (220/1988) as amended by 109(I)2002 prohibits any open burning of waste or any other material by the population, including waste. There is a provision to the law that for the months December and January, orchards, olive and vineyard waste can be burned with the permission and supervision of local authorities.

Following the recommendation of ESD experts (2024), Cyprus estimated the emissions from open burning of agriculture waste for the period 2009-2023 based on areas of orchard, olive groves and vineyards from Statistical Service of Cyprus (Table 7.23) and the assumptions, made by Portugal (2023-NIR of Portugal, page 5-86 to 87) on the share of plantations open burning its prunings and the mass of biomass generated per ha (Table 7.24). The $CH_4$ emission factor for open burning is 6.5 kg $CH_4$ per ton of wet waste, which is (assuming 65% dry matter in prunings) 10 kg $CH_4$ per ton of dry waste; the N2O emission factor is 0.15 kg per ton of dry waste (IPCC 2006, vol.5, chap.5, pg. 5.20-5.22).

The estimated emissions increased by 1.925-3.14 kt CO2eq., or 0.022-0.033 per cent of the national total, which is below the significance threshold of 0.05 per cent of the national total (3.90-4.83 kt CO2 eq), or 500 kt $CO_2$ eq. Cyprus decided, since the emissions are below the significance threshold, to report these emissions as “NE” due to the high uncertainties of both the activity data and emission factors accompanied the estimation of the emissions.

**Table 7.22. Activity data used for estimate emissions from open burning of agriculture waste**

| Area (ha) | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** |
|---|---|---|---|---|---|---|---|---|
| Apple - pear | 1333 | 870 | 946 | 957 | 715 | 689 | 683 | 597 |
| Citrus | 3884 | 2783 | 3063 | 3214 | 2629 | 2686 | 2840 | 3408 |
| Peaches | 724 | 534 | 540 | 560 | 408 | 444 | 462 | 404 |
| Olives | 12019 | 11645 | 10762 | 10465 | 10653 | 10889 | 10012 | 10612 |
| Wine | 8892 | 7620 | 7693 | 6790 | 5906 | 6142 | 6584 | 6052 |

| Area (ha) | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
|---|---|---|---|---|---|---|---|---|
| Apple - pear | 438 | 434 | 427 | 486 | 495 | 508 | 470 | |
| Citrus | 2891 | 3053 | 3203 | 3033 | 2908 | 2944 | 2920 | |
| Peaches | 297 | 291 | 310 | 339 | 354 | 371 | 240 | |
| Olives | 10830 | 10761 | 11063 | 9687 | 9978 | 10586 | 10530 | |
| Wine | 5921 | 6658 | 6654 | 6155 | 6144 | 5872 | 5940 | |

**Table 7.23. Parameters used for estimate emissions from open burning of agriculture waste**

| | % burnt | $M_B$ (ton dm/ha) |
|---|---|---|
| Apple -pear | 22 | 1.69 |
| Citrus | 22 | 1.69 |
| Peaches | 22 | 1.69 |
| Olives | 65 | 0.27 |
| Wine | 52 | 1.19 |

## 7.5. Wastewater Treatment and Discharge (5D)

Wastewater can be a source of methane ($CH_4$) when treated or disposed anaerobically. It can also be a source of nitrous oxide ($N_2O$) emissions. Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on site (uncollected), sewered to a centralized plant (collected) or disposed untreated nearby or via an outfall. In Cyprus there is no disposal of untreated wastewater nearby or via an outfall. Wastewater treatment systems and discharge pathways in Cyprus are presented in Figure 7.7.

Emissions from Wastewater treatment and discharge accounted for 10.8% of the total GHG emissions from the Waste sector in 2023 and 0.81% of total national emissions without LULUCF. The emissions from Wastewater treatment and discharge between 1990 and 2023 decreased by 52.9%, mainly due to the shift from septic tanks to centralised aerobic treatment systems for the treatment of domestic wastewater. The emissions from these sources are presented in Table 7.24 and Figure 7.8.

**Table 7.24. Emissions from Wastewater treatment and discharge (5D) 1990–2023**

| | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| **D. Wastewater treatment and discharge** | **139.82** | **153.51** | **137.22** | **97.04** | **85.70** | **82.60** | **81.60** | **80.77** | **77.76** |
| 1. Domestic wastewater | 112.44 | 121.97 | 108.02 | 66.24 | 52.64 | 52.66 | 51.96 | 51.08 | 45.65 |
| 2. Industrial wastewater | 27.10 | 31.23 | 28.95 | 30.55 | 32.79 | 29.70 | 29.41 | 29.46 | 31.87 |
| | | | | | | | | | |
| $CH_4$ (Gg) | 4.64 | 5.04 | 4.47 | 2.98 | 2.56 | 2.45 | 2.41 | 2.39 | 2.28 |
| $N_2O$ (Gg) | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Total (Gg $CO_2$ eq.)** | **139.82** | **153.51** | **137.22** | **97.04** | **85.70** | **82.60** | **81.60** | **80.77** | **77.76** |

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|---|---|
| **D. Wastewater treatment and discharge** | **74.05** | **74.00** | **73.72** | **75.21** | **68.74** | **71.11** | **73.44** | **73.99** | |
| 1. Domestic wastewater | 40.45 | 39.30 | 39.03 | 39.57 | 37.45 | 37.82 | 38.47 | 39.02 | |
| 2. Industrial wastewater | 33.36 | 34.43 | 34.42 | 35.37 | 31.04 | 31.04 | 34.98 | 34.98 | |
| | | | | | | | | | |
| $CH_4$ (Gg) | 2.15 | 2.14 | 2.12 | 2.17 | 1.93 | **2.01** | 2.10 | 2.11 | |
| $N_2O$ (Gg) | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | |
| **Total (Gg $CO_2$ eq.)** | **74.05** | **74.00** | **73.72** | **75.21** | **68.74** | **71.11** | **73.44** | **73.99** | |

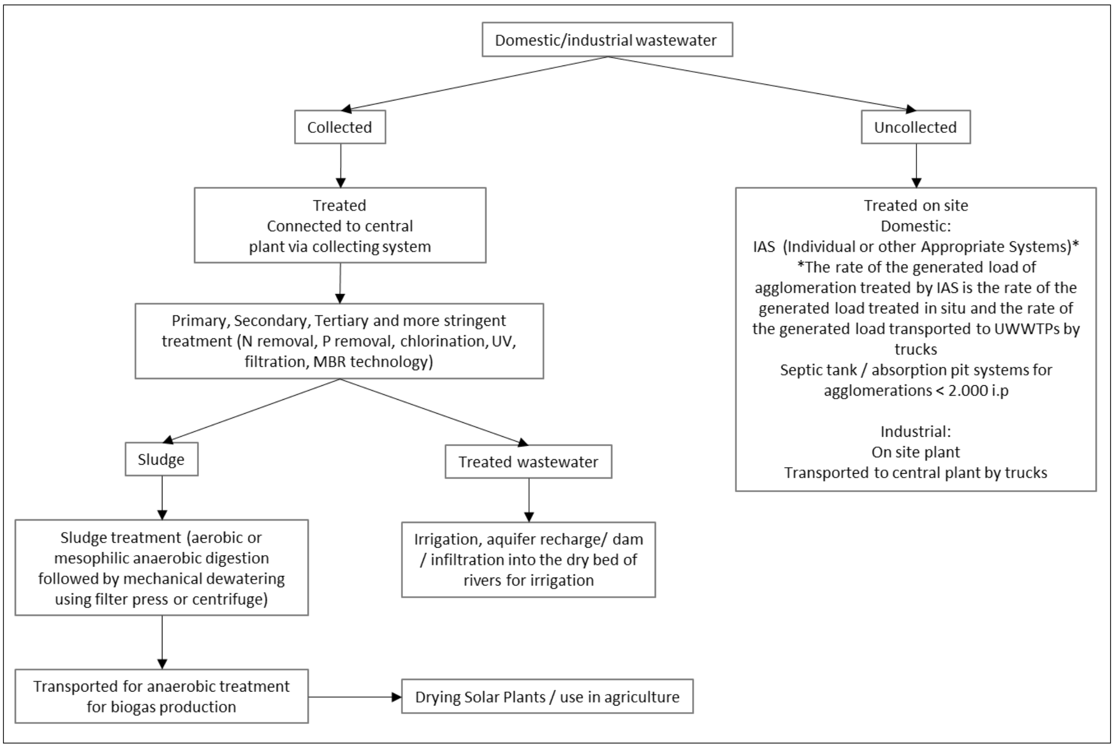


**Figure 7.7. Wastewater treatment systems and discharge pathways in Cyprus[78]**

[78] Stella Perikenti, Environment Officer, National expert on urban wastewater management, Pollution Control Unit, Department of Environment (+35726804573, sperikenti@environment.moa.gov.cy)

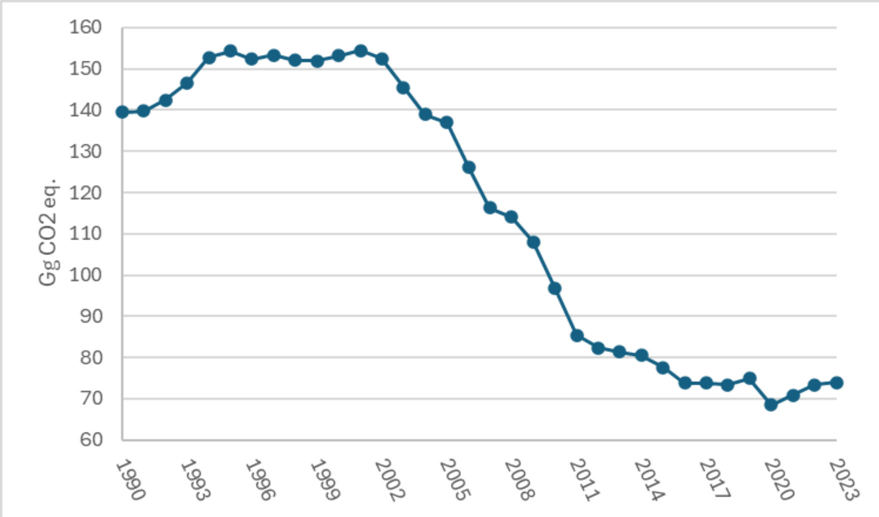


**Figure 7.8. Total emissions from Wastewater treatment and discharge (5D) 1990–2023**

## 7.5.1. Domestic Wastewater Treatment and Discharge (5D1)

According to the 2006 IPCC Guidelines, Domestic wastewater is defined as "wastewater from household water use, while industrial wastewater is from industrial practices only"[79]. Sewers in Cyprus are closed and underground, which is not believed to be a significant source of $CH_4$. An overview of most wastewater treatment methods and pathways in Cyprus is presented in Figure 7.8. All information presented regarding urban wastewater has been obtained from Ms. Stella Perikenti (Pollution Control Unit, Department of Environment) and Ms. Lia Georgiou (Division of Waste Water and Reuse, Water Development Department).

To meet regulatory standards, many large industrial facilities pre-treat their wastewater before releasing it into the sewage system. Domestic wastewater is also treated in on-site septic systems. These are advanced systems that may treat wastewater from one household. They consist of an anaerobic underground tank and a drainage field for the treatment of effluent from the tank. This used to be a common practice in the 1990s, but gradually decreased due to the construction of the wastewater collection systems and treatment stations (Figure 7.10). 10% of wastewater disposed in septic tanks is collected by authorised wastewater collectors and transported to aerobic wastewater treatment plants. Some industrial wastewater may be discharged into municipal sewer lines, where it combines with domestic wastewater, provided that the organic load of the wastewater is reduced to the limits set in the wastewater disposal permit issued by the Department of Environment.

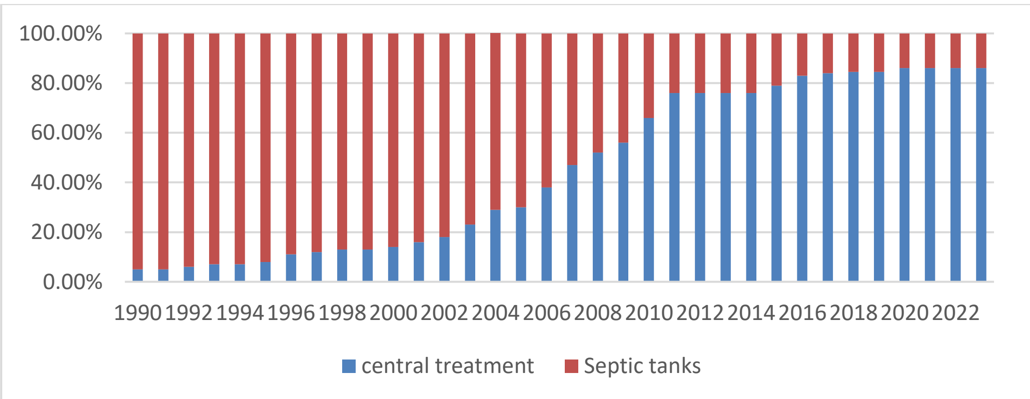


**Figure 7.9. Domestic Wastewater treatment in Cyprus 1990–2023**

[79] 2006 IPCC Guidelines, 2015 Corrigendum, Volume 5, pg. 6.6

Centralised wastewater treatment methods can be classified as primary, secondary, and tertiary treatment. In primary treatment, physical barriers remove larger solids from the wastewater. Remaining particulates are then allowed to settle. Secondary treatment consists of a combination of biological processes that promote biodegradation by micro-organisms. Tertiary treatment processes are used to further purify the wastewater of pathogens, contaminants, and remaining nutrients such as nitrogen and phosphorus compounds. This is achieved using one or a combination of processes that can include biological processes, advanced filtration, carbon adsorption, UV and disinfection. Details on the technologies used in Cyprus are presented in Table 7.25.

**Table 7.25. Wastewater treatment technologies implemented in Cyprus for the treatment of urban wastewaters**

| **Wastewater treatment plant** | **Capacity** | **Primary** | **Secondary** | **Tertiary** | **N Removal** | **P Removal** | **UV** | **Chlorination** | **Sand Filtration** | **MBR Technology** |
|---|---|---|---|---|---|---|---|---|---|---|
| Kakopetria | 2200 | √ | √ | | | | | | | |
| Paralimni | 68750 | √ | √ | √ | √ | √ | | √ | √ | |
| Ayia Napa | 56250 | √ | √ | √ | √ | √ | | √ | √ | |
| Livadhia Refugee Camp | 2000 | √ | √ | √ | | | | √ | √ | |
| Larnaca | 70000 | √ | √ | √ | √ | | | √ | √ | √ |
| Kyperounda | 3500 | √ | √ | √ | | | | √ | √ | |
| Platres | 3500 | √ | √ | √ | | | | √ | √ | |
| Agros | 5250 | √ | √ | √ | | | | √ | √ | |
| Limassol | 272000 | √ | √ | √ | √ | √ | | √ | √ | |
| Paphos | 162500 | √ | √ | √ | √ | √ | | √ | √ | |
| Dhali | 5000 | √ | √ | √ | | | | √ | √ | |
| Mia Milia | 160000 | √ | √ | | | | | | | |
| Central Vathia Gonia | 45765 | √ | √ | √ | | | | √ | √ | |
| Anthoupolis-A | 7200 | √ | √ | √ | | | | √ | | |
| Anthoupolis-B | 130000 | √ | √ | √ | √ | √ | | | | √ |
| Vathia-Gonia-A | 201667 | √ | √ | √ | √ | √ | √ | | | √ |
| Pelendri | 3000 | √ | √ | √ | | | | √ | √ | |
| Lythrodontas | 3500 | √ | √ | √ | | | | √ | √ | |
| Mia Milia B | 269117 | √ | √ | √ | √ | √ | | | | √ |
| Astromeritis | 14767 | √ | √ | √ | | | | √ | √ | |

Sludge is produced in all of the primary, secondary and tertiary stages of treatment. Sludge that is produced in primary treatment consists of solids that are removed from the wastewater and is not accounted for in this category. Sludge produced in secondary and tertiary treatment results from biological growth in the biomass, as well as the collection of small particles. This sludge is treated further before it can be safely disposed of. Methods of sludge treatment include aerobic and anaerobic stabilisation (digestion), centrifugation, composting, and drying. The utilization of sludge produced by the wastewater treatment plants in Cyprus is shown in Table 7.26. Table 7.27 shows the load entering the UWWTPs currently in operation in population equivalent.

$CH_4$ emissions and $N_2O$ emissions from this source are presented in Table 7.28 and Figure 7.11.

**Table 7.26. Utilisation of sludge produced by the wastewater treatment plants in Cyprus (t of dry matter/yr)**

| **Year** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| Sludge production | 8035 | 7974 | 9163 | 7083 | 6815 | 6533 | 6123 | 6160 | 6695 |
| Sludge used in agriculture | 5745 | 6515 | 7903 | 5294 | 3912 | 2756 | 2924 | 1391 | 936 |
| Sludge transported for anaerobic treatment for biogas production | | | 620 | | 2478 | | | 4061 | |
| Sludge stored at the plants | | | | | 425 | | | 621 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Incineration | | | 640 | | | | | | |
| Sludge transported for composting | | | | | | | | | |
| Others (green areas) | | | | | | | | | |
| | | | | | | | | | |
| **Year** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | | | |
| Sludge production | 6850 | 7166 | 8406 | 8681 | 8216 | 8832 | | | |
| Sludge used in agriculture | 1436 | 1075 | 937 | 1015 | 1014 | 867 | | | |
| Sludge transported for anaerobic treatment for biogas production | 4380 | 1044 | 1281 | 1192 | 508 | 866 | | | |
| Sludge stored at the plants | 309 | 781 | 1062 | 1504 | 1728 | 2083 | | | |
| Incineration | 608 | 788 | 266 | 479 | 284 | 464 | | | |
| Sludge transported for composting | | 3425 | 4705 | 4293 | 4682 | 4552 | | | |
| Others (green areas) | 117 | 53 | 155 | 198 | 0 | 0 | | | |

**Table 7.27. Load entering the Urban Waste Water Treatment Plants (UWWTP) (p.e.)**

| UWW Name or IAS | 2007 | 2009 | 2011 | 2014 | 2016 | 2020 |
|---|---|---|---|---|---|---|
| Kakopetria | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 |
| Paralimni | 68487 | 62700 | 52665 | 53500 | 68750 | 68750 |
| Ayia Napa | | | 37500 | 37500 | 56250 | 56250 |
| Livadhia Refugee Camp | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |
| Larnaca | 39090 | 68000 | 70000 | 70000 | 70000 | 80800 |
| Kyperounda | 2068 | 2068 | 2200 | 2200 | 2200 | 2200 |
| Platres | 1820 | 1820 | 2000 | 2000 | 2000 | 2000 |
| Agros | 2400 | 2400 | 2500 | 2500 | 2500 | 2500 |
| Limassol | 131178 | 130000 | 182926 | 193417 | 225989 | 240800 |
| Paphos | 50000 | 85300 | 123925 | 119611 | 120100 | 120100 |
| Dhali | 4710 | 4710 | 5000 | N/O | N/O | N/O |
| Mia Milia | 140000 | 140000 | 140000 | N/O | N/O | N/O |
| Central Vathia Gonia | 9240 | 13900 | 20068 | 1230 | 14857 | 7391 |
| Anthoupolis-A | 4800 | N/O | N/O | N/O | N/O | N/O |
| Anthoupolis-B | N/O | 26500 | 37706 | 34132 | 35983 | 44476 |
| Vathia-Gonia-A | N/O | N/O | 39781 | 57252 | 63187 | 63202 |
| Pelendri | N/O | 2200 | 2200 | 2200 | 2200 | 2200 |
| Lythrodontas | N/O | 2100 | 3500 | 3500 | 3500 | 3500 |
| Mia Milia B | N/O | N/O | N/O | 157116 | 156330 | 156322 |
| IAS | 9240 | 13900 | 26328 | 16219 | 34117 | 24865 |
| Astromeritis | N/O | N/O | N/O | N/O | N/O | 7700 |

N/O – not operated

**Table 7.28. Total emissions from Domestic wastewater 1990–2023**

| | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| $CH_4$ (Gg) | 3.68 | 3.93 | 3.43 | 1.88 | 1.39 | 1.38 | 1.36 |
| $N_2O$ (Gg) | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Total (Gg $CO_2$ eq.)** | **112.44** | **121.97** | **108.02** | **66.24** | **52.64** | **52.66** | **51.96** |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| $CH_4$ (Gg) | 1.34 | 1.14 | 0.95 | 0.91 | 0.89 | 0.90 | 0.82 |
| $N_2O$ (Gg) | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Total (Gg $CO_2$ eq.)** | **51.08** | **45.65** | **40.45** | **39.30** | **39.03** | **39.57** | **37.45** |

| | 2021 | 2022 | 2023 | | | | |
|---|---|---|---|---|---|---|---|
| $CH_4$ (Gg) | 0.83 | 0.85 | 0.86 | | | | |
| $N_2O$ (Gg) | 0.05 | 0.06 | 0.06 | | | | |
| **Total (Gg $CO_2$ eq.)** | **37.82** | **38.47** | **39.02** | | | | |

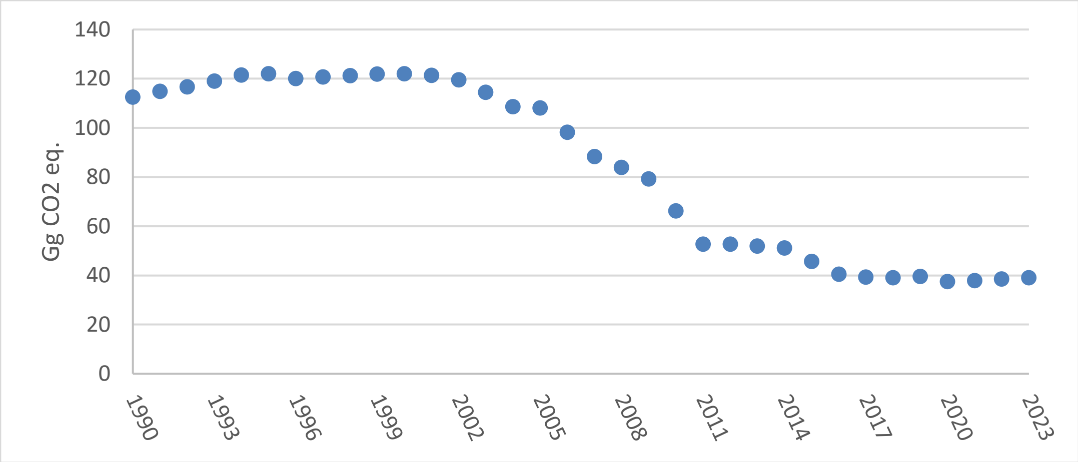


**Figure 7.10. Total emissions from Domestic wastewater (5D1) 1990–2023**

#### 7.5.1.1. Methodological Issues

Methane emissions from wastewater

Emissions are a function of the amount of organic waste generated and an emission factor that characterises the extent to which this waste generates $CH_4$. Three tier methods for $CH_4$ from this category. Tier 1 methodology is applied for estimation of Methane emissions from wastewater in Cyprus.

The steps for inventory preparation for $CH_4$ from domestic wastewater are as follows:

**Step 1**: Use Equation 6.3 (2006 IPCC Guidelines, vol. 5, pg. 6.13) to estimate total organically degradable carbon in wastewater (TOW).

BOD is country-specific, and according to Ms. Stella Perikenti 60 g/person/day should be used[80]. Country population has already been presented in Table 7.5. It is assumed as 1.00 for waste disposed in septic tanks (assuming default for uncollected; IPCC 2006, vol.5, pg. 6.14), eqn.6.3; and 1.25 for wastewater treated in central wastewater treatment stations (assuming default for collected; IPCC 2006, vol.5, pg. 6.14). Distribution of wastewater to septic tanks and central treatment stations (Ui) is presented in Table 7.29, along with the estimated TOW for the whole period.

Ui has been recalculated after meetings with representatives of the Water Development Department (responsible department for the construction and management of the Urban Wastewater Treatment Units)[81] and the Pollution Prevention Unit of the Department of Environment on completion of the time series. Data on population equivalents served by wastewater treatment plants (on the basis of the actual BOD loads) was available for the years 1992-2005 from the Statistical Service[82] and for 2007, 2009, 2011, 2014 and 2016 from the Pollution Control Unit of the Department of Environment. 1990-1991 has been estimated from the trend of 1992-2005 ($y=0.0417e^{0.1204x}$, $R^2 = 0.9706$), years 2006, 2008, 2010, 2012, 2013 and 2015 from the average of the years before and after. For the period 2017-2019 an exponential smoothing forecast based on 1990-2016 values was used (function forecast.ets in excel). The population served by septic tanks has been estimated by subtracting the connected population from 100%.

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[82] resident population connected to wastewater collecting system and wastewater treatment plants, 2007, available at http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/CB1FB8138D95CBB5C22573210044E253/$file/WASTEWATER_TREATMENT-EN-240707.xls?OpenElement

**Table 7.29. Distribution of wastewater to septic tanks and central treatment stations Ui and estimated TOW**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| **Septic** | | | | | | | |
| Ui | 95.3% | 94.7% | 93.6% | 93.2% | 93.3% | 91.9% | 88.8% |
| TOW (kt BOD/yr) | 12.25 | 12.51 | 12.69 | 12.92 | 13.19 | 13.21 | 12.96 |
| **Treatment** | | | | | | | |
| Ui | 4.7% | 5.3% | 6.4% | 6.8% | 6.7% | 8.1% | 11.2% |
| TOW (kt BOD/yr) | 0.76 | 0.88 | 1.08 | 1.18 | 1.18 | 1.46 | 2.04 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| **Septic** | | | | | | | |
| Ui | 88.0% | 87.2% | 86.7% | 85.7% | 84.1% | 81.7% | 77.0% |
| TOW (kt BOD/yr) | 13.01 | 13.04 | 13.11 | 13.09 | 12.99 | 12.77 | 12.19 |
| **Treatment** | | | | | | | |
| Ui | 12.0% | 12.8% | 13.3% | 14.3% | 15.9% | 18.3% | 23.0% |
| TOW (kt BOD/yr) | 2.22 | 2.39 | 2.51 | 2.73 | 3.07 | 3.58 | 4.55 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| **Septic** | | | | | | | |
| Ui | 71.5% | 70.2% | 61.7% | 53.1% | 48.5% | 43.8% | 34.2% |
| TOW (kt BOD/yr) | 11.48 | 11.44 | 10.24 | 9.04 | 8.46 | 7.86 | 6.28 |
| **Treatment** | | | | | | | |
| Ui | 28.5% | 29.8% | 38.3% | 46.9% | 51.5% | 56.2% | 65.8% |
| TOW (kt BOD/yr) | 5.72 | 6.07 | 7.95 | 9.96 | 11.24 | 12.59 | 15.14 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| **Septic** | | | | | | | |
| Ui | 24.5% | 24.3% | 24.2% | 24.1% | 20.5% | 17% | 16% |
| TOW (kt BOD/yr) | 4.62 | 4.61 | 4.55 | 4.46 | 3.81 | 3.18 | 3.03 |
| **Treatment** | | | | | | | |
| Ui | 75.5% | 75.7% | 75.8% | 75.9% | 79.5% | 83% | 84% |
| TOW (kt BOD/yr) | 17.82 | 17.94 | 17.80 | 17.61 | 18.45 | 19.42 | 19.87 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| **Septic** | | | | | | | |
| Ui | 15.5% | 15.5% | 14.0% | 14.0% | 14.0% | 14.0% | |
| TOW (kt BOD/yr) | 2.97 | 3.01 | 2.75 | 2.77 | 2.82 | 2.86 | |
| **Treatment** | | | | | | | |
| Ui | 84.5% | 84.5% | 86.0% | 86.0% | 86.0% | 86.0% | |
| TOW (kt BOD/yr) | 20.26 | 20.54 | 21.09 | 21.30 | 21.66 | 21.98 | |

**Step 2**: Select the pathway and systems according to country activity data. Use Equation 6.2 (2006 IPCC Guidelines, vol. 5, pg. 6.12) to obtain the emission factor for each domestic wastewater treatment/discharge pathway or system.

Bo is considered as 0.6 $kgCH_4/kgBOD$ (default proposed by IPCC, 2006 guidelines, vol.5, pg. 6.12, table 6.2). MCFj is 0.5 for septic tanks and 0 for central wastewater treatment units, as recommended by the IPCC (2006 guidelines, vol.5, pg. 6.13, table 6.3). 0 was chosen for MCF for WWTP, since the information available indicated that they are well managed.

According to further investigation from TERT during the 2017 annual review of the issue it was found that the European Commission published a database on all waste water treatment plants, which shows the status of compliance of those plants with EU legislation. This source also contains information on the

Cypriot plants[83]. According to this website, all but one of the Cypriot waste water treatment plants are fully compliant with UWWTD (Urban Waste Water Treatment Directive) standards. Most important is the compliance on DOC5. DOC5 is the biodegradable part of the organic load into the waste water treatment plant. All experts in the TERT agree that when a plant is overloaded or not well managed, an increase in DOC5 is expected before an increased methane emissions becomes apparent. The single plant that is not compliant with legislation in Cyprus still complies with the DOC5-criterion. For the TERT the information provided on this website seems to prove that all Cypriot waste water treatment plants are well-managed, and therefore a MCF=0 for collected waste water is justified. This is independent EU information demonstrating compliance of wastewater treatment plants in Cyprus, justifying an MCF of 0.

The resulting EFs are 0.3 kg$CH_4$/kgBOD for septic and 0 kg$CH_4$/kgBOD for centralised treatment.

**Step 3**: Use Equation 6.1 (2006 IPCC Guidelines, vol. 5, pg. 6.11) to estimate emissions, adjust for possible sludge removal and/or $CH_4$ recovery and sum the results for each pathway/system. $CH_4$ Emissions (Table 7.31) have been estimated using the parameters listed in Table 7.30.

**Table 7.30. Parameters used for the estimation of $CH_4$ emissions from wastewater treatment**

| Parameter | Value |
|---|---|
| Total organics in wastewater in inventory year, kg BOD/yr (TOW) | Table 7.29 |
| Fraction of population in income group i in inventory year (Ui) | Table 7.29 |
| Degree of utilisation of treatment/discharge pathway or system, j, for each income group (Ti,j) fraction i in inventory year | 100% |
| EFj = emission factor, kg $CH_4$ / kg BOD | Septic: 0.3 kg$CH_4$/kgBOD<br>Centralised treatment: 0 kg$CH_4$/kgBOD |
| R = amount of $CH_4$ recovered in inventory year, kg $CH_4$/yr | 0 |

**Table 7.31. $CH_4$ emissions from domestic wastewater treatment 1990–2023**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|---|---|
| $CH_4$ – septic (t) | 3676 | 3752 | 3808 | 3875 | 3956 | 3963 | 3887 |
| $CH_4$ – centralized (t) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total (t) | 3676 | 3752 | 3808 | 3875 | 3956 | 3963 | 3887 |

| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
|---|---|---|---|---|---|---|---|
| $CH_4$ – septic (t) | 3904 | 3912 | 3933 | 3927 | 3898 | 3831 | 3657 |
| $CH_4$ – centralized (t) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total (t) | 3904 | 3912 | 3933 | 3927 | 3898 | 3831 | 3657 |

| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|---|---|
| $CH_4$ – septic (t) | 3443 | 3431 | 3071 | 2711 | 2539 | 2359 | 1885 |
| $CH_4$ – centralized (t) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total (t) | 3443 | 3431 | 3071 | 2711 | 2539 | 2359 | 1885 |

| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
|---|---|---|---|---|---|---|---|
| $CH_4$ – septic (t) | 1386 | 1384 | 1364 | 1339 | 1144 | 955 | 908 |
| $CH_4$ – centralized (t) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total (t) | 1386 | 1384 | 1364 | 1339 | 1144 | 955 | 908 |

| | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
|---|---|---|---|---|---|---|---|
| $CH_4$ – septic (t) | 892 | 904 | 824 | 832 | 846 | 859 | |
| $CH_4$ – centralized (t) | 0 | 0 | 0 | 0 | 0 | 0 | |
| Total (t) | 892 | 904 | 824 | 832 | 846 | 859 | |

[83] http://uwwtd.oieau.fr/Cyprus/uwwtps/compliance

Nitrous oxide emissions from wastewater

The activity data that are needed for estimating $N_2O$ emissions are nitrogen content in the wastewater effluent, country population and average annual per capita protein generation (Table 7.32). Per capita protein generation consists of intake (consumption) which has been obtained from the Food and Agriculture Organization[84], multiplied by factors to account for additional 'non-consumed' protein and for industrial protein discharged into the sewer system. Food (waste) that is not consumed may be washed down the drain (e.g., as result of the use of garbage disposals in some developed countries), bath and laundry water can also be expected to contribute to nitrogen loadings. Wastewater from industrial or commercial sources that is discharged into the sewer may contain protein (e.g., from grocery stores and butchers).

The total nitrogen in the effluent is estimated using equation 6.8 (pg. 6.25, vol. 5, 2006 IPCC guidelines), with human population as presented in Table 7.5 and annual per capita protein consumption as presented in Table 7.32. Data is not available after 2007 and therefore considered constant for the remaining years, due to an unclear trend. The following defaults are used: fraction of nitrogen in protein (FNPR), 0.16 kg N/kg protein; factor for non-consumed protein added to the wastewater (FNON-CON), 1.1; default factor for industrial and commercial co-discharged protein into the sewer system (FIND-COM), 1.25; and default nitrogen removed with sludge (NSLUDGE), 0.03 kg N/yr.

**Table 7.32. Annual per capita protein consumption and resulting NEFFLUENT (kg/person/yr)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** |
|---|---|---|---|---|---|---|
| Protein consumption (kg/person/yr) | 35.4 | 35.4 | 35.4 | 36.1 | 36.1 | 36.9 |
| NEFFLUENT (kg N/yr) | 4572981 | 4697606 | 4823011 | 5031365 | 5130736 | 5322790 |

| | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
|---|---|---|---|---|---|---|
| Protein consumption (kg/person/yr) | 36.9 | 36.9 | 37.2 | 37.2 | 37.6 | 37.6 |
| NEFFLUENT (kg N/yr) | 5403893 | 5476075 | 5593361 | 5655609 | 5768953 | 5835120 |

| | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
|---|---|---|---|---|---|---|
| Protein consumption (kg/person/yr) | 37.6 | 36.3 | 36.3 | 35.0 | 35.0 | 35.0 |
| NEFFLUENT (kg N/yr) | 5902941 | 5775863 | 5856560 | 5735347 | 5842500 | 5985112 |

| | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|
| Protein consumption (kg/person/yr) | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 |
| NEFFLUENT (kg N/yr) | 6143143 | 6314278 | 6473850 | 6644986 | 6675050 | 6614150 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|
| Protein consumption (kg/person/yr) | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 |
| NEFFLUENT (kg N/yr) | 6529354 | 6539375 | 6589482 | 6661945 | 6752138 | 6845414 |

| | **2020** | **2021** | **2022** | **2023** | | |
|---|---|---|---|---|---|---|
| Protein consumption (kg/person/yr) | 35.0 | 35.0 | 35.0 | 35.0 | | |
| NEFFLUENT (kg N/yr) | 6907085 | 6974190 | 7093723 | 7196203 | | |

After the collection of the information presented above regarding wastewater treatment, it appeared that emissions from advanced centralised wastewater treatment plants should also be estimated and subtracted from the overall emissions. Thus, the emissions have been estimated using the overall emission factor to estimate $N_2O$ emissions from such plants as 3.2 g $N_2O$/person/year, recommended in the 2006 IPCC Guidelines (Box 6.1, pg. 6.26, vol. 5). The population used is the population presented in Table 7.5. The

[84] FAOSTAT, 2009, Food consumption, Dietary Protein Consumption (g/person/day), available from http://www.fao.org/filead min/templates/ess/documents/food_security_statistics/FoodConsumptionNutrients_en.xls

resulting emissions are presented in Table 7.33. The amount of nitrogen associated with these emissions (NWWT, Table 7.34) have been back calculated and subtracted from the NEFFLUENT. The NWWT is calculated by multiplying $N_2$OPLANTS by 28/44.

The resulting $N_2O$ emissions from wastewater are also presented in Table 7.34.

**Table 7.33. $N_2O$ emissions from advanced centralised wastewater treatment plants, NWWT and resulting NEFFLUENT**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| $N_2$OPLANTS (t) | 35.92 | 36.90 | 37.89 | 39.52 | 40.30 | 41.81 | 42.45 |
| NWWT (kg N/yr) | 1196 | 1228 | 1261 | 1289 | 1314 | 1336 | 1357 |
| NEFFLUENT – NWWT (kg N/yr) | 4571785 | 4696378 | 4821750 | 5030076 | 5129422 | 5321453 | 5402536 |
| $N_2O$ emissions (t) | 35.92 | 36.90 | 37.89 | 39.52 | 40.30 | 41.81 | 42.45 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| $N_2$OPLANTS (t) | 43.02 | 43.94 | 44.43 | 45.32 | 45.84 | 46.37 | 45.37 |
| NWWT (kg N/yr) | 1375 | 1391 | 1406 | 1420 | 1437 | 1453 | 1472 |
| NEFFLUENT – NWWT (kg N/yr) | 5474700 | 5591970 | 5654203 | 5767532 | 5833683 | 5901488 | 5774390 |
| $N_2O$ emissions (t) | 43.02 | 43.94 | 44.43 | 45.32 | 45.84 | 46.37 | 45.37 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| $N_2$OPLANTS (t) | 46.00 | 45.05 | 45.89 | 47.01 | 48.25 | 49.60 | 50.85 |
| NWWT (kg N/yr) | 1493 | 1515 | 1543 | 1581 | 1623 | 1668 | 1710 |
| NEFFLUENT – NWWT (kg N/yr) | 5855067 | 5733832 | 5840956 | 5983531 | 6141520 | 6312610 | 6472140 |
| $N_2O$ emissions (t) | 46.00 | 45.05 | 45.89 | 47.01 | 48.25 | 49.60 | 50.85 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| $N_2$OPLANTS (t) | 52.20 | 52.43 | 51.95 | 51.29 | 51.37 | 51.76 | 52.33 |
| NWWT (kg N/yr) | 1755 | 1763 | 1747 | 1725 | 1727 | 1741 | 1760 |
| NEFFLUENT – NWWT (kg N/yr) | 5855067 | 5733832 | 5840956 | 5983531 | 6141520 | 6312610 | 6472140 |
| $N_2O$ emissions (t) | 52.20 | 52.43 | 51.95 | 51.29 | 51.37 | 51.76 | 52.33 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| $N_2$OPLANTS (t) | 53.04 | 53.77 | 54.26 | 54.78 | 55.72 | 56.53 | |
| NWWT (kg N/yr) | 1784 | 1808 | 1825 | 1842 | 1874 | 1901 | |
| NEFFLUENT – NWWT (kg N/yr) | 6750354 | 6843606 | 6905260 | 6972348 | 7091849 | 7194302.4 | |
| $N_2O$ emissions (t) | 53.04 | 53.77 | 54.26 | 54.78 | 55.72 | 56.53 | |

#### 7.5.1.2 Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 7.5.1.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 7.5.1.4. Category-specific recalculations

No recalculations to be reported.

#### 7.5.1.5. Category-specific planned improvements

Efforts are in place to move in higher Tier methodology but for now no data are available. Please refer to Annex 7 for the National Inventory Improvement Plan.

### 7.5.2. Industrial wastewater (5D2)

The principal factor that determines methane generation potential of wastewater is the amount of organic material in the wastewater stream. For industrial wastewater, this is indicated by the Chemical Oxygen Demand (COD). COD indicates the total amount of carbon, biodegradable and non-biodegradable, that is available for oxidation. According to the IPCC guidelines, industrial production should be grouped according to their methane production potential. The main groups are paper and pulp manufacture, slaughterhouses, alcohol, beer, starch, organic chemicals and others (vegetable oil production, textiles, rubber, petroleum refineries, fruits and vegetables). The industrial activities taking place in Cyprus are predominately food and drink industries.

Regarding the treatment of wastewaters produced by the manufacturing processes implemented, the following apply:

- Alcohol - Cyprus has one installation producing alcohol. Its wastewater is treated by anaerobic digestion, followed by further aerobic treatment before the final effluent is discharged into the local municipal sewerage system.
- Beer - Wastewater derived from two brewery installations are also treated by anaerobic digestion and subsequently by further aerobic treatment. One brewery discharges the final effluent into the local municipal sewerage system, while the other uses the effluent for irrigation.
- Dairy products - Wastewater derived from one dairy installation is treated by anaerobic digestion and subsequently by further aerobic treatment before the final effluent is discharged into the local municipal sewerage system.
- Meat and Poultry - Wastewater derived from meat and poultry installations are treated by anaerobic digestion plants that treat mainly pig slurry, and subsequently treated by further aerobic treatment before their final disposal to evaporation lagoons.
- Vegetable oils - Cyprus has several olive oil mills. A portion of the produced wastewater is treated by anaerobic digestion plants that treat mainly pig slurry. In addition, during the process of producing biodiesel from used cooking oils, glycerol is produced and it is mainly treated by anaerobic digestion.
- Veg., fruits and juices, and soft drinks. - Cyprus has one installation that is treating wastewater and other waste derived from the production of vegetables, fruits, juices and soft drinks. The treatment uses anaerobic digestion.

Emissions from industrial wastewater increased by 29.1% between 1990 and 2023 (Table 7.34, Figure 7.13). Emission estimates from this source have been revised due to the availability of new data for 2020.

**Table 7.34. Total emissions from industrial wastewater 1990–2023**

| | **1990** | **2000** | **2005** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|
| $CH_4$ (t) | 967.9 | 1115.2 | 1033.8 | 1091.1 | 1171.2 | 1060.7 | 1050.3 |
| $N_2O$ (t) | 0.001042 | 0.001175 | 0.000958 | 0.000926 | 0.000991 | 0.000890 | 0.000870 |
| **Total (Gg $CO_2$ eq.)** | **27.10** | **31.23** | **28.95** | **30.55** | **32.79** | **29.70** | **29.41** |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|
| $CH_4$ (t) | 1052.2 | 1138.2 | 1191.3 | 1229.6 | 1229.3 | 1263.1 | 1108.7 |
| $N_2O$ (t) | 0.000862 | 0.000914 | 0.000955 | 0.000991 | 0.001003 | 0.001038 | 0.000918 |
| **Total (Gg $CO_2$ eq.)** | **29.46** | **31.87** | **33.36** | **34.43** | **34.42** | **35.37** | **31.04** |

| | **2021** | **2022** | **2023** | | | | |
|---|---|---|---|---|---|---|---|
| $CH_4$ (t) | 1179.8 | 1249.0 | 1249.0 | | | | |
| $N_2O$ (t) | 0.00098 | 0.00104 | 0.00104 | | | | |
| **Total (Gg $CO_2$ eq.)** | **31.04** | **34.97** | **34.97** | | | | |

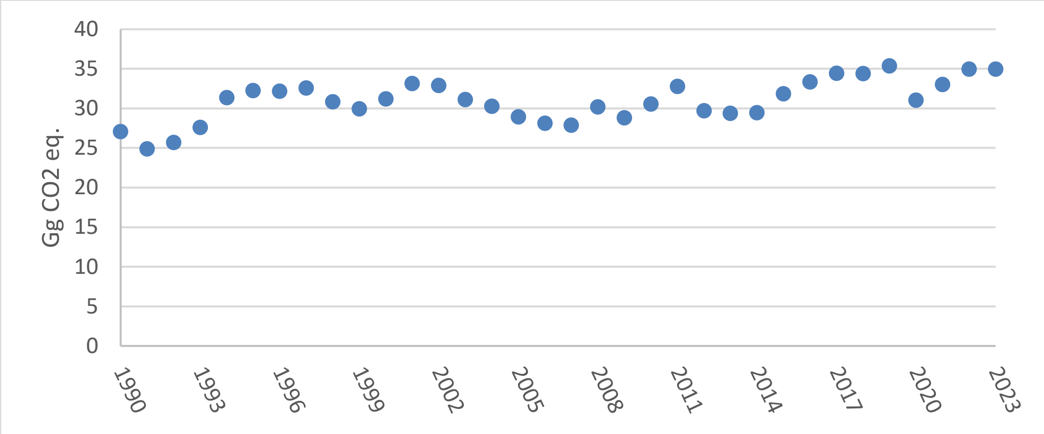


**Figure 7.11. Emissions from industrial wastewater 1990–2023**

#### 7.5.2.1. Methodological Issues

<u>Methane emissions</u>

According to the IPCC guidelines, to estimate total emissions from wastewater the selected emissions factors are multiplied by the associated organic wastewater production and summed. The amount of $CH_4$ recovered and thus not emitted into the atmosphere for each handling method should be subtracted: no methane recovery takes place in Cyprus, therefore recovery is assumed to be 0. The sum of the emissions for each handling method provides the total $CH_4$ emissions from industrial wastewater. In equation form, the estimate of total $CH_4$ emissions from wastewater handling is as follows (equation 6.4, 2006 IPCC guidelines, volume 5 pg. 6.20):

$$CH_4\ Emissions = \Sigma[(TOW_i - S_i) * EF_i - R_i]$$

where $CH_4$ emissions is the total methane emissions from wastewater in kg $CH_4$, TOWi is the total organically degradable material in wastewater from industry i in kg COD/yr, Si is the organic component removed as sludge in inventory year in kg COD/yr, EFi is the emission factor for industry i in kg $CH_4$/kg COD, and Ri is the total amount of methane recovered in kg $CH_4$/yr.

To estimate total organic wastewater (TOW) for a particular industry the following equation should be used (equation 6.6, IPCC 2006 guidelines, volume 5, pg. 6.22):

$$TOWi = Pi \times Wi \times COD$$

where TOW is the total industrial organically material in wastewater for industry in kg COD/yr, P is the total industrial product for industrial sector W is the wastewater generated in $m^3$/tonne of product, and COD is the chemical oxygen demand (industrial degradable organic component in kg COD/$m^3$ wastewater).

To estimate the emission factor for industrial wastewater, the following equation is proposed by the IPCC guidelines (Equation 6.5, IPCC 2006 guidelines, volume 5,pg. 6.21):

$$EF_j = B_o \times MCF_j$$

where $EF_j$ is the emission factor (kg $CH_4$/kg DC) for each treatment (e.g. aerobic treatment, anaerobic digester for sludge, etc.), Bo is the maximum methane producing capacity (kg $CH_4$/kg DC), and $MCF_j$ is the methane correction factor. Since no country specific data is available, Bo is considered to be 0.25 (2006 IPCC guidelines, volume 5, pg. 6.21).

A verbal description of the methodology applied for the estimation of methane emissions from industrial wastewater is as follows:

(a) Collection of data for industrial production (Table 7.36).
(b) Total industrial organic wastewater was estimated by multiplying the industrial production by the wastewater generation coefficients and by COD in Table 7.37 (2006 IPCC guidelines, volume 5, pg. 6.22, Table 6.8).
(c) Organically Degradable material (TOW) in Gg is the sum of the TOW of each industrial product divided by 1,000,000 (Table 7.38).
(d) The wastewater generated was categorised as either anaerobic or aerobic treatment according to the assumptions of Table 7.39.
(e) The methane correction factor (MCF) was assumed to be 0.3 for aerobic treatment, following a recommendation of the ERT during the in-country review of the 2016 submission. In the initial submission, the MCF used was 0, which is the default for centralised. 0.3, which is currently used, is the default for not well managed, centralised, overloaded aerobic treatment (table 6.3, pg. 6.13, volume 5, 2006 IPCC guidelines). This change has been made until sufficient information is available for the wastewater treatment plants in Cyprus to justify the use of 0. Per the defaults provided in the 2006 IPCC guidelines, a MCF of 0.8 was used for anaerobic treatment, while maximum producing capacity was assumed to be 0.25 kg $CH_4$/kg COD (pg. 6.21, volume 5). The resulting methane emission factor estimated according to the waste stream is presented in Table 7.38.
(f) The emission factor for each waste streams was multiplied by the TOW (kg COD/ year) of the respective waste stream to estimate the annual emissions of methane per waste stream. The total $CH_4$ emissions are the sum of the $CH_4$ emitted per waste stream.

Data for industrial production

Detailed statistics on industrial production in Cyprus do not exist. Therefore, data on industrial consumption is used instead. Another issue associated with the national statistics on industrial activity is that the sales of industrial products for the year x-2 (which in this case is 2023) are completed and published in the summer after the inventory has to be submitted (which in this case is summer 2025). Therefore, the 2023 “production" is assumed to be equal to the 2022 “production”. The industrial production data used is presented in Table 7.35.

**Table 7.35. Industrial production 1990–2023 (Gg)**

| **Gg product** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|---|---|
| Alcohol | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 0.9 |
| Beer | 33.1 | 34.8 | 36.6 | 36.1 | 35.6 | 35.2 | 33.1 |
| Soft drinks | 46.6 | 50.5 | 54.7 | 55.4 | 56.2 | 56.9 | 57.5 |
| Dairy products | 60.7 | 64.6 | 68.8 | 71.2 | 73.9 | 76.7 | 81.1 |
| Meat & poultry | 64.4 | 63.1 | 67.7 | 76.0 | 80.9 | 81.0 | 88.0 |
| Refinery | 635.3 | 763.2 | 727.1 | 781.2 | 896.8 | 827.9 | 760.0 |
| Soaps & detergents | 12.1 | 12.9 | 13.8 | 10.9 | 9.8 | 9.5 | 9.0 |
| Vegetable oils | 21.7 | 24.9 | 28.6 | 27.5 | 26.5 | 25.7 | 28.1 |
| Vegetables, fruits & juices | 47.9 | 34.9 | 34.0 | 38.0 | 52.1 | 56.3 | 53.0 |
| Wine | 49.4 | 52.8 | 56.5 | 56.3 | 56.0 | 55.8 | 54.3 |

| **Gg product** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
|---|---|---|---|---|---|---|---|
| Alcohol | 1.0 | 1.0 | 2.1 | 2.6 | 3.9 | 3.8 | 2.5 |
| Beer | 33.3 | 36.5 | 40.5 | 40.9 | 40.4 | 38.3 | 36.7 |
| Soft drinks | 58.3 | 59.3 | 60.0 | 60.9 | 62.7 | 62.3 | 62.1 |
| Dairy products | 81.4 | 86.3 | 84.1 | 83.3 | 89.5 | 92.4 | 93.2 |
| Meat & poultry | 97.0 | 93.7 | 69.5 | 80.5 | 87.8 | 90.0 | 92.4 |
| Refinery | 1042.7 | 1082.6 | 1140.4 | 1134.8 | 1115.1 | 1045.5 | 931.9 |
| Soaps & detergents | 7.1 | 7.2 | 7.2 | 7.0 | 7.8 | 8.1 | 6.2 |
| Vegetable oils | 26.3 | 22.7 | 23.2 | 21.8 | 20.1 | 21.3 | 19.4 |
| Vegetables, fruits & juices | 52.5 | 48.0 | 49.0 | 49.9 | 51.6 | 48.7 | 44.2 |
| Wine | 42.0 | 30.9 | 43.2 | 37.4 | 34.5 | 37.5 | 35.5 |

| **Gg product** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|---|---|
| Alcohol | 1.9 | 1.3 | 1.2 | 1.0 | 0.9 | 0.7 | 0.7 |
| Beer | 37.1 | 37.7 | 37.4 | 39.8 | 42.7 | 35.7 | 34.3 |
| Soft drinks | 60.5 | 66.6 | 58.3 | 62.5 | 62.9 | 59.4 | 57.9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dairy products | 93.9 | 96.3 | 99.5 | 97.8 | 112.1 | 104.1 | 106.0 |
| Meat & poultry | 93.4 | 95.5 | 94.0 | 94.5 | 102.1 | 99.1 | 105.6 |
| Refinery | 269.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Soaps & detergents | 7.4 | 6.1 | 6.2 | 6.3 | 6.8 | 6.9 | 7.1 |
| Vegetable oils | 19.6 | 19.3 | 19.1 | 18.1 | 18.2 | 16.3 | 16.9 |
| Vegetables, fruits & juices | 42.1 | 37.6 | 34.4 | 35.4 | 40.6 | 40.4 | 45.5 |
| Wine | 31.7 | 29.8 | 26.5 | 20.2 | 15.9 | 12.4 | 11.1 |

| **Gg product** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
|---|---|---|---|---|---|---|---|
| Alcohol | 0.6 | 0.7 | 0.7 | 0.6 | 0.57 | 0.61 | 0.65 |
| Beer | 32.2 | 33.0 | 32.9 | 32.8 | 34.18 | 37.55 | 39.43 |
| Soft drinks | 54.6 | 35.6 | 26.0 | 10.8 | 11.13 | 14.46 | 14.57 |
| Dairy products | 109.3 | 106.2 | 100.9 | 99.8 | 100.12 | 103.73 | 108.45 |
| Meat & poultry | 103.6 | 96.0 | 83.6 | 79.7 | 82.43 | 84.72 | 87.47 |
| Refinery | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Soaps & detergents | 6.7 | 7.1 | 6.5 | 7.3 | 6.79 | 8.20 | 7.30 |
| Vegetable oils | 15.7 | 14.3 | 12.2 | 12.6 | 12.06 | 11.72 | 13.97 |
| Vegetables, fruits & juices | 56.5 | 48.0 | 54.5 | 57.9 | 68.46 | 72.93 | 74.90 |
| Wine | 14.2 | 10.9 | 11.5 | 11.0 | 8.95 | 8.45 | 9.27 |

| **Gg product** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
|---|---|---|---|---|---|---|---|
| Alcohol | 0.55 | 0.55 | 0.48 | 0.53 | 0.73 | 0.73 | |
| Beer | 41.07 | 40.41 | 31.06 | 35.79 | 41.67 | 41.67 | |
| Soft drinks | 13.76 | 13.17 | 8.05 | 10.73 | 12.55 | 12.55 | |
| Dairy products | 117.81 | 123.70 | 126.00 | 124.70 | 128.40 | 128.40 | |
| Meat & poultry | 87.59 | 92.12 | 87.53 | 90.96 | 91.19 | 91.19 | |
| Refinery | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Soaps & detergents | 8.23 | 9.13 | 9.37 | 8.47 | 11.18 | 11.18 | |
| Vegetable oils | 13.74 | 15.67 | 14.66 | 12.05 | 13.87 | 13.87 | |
| Vegetables, fruits & juices | 72.75 | 73.52 | 57.82 | 63.83 | 69.69 | 69.69 | |
| Wine | 9.95 | 10.75 | 8.59 | 11.10 | 11.77 | 11.77 | |

Industrial organic wastewater

Wastewater production was estimated by multiplying the industrial production by the wastewater generation coefficients in Table 7.36 (volume 5, pg. 6.22, Table 6.8). Information in the 2006 guidelines is not available for soft drinks, soaps and detergents, and COD of vegetable oils. For these categories, the values recommended in the 2000 IPCC Good Practice Guide (pg.5.22) are used.

**Table 7.36. Wastewater generation coefficient ($m^3$ /t product) and COD concentration (kg COD/$m^3$) according to industrial product**

| | **Wastewater generation ($m^3$/t)** | **COD (kg/$m^3$)** |
|---|---|---|
| Alcohol | 24 | 11 |
| Beer | 6.3 | 2.9 |
| Soft drinks | 2 [a] | 2 [a] |
| Dairy products | 7 | 2.7 |
| Meat& poultry | 13 | 4.1 |
| Refinery | 0.6 | 1.0 |
| Soaps& detergents | 3.0 [a] | 0.9 [a] |
| Vegetable oils | 3.1 | 0.9 [a] |
| Vegetables, fruits & juices | 20.0 | 5.0 |
| Wine | 23.0 | 1.5 |

[a] 2000 IPCC Good Practice Guide, pg. 5.22

Total organic wastewater

Total organically degradable material in wastewater in kg COD/year per industrial product was then estimated by multiplying the industrial production by the wastewater generated and by the COD coefficient of each industrial product in Table 7.36 (2006 IPCC guidelines, p.6.22). The sum of the TOW of each industrial product divided by $10^6$ is presented in Table 7.37.

**Table 7.37. Total organically degradable material (Gg), 1990–2023**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|---|---|---|---|
| Gg DC | 12.61 | 11.55 | 11.96 | 12.85 | 14.64 | 15.07 | 15.04 | 15.22 | 14.40 | 13.98 |

| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|
| Gg DC | 14.58 | 15.49 | 15.38 | 14.53 | 13.72 | 13.08 | 12.53 | 12.42 | 13.51 | 12.86 |

| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|---|---|---|---|
| Gg DC | 13.68 | 14.75 | 13.28 | 13.14 | 13.16 | 14.31 | 15.02 | 15.53 | 15.52 | 15.98 |

| | **2020** | **2021** | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gg DC | 13.92 | 14.87 | 15.79 | 15.79 | | | | | | |

Categorisation of wastewater treatment to aerobic and anaerobic

The wastewater generated was categorised as either anaerobic or aerobic treatment according to the assumptions of Table 7.38. The assumptions were prepared in collaboration with the Pollution Prevention Unit of the Department of Environment.

Methane emission factor

The methane conversion factor was assumed to be 0 for aerobic treatment and 0.8 for anaerobic treatment, as according to the 2006 IPCC guidelines (volume 5, pg. 6.21, Table 6.7). Maximum producing capacity was assumed to be 0.25 kg $CH_4$/kg COD, also as according to the 2006 IPCC guidelines (pg. 6.21, volume 5). The resulting methane emission factor estimated according to the waste stream is presented in Table 7.39.

The aggregate MCF for all waste streams was multiplied by the total annual organic wastewater generation (kg COD/year) to estimate the annual emissions of methane.

**Table 7.38. Treatment of waste by anaerobic treatment according to industrial production, 1990–2023**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** |
|---|---|---|---|---|---|---|---|
| alcohol | 2.0% | 2.1% | 2.1% | 2.0% | 1.9% | 1.9% | 2.2% |
| beer | 20% | 19% | 18% | 18% | 19% | 19% | 20% |
| soft drinks | 1.00% | 0.92% | 0.85% | 0.84% | 0.83% | 0.82% | 0.81% |
| dairy products | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| meat & poultry | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| refinery | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| soaps & detergents | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| vegetable oils | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| veg., fruits & juices | 1.0% | 1.4% | 1.4% | 1.3% | 0.9% | 0.9% | 0.9% |
| wine | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
|---|---|---|---|---|---|---|---|
| alcohol | 2.1% | 2.0% | 1.0% | 0.8% | 0.5% | 0.5% | 0.8% |
| beer | 20% | 18% | 16% | 16% | 16% | 17% | 18% |
| soft drinks | 0.80% | 0.79% | 0.78% | 0.76% | 0.74% | 0.75% | 0.75% |
| dairy products | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| meat & poultry | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| refinery | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| soaps & detergents | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| vegetable oils | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| veg., fruits & juices | 0.9% | 1.0% | 1.0% | 1.0% | 0.9% | 1.0% | 1.1% |
| wine | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| alcohol | 1.1% | 1.5% | 1.8% | 2.1% | 2.3% | 2.8% | 2.8% |
| beer | 18% | 18% | 18% | 17% | 15% | 19% | 19% |
| soft drinks | 0.77% | 0.70% | 0.80% | 0.75% | 0.74% | 0.78% | 0.80% |
| dairy products | 0 | 0 | 5.00% | 5.09% | 4.44% | 4.78% | 4.69% |
| meat & poultry | 5.00% | 4.89% | 4.97% | 4.95% | 4.57% | 4.71% | 4.42% |
| refinery | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| soaps & detergents | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| vegetable oils | 0 | 0 | 0.5% | 0.5% | 0.5% | 0.6% | 0.5% |
| veg., fruits & juices | 1.1% | 1.3% | 1.4% | 1.4% | 1.2% | 1.2% | 1.1% |
| wine | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| alcohol | 3.5% | 3.1% | 3.1% | 3.2% | 3.6% | 3.4% | 3.1% |
| beer | 21% | 20% | 20% | 20% | 19% | 18% | 17% |
| soft drinks | 0.85% | 1.31% | 1.79% | 4.31% | 4.19% | 3.22% | 3.20% |
| dairy products | 4.55% | 4.69% | 4.93% | 4.99% | 4.97% | 4.80% | 4.59% |
| meat & poultry | 4.51% | 4.86% | 5.59% | 5.86% | 5.67% | 5.51% | 5.34% |
| refinery | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| soaps & detergents | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| vegetable oils | 0.6% | 0.6% | 0.7% | 0.7% | 0.7% | 0.8% | 0.6% |
| veg., fruits & juices | 0.8% | 1.0% | 0.9% | 0.8% | 0.7% | 0.7% | 0.6% |
| wine | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
|---|---|---|---|---|---|---|---|
| alcohol | 3.7% | 3.7% | 4.3% | 3.8% | 2.8% | 2.8% | |
| beer | 16% | 16% | 21% | 18% | 16% | 16% | |
| soft drinks | 3.39% | 3.54% | 5.79% | 4.34% | 3.71% | 3.71% | |
| dairy products | 4.22% | 4.02% | 3.95% | 3.99% | 3.87% | 3.87% | |
| meat & poultry | 5.33% | 5.07% | 5.34% | 5.14% | 5.07% | 5.07% | |
| refinery | 0 | 0 | 0 | 0 | 0 | 0 | |
| soaps & detergents | 0 | 0 | 0 | 0 | 0 | 0 | |
| vegetable oils | 0.7% | 0.6% | 0.6% | 0.7% | 0.6% | 0.6% | |
| veg., fruits & juices | 0.7% | 0.7% | 0.8% | 0.8% | 0.7% | 0.7% | |
| wine | 0 | 0 | 0 | 0 | 0 | 0 | |

**Table 7.39. Methane emission factor estimated according to waste stream (kg $CH_4$/kg COD), 1990–2023**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| alcohol | 0.078 | 0.078 | 0.078 | 0.078 | 0.077 | 0.077 | 0.078 |
| beer | 0.100 | 0.099 | 0.098 | 0.098 | 0.098 | 0.099 | 0.100 |
| soft drinks | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| dairy products | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| meat & poultry | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| refinery | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| soaps & detergents | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| vegetable oils | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| veg., fruits & juices | 0.076 | 0.077 | 0.077 | 0.077 | 0.076 | 0.076 | 0.076 |
| wine | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|
| alcohol | 0.078 | 0.078 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| beer | 0.100 | 0.098 | 0.095 | 0.095 | 0.095 | 0.097 | 0.098 |
| soft drinks | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| dairy products | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| meat & poultry | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| refinery | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| soaps & detergents | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| vegetable oils | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| veg., fruits & juices | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| wine | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |

| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|---|---|
| alcohol | 0.076 | 0.077 | 0.077 | 0.078 | 0.078 | 0.079 | 0.078 |
| beer | 0.097 | 0.097 | 0.097 | 0.096 | 0.094 | 0.098 | 0.099 |
| soft drinks | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| dairy products | 0.075 | 0.075 | 0.081 | 0.081 | 0.081 | 0.081 | 0.081 |
| meat & poultry | 0.081 | 0.081 | 0.081 | 0.081 | 0.081 | 0.081 | 0.081 |
| refinery | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| soaps & detergents | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| vegetable oils | 0.075 | 0.075 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| veg., fruits & juices | 0.076 | 0.077 | 0.077 | 0.077 | 0.076 | 0.076 | 0.076 |
| wine | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |

| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
|---|---|---|---|---|---|---|---|
| alcohol | 0.079 | 0.079 | 0.079 | 0.079 | 0.080 | 0.079 | 0.079 |
| beer | 0.101 | 0.100 | 0.100 | 0.100 | 0.099 | 0.097 | 0.096 |
| soft drinks | 0.076 | 0.077 | 0.077 | 0.080 | 0.080 | 0.079 | 0.079 |
| dairy products | 0.081 | 0.081 | 0.081 | 0.081 | 0.081 | 0.081 | 0.081 |
| meat & poultry | 0.081 | 0.081 | 0.082 | 0.082 | 0.082 | 0.082 | 0.082 |
| refinery | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| soaps & detergents | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| vegetable oils | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| veg., fruits & juices | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 |
| wine | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |

| | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
|---|---|---|---|---|---|---|---|
| alcohol | 0.080 | 0.080 | 0.080 | 0.080 | 0.079 | 0.079 | |
| beer | 0.095 | 0.095 | 0.102 | 0.098 | 0.095 | 0.095 | |
| soft drinks | 0.079 | 0.079 | 0.082 | 0.080 | 0.080 | 0.080 | |
| dairy products | 0.080 | 0.080 | 0.080 | 0.080 | 0.080 | 0.080 | |
| meat & poultry | 0.082 | 0.081 | 0.082 | 0.081 | 0.081 | 0.081 | |
| refinery | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | |
| soaps & detergents | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | |
| vegetable oils | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | |
| veg., fruits & juices | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | 0.076 | |
| wine | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | |

**Estimation of $N_2O$ emissions**

The nitrous oxide emissions were estimated by multiplying the total annual industrial wastewater production (Table 7.40) by the default emission factor of 0.25 g $N_2O/m^3$ wastewater, as according to the EMEP/CORINAIR 2007 methodology[85].

**Table 7.40. Total industrial wastewater production (1000 $m^3$/year), 1990–2023**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| Alcohol | 24 | 24 | 23 | 24 | 25 | 26 | 22 | 23 |
| Beer | 208 | 219 | 231 | 227 | 225 | 222 | 208 | 210 |
| Soft drinks | 93 | 101 | 109 | 111 | 112 | 114 | 115 | 117 |
| Dairy products | 425 | 452 | 481 | 499 | 517 | 537 | 568 | 570 |

[85] EMEP/CORINAIR Emission Inventory Guidebook – 2007, Group 9: Waste treatment and disposal; 091001 - Waste water treatment in industry, EEA Technical report No 16/2007, available at https://www.eea.europa.eu/publications/EMEPCORINAIR5/B9101vs1.pdf, table 2, pg. B9101-2.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Meat & poultry | 837 | 820 | 880 | 987 | 1052 | 1052 | 1145 | 1261 |
| Refinery | 381 | 458 | 436 | 469 | 538 | 497 | 456 | 626 |
| Soaps &detergents | 36 | 39 | 41 | 33 | 29 | 29 | 27 | 21 |
| Vegetable oils | 67 | 77 | 89 | 85 | 82 | 80 | 87 | 82 |
| Veg., fruits & juices | 959 | 698 | 680 | 759 | 1041 | 1127 | 1060 | 1050 |
| Wine | 1136 | 1215 | 1300 | 1295 | 1289 | 1283 | 1250 | 965 |

| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| Alcohol | 24 | 50 | 61 | 94 | 92 | 59 | 46 | 32 |
| Beer | 230 | 255 | 257 | 255 | 242 | 231 | 234 | 238 |
| Soft drinks | 119 | 120 | 122 | 125 | 125 | 124 | 121 | 133 |
| Dairy products | 604 | 589 | 583 | 626 | 647 | 652 | 657 | 674 |
| Meat & poultry | 1218 | 903 | 1047 | 1142 | 1170 | 1202 | 1214 | 1242 |
| Refinery | 650 | 684 | 681 | 669 | 627 | 559 | 161 | 0 |
| Soaps &detergents | 22 | 22 | 21 | 23 | 24 | 19 | 22 | 18 |
| Vegetable oils | 70 | 72 | 68 | 62 | 66 | 60 | 61 | 60 |
| Veg., fruits & juices | 961 | 980 | 999 | 1031 | 974 | 884 | 842 | 751 |
| Wine | 711 | 993 | 860 | 793 | 863 | 817 | 730 | 685 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| Alcohol | 28 | 24 | 21 | 17 | 18 | 14 | 16 | 16 |
| Beer | 236 | 251 | 269 | 225 | 216 | 203 | 208 | 207 |
| Soft drinks | 117 | 125 | 126 | 119 | 116 | 109 | 71 | 52 |
| Dairy products | 696 | 684 | 785 | 729 | 742 | 765 | 743 | 706 |
| Meat & poultry | 1222 | 1228 | 1327 | 1289 | 1373 | 1347 | 1248 | 1086 |
| Refinery | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soaps &detergents | 19 | 19 | 21 | 21 | 21 | 20 | 21 | 20 |
| Vegetable oils | 59 | 56 | 56 | 50 | 52 | 49 | 44 | 38 |
| Veg., fruits & juices | 687 | 708 | 812 | 808 | 911 | 1129 | 960 | 1090 |
| Wine | 609 | 465 | 366 | 285 | 254 | 327 | 250 | 265 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| Alcohol | 15 | 14 | 15 | 16 | 13 | 13 | 11 | 13 |
| Beer | 206 | 215 | 237 | 248 | 259 | 255 | 196 | 225 |
| Soft drinks | 22 | 22 | 29 | 29 | 28 | 26 | 16 | 21 |
| Dairy products | 698 | 701 | 726 | 759 | 825 | 866 | 882 | 873 |
| Meat & poultry | 1037 | 1072 | 1101 | 1137 | 1139 | 1197 | 1138 | 1182 |
| Refinery | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soaps &detergents | 22 | 20 | 25 | 22 | 25 | 27 | 28 | 25 |
| Vegetable oils | 39 | 37 | 36 | 43 | 43 | 49 | 45 | 37 |
| Veg., fruits & juices | 1157 | 1369 | 1459 | 1498 | 1455 | 1470 | 1156 | 1277 |
| Wine | 253 | 206 | 194 | 213 | 229 | 247 | 197 | 255 |

| | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Alcohol | 11 | 13 | | | | | | |
| Beer | 196 | 225 | | | | | | |
| Soft drinks | 16 | 21 | | | | | | |
| Dairy products | 882 | 873 | | | | | | |
| Meat & poultry | 1138 | 1182 | | | | | | |
| Refinery | 0 | 0 | | | | | | |
| Soaps &detergents | 28 | 25 | | | | | | |
| Vegetable oils | 45 | 37 | | | | | | |
| Veg., fruits & juices | 1156 | 1277 | | | | | | |
| Wine | 197 | 255 | | | | | | |

#### 7.5.2.2 Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

#### 7.5.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

#### 7.5.2.4. Category-specific recalculations

Emissions from Industrial Wastewater Treatment and Discharge (5D2) were recalculated for the year 2021 due to revision of the activity data of solid waste production by the Statistical Service. Emissions increased for the particular year from 31.04 to 33.03 Gg $CO_2$ eq., which corresponds to an increase of emissions by 6.41%.

#### 7.5.2.5. Category-specific planned improvements

Efforts are in place to move in higher Tier methodology but for now no data are available. Please refer to Annex 7 for the National Inventory Improvement Plan.

## 7.6. Other (5E)

Not occurring.

# Chapter 8.
## Other (CRT sector 6)

Not applicable

# Chapter 9.
## Indirect $CO_2$ and $N_2O$ emissions

## 9.1 Description of Sources of Indirect Emissions in GHG Inventory

The use of solvents manufactured using fossil fuels as feedstocks can lead to evaporative emissions of various non-methane volatile organic compounds (NMVOC), which are subsequently further oxidised in the atmosphere. The IPCC source sector 2.D.3, Solvent and Other Produce Use, is important in relation to the emissions of NMVOC. NMVOC are indirect greenhouse gases which result from the use of solvents and various other volatile compounds, and are therefore reported as $CO_2$ equivalent emissions included in national totals.

Categories present in 2.D.3 include:

- Dry cleaning
- Coating Applications
- Chemical products
- Asphalt roofing
- Domestic solvent use including fungicides
- Road paving with asphalt
- Printing
- Other solvent use (glue consumption).

Also included are emissions from sector 2.G.4 Other product use (Use of tobacco).

Indirect $CO_2$ emissions from NMVOC accounted for 0.14% (7.362 kt of $CO_2$ equivalent) and 0.07% (6.653 kt of $CO_2$ equivalent) of total national emissions in 1990 and 2023, respectively. The total $CO_2$ emissions from solvent use are presented in Table 9.1 and Figure 9.1.

**Table 9.1. $CO_2$ emissions from Solvent and Other Product Use (2.D.3. and 2.G.4.)**

| **Gg $CO_2$ eq.** | **1990** | **2000** | **2005** | **2010** | **2015** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|
| **2.D.3. Solvent and Other Product Use** | **7.321** | **7.608** | **12.624** | **11.848** | **10.610** | **8.708** | **8.015** |
| Dry cleaning | 0.440 | 0.445 | 0.425 | 0.133 | 0.116 | 0.058 | 0.059 |
| Coating applications | 3.825 | 3.524 | 8.393 | 7.699 | 2.359 | 3.166 | 3.365 |
| Chemical products | 0.910 | 1.097 | 1.164 | 1.301 | 4.487 | 0.442 | 0.412 |
| Asphalt roofing | 0.095 | 0.107 | 0.086 | 0.155 | 0.025 | 0.030 | 0.030 |
| Domestic solvent use | 1.204 | 1.452 | 1.541 | 1.722 | 2.723 | 4.114 | 3.139 |
| Road paving with asphalt | 0.014 | 0.015 | 0.012 | 0.022 | 0.004 | 0.004 | 0.004 |
| Printing | 0.642 | 0.738 | 0.758 | 0.542 | 0.556 | 0.343 | 0.353 |
| Other (glue consumption) | 0.191 | 0.230 | 0.244 | 0.273 | 0.341 | 0.551 | 0.653 |
| **2.G.4 Other product use (Use of tobacco)** | **0.041** | **0.115** | **0.031** | **0.023** | **0.012** | **0.010** | **0.010** |
| **Total Indirect Emissions** | **7.362** | **7.723** | **12.655** | **11.871** | **10.622** | **8.718** | **8.026** |

| **Gg $CO_2$ eq.** | **2022** | **2023** | | | | | |
|---|---|---|---|---|---|---|---|
| **2.D.3. Solvent and Other Product Use** | **6.078** | **6.644** | | | | | |
| Dry cleaning | 0.052 | 0.081 | | | | | |
| Coating applications | 3.395 | 3.733 | | | | | |
| Chemical products | 0.167 | 0.245 | | | | | |
| Asphalt roofing | 0.003 | 0.003 | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Domestic solvent use | 1.871 | 1.938 | | | | | |
| Road paving with asphalt | 0.000 | 0.000 | | | | | |
| Printing | 0.357 | 0.359 | | | | | |
| Other (glue consumption) | 0.232 | 0.285 | | | | | |
| **2.G.4 Other product use (Use of tobacco)** | **0.010** | **0.009** | | | | | |
| **Total Indirect Emissions** | **6.088** | **6.653** | | | | | |

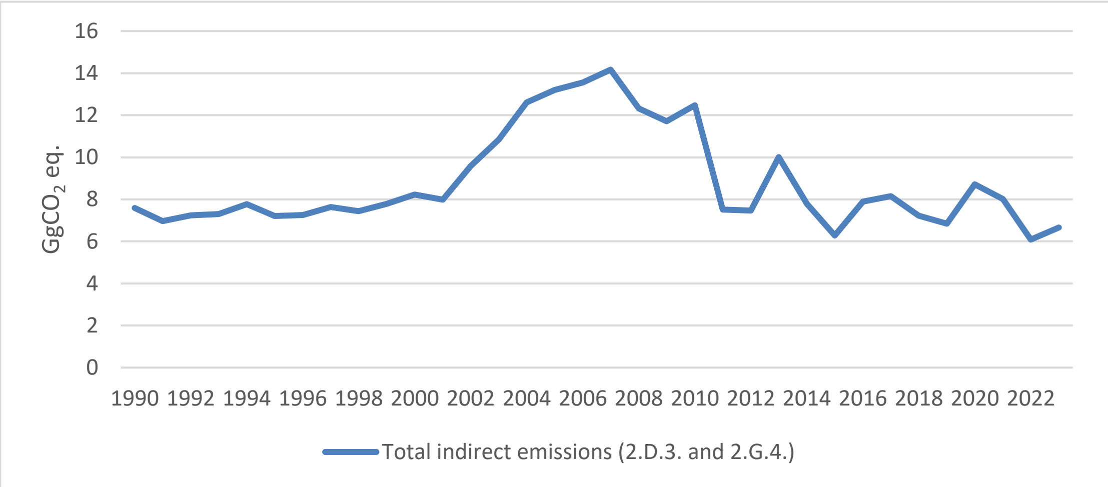


**Figure 9.1. Emissions from Solvent and Other Product Use (2.D.3. and 2.G.4.) 1990–2023**

## 9.1.1 Methodological Issues

2.D.3. Solvent and Other Product Use

Carbon dioxide emissions from other product use are calculated from NMVOC emissions (Table 9.2), assuming that the carbon content of NMVOC (C) is 60% (carbon content fractions for NMVOCs from road paving with asphalt is 50% and from asphalt roofing is 80%[86]). NMVOC emissions are obtained from the Department of Labour Inspection, which is responsible for the preparation of the air pollutants inventory for Directive 2001/81/EC. The estimation of NMVOC emissions is based on the CONINAIR methodology. Therefore, the equation applied for the estimation of the $CO_2$ emissions is the following:

$$CO_2 \text{ emissions (Gg)} = C * NMVOC \text{ emissions (Gg)} * 44/12$$

**Table 9.2. NMVOCs emissions used for the estimation of $CO_2$ emissions from Solvent use (2D3)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** |
|---|---|---|---|---|---|---|
| Dry cleaning | 0.2002 | 0.2003 | 0.2003 | 0.2004 | 0.2005 | 0.2006 |
| Coating applications | 1.7387 | 1.4241 | 1.5170 | 1.5202 | 1.7083 | 1.4102 |
| Chemical products | 0.4134 | 0.4239 | 0.4354 | 0.4470 | 0.4569 | 0.4659 |
| Asphalt roofing | 0.0325 | 0.0325 | 0.0325 | 0.0325 | 0.0325 | 0.0325 |
| Domestic solvent use | 0.5472 | 0.5611 | 0.5763 | 0.5917 | 0.6048 | 0.6167 |
| Road paving with asphalt | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 |
| Printing | 0.2920 | 0.2920 | 0.2920 | 0.2920 | 0.2920 | 0.2920 |
| Other (glue consumption) | 0.0867 | 0.0889 | 0.0914 | 0.0938 | 0.0959 | 0.0978 |

| | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
|---|---|---|---|---|---|---|
| Dry cleaning | 0.2007 | 0.2008 | 0.2009 | 0.2012 | 0.2021 | 0.2005 |
| Coating applications | 1.4097 | 1.5604 | 1.4476 | 1.4578 | 1.6020 | 1.4785 |

[86] 2006 IPCC Guidelines volume 3, p. 5.16.

| | | | | | | |
|---|---|---|---|---|---|---|
| Chemical products | 0.4738 | 0.4810 | 0.4874 | 0.4930 | 0.4985 | 0.5036 |
| Asphalt roofing | 0.0325 | 0.0325 | 0.0325 | 0.0325 | 0.0366 | 0.0298 |
| Domestic solvent use | 0.6272 | 0.6367 | 0.6452 | 0.6525 | 0.6598 | 0.6666 |
| Road paving with asphalt | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0084 | 0.0069 |
| Printing | 0.2920 | 0.2920 | 0.2920 | 0.3273 | 0.3355 | 0.3801 |
| Other (glue consumption) | 0.0994 | 0.1009 | 0.1023 | 0.1034 | 0.1046 | 0.1057 |

| | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
|---|---|---|---|---|---|---|
| Dry cleaning | 0.2004 | 0.2001 | 0.1998 | 0.1930 | 0.1100 | 0.1110 |
| Coating applications | 2.2579 | 2.8364 | 3.5522 | 3.8150 | 4.0272 | 4.3205 |
| Chemical products | 0.5093 | 0.5152 | 0.5219 | 0.5292 | 0.5371 | 0.5472 |
| Asphalt roofing | 0.0324 | 0.0308 | 0.0368 | 0.0293 | 0.0265 | 0.0246 |
| Domestic solvent use | 0.6742 | 0.6820 | 0.6908 | 0.7005 | 0.7110 | 0.7243 |
| Road paving with asphalt | 0.0075 | 0.0071 | 0.0085 | 0.0068 | 0.0061 | 0.0057 |
| Printing | 0.3075 | 0.2884 | 0.3399 | 0.3446 | 0.3628 | 0.3195 |
| Other (glue consumption) | 0.1069 | 0.1081 | 0.1095 | 0.1110 | 0.1127 | 0.1148 |

| | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|
| Dry cleaning | 0.0789 | 0.0602 | 0.0605 | 0.0600 | 0.0539 | 0.0265 |
| Coating applications | 3.3507 | 3.1421 | 3.4997 | 1.1160 | 1.1342 | 0.9821 |
| Chemical products | 0.5604 | 0.5753 | 0.5914 | 0.6062 | 0.6223 | 2.0852 |
| Asphalt roofing | 0.0233 | 0.0396 | 0.0529 | 0.0516 | 0.0403 | 0.0213 |
| Domestic solvent use | 0.7419 | 0.7615 | 0.7828 | 0.8025 | 0.8237 | 1.2035 |
| Road paving with asphalt | 0.0054 | 0.0091 | 0.0122 | 0.0119 | 0.0093 | 0.0049 |
| Printing | 0.4469 | 0.3260 | 0.2464 | 0.3347 | 0.2658 | 0.2072 |
| Other (glue consumption) | 0.1176 | 0.1207 | 0.1241 | 0.1272 | 0.1306 | 0.0029 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|
| Dry cleaning | 0.0262 | 0.0527 | 0.0261 | 0.0132 | 0.0262 | 0.0267 |
| Coating applications | 0.8677 | 1.0721 | 1.1182 | 1.2681 | 1.4052 | 1.4971 |
| Chemical products | 2.0662 | 2.0397 | 0.0645 | 0.9791 | 0.3118 | 0.1231 |
| Asphalt roofing | 0.0098 | 0.0086 | 0.0089 | 0.0111 | 0.0145 | 0.0112 |
| Domestic solvent use | 1.1925 | 1.2378 | 0.9291 | 0.9011 | 0.9794 | 1.0068 |
| Road paving with asphalt | 0.0023 | 0.0020 | 0.0020 | 0.0026 | 0.0033 | 0.0026 |
| Printing | 0.2618 | 0.2526 | 0.2650 | 0.2655 | 0.2273 | 0.2458 |
| Other (glue consumption) | 0.0029 | 0.1548 | 0.2332 | 0.2131 | 0.3030 | 0.1910 |

| | **2020** | **2021** | **2022** | **2023** | | |
|---|---|---|---|---|---|---|
| Dry cleaning | 0.0265 | 0.0269 | 0.0239 | 0.0367 | | |
| Coating applications | 1.4389 | 1.5295 | 1.5430 | 1.6967 | | |
| Chemical products | 0.2009 | 0.1872 | 0.0760 | 0.1112 | | |
| Asphalt roofing | 0.0103 | 0.0103 | 0.0011 | 0.0011 | | |
| Domestic solvent use | 1.8700 | 1.4268 | 0.8503 | 0.8808 | | |
| Road paving with asphalt | 0.0024 | 0.0024 | 0.0003 | 0.0003 | | |
| Printing | 0.1560 | 0.1604 | 0.1623 | 0.1632 | | |
| Other (glue consumption) | 0.2503 | 0.2967 | 0.1055 | 0.1297 | | |

2.G.4. Other Product Use

Carbon dioxide emissions from Other product use are calculated from NMVOC emissions (Table 9.3), assuming that the carbon content of NMVOC is 60%[87]. NMVOC emissions are obtained from the Department of Labour Inspection, which is responsible for the preparation of the air pollutants inventory for Directive 2001/81/EC. The estimation of NMVOC emissions is based on the CONINAIR methodology. Therefore, the equation applied for the estimation of the $CO_2$ emissions is the following:

$$CO_2 \textit{ emissions (Gg)} = 60\% * \textit{NMVOC emissions (Gg)} * 44/12$$

**Table 9.3. NMVOCs emissions used for the estimation of $CO_2$ emissions from Other Product Use (2G4)**

| Gg | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| Other | 0.0185 | 0.0185 | 0.0202 | 0.0056 | 0.0056 | 0.0163 | 0.0173 | 0.0193 |

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Other | 0.0197 | 0.0275 | 0.0518 | 0.0159 | 0.0149 | 0.0107 | 0.0160 | 0.0139 |

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| Other | 0.0087 | 0.0091 | 0.0088 | 0.0098 | 0.0105 | 0.0086 | 0.0093 | 0.0073 |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| Other | 0.0029 | 0.0054 | 0.0051 | 0.0056 | 0.0049 | 0.0051 | 0.0044 | 0.0047 |
| | | | | | | | | |
| | 2022 | 2023 | | | | | | |
| Other | 0.0044 | 0.0041 | | | | | | |

## 9.1.2. Uncertainties and time-series consistency

The results of the uncertainty analysis undertaken for the GHG emissions inventory of Cyprus are presented in Section 1.5, while the detailed calculations are presented in Annex 2.

## 9.1.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. No sector-specific QA/QC and verification activities are applied for this sector.

## 9.1.4. Category-specific recalculations

2.D.3. Solvent and Other Product Use

$CO_2$ emissions have been recalculated mainly with reference to 2.D.3. (Domestic Solvent Use). The values of NMVOCS are taken from the Cyprus Informative Inventory Report. The impact of recalculations on emissions is shown in Table 9.4 and Figure 9.2.

**Table 9.4. Recalculations from Indirect $CO_2$ emissions (Gg $CO_2$ eq.)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| NIR2024 | 7.58 | 6.96 | 7.25 | 7.30 | 7.78 | 7.20 | 7.26 |
| NIR2025 | 7.36 | 6.73 | 7.00 | 7.04 | 7.51 | 6.93 | 6.97 |
| Change | -2.9% | -3.3% | -3.4% | -3.5% | -3.4% | -3.8% | -3.9% |
| | | | | | | | |
| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
| NIR2024 | 7.64 | 7.44 | 7.79 | 8.23 | 7.99 | 9.59 | 10.84 |

[87] 2006 IPCC Guidelines volume 3, p. 5.17, the default fossil carbon content fraction of NMVOC is 60 per cent by mass

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NIR2025 | 7.35 | 7.14 | 7.29 | 7.72 | 7.47 | 9.07 | 10.31 |
| Change | -3.8% | -4.0% | -6.5% | -6.2% | -6.5% | -5.4% | -4.9% |
| | | | | | | | |
| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
| NIR2024 | 12.61 | 13.20 | 13.55 | 14.17 | 12.32 | 11.71 | 12.48 |
| NIR2025 | 12.07 | 12.65 | 13.00 | 13.60 | 11.75 | 11.12 | 11.87 |
| Change | -4.2% | -4.1% | -4.1% | -4.0% | -4.7% | -5.0% | -4.9% |
| | | | | | | | |
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| NIR2024 | 7.52 | 7.46 | 10.00 | 7.79 | 6.28 | 7.90 | 8.14 |
| NIR2025 | 6.89 | 6.82 | 10.00 | 9.76 | 10.62 | 5.84 | 8.06 |
| Change | -8.3% | -8.6% | 0.0% | 25.2% | 69.2% | -26.1% | -1.1% |
| | | | | | | | |
| | **2018** | **2019** | **2020** | **2021** | **2022** | | |
| NIR2024 | 7.22 | 6.85 | 8.71 | 8.02 | 6.18 | | |
| NIR2025 | 7.22 | 6.85 | 8.72 | 8.03 | 6.09 | | |
| Change | 0.0% | 0.0% | 0.1% | 0.1% | -1.5% | | |

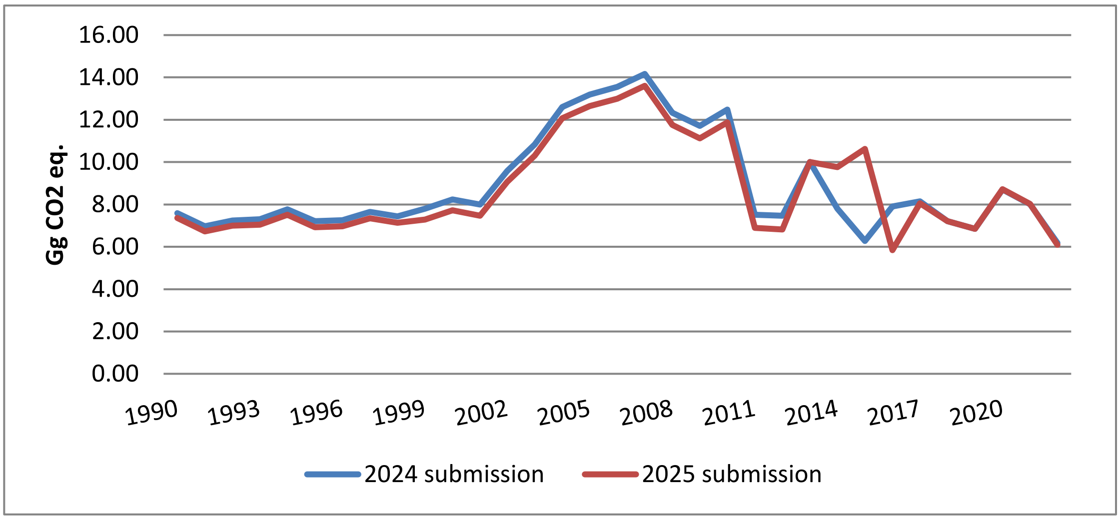


**Figure 9.2.** **Recalculations from Indirect $CO_2$ emissions (Gg $CO_2$ eq.)**

# Chapter 10.
## Recalculations and improvements

## 10.1. Explanations and justifications for recalculations

The recalculations made are driven by the results of the various review processes, QC checks and internal audits, and the ERT reviews of the annual submissions of Cyprus by the nominated experts from the UNFCCC. In the 2023 submission, several recalculations were implemented as a result of the following:

- Changes or refinements in methods: A methodological change occurs when an inventory agency uses a different tier to estimate emissions from a source category (e.g. for key source categories) or when it moves from a tier described in the IPCC Guidelines to a national method. Methodological changes are often driven by the development of new and different data sets. A methodological refinement occurs when an inventory agency uses the same tier to estimate emissions but applies it using a different data source or a different level of aggregation.
- Inclusion of new sources: A new source is defined as a source for which estimates (all or some gases) did not exist in previous inventories either due to lack of data or because it has just been identified.
- Allocation: Changes in allocation of emissions to different sectors or sources/sub-sources.
- Correction of errors: This case concerns errors during calculating emissions (e.g. transcript errors) or while filling in the required information in the CRT tables. Resolving inconsistencies is also included in this category.
- Updated activity data.
- Change of GWP values of gases according to the new Assessment Report (AR5)

## 10.2. Implications for emission levels

The justification of the recalculations made in the present submission as far as the preparation of GHG inventory is concerned has been presented in details in Chapters 3 – 7. In Table 10.1 the effect of the recalculations made on the total GHG emissions in Cyprus on a per sector basis is presented.

**Table 10.1. Comparison of NIR2024 to NIR2025, in kt $CO_2$ eq.**

| **NIR2024** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** |
|---|---|---|---|---|---|---|
| 1. Energy | 3952.50 | 4485.04 | 4808.67 | 4985.59 | 5197.89 | 5105.05 |
| 2. IPPU | 727.93 | 687.86 | 762.12 | 833.50 | 870.22 | 839.71 |
| 3. Agriculture | 454.74 | 461.29 | 491.51 | 519.70 | 514.25 | 544.36 |
| 4. LULUCF | -153.07 | -166.99 | -172.65 | -174.81 | -183.36 | -180.05 |
| 5. Waste | 435.18 | 440.71 | 449.08 | 459.80 | 472.74 | 481.39 |
| Total (incl. LULUCF) | 5570.35 | 6074.90 | 6511.38 | 6798.58 | 7055.11 | 6970.52 |
| Total (excl. LULUCF) | 5417.28 | 5907.91 | 6338.73 | 6623.77 | 6871.75 | 6790.48 |
| **NIR2025** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** |
| 1. Energy | 3955.24 | 4486.90 | 4810.19 | 4985.64 | 5195.44 | 5100.38 |
| 2. IPPU | 727.93 | 687.86 | 762.12 | 833.49 | 870.23 | 839.71 |
| 3. Agriculture | 454.74 | 461.29 | 491.51 | 519.70 | 514.25 | 544.36 |
| 4. LULUCF | -153.07 | -166.98 | -172.65 | -174.80 | -183.35 | -180.03 |
| 5. Waste | 435.18 | 440.71 | 449.08 | 459.80 | 472.74 | 481.39 |
| Total (incl. LULUCF) | 5573.09 | 6076.75 | 6512.90 | 6798.63 | 7052.66 | 6965.84 |
| Total (excl. LULUCF) | 5420.02 | 5909.76 | 6340.25 | 6623.82 | 6869.31 | 6785.81 |
| ***Difference*** | | | | | | |
| *1. Energy* | 0.07% | 0.04% | 0.03% | 0.00% | -0.05% | -0.09% |
| *2. IPPU* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *3. Agriculture* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *4. LULUCF* | 0.00% | 0.00% | 0.00% | 0.00% | -0.01% | -0.01% |

| | | | | | | |
|---|---|---|---|---|---|---|
| *5. Waste* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Total (incl. LULUCF)* | 0.05% | 0.03% | 0.02% | 0.00% | -0.03% | -0.07% |
| *Total (excl. LULUCF)* | 0.05% | 0.03% | 0.02% | 0.00% | -0.04% | -0.07% |
| | | | | | | |
| **NIR2024** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| 1. Energy | 5400.03 | 5523.11 | 5865.32 | 6130.61 | 6355.20 | 6249.67 |
| 2. IPPU | 904.12 | 876.05 | 840.12 | 852.95 | 882.17 | 875.28 |
| 3. Agriculture | 551.74 | 541.38 | 543.56 | 534.94 | 542.91 | 586.21 |
| 4. LULUCF | -185.37 | -184.23 | -190.51 | -198.40 | -142.53 | -168.62 |
| 5. Waste | 487.64 | 497.08 | 504.51 | 513.07 | 523.24 | 533.60 |
| Total (incl. LULUCF) | 7343.52 | 7437.62 | 7753.51 | 8031.57 | 8303.52 | 8244.76 |
| Total (excl. LULUCF) | 7158.15 | 7253.39 | 7563.01 | 7833.17 | 8160.99 | 8076.14 |
| **NIR2025** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| 1. Energy | 5393.40 | 5514.13 | 5854.56 | 6116.57 | 6341.69 | 6231.79 |
| 2. IPPU | 904.12 | 876.05 | 840.12 | 852.94 | 882.17 | 875.27 |
| 3. Agriculture | 551.74 | 541.38 | 543.56 | 534.94 | 542.91 | 586.21 |
| 4. LULUCF | -185.36 | -184.22 | -190.49 | -198.38 | -142.51 | -168.60 |
| 5. Waste | 487.64 | 497.08 | 504.51 | 513.07 | 523.24 | 533.60 |
| Total (incl. LULUCF) | 7336.90 | 7428.64 | 7742.75 | 8017.53 | 8290.01 | 8226.88 |
| Total (excl. LULUCF) | 7151.54 | 7244.43 | 7552.26 | 7819.15 | 8147.51 | 8058.28 |
| ***Difference*** | | | | | | |
| *1. Energy* | -0.12% | -0.16% | -0.18% | -0.23% | -0.21% | -0.29% |
| *2. IPPU* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *3. Agriculture* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *4. LULUCF* | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% |
| *5. Waste* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Total (incl. LULUCF)* | -0.09% | -0.12% | -0.14% | -0.17% | -0.16% | -0.22% |
| *Total (excl. LULUCF)* | -0.09% | -0.12% | -0.14% | -0.18% | -0.17% | -0.22% |
| | | | | | | |
| **NIR2024** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
| 1. Energy | 6410.69 | 6801.44 | 6941.75 | 7139.72 | 7324.45 | 7646.31 |
| 2. IPPU | 918.24 | 932.75 | 1014.78 | 1003.19 | 1059.55 | 1072.03 |
| 3. Agriculture | 609.97 | 592.67 | 572.69 | 525.54 | 531.15 | 529.50 |
| 4. LULUCF | -201.96 | -214.05 | -214.59 | -220.87 | -222.53 | -182.94 |
| 5. Waste | 541.54 | 544.68 | 548.53 | 557.57 | 557.86 | 559.92 |
| Total (incl. LULUCF) | 8480.44 | 8871.55 | 9077.76 | 9226.01 | 9473.01 | 9807.77 |
| Total (excl. LULUCF) | 8278.47 | 8657.49 | 8863.17 | 9005.14 | 9250.47 | 9624.83 |
| **NIR2025** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
| 1. Energy | 6391.43 | 6779.11 | 6938.54 | 7129.10 | 7317.73 | 7612.99 |
| 2. IPPU | 918.24 | 932.75 | 1014.78 | 1003.19 | 1059.55 | 1072.03 |
| 3. Agriculture | 609.97 | 592.67 | 572.69 | 525.54 | 531.15 | 529.50 |
| 4. LULUCF | -201.94 | -214.02 | -214.55 | -220.83 | -222.49 | -182.89 |
| 5. Waste | 541.54 | 544.68 | 548.53 | 557.57 | 557.86 | 559.92 |
| Total (incl. LULUCF) | 8461.18 | 8849.20 | 9074.54 | 9215.40 | 9466.28 | 9774.43 |
| Total (excl. LULUCF) | 8259.24 | 8635.19 | 8859.99 | 8994.57 | 9243.79 | 9591.55 |
| ***Difference*** | | | | | | |
| *1. Energy* | -0.30% | -0.33% | -0.05% | -0.15% | -0.09% | -0.44% |
| *2. IPPU* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *3. Agriculture* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *4. LULUCF* | -0.01% | -0.02% | -0.02% | -0.02% | -0.02% | -0.03% |
| *5. Waste* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Total (incl. LULUCF)* | -0.23% | -0.25% | -0.04% | -0.12% | -0.07% | -0.34% |
| *Total (excl. LULUCF)* | -0.23% | -0.26% | -0.04% | -0.12% | -0.07% | -0.35% |
| | | | | | | |
| **NIR2024** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| 1. Energy | 7859.01 | 7788.16 | 7551.64 | 7255.22 | 6772.66 | 5849.91 |
| 2. IPPU | 1093.85 | 929.90 | 809.87 | 811.54 | 772.13 | 1013.20 |
| 3. Agriculture | 508.12 | 500.49 | 514.80 | 506.90 | 484.68 | 449.17 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4. LULUCF | -249.89 | -277.70 | -265.08 | -300.82 | -293.66 | -297.33 |
| 5. Waste | 570.25 | 577.38 | 583.92 | 588.96 | 599.05 | 609.15 |
| Total (incl. LULUCF) | 10031.23 | 9795.93 | 9460.23 | 9162.61 | 8628.51 | 7921.43 |
| Total (excl. LULUCF) | 9781.34 | 9518.23 | 9195.15 | 8861.79 | 8334.85 | 7624.11 |
| **NIR2025** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| 1. Energy | 7829.24 | 7748.43 | 7516.29 | 7254.07 | 6767.31 | 5842.15 |
| 2. IPPU | 1093.84 | 929.89 | 809.86 | 811.54 | 772.13 | 1013.20 |
| 3. Agriculture | 508.12 | 500.49 | 514.80 | 506.90 | 484.68 | 449.17 |
| 4. LULUCF | -249.84 | -277.65 | -265.04 | -300.78 | -293.62 | -297.29 |
| 5. Waste | 570.25 | 577.38 | 583.92 | 588.96 | 599.05 | 609.15 |
| Total (incl. LULUCF) | 10001.45 | 9756.19 | 9424.88 | 9161.46 | 8623.16 | 7913.67 |
| Total (excl. LULUCF) | 9751.61 | 9478.54 | 9159.84 | 8860.68 | 8329.54 | 7616.38 |
| ***Difference*** | | | | | | |
| *1. Energy* | -0.38% | -0.51% | -0.47% | -0.02% | -0.08% | -0.13% |
| *2. IPPU* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *3. Agriculture* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *4. LULUCF* | -0.02% | -0.02% | -0.02% | -0.01% | -0.01% | -0.01% |
| *5. Waste* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Total (incl. LULUCF)* | -0.30% | -0.41% | -0.37% | -0.01% | -0.06% | -0.10% |
| *Total (excl. LULUCF)* | -0.30% | -0.42% | -0.38% | -0.01% | -0.06% | -0.10% |
| | | | | | | |
| **NIR2024** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| 1. Energy | 5997.56 | 6121.94 | 6498.48 | 6581.02 | 6515.56 | 6570.34 |
| 2. IPPU | 1241.76 | 1157.03 | 1185.19 | 1248.90 | 1197.29 | 1168.96 |
| 3. Agriculture | 437.17 | 441.85 | 462.39 | 476.12 | 481.80 | 495.53 |
| 4. LULUCF | -299.15 | -296.14 | -190.93 | -307.07 | -302.35 | -297.07 |
| 5. Waste | 619.19 | 623.02 | 626.15 | 633.61 | 643.33 | 654.18 |
| Total (incl. LULUCF) | 8295.68 | 8343.85 | 8772.20 | 8939.65 | 8837.98 | 8889.02 |
| Total (excl. LULUCF) | 7996.53 | 8047.70 | 8581.27 | 8632.58 | 8535.63 | 8591.94 |
| **NIR2025** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| 1. Energy | 5973.19 | 6097.70 | 6488.46 | 6568.77 | 6495.10 | 6548.31 |
| 2. IPPU | 1241.75 | 1157.02 | 1185.18 | 1248.89 | 1198.37 | 1170.76 |
| 3. Agriculture | 437.17 | 441.85 | 462.38 | 476.12 | 481.79 | 495.52 |
| 4. LULUCF | -299.11 | -296.11 | -190.89 | -307.03 | -302.31 | -297.04 |
| 5. Waste | 619.19 | 623.02 | 626.15 | 633.61 | 643.33 | 654.18 |
| Total (incl. LULUCF) | 8271.30 | 8319.60 | 8762.17 | 8927.40 | 8818.59 | 8417.41 |
| Total (excl. LULUCF) | 7972.20 | 8023.49 | 8571.28 | 8620.37 | 8516.28 | 8120.37 |
| ***Difference*** | | | | | | |
| *1. Energy* | -0.41% | -0.40% | -0.15% | -0.19% | -0.31% | -0.34% |
| *2. IPPU* | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.15% |
| *3. Agriculture* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *4. LULUCF* | -0.01% | -0.01% | -0.02% | -0.01% | -0.01% | -0.01% |
| *5. Waste* | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Total (incl. LULUCF)* | -0.29% | -0.29% | -0.11% | -0.14% | -0.22% | -5.31% |
| *Total (excl. LULUCF)* | -0.30% | -0.30% | -0.12% | -0.14% | -0.23% | -5.49% |
| **NIR2024** | **2020** | **2021** | **2022** | | | |
| 1. Energy | 6063.73 | 6225.90 | 6260.04 | | | |
| 2. IPPU | 1266.17 | 1284.79 | 1313.34 | | | |
| 3. Agriculture | 531.54 | 546.27 | 533.60 | | | |
| 4. LULUCF | -298.58 | -235.35 | -299.41 | | | |
| 5. Waste | 653.35 | 660.59 | 665.31 | | | |
| Total (incl. LULUCF) | 8514.79 | 8717.55 | 8772.29 | | | |
| Total (excl. LULUCF) | 8216.22 | 8482.19 | 8472.88 | | | |
| **NIR2025** | 2020 | 2021 | 2022 | | | |
| 1. Energy | 6039.19 | 6092.14 | 6210.45 | | | |
| 2. IPPU | 1268.32 | 1290.19 | 1324.48 | | | |
| 3. Agriculture | 531.54 | 546.27 | 528.61 | | | |
| 4. LULUCF | -298.54 | -235.33 | -299.39 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5. Waste | 653.35 | 660.59 | 667.16 | | | |
| Total (incl. LULUCF) | 8061.10 | 8177.02 | 8336.76 | | | |
| Total (excl. LULUCF) | 7762.56 | 7941.69 | 8037.37 | | | |
| ***Difference*** | | | | | | |
| *1. Energy* | -0.40% | -2.15% | -0.79% | | | |
| *2. IPPU* | 0.17% | 0.42% | 0.85% | | | |
| *3. Agriculture* | 0.00% | 0.00% | -0.94% | | | |
| *4. LULUCF* | -0.01% | -0.01% | -0.01% | | | |
| *5. Waste* | 0.00% | 0.00% | 0.28% | | | |
| *Total (incl. LULUCF)* | -5.33% | -6.20% | -4.96% | | | |
| *Total (excl. LULUCF)* | -5.52% | -6.37% | -5.14% | | | |

## 10.3. Implications for emission trends

The emission trends for the period 1990 –2022 according to the inventories submitted in 2025 and 2024 are shown in Figure 10.1 (LULUCF excluded). Emission trends for the period have not been affected significantly by the recalculations because in most cases the recalculations concerned the whole period.

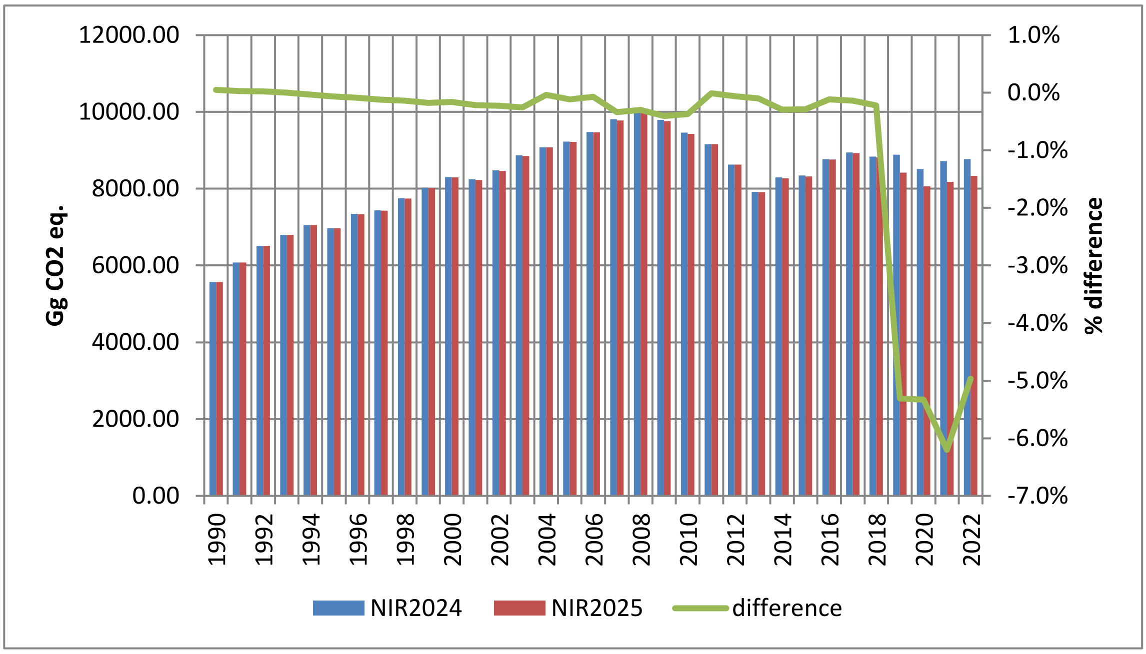


**Figure 10.1. Comparison of NIR2024 to NIR2025, LULUCF excluded [kt $CO_2$ eq.]**

## 10.4. Planned improvements

An inventory improvement procedure is in place, which utilises:

- the recommendations from UNFCCC ERT reports,
- the annual QA/QC checks of the inventory by EU under the Monitoring Mechanism Regulation (MMR),
- the recommendations of 2017 comprehensive review of national greenhouse gas inventory data pursuant to Article 19(1) of Regulation (EU) No 525 (MMR),
- the findings of independent audits carried out by local experts at the end of each year,
- the output of key category analysis, uncertainty analysis and QA/QC procedures.

These serve as a basis to prioritise, plan and materialize future improvements and recalculations. As mentioned above, details on the resultant recalculations and improvements planned per source/sink category have been presented in the respective chapters (Chapters 3 – 7).

Finally, it should be mentioned that the results and the proposals that will arise from the review of the present inventory, within the technical review process defined in relevant decisions of the Conference of the Parties, will be integrated in the plan for the improvement of the GHG emissions inventory.

# Chapter 11.
## Information on changes in national system

The national inventory arrangements and the QA/QC procedures have been restructured in 2017, to meet the requirements of CMP and COP Decisions relevant to national systems and QA/QC. The most important change is that the legal framework defining the roles-responsibilities and the co-operation between the DoE Inventory team and the designated contact points of the competent Ministries was formalized by the Council of Ministers' Decision adopted 15/11/2017 and entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

# Chapter 12.
## Information on changes in national registry

The information regarding the National Registry that should be included in the NIR in accordance decision 5/CMP.1 and the annex to decision 13/CMP.1 in conjunction with decision 3/CMP.11 and other relevant provisions and standards are presented in the following table.

Cyprus national registry has been fully connected to the ITL.

Also, about the national registry:

- No discrepancies have been identified by the transaction log pursuant to paragraph 43 of the annex to decision 13/CMP.1 and paragraph 54 of the annex to decision 5/CMP.1.
- No notification has been received from the Executive Board of the clean development mechanism (CDM) directing the Party to replace lCERs in accordance with paragraph 49 of the annex to decision 5/CMP.1.
- No notification has been received from the Executive Board of the clean development mechanism (CDM) directing the Party to replace lCERs in accordance with paragraph 50 of the annex to decision 5/CMP.1.
- No record to report of non-replacement identified by the transaction log in accordance with paragraph 56 of the annex to decision 5/CMP.1.
- All ERUs, CERs, tCERs, lCERs, AAUs and RMUs held in the national registry at the end of 2021 are valid for use towards compliance with commitments under Article 3, paragraph 1, pursuant to paragraph 43 (b) of the annex to decision 13/CMP.1.
- The SEF tables have been completed and submitted as part of the national 2023 GHG NIR submission,
- Publicly accessible registry information is available on the following website: http://www.moa.gov.cy/moa/environment/environmentnew.nsf/All/121CAE00B02167ACC22588B1004174FB?OpenDocument .

Cyprus commitment period reserve (CPR) is 42 705 115 t CO2 eq. which corresponds to 90% of Cyprus' assigned amount calculated pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol. The CPR was calculated in accordance with the annex to decision 18/CP.7, the annex to decision 11/CMP.1 and decision 1/CMP.8, paragraph 18, and can be found in table 4 of Annex I of the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Cyprus.

The CPR of Cyprus has not changed since the previous submission, and initial report, as 100 % of eight times Cyprus' most recently reviewed inventory emains higher than 90 % of the assigned amount.

| Ref: | Category | Subject | Question | Response |
|---|---|---|---|---|
| 1 | Registry | Organization & system | Country or organization? | Cyprus |
| 1.1 | | | By what name is your organization known? | Department of Environment<br>Ministry of Agriculture, Rural Development and Environment |
| 1.2 | | | By what name is your Registry system known? | CY Union Registry |
| 1.3 | | Location | Where / in which nation is your Registry located? (Please provide your full address for correspondence) | Postal Address: Department of Environment<br>1498, Nicosia, Cyprus<br>Offices: 20-22 28th Oktovriou Ave., Engomi, 2414, Nicosia, Cyprus |
| 1.4 | | Time zone: | Please state GMT +/- hours. | Standard Time is 2 hours ahead of Greenwich Mean Time (GMT+2). |
| 1.5 | | Days/hours of operation | Please indicate periods when the system will be operational, including uptime / downtime. | |
| 1.6 | | Calendar constraints | Please identify critical dates/periods (e.g. service deadlines, holidays/reduced service, etc.) | |
| 2.1 | Personnel | Primary (Business) contact: | Please provide the following details for your business Registry System Administrator. This is the person responsible for day-to-day operation of the Registry:<br><br>• Name<br>• Role / Job title<br>• Telephone number<br>• Email address<br>• Level of training / expertise in registry system (e.g. developer, administrator, user)<br>• Competence level in English (e.g. native, fluent, proficient, etc.) | • Name: Dr. Theodoulos MESIMERIS<br>• Role / Job title: Senior Environment Officer /Head of Climate Action Unit/ National Administrator<br>• Telephone number: +357 22408948<br>• Email address tmesimeris@environment.moa.gov.cy<br>• Level of training / expertise in registry system (e.g. developer, administrator, user): National Administrator<br>• Competence level in English (e.g. native, fluent, proficient, etc.): Proficient user |
| 2.2 | | Secondary (Technical) contact: | Please provide the following details for your technical support. This is the person responsible for technical support of your infrastructure and networking operation of the Registry:<br><br>• Name | |

| | | | | |
|---|---|---|---|---|
| | | | • Role / Job title<br>• Telephone number<br>• Email address<br>• Level of training / expertise in registry system (e.g. developer, administrator, user)<br>• Competence level in English (e.g. native, fluent, proficient, etc.) | |
| 2.3 | | Other possible contacts? | How many other members of staff are regularly involved on a frequent basis? | Two other members of staff are regularly involved on a frequent basis.<br><br>Person 1:<br>• Name: Nicoletta Kythreotou<br>• Role / Job title: Environment Officer<br>• Telephone number: +357 22408947<br>• Email address: nkythreotou@environment.moa.gov.cy<br>• Level of training / expertise in registry system (e.g. developer, administrator, user): National Administrator (2)<br>• Competence level in English (e.g. native, fluent, proficient, etc.): Proficient user<br><br>Person 2:<br>• Name: Niki Papaki<br>• Role / Job title: Environment Technician<br>• Telephone number: +357 22408946<br>• Email address: npapaki@environment.moa.gov.cy<br>• Level of training / expertise in registry system (e.g. developer, administrator, user): National Administrator (3)<br>• Competence level in English (e.g. native, fluent, proficient, etc.): Independent user |

# Chapter 13.

## Information on minimising adverse impacts in accordance with article 3, paragraph 14

## 13.1. Introduction

Article 3, paragraph 14, of the Kyoto Protocol requires that Annex I Parties shall strive to meet their commitments under Article 3, paragraph 1 of the Kyoto Protocol in such a way as to minimize adverse social environmental and economic impacts on developing country Parties, particularly those Parties identified in Article 4, paragraphs 8 and 9, of the Convention. Information on how commitments under Article 3, paragraph 14, are being implemented is to be prioritised under a number of actions as set down in section H of the annex to guidelines for the preparation of supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol (Decision 15/CMP.1). These requirements are addressed in this chapter.

## 13.2. Context

As a Member State of the European Union, Cyprus commitments under the Kyoto Protocol are being implemented under Decision 2005/166/EC, governing joint fulfilment under Article 4, and Decision 280/2004/EC, which covers specific emissions monitoring and reporting requirements. In this context, the minimization of adverse impacts on developing countries is also largely dictated by the European Commission's policy on climate change and by its policies and programmes affecting developing countries. Regulation at the European level also controls or influences market conditions, fiscal incentives, tax and duty exemptions and subsidies in all economic sectors in Member States.

The impact assessment of new policy initiatives has been established in the European Union, which allows their potential adverse social, environmental and economic impacts on various stakeholders, including developing country Parties, to be identified and limited at an early stage within the legislative process. Impact Assessment Guidelines specifically address impacts on third countries and also issues related to international relations. This provides a framework in which Member States like Cyprus can also ensure a high level of protection of the environment and contribute to the integration of environmental considerations into the preparation and adoption of specified plans and programmes with a view to promoting sustainable development.

## 13.3. Specific Elements

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

The current paragraph includes information on the means used by the country in order to enhance the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies that run counter to the objectives of the Convention and on the application of market instruments.

Cyprus, as a Member of the EU, supports and makes the necessary steps to implement the EU Common Agricultural Policy. In the specific policy environmental concerns have been gradually incorporated. Such examples are the including "decoupled" direct payments which have replaced price support; environmental cross compliance; a substantial increase in budget for rural development. As part of 2008

Common Agriculture Policy Health Check, additional part of direct aid has been shifted to climate change, renewable energy, water management, biodiversity, innovation; - transparency of agricultural subsidies has improved. It is important to note that in the other areas most subsidies are within the competence of the country.

The energy market liberalisation (National Laws 122(I)/2003 and 183(I)/2004) has been an important step to create an original internal energy market and can be considered as a mean to address market imperfections and to reflect externalities. The existence of a competitive internal energy market is a strategic instrument both in terms of giving local consumers a choice between different companies supplying gas and electricity at reasonable prices, but also in terms of making the market accessible for all suppliers, especially the smallest and those investing in renewable forms of energy.

At the same time, Cyprus participates in the EU Emissions Trading Scheme, which constitutes an important market instrument to implement the objectives of the Convention and Article 3, paragraph 1 of the Kyoto Protocol which aims at creating the right incentives for forward looking low carbon investment decisions by reinforcing a clear, undistorted and long-term carbon price signal.

Finally, the taxation on energy products and electricity, as defined by the Directive 2003/96/EC, contribute to establishment of rules for the taxation of energy products used as motor or heating fuel, taxes on energy consumption, and common minimum levels of taxation. The Directive has been transposed into Cyprus legislation with Law 91(I)/2004.

(b) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort

Cyprus considers important that EU remains committed to the climate change mitigation, through the international funding. Therefore, Cyprus has already contributed through the direct funding of the EU, with the amount of 1.2 million € for two projects in Nepal and eastern Caribbean. In the fulfilment of the requirements of Article 16 of Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC, Cyprus submits reports including information regarding funding provided by the Republic of Cyprus to developing countries. No private funding, technology and capacity building have been provided to developing countries since 2013 due to the fact that Cyprus is implementing a macroeconomic adjustment program in order to improve key sectors of the economy as well as its public finances, pursuant to the provisions of the Memorandum of Understanding.

# Annexes
## to the national inventory report

## Annex 1: Key categories

The 2006 IPCC Guidelines defines procedures (in the form of decision trees) for the choice of estimation methods within the context of the IPCC Guidelines. Decision trees formalize the choice of the estimation method most suited to national circumstances while simultaneously considering the need for accuracy and the available resources (both financial and human). It is considered good practice to identify those source categories (key source categories) that have the greatest contribution to overall inventory uncertainty in order to make the most efficient use of available resources.

In that context, a “key source category” is one that is prioritised within the national inventory system because its estimate has a significant influence on a country’s total inventory of direct greenhouse gases in terms of the absolute level of emissions (level assessment) and/or to the trend of emissions (trend assessment).

As far as possible, key source categories should receive special consideration in terms of two important inventory aspects.

1. The use of source category-specific good practice methods is preferable, unless resources are unavailable.

2. The key source categories should receive additional attention with respect to quality assurance (QA) and quality control (QC).

The determination of the key categories without LULUCF for the Greek inventory system is based on the application of the Tier 1 methodology described in the 2006 IPCC Guidelines, adopting the categorization of sources that is presented in the GLs. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms. It should be noted that according to the 2006 IPCC GLs, the trend is estimated on the basis of the base year (1990). The methodology for the determination of key categories with LULUCF is the same as for the one for key sources without LULUCF.

The key categories analysis has been performed for the years 1990 and 2023 on both level and trend analysis basis. Any differences between the key categories in the time-series are due to the fluctuation of the trend in specific categories and refer to trend analysis.

**Table A1.1.Key categories analysis without/with LULUCF – Level and trend assessment for 2023**

| Key categories of emissions and removals | Gas | Emissions/removals [2023] | Without LULUCF | | | With LULUCF | | |
|---|---|---|---|---|---|---|---|---|
| | | ($ktCO_2$ eq) | Level (%) | Trend (%) | Key category | Level (%) | Trend (%) | Key category |
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $CO_2$ | 3,049.9 | **34.3** | **9.9** | **X** | **33.0** | **9.5** | **X** |
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $CH_4$ | 3.3 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $N_2O$ | 6.3 | 0.1 | 0.0 | | 0.1 | 0.0 | |
| 1.A.1 Fuel combustion - Energy Industries - Biomass | $CH_4$ | 0.1 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.1 Fuel combustion - Energy Industries - Biomass | $N_2O$ | 0.1 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $CO_2$ | 286.2 | **3.2** | **5.7** | **X** | **3.1** | **5.0** | **X** |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $CH_4$ | 0.3 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $N_2O$ | 0.5 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $CO_2$ | 101.2 | **1.1** | **10.8** | **X** | **1.1** | **9.5** | **X** |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $CH_4$ | 0.3 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $N_2O$ | 0.4 | 0.0 | 0.0 | | 0.0 | 0.0 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels | $CO_2$ | 170.3 | **1.9** | **6.9** | **X** | **1.8** | **6.1** | **X** |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels | $CH_4$ | 1.6 | 0.0 | 0.1 | | 0.0 | 0.1 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels | $N_2O$ | 2.0 | 0.0 | 0.1 | | 0.0 | 0.1 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass | $CH_4$ | 1.3 | 0.0 | 0.1 | | 0.0 | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass | $N_2O$ | 1.6 | 0.0 | 0.1 | | 0.0 | 0.1 | |
| 1.A.3.a Domestic Aviation | $CO_2$ | 1.1 | 0.0 | **1.6** | **X** | 0.0 | **1.4** | **X** |
| 1.A.3.a Domestic Aviation | $CH_4$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.a Domestic Aviation | $N_2O$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.b Road Transportation | $CO_2$ | 2,139.2 | **24.1** | **9.8** | **X** | **23.1** | **9.2** | **X** |
| 1.A.3.b Road Transportation | $CH_4$ | 2.5 | 0.0 | 0.4 | | 0.0 | 0.4 | |
| 1.A.3.b Road Transportation | $N_2O$ | 12.0 | 0.1 | 0.2 | | 0.1 | 0.1 | |
| 1.A.3.d Domestic Navigation - Liquid Fuels | $CO_2$ | 5.8 | 0.1 | 0.1 | | 0.1 | 0.1 | |
| 1.A.3.d Domestic Navigation - Liquid Fuels | $CH_4$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.d Domestic Navigation - Liquid Fuels | $N_2O$ | 0.1 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.d Domestic Navigation - Other Fossil Fuels | $CO_2$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.d Domestic Navigation - Other Fossil Fuels | $CH_4$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.d Domestic Navigation - Other Fossil Fuels | $N_2O$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.d Domestic Navigation - Biomass Fuels | $CH_4$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.3.d Domestic Navigation - Biomass Fuels | $N_2O$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.4 Other Sectors - Liquid Fuels | $CO_2$ | 445.5 | **5.0** | **9.7** | **X** | **4.8** | **8.4** | **X** |
| 1.A.4 Other Sectors - Liquid Fuels | $CH_4$ | 1.5 | 0.0 | 0.0 | | 0.0 | 0.0 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1.A.4 Other Sectors - Liquid Fuels | $N_2O$ | 0.7 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.4 Other Sectors - Other Fossil Fuels | $CO_2$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.4 Other Sectors - Other Fossil Fuels | $CH_4$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.4 Other Sectors - Other Fossil Fuels | $N_2O$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.4 Other Sectors - Biomass | $CH_4$ | 8.0 | 0.1 | 0.2 | | 0.1 | 0.2 | |
| 1.A.4 Other Sectors - Biomass | $N_2O$ | 0.8 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Liquid Fuels | $CO_2$ | 23.1 | 0.3 | 0.2 | | 0.2 | 0.2 | |
| 1.A.5 Other (Not specified elsewhere) - Liquid Fuels | $CH_4$ | 0.1 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Liquid Fuels | $N_2O$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Other Fossil Fuels | $CO_2$ | 0.1 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Other Fossil Fuels | $CH_4$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Other Fossil Fuels | $N_2O$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Biomass | $CH_4$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Biomass | $N_2O$ | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 2.A.1 Cement Production | $CO_2$ | 938.2 | **10.6** | **5.1** | **X** | **10.1** | **4.2** | **X** |
| 2.A.2 Lime Production | $CO_2$ | 6.0 | 0.1 | 0.1 | | 0.1 | 0.1 | |
| 2.A.4 Other Process Uses of Carbonates | $CO_2$ | 16.1 | 0.2 | **2.2** | **X** | 0.2 | **1.9** | **X** |
| 2.D Non-energy Products from Fuels and Solvent Use | $CO_2$ | 5.4 | 0.1 | 0.1 | | 0.1 | 0.0 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2.F.1 Refrigeration and Air conditioning | Aggregate F-gases | 401.4 | **4.5** | **16.2** | **X** | **4.3** | **14.4** | **X** |
| 2.F.2 Foam Blowing Agents | Aggregate F-gases | 1.3 | 0.0 | 0.1 | | 0.0 | 0.0 | |
| 2.F.3 Fire Protection | Aggregate F-gases | 9.4 | 0.1 | 0.4 | | 0.1 | 0.3 | |
| 2.F.4 Aerosols | Aggregate F-gases | 3.0 | 0.0 | 0.1 | | 0.0 | 0.1 | |
| 2.G Other Product Manufacture and Use | $N_2O$ | 6.3 | 0.1 | 0.0 | | 0.1 | 0.0 | |
| 2.G Other Product Manufacture and Use | Aggregate F-gases | 17.8 | 0.2 | 0.5 | | 0.2 | **0.5** | **X** |
| 2. Industrial Proccesses and Produc Use (indirect $CO_2$ emissions) | $CO_2$ | 6.7 | 0.1 | 0.2 | | 0.1 | 0.2 | |
| 3.A Enteric Fermentation | $CH_4$ | 336.1 | **3.8** | **0.6** | **X** | **3.6** | 0.4 | **X** |
| 3.B Manure Management | $CH_4$ | 75.0 | 0.8 | **4.3** | **X** | **0.8** | **3.8** | **X** |
| 3.B Manure Management | $N_2O$ | 68.0 | 0.8 | **1.0** | **X** | 0.7 | **0.9** | **X** |
| 3.D.1 Direct N2O Emissions From Managed Soils | $N_2O$ | 33.7 | 0.4 | **1.2** | **X** | 0.4 | **1.1** | **X** |
| 3.D.2 Indirect N2O Emissions From Managed Soils | $N_2O$ | 16.9 | 0.2 | 0.4 | | 0.2 | 0.3 | |
| 3.F Field burning of agricultural residues | $CH_4$ | 0.5 | 0.0 | 0.1 | | 0.0 | 0.1 | |
| 3.F Field burning of agricultural residues | $N_2O$ | 0.1 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| 3.H Urea Application | $CO_2$ | 0.2 | 0.0 | 0.1 | | 0.0 | 0.1 | |
| 4.A.1 Forest Land Remaining Forest Land | $CO_2$ | -168.8 | | | | **1.8** | **6.1** | **X** |
| 4.A.2 Land Converted to Forest Land | $CO_2$ | -19.1 | | | | 0.2 | **0.7** | **X** |
| 4.B.1 Cropland Remaining Cropland | $CO_2$ | -133.1 | | | | **1.4** | **2.8** | **X** |
| 4.B.2 Land Converted to Cropland | $CO_2$ | 6.1 | | | | 0.1 | 0.2 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4.C.1 Grassland Remaining Grassland | $CO_2$ | -21.6 | | | | 0.2 | 0.4 | |
| 4.C.2 Land Converted to Grassland | $CO_2$ | 2.0 | | | | 0.0 | 0.1 | |
| 4.D.2 Land Converted to Wetlands | $CO_2$ | 0.5 | | | | 0.0 | 0.0 | |
| 4.E.2 Land Converted to Settlements | $CO_2$ | 2.9 | | | | 0.0 | 0.1 | |
| 4.F.1 Other Land Remaining Other Land | $CO_2$ | | | | | | | |
| 4.G Harvested Wood Products | $CO_2$ | 19.3 | | | | 0.2 | **0.6** | **X** |
| 4(III).Direct and indirect N2O emissions from N mineralization/immobilization | $N_2O$ | 0.6 | | | | 0.0 | 0.0 | |
| 4(IV) Biomass Burning | $CH_4$ | 0.3 | | | | 0.0 | 0.0 | |
| 4(IV) Biomass Burning | $N_2O$ | 0.2 | | | | 0.0 | 0.0 | |
| 4.H Other | $CO_2$ | | | | | | | |
| 4.H Other | $CH_4$ | | | | | | | |
| 5.A Solid Waste Disposal | $CH_4$ | 578.8 | **6.5** | **4.4** | **X** | **6.3** | **4.0** | **X** |
| 5.B Biological Treatment of Solid Waste | $CH_4$ | 12.3 | 0.1 | 0.5 | | 0.1 | 0.4 | |
| 5.B Biological Treatment of Solid Waste | $N_2O$ | 6.9 | 0.1 | 0.3 | | 0.1 | 0.2 | |
| 5.D Wastewater Treatment and Discharge | $CH_4$ | 59.0 | 0.7 | **6.0** | **X** | 0.6 | **5.2** | **X** |
| 5.D Wastewater Treatment and Discharge | $N_2O$ | 15.3 | 0.2 | 0.0 | | 0.2 | 0.0 | |

**Table A1.2.Key categories analysis without/with LULUCF – Level assessment for 1990**

| Key categories of emissions and removals | Gas | Emissions/removals [1990] | Without LULUCF | | With LULUCF | |
|---|---|---|---|---|---|---|
| | | ($ktCO_2$ eq) | Level (%) | Key category | Level (%) | Key category |
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $CO_2$ | 1,761.5 | 31.6 | X | 30.7 | X |
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $CH_4$ | 1.9 | 0.0 | | 0.0 | |
| 1.A.1 Fuel combustion - Energy Industries - Liquid Fuels | $N_2O$ | 3.5 | 0.1 | | 0.1 | |
| 1.A.1 Fuel combustion - Energy Industries - Biomass | $CH_4$ | 0.1 | 0.0 | | 0.0 | |
| 1.A.1 Fuel combustion - Energy Industries - Biomass | $N_2O$ | 0.1 | 0.0 | | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $CO_2$ | 270.6 | 4.8 | X | 4.7 | X |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $CH_4$ | 0.3 | 0.0 | | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels | $N_2O$ | 0.5 | 0.0 | | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $CO_2$ | 231.7 | 4.2 | X | 4.0 | X |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $CH_4$ | 0.7 | 0.0 | | 0.0 | |
| 1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels | $N_2O$ | 1.0 | 0.0 | | 0.0 | |
| 1.A.3.a Domestic Aviation | $CO_2$ | 26.0 | 0.5 | | 0.5 | |
| 1.A.3.a Domestic Aviation | $CH_4$ | 0.0 | 0.0 | | 0.0 | |
| 1.A.3.a Domestic Aviation | $N_2O$ | 0.2 | 0.0 | | 0.0 | |
| 1.A.3.b Road Transportation | $CO_2$ | 1,191.2 | 21.3 | X | 20.7 | X |
| 1.A.3.b Road Transportation | $CH_4$ | 7.9 | 0.1 | | 0.1 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.A.3.b Road Transportation | $N_2O$ | 10.1 | 0.2 | | 0.2 | |
| 1.A.3.d Domestic Navigation - Liquid Fuels | $CO_2$ | 2.2 | 0.0 | | 0.0 | |
| 1.A.3.d Domestic Navigation - Liquid Fuels | $CH_4$ | 0.0 | 0.0 | | 0.0 | |
| 1.A.3.d Domestic Navigation - Liquid Fuels | $N_2O$ | 0.0 | 0.0 | | 0.0 | |
| 1.A.4 Other Sectors - Liquid Fuels | $CO_2$ | 430.4 | 7.7 | X | 7.5 | X |
| 1.A.4 Other Sectors - Liquid Fuels | $CH_4$ | 1.4 | 0.0 | | 0.0 | |
| 1.A.4 Other Sectors - Liquid Fuels | $N_2O$ | 0.7 | 0.0 | | 0.0 | |
| 1.A.4 Other Sectors - Biomass | $CH_4$ | 1.4 | 0.0 | | 0.0 | |
| 1.A.4 Other Sectors - Biomass | $N_2O$ | 0.2 | 0.0 | | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Liquid Fuels | $CO_2$ | 11.0 | 0.2 | | 0.2 | |
| 1.A.5 Other (Not specified elsewhere) - Liquid Fuels | $CH_4$ | 0.0 | 0.0 | | 0.0 | |
| 1.A.5 Other (Not specified elsewhere) - Liquid Fuels | $N_2O$ | 0.0 | 0.0 | | 0.0 | |
| 1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil | $CH_4$ | 0.5 | 0.0 | | 0.0 | |
| 2.A.1 Cement Production | $CO_2$ | 667.7 | 12.0 | X | 11.6 | X |
| 2.A.2 Lime Production | $CO_2$ | 5.3 | 0.1 | | 0.1 | |
| 2.A.4 Other Process Uses of Carbonates | $CO_2$ | 44.1 | 0.8 | | 0.8 | |
| 2.D Non-energy Products from Fuels and Solvent Use | $CO_2$ | 4.2 | 0.1 | | 0.1 | |
| 2.G Other Product Manufacture and Use | $N_2O$ | 3.9 | 0.1 | | 0.1 | |
| 2.G Other Product Manufacture and Use | Aggregate F-gases | 2.7 | 0.0 | | 0.0 | |
| 2. Industrial Proccesses and Produc Use (indirect $CO_2$ emissions) | $CO_2$ | 7.6 | 0.1 | | 0.1 | |
| 3.A Enteric Fermentation | $CH_4$ | 220.6 | 4.0 | X | 3.8 | X |
| 3.B Manure Management | $CH_4$ | 113.9 | 2.0 | X | 2.0 | X |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3.B Manure Management | $N_2O$ | 58.5 | 1.0 | | 1.0 | X |
| 3.D.1 Direct N2O Emissions From Managed Soils | $N_2O$ | 40.3 | 0.7 | | 0.7 | |
| 3.D.2 Indirect N2O Emissions From Managed Soils | $N_2O$ | 16.6 | 0.3 | | 0.3 | |
| 3.F Field burning of agricultural residues | $CH_4$ | 2.4 | 0.0 | | 0.0 | |
| 3.F Field burning of agricultural residues | $N_2O$ | 0.6 | 0.0 | | 0.0 | |
| 3.H Urea Application | $CO_2$ | 1.8 | 0.0 | | 0.0 | |
| 4.A.1 Forest Land Remaining Forest Land | $CO_2$ | 1.6 | | | 0.0 | |
| 4.A.2 Land Converted to Forest Land | $CO_2$ | -0.1 | | | 0.0 | |
| 4.B.1 Cropland Remaining Cropland | $CO_2$ | -134.0 | | | 2.3 | X |
| 4.B.2 Land Converted to Cropland | $CO_2$ | -0.3 | | | 0.0 | |
| 4.C.1 Grassland Remaining Grassland | $CO_2$ | -23.4 | | | 0.4 | |
| 4.C.2 Land Converted to Grassland | $CO_2$ | 0.4 | | | 0.0 | |
| 4.E.2 Land Converted to Settlements | $CO_2$ | 0.5 | | | 0.0 | |
| 4.F.2 Land Converted to Other Land | $CO_2$ | 0.1 | | | 0.0 | |
| 4.G Harvested Wood Products | $CO_2$ | 2.1 | | | 0.0 | |
| 4(III).Direct and indirect N2O emissions from N mineralization/immobilization | $N_2O$ | 0.0 | | | 0.0 | |
| 4(IV) Biomass Burning | $CH_4$ | 0.0 | | | 0.0 | |
| 4(IV) Biomass Burning | $N_2O$ | 0.0 | | | 0.0 | |
| 5.A Solid Waste Disposal | $CH_4$ | 295.4 | 5.3 | X | 5.1 | X |
| 5.D Wastewater Treatment and Discharge | $CH_4$ | 130.0 | 2.3 | X | 2.3 | X |
| 5.D Wastewater Treatment and Discharge | $N_2O$ | 9.8 | 0.2 | | 0.2 | |

# Annex 2: Assessment of uncertainty

## A2.1: Description of methodology used for identifying uncertainties

Uncertainty analysis constitutes a key activity in the annual inventory cycle. The realisation of such an analysis is foreseen in the reporting guidelines under the Convention and represents a specific function to be performed by a National System (Decision 24/CP.19).

Uncertainty information is not intended to dispute the validity of the inventory estimates, but to help prioritize efforts to improve the accuracy of inventories and guide decisions on methodological choice. This will be achieved with the correct application of the analytic calculating methods at least for the key categories.

There are two methods for the uncertainty estimation suggested by the 2006 IPCC Guidelines; a basic method (Tier 1) which is mandatory and an analytic one (Tier 2).

The Tier 2 methodology is based on Monte Carlo analysis. The principle of Monte Carlo analysis is to select random values of emission factor and activity data from within their individual probability density functions, and to calculate the corresponding emission values. This procedure is repeated many times, and the results of each calculation run build up the overall emission probability density function. Monte Carlo analysis can be performed at the source category level, for aggregations of source categories or for the inventory as a whole. This analysis is suitable for a composite system such as the calculation of GHG emissions in national level. but its application requires significant resources and time.

The application of the Tier 1 methodology for uncertainty analysis is based on the following equations.

**A. Uncertainty of total emissions**

$$u_{i,g} = \sqrt{u^2_{AD,i} + u^2_{EF,i,g}}$$

$$U_{i,g} = \frac{u_{i,g} \cdot E_{i,g}}{\sum_{i,g} E_{i,g}}$$

$$U_{tot} = \sqrt{\sum_{i,g} U^2_{i,g}}$$

where. i is the index referring to emission sources, g is the index referring to GHG, ui.g is the combined uncertainty for emissions of g-gas and i-source, uAD.i is the uncertainty of activity data of the i-source, uEF.i.g is the uncertainty of the emission factor of g-gas and i-source, Ui.g is the uncertainty of the calculated emissions of g-gas and i-source, Ei.g are the emissions of g-gas and i-source and Utot is the uncertainty of total emissions. Uncertainty estimations on activity data (uAD.i) and on the emission factors (uEF.i.g) are based on IPCC defaults using expert judgement and reasoning details and detailed explanation regarding their choice for each sector is presented in reasoning details and detailed explanation regarding their choice for each sector is presented in Table A2.1.

**B. Uncertainty in trend in emissions**

$$A_{i,g} = \frac{0{,}01 \cdot E_{i,g,t} + \sum_{i,g} E_{i,g,t} - \left(0{,}01 \cdot E_{i,g,0} + \sum_{i,g} E_{i,g,0}\right)}{0{,}01 \cdot E_{i,g,0} + \sum_{i,g} E_{i,g,0}} \cdot 100 - \frac{\sum_{i,g} E_{i,g,t} - \sum_{i,g} E_{i,g,0}}{\sum_{i,g} E_{i,g,0}} \cdot 100$$

$$B_{i,g} = \frac{E_{i,g,t}}{\sum_{i,g} E_{i,g,0}}$$

$$TREF_{i,g} = A_{i,g} \cdot u_{EF,i,g}$$

$$TRAD_i = B_{i,g} \cdot u_{AD,i} \cdot \sqrt{2}$$

$$U_{TR} = \sqrt{\sum_{i,g} TREF_{i,g}^2 + TRAD_{i,g}^2}$$

where, t is the index referring to the inventory year, 0 is the index referring to the base year, Ai,g is the difference (%) of emissions of g-gas and i-source in response to a 1% increase of emissions in the base year and inventory year, Ei,g,t emissions of g-gas and i-source in the inventory year, Ei,g, 0 emissions of g-gas and i-source in the base year, Bi,g the difference (%) of emissions of g-gas and i-source in response to a 1% increase of emissions in the inventory year, TREFi,g the contribution of EF uncertainty of g-gas and i-source to the uncertainty in the trend of emissions, TRADi the contribution of AD uncertainty i-source to the uncertainty in the trend of emissions and UTR is the uncertainty in the trend of emissions.

The uncertainty analysis for the Cyprus' GHG inventory is based on Tier 1 methodology with 1990 as base year for $CO_2$, CH4, N2O and 1995 for F-gases emissions.

Moreover:

- For the estimation of uncertainties per gas, a combination of the information provided by the IPCC and critical evaluation of information from indigenous sources was applied.
- 100% of emissions are used for the uncertainty analysis.
- The uncertainty analysis was carried out both without and with the LULUCF sector.

In Tables A2.2 and A2.3, the analytical calculations of the emissions estimates uncertainty are presented, without the sector of LULUCF for 1990 and 2021.

**Table A2.1.Reasoning for activity data and emission factor uncertainty value**

| **IPCC Source category** | **Reasoning for activity data uncertainty** | **Reasoning for emission factor uncertainty** |
|---|---|---|
| Stationary Combustion | 5% corresponds to the IPCC default uncertainty range for AD obtained from national energy balances. After 2005 that AD are cross-checked with PS AD from verified EUETS reports (source specific QA/QC), the uncertainty of AD is reduced to 3%. | • $CO_2$: According to IPCC guidelines the use of default carbon content per fuel corresponds to 95% confidence intervals and the % uncertainty is estimated < 5%. 1990–2004 5%; PS data from verified EU-ETS reports are used for the calculation of EFs for the majority of fuels after 2005. We estimate the EF uncertainty to be 3%.<br>• $CH_4$: In IPCC guidelines is mentioned that the default uncertainty for stationary combustion EF is 50-150%. We select the mean 100%.<br>• $N_2O$: Although in IPCC GPG is mentioned that EF from Table 2.16 may be expected to limit uncertainties to within an order of magnitude. In order to be conservative we select 300% as uncertainty. |

| IPCC Source category | Reasoning for activity data uncertainty | Reasoning for emission factor uncertainty |
|---|---|---|
| Road transport | 5% corresponds to the IPCC default uncertainty range for AD obtained from national energy balances. | IPCC defaults are used: 5% for $CO_2$; 40% for $CH_4$ and 50% for $N_2O$ |
| Navigation | Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range. | IPCC defaults are used: 5% for $CO_2$; 100% for $CH_4$ and 300% for $N_2O$ |
| Civil Aviation | Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range. | IPCC defaults are used: 5% for $CO_2$; 100% for $CH_4$ and 300% for $N_2O$ |
| Not specified - Mobile | Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range. | IPCC defaults are used: 5% for $CO_2$; 100% for $CH_4$ and 300% for $N_2O$ |
| Oil and Natural gas | Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range. | In IPCC guidelines is mentioned that the EF used may be expected to limit uncertainties to within an order of magnitude. However, in order to be conservative the value 300% is selected for all gases |
| Cement Production | Plant level production data (2%). | Plant level production data (2%) |
| Lime Production | Plant level production data (2%). | In IPCC guidelines is mentioned that the EF used may be expected to range between 1-5%. In order to be conservative the value 5% is selected. |
| Other process uses of carbonates | Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range. | In IPCC guidelines is mentioned that the EF used may be expected to range between 1-5%. In order to be conservative the value 5% is selected. |
| Non-Energy Products from Fuels and Solvent Use | Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range. | In IPCC guidelines is mentioned that the EF used may be expected to range between 1-5%. In order to be conservative the value 5% is selected. |
| Refrigeration and Air Conditioning Equipment | Activity data obtained from national statistics (population, inventory of fluorinated and ozone depleting containing equipment): 5% | Expert judgement; 500% |
| Foam Blowing | Activity data obtained from national statistics (population): 5% | Expert judgement; 500% |
| Fire Extinguishers | Activity data obtained from national statistics (population): 5% | Expert judgement; 500% |
| Aerosols/MDIs | Activity data obtained from national statistics (population): 5% | Expert judgement; 500% |
| $SF_6$ from electrical equipment | Activity data obtained from national statistics (population): 5% | Expert judgement; 500% |
| $N_2O$ from product uses | Uncertainty given by Statistical Service for the population data: 5% | Expert judgement; 500% |
| Enteric fermentation | Uncertainty given by Statistical Service for the livestock population data: 5% | ±20% proposed by 2006 IPCC guidelines using the Tier 2 method. |
| Manure management | Uncertainty given by Statistical Service for the livestock population data: 5% | Conservative IPCC values: 30% for $CH_4$ and 100% for $N_2O$ |
| Indirect $N_2O$ | Uncertainty given by Statistical | Conservative IPCC values: 50% for $N_2O$ |

| IPCC Source category | Reasoning for activity data uncertainty | Reasoning for emission factor uncertainty |
|---|---|---|
| emissions | Service for the livestock population data: 20% | |
| Agricultural soils – direct emissions | Uncertainty given by Statistical Service for the livestock population data: 20% | In IPCC guidelines is mentioned that the EF used may be expected to range between 3-30%. In order to be conservative the value 30% is selected. |
| Agricultural soils – indirect emissions | Uncertainty given by Statistical Service for the livestock population data: 20% | 50% (According to Good Practice Guidance. Page 4.75) |
| Field burning of agricultural Residues | Uncertainty given by Statistical Service for the livestock population data: 20% | 20% (According to Good Practice Guidance. Page 4.82. Table 4.20) |
| Urea application | Uncertainty given by Statistical Service for the livestock population data: 20% | 50% (According to Good Practice Guidance) |
| Solid waste disposal | IPCC proposes 10-30%. 30% chosen as Cyprus is a country collecting data on regular basis | Estimated based on information from 2006 IPCC guidelines (vol. 5, pg. 3.27, table 3.5) using highest values to be conservative: 30% |
| Composting | IPCC proposes 10-30%. 30% chosen as Cyprus is a country collecting data on regular basis | Estimated based on information from 2006 IPCC guidelines using highest values to be conservative: 100% |
| Wastewater handling | Domestic: 30%<br>Industrial: 100% | Estimated 30% based on information in 2006 IPCC guidelines |

**Table A2.2.Analytical calculations of uncertainty, with LULUCF 2022**

| IPCC category | Gas | Base year emissions or removals | Year x emissions or removals | Activity data uncertainty | Emission factor/estimation parameter uncertainty | Combined uncertainty | Contribution to Variance by Category in Year x | | Type B sensitivity | Uncertainty in trend in national emissions introduced by emission factor/estimation parameter uncertainty | Uncertainty in trend in national emissions introduced by activity data uncertainty | Uncertainty introduced into the trend in total national emissions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Input data | Input data | Input data Note A | Input data Note A | $\sqrt{E^2+F^2}$ | $\frac{(G*D)^2}{(\sum D)^2}$ | | $\left\lvert\frac{D}{\sum C}\right\rvert$ | $I*F$ Note C | $J*E*\sqrt{2}$ Note D | $K^2+L^2$ |
| | | Gg $CO_2$ equivalent | Gg $CO_2$ equivalent | % | % | % | | | % | % | % | % |
| 1A1a. Public electricity and heat production | CH4 | 1.96 | 3.34 | 3% | 100% | 1.0004 | 0.0000 | | 0.0006 | 0.0000 | 0.0000 | 7.02946E-10 |
| 1A1b. Petroleum refining | CH4 | 0.06 | 0.00 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0 |
| 1A1c. Manufacture of solid fuels and other energy industries | CH4 | 0.09 | 0.06 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 2.62909E-12 |
| 1A2b. Non-ferrous metals | CH4 | 0.00 | 0.00 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.66672E-16 |
| 1A2c. Chemicals | CH4 | 0.00 | 0.02 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 6.76297E-14 |
| 1A2d. Pulp, paper and print | CH4 | 0.01 | 0.00 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 4.9869E-16 |
| 1A2e. Food processing, beverages and tobacco | CH4 | 0.07 | 0.16 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 7.75739E-12 |
| 1A2f. Non-metallic minerals | CH4 | 0.85 | 3.20 | 3% | 100% | 1.0004 | 0.0000 | | 0.0006 | 0.0000 | 0.0000 | 6.62757E-10 |
| 1A2g. Other | CH4 | 0.04 | 0.10 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.3229E-12 |
| 1A3a. Domestic aviation | CH4 | 0.01 | 0.00 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 9.8349E-18 |
| 1A3b. Road transportation | CH4 | 7.84 | 2.53 | 5% | 40% | 0.4031 | 0.0000 | | 0.0006 | 0.0000 | 0.0000 | 1.84209E-09 |
| 1A3d. Domestic navigation | CH4 | 0.00 | 0.01 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 9.63636E-15 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A4a. Commercial/institutional | CH4 | 0.47 | 2.21 | 5% | 100% | 1.0012 | 0.0000 | | 0.0005 | 0.0000 | 0.0000 | 1.31626E-09 |
| 1A4b. Residential | CH4 | 2.13 | 6.85 | 5% | 100% | 1.0012 | 0.0000 | | 0.0015 | 0.0000 | 0.0001 | 1.06067E-08 |
| 1A4c. Agriculture/forestry/fishing | CH4 | 0.21 | 0.41 | 5% | 100% | 1.0012 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 2.07748E-11 |
| 1A5a. Stationary | CH4 | 0.04 | 0.07 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 8.4237E-13 |
| 1A5b. Mobile | CH4 | 0.00 | 0.01 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 5.86739E-14 |
| 1B2a. Oil | CH4 | 0.45 | 0.00 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0 |
| 3A1a. Dairy cattle | CH4 | 61.99 | 141.03 | 5% | 20% | 0.2062 | 0.0000 | | 0.0248 | 0.0000 | 0.0018 | 3.08529E-06 |
| 3A1b. Non-dairy cattle | CH4 | 51.50 | 69.44 | 5% | 50% | 0.5025 | 0.0000 | | 0.0126 | 0.0000 | 0.0009 | 7.92643E-07 |
| 3A2. Sheep | CH4 | 64.96 | 79.19 | 5% | 50% | 0.5025 | 0.0000 | | 0.0143 | 0.0000 | 0.0010 | 1.01896E-06 |
| 3A3. Swine | CH4 | 11.67 | 13.00 | 5% | 50% | 0.5025 | 0.0000 | | 0.0026 | 0.0000 | 0.0002 | 3.3012E-08 |
| 3A4a. Goats | CH4 | 28.84 | 32.75 | 5% | 50% | 0.5025 | 0.0000 | | 0.0067 | 0.0000 | 0.0005 | 2.23782E-07 |
| 3A4b. Horses | CH4 | 0.23 | 0.36 | 5% | 50% | 0.5025 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 2.11436E-11 |
| 3A4c. Mules and Asses | CH4 | 1.41 | 0.37 | 5% | 50% | 0.5025 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 2.264E-11 |
| 3B1a. Dairy cattle | CH4 | 11.65 | 23.00 | 5% | 30% | 0.3041 | 0.0000 | | 0.0041 | 0.0000 | 0.0003 | 8.2082E-08 |
| 3B1b. Non-dairy cattle | CH4 | 7.71 | 9.03 | 5% | 30% | 0.3041 | 0.0000 | | 0.0016 | 0.0000 | 0.0001 | 1.33899E-08 |
| 3B2. Sheep | CH4 | 2.27 | 2.77 | 5% | 30% | 0.3041 | 0.0000 | | 0.0005 | 0.0000 | 0.0000 | 1.24823E-09 |
| 3B3. Swine | CH4 | 88.60 | 36.59 | 5% | 30% | 0.3041 | 0.0000 | | 0.0073 | 0.0000 | 0.0005 | 2.63754E-07 |
| 3B4a. Goats | CH4 | 1.15 | 1.31 | 5% | 30% | 0.3041 | 0.0000 | | 0.0003 | 0.0000 | 0.0000 | 3.58051E-10 |
| 3B4b. Horses | CH4 | 0.03 | 0.05 | 5% | 30% | 0.3041 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 3.57327E-13 |
| 3B4c. Mules and Asses | CH4 | 0.15 | 0.04 | 5% | 30% | 0.3041 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 2.73944E-13 |
| 3B4d. Poultry | CH4 | 2.36 | 2.21 | 5% | 30% | 0.3041 | 0.0000 | | 0.0004 | 0.0000 | 0.0000 | 7.79765E-10 |
| 3F. Field burning of agricultural residues | CH4 | 2.37 | 0.50 | 20% | 20% | 0.2828 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 9.00537E-10 |
| 4.A.1 Forest Land remaining Forest Land | CH4 | 0.03 | | 10% | 230% | 2.3022 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 5.10999E-11 |
| 5A1. Managed waste disposal sites | CH4 | 0.00 | 202.17 | 30% | 30% | 0.4243 | 0.0001 | | 0.0331 | 0.0000 | 0.0140 | 0.00019684 |
| 5A2. Unmanaged waste disposal sites | CH4 | 295.37 | 376.60 | 30% | 30% | 0.4243 | 0.0004 | | 0.0720 | 0.0000 | 0.0305 | 0.000932966 |
| 5B1. Composting | CH4 | 0.00 | 19.12 | 30% | 100% | 1.0440 | 0.0000 | | 0.0022 | 0.0000 | 0.0009 | 8.44813E-07 |
| 5D1. Domestic wastewater | CH4 | 102.92 | 24.08 | 30% | 30% | 0.4243 | 0.0000 | | 0.0043 | 0.0000 | 0.0018 | 3.37667E-06 |
| 5D2. Industrial wastewater | CH4 | 27.10 | 34.97 | 30% | 30% | 0.4243 | 0.0000 | | 0.0060 | 0.0000 | 0.0026 | 6.56061E-06 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A1a. Public electricity and heat production | CO2 | 1675.77 | 3049.92 | 3% | 3% | 0.0424 | 0.0003 | | 0.5663 | 0.0000 | 0.0240 | 0.000577348 |
| 1A1b. Petroleum refining | CO2 | 85.72 | 0.00 | 5% | 5% | 0.0707 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0 |
| 1A2b. Non-ferrous metals | CO2 | 4.38 | 1.95 | 5% | 5% | 0.0707 | 0.0000 | | 0.0004 | 0.0000 | 0.0000 | 8.03046E-10 |
| 1A2c. Chemicals | CO2 | 2.20 | 11.80 | 5% | 5% | 0.0707 | 0.0000 | | 0.0018 | 0.0000 | 0.0001 | 1.6844E-08 |
| 1A2d. Pulp, paper and print | CO2 | 4.82 | 1.98 | 5% | 5% | 0.0707 | 0.0000 | | 0.0003 | 0.0000 | 0.0000 | 4.53888E-10 |
| 1A2e. Food processing, beverages and tobacco | CO2 | 72.57 | 49.34 | 5% | 5% | 0.0707 | 0.0000 | | 0.0122 | 0.0000 | 0.0009 | 7.47865E-07 |
| 1A2f. Non-metallic minerals | CO2 | 379.83 | 404.23 | 3% | 3% | 0.0424 | 0.0000 | | 0.0750 | 0.0000 | 0.0032 | 1.0132E-05 |
| 1A2g. Other | CO2 | 38.01 | 88.29 | 5% | 5% | 0.0707 | 0.0000 | | 0.0143 | 0.0000 | 0.0010 | 1.02347E-06 |
| 1A3a. Domestic aviation | CO2 | 26.05 | 1.07 | 5% | 5% | 0.0707 | 0.0000 | | 0.0002 | 0.0000 | 0.0000 | 2.56523E-10 |
| 1A3b. Road transportation | CO2 | 1191.19 | 2139.19 | 5% | 5% | 0.0707 | 0.0003 | | 0.3673 | 0.0000 | 0.0260 | 0.000674582 |
| 1A3d. Domestic navigation | CO2 | 2.20 | 5.82 | 5% | 5% | 0.0707 | 0.0000 | | 0.0009 | 0.0000 | 0.0001 | 3.89655E-09 |
| 1A4a. Commercial/institutional | CO2 | 75.21 | 103.36 | 5% | 5% | 0.0707 | 0.0000 | | 0.0188 | 0.0000 | 0.0013 | 1.76955E-06 |
| 1A4b. Residential | CO2 | 299.70 | 269.99 | 5% | 5% | 0.0707 | 0.0000 | | 0.0577 | 0.0000 | 0.0041 | 1.66656E-05 |
| 1A4c. Agriculture/forestry/fishing | CO2 | 55.48 | 72.17 | 5% | 5% | 0.0707 | 0.0000 | | 0.0148 | 0.0000 | 0.0010 | 1.0928E-06 |
| 1A5a. Stationary | CO2 | 10.99 | 20.17 | 5% | 5% | 0.0707 | 0.0000 | | 0.0037 | 0.0000 | 0.0003 | 6.71715E-08 |
| 1A5b. Mobile | CO2 | 0.00 | 2.96 | 5% | 5% | 0.0707 | 0.0000 | | 0.0009 | 0.0000 | 0.0001 | 3.82596E-09 |
| 2A1. Cement production | CO2 | 667.66 | 938.19 | 2% | 2% | 0.0283 | 0.0000 | | 0.1608 | 0.0000 | 0.0045 | 2.0673E-05 |
| 2A2. Lime production | CO2 | 5.33 | 5.96 | 2% | 5% | 0.0539 | 0.0000 | | 0.0007 | 0.0000 | 0.0000 | 4.08556E-10 |
| 2A4. Other process uses of carbonates | CO2 | 44.08 | 16.13 | 5% | 5% | 0.0707 | 0.0000 | | 0.0031 | 0.0000 | 0.0002 | 4.75318E-08 |
| 2D1. Lubricant use | CO2 | 4.13 | 4.90 | 5% | 5% | 0.0707 | 0.0000 | | 0.0008 | 0.0000 | 0.0001 | 3.48008E-09 |
| 2D2. Paraffin wax use | CO2 | 0.06 | 0.08 | 5% | 5% | 0.0707 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.53881E-12 |
| 2D3. Other | CO2 | 0.00 | 0.40 | 5% | 5% | 0.0707 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 4.36572E-11 |
| 3H. Urea application | CO2 | 1.82 | 0.18 | 20% | 50% | 0.5385 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.96714E-10 |
| 4.A.1 Forest Land remaining Forest Land | CO2 | 1.55 | | 15% | 60% | 0.6185 | 0.0002 | | 0.0325 | 0.0000 | 0.0069 | 4.7392E-05 |
| 4.A.2 Land converted to Forest Land | CO2 | -0.10 | | 15% | 40% | 0.4272 | 0.0001 | | 0.0291 | 0.0000 | 0.0062 | 3.8176E-05 |
| 4.B.1 Cropland remaining Cropland | CO2 | -133.97 | | 15% | 65% | 0.6671 | 0.0001 | | 0.0244 | 0.0000 | 0.0052 | 2.67902E-05 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.B.2 Land converted to Cropland | CO2 | -0.27 | | 15% | 95% | 0.9618 | 0.0000 | | 0.0011 | 0.0000 | 0.0002 | 5.62305E-08 |
| 4.C.1 Grassland remaining Grassland | CO2 | -23.42 | | 15% | 35% | 0.3808 | 0.0000 | | 0.0040 | 0.0000 | 0.0008 | 7.07507E-07 |
| 4.C.2 Land converted to Grassland | CO2 | 0.36 | | 15% | 50% | 0.5220 | 0.0000 | | 0.0004 | 0.0000 | 0.0001 | 6.1302E-09 |
| 4.D.2 Land converted to Wetlands | CO2 | 0.00 | | 15% | 50% | 0.5220 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 3.69937E-10 |
| 4.E.2 Land converted to Settlements | CO2 | 0.46 | | 15% | 350% | 3.5032 | 0.0000 | | 0.0006 | 0.0000 | 0.0001 | 1.57264E-08 |
| 4.F.2 Land converted to Other Land | CO2 | 0.11 | | 15% | 30% | 0.3354 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0 |
| 4.G Harvested Wood Products | CO2 | 2.14 | | 15% | 50% | 0.5220 | 0.0000 | | 0.0037 | 0.0000 | 0.0008 | 6.14017E-07 |
| 2F1. Refrigeration and air conditioning | HFCs(1) | 0.00 | 401.36 | 5% | 500% | 5.0002 | 0.0496 | | 0.0676 | 0.0000 | 0.0048 | 2.28575E-05 |
| 2F2. Foam blowing agents | HFCs(1) | 0.00 | 1.28 | 5% | 500% | 5.0002 | 0.0000 | | 0.0002 | 0.0000 | 0.0000 | 2.65848E-10 |
| 2F3. Fire protection | HFCs(1) | 0.00 | 9.35 | 5% | 500% | 5.0002 | 0.0000 | | 0.0017 | 0.0000 | 0.0001 | 1.52946E-08 |
| 2F4. Aerosols | HFCs(1) | 0.00 | 2.96 | 5% | 500% | 5.0002 | 0.0000 | | 0.0005 | 0.0000 | 0.0000 | 1.43617E-09 |
| 1A1a. Public electricity and heat production | N2O | 3.45 | 6.31 | 3% | 300% | 3.0001 | 0.0000 | | 0.0012 | 0.0000 | 0.0001 | 2.51859E-09 |
| 1A1b. Petroleum refining | N2O | 0.10 | 0.00 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0 |
| 1A1c. Manufacture of solid fuels and other energy industries | N2O | 0.12 | 0.08 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 4.40755E-12 |
| 1A2b. Non-ferrous metals | N2O | 0.00 | 0.00 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.71742E-16 |
| 1A2c. Chemicals | N2O | 0.00 | 0.30 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.75505E-13 |
| 1A2d. Pulp, paper and print | N2O | 0.01 | 0.00 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.72433E-15 |
| 1A2e. Food processing, beverages and tobacco | N2O | 0.14 | 0.22 | 5% | 300% | 3.0004 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 1.54893E-11 |
| 1A2f. Non-metallic minerals | N2O | 1.28 | 4.17 | 3% | 300% | 3.0001 | 0.0000 | | 0.0008 | 0.0000 | 0.0000 | 1.11827E-09 |
| 1A2g. Other | N2O | 0.08 | 0.20 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 5.49055E-12 |
| 1A3a. Domestic aviation | N2O | 0.19 | 0.01 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.4095E-14 |
| 1A3b. Road transportation | N2O | 10.14 | 12.01 | 5% | 50% | 0.5025 | 0.0000 | | 0.0023 | 0.0000 | 0.0002 | 2.5898E-08 |
| 1A3d. Domestic navigation | N2O | 0.03 | 0.09 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 8.63155E-13 |
| 1A4a. Commercial/institutional | N2O | 0.12 | 0.33 | 5% | 300% | 3.0004 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 2.5244E-11 |
| 1A4b. Residential | N2O | 0.62 | 1.05 | 5% | 300% | 3.0004 | 0.0000 | | 0.0002 | 0.0000 | 0.0000 | 2.59834E-10 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A4c. Agriculture/forestry/fishing | N2O | 1.94 | 0.16 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 4.85712E-12 |
| 1A5a. Stationary | N2O | 0.39 | 0.05 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 3.43183E-13 |
| 1A5b. Mobile | N2O | 0.00 | 0.01 | 5% | 300% | 3.0004 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.89201E-14 |
| 2G3. N2O from product uses | N2O | 3.93 | 6.25 | 5% | 500% | 5.0002 | 0.0000 | | 0.0011 | 0.0000 | 0.0001 | 6.3414E-09 |
| 3B1a. Dairy cattle | N2O | 4.50 | 7.36 | 5% | 100% | 1.0012 | 0.0000 | | 0.0013 | 0.0000 | 0.0001 | 8.89605E-09 |
| 3B1b. Non-dairy cattle | N2O | 2.91 | 3.43 | 5% | 100% | 1.0012 | 0.0000 | | 0.0006 | 0.0000 | 0.0000 | 1.90038E-09 |
| 3B2. Sheep | N2O | 12.18 | 14.84 | 5% | 100% | 1.0012 | 0.0000 | | 0.0027 | 0.0000 | 0.0002 | 3.58041E-08 |
| 3B3. Swine | N2O | 0.69 | 0.72 | 5% | 100% | 1.0012 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 1.03107E-10 |
| 3B4a. Goats | N2O | 7.98 | 9.10 | 5% | 100% | 1.0012 | 0.0000 | | 0.0019 | 0.0000 | 0.0001 | 1.72868E-08 |
| 3B4b. Horses | N2O | 0.05 | 0.08 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 9.83097E-13 |
| 3B4c. Mules and Asses | N2O | 0.24 | 0.06 | 5% | 100% | 1.0012 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 6.76777E-13 |
| 3B4d. Poultry | N2O | 6.99 | 5.51 | 5% | 100% | 1.0012 | 0.0000 | | 0.0010 | 0.0000 | 0.0001 | 4.83044E-09 |
| 3B5. Indirect N2O emissions | N2O | 23.02 | 26.86 | 20% | 50% | 0.5385 | 0.0000 | | 0.0050 | 0.0000 | 0.0014 | 2.02177E-06 |
| 3D. Agricultural soils | N2O | 56.90 | 50.55 | 5% | 3% | 0.0583 | 0.0000 | | 0.0094 | 0.0000 | 0.0007 | 4.4592E-07 |
| 3F. Field burning of agricultural residues | N2O | 0.58 | 0.12 | 20% | 20% | 0.2828 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 5.42183E-11 |
| 4.A.1 Forest Land remaining Forest Land | N2O | 0.02 | | 10% | 220% | 2.2023 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.40071E-11 |
| 4.B.2 Land converted to Cropland | N2O | 0.01 | | 15% | 175% | 1.7564 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 1.77127E-11 |
| 4.E.2 Land converted to Settlements | N2O | 0.00 | | 15% | 380% | 3.8030 | 0.0000 | | 0.0001 | 0.0000 | 0.0000 | 6.21324E-10 |
| 4.F.2 Land converted to Other Land | N2O | 0.00 | 6.73 | 30% | 100% | 1.0440 | 0.0000 | | 0.0012 | 0.0000 | 0.0005 | 2.7242E-07 |
| 5B1. Composting | N2O | 0.00 | 6.92 | 30% | 30% | 0.4243 | 0.0000 | | 0.0027 | 0.0000 | 0.0011 | 1.31084E-06 |
| 5D1. Domestic wastewater | N2O | 9.52 | 14.98 | 100% | 30% | 1.0440 | 0.0000 | | 0.0000 | 0.0000 | 0.0001 | 4.4817E-09 |
| 5D2. Industrial wastewater | N2O | 0.28 | 0.27 | 5% | 500% | 5.0002 | 0.0001 | | 0.0030 | 0.0000 | 0.0002 | 4.40462E-08 |
| 2G1. Electrical equipment | SF6 | 2.73 | 17.84 | | | | 0.05122763 | | | | | 0.002591136 |
| Total | | 1.85 | 3.42 | 3% | 100% | 1.0004 | 0.0000 | | 0.0006 | 0.0000 | 0.0000 | 7.02946E-10 |
| | | ΣC | ΣD | | Percentage uncertainty in total inventory: | | 0.226335207 | | | | Trend uncertainty: | 0.050903205 |

# Annex 3: Detailed methodological descriptions for individual source or sink categories

## A.3.1. Fuel combustion (1A)

The fuel consumption data published by the National Statistical Service in 2019 for the period 1990–2019 are presented in Table A3.1.3. In green are sectors/consumers that have been added for the first time in 2019 and in red are the revisions.

Due to the unavailability of consumption data for several years, using the data as is would create issues of inconsistency and incomparability. Therefore, it was decided to complete the period using the following assumptions. The resulting data used for the estimation of the emissions will be presented at the methodological issues Section of the appropriate sector in Chapter 3. The following pages present the assumptions made to allocate consumption to activities where data was not available.

LPG

(a) 2006-2009 consumption from Not elsewhere specified (Industry) has been moved to Non-metallic minerals.

(b) There is available data for all the consumers of LPG during the period 2006-2015. Since there is no particular trend during this period, it was decided to use the same ratio as 2006 to distribute the consumption that was allocated to residential to all sectors for the period 1990-2005 (Table A3.1.1).

**Table A3.1.1. Contribution of different activities to LPG consumption (2006) used to allocate consumption to different sectors for 1990-2005**

| Activity | Consumption |
|---|---|
| Non-ferrous metals | 1.9% |
| Non-metallic minerals | 1.9% |
| Food, beverages and tobacco | 5.6% |
| Commercial and public services | 24.1% |
| Residential | 64.8% |
| Agriculture/forestry | 1.9% |

Jet kerosene

Information on fuel consumption for domestic flights is not available from national statistics. To estimate the emissions from aviation, the available information on fuel consumption from EUROCONTROL was used (Table A3.1.2) for 2005-2023.

**Table A3.1.2. International and domestic flights' fuel consumptions, EUROCONTROL data (2005-2023)**

| Fuel consumption (kt) | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| Domestic | 3.9 | 3.3 | 2.9 | 2.8 | 2.3 | 2.5 | 0.8 | 0.6 | 0.4 | 0.3 |
| International | 263 | 265 | 261 | 270 | 255 | 260 | 270 | 260 | 243 | 244 |
| | | | | | | | | | | |
| | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | |
| Domestic | 0.4 | 0.2 | 0.4 | 0.3 | 0.1 | 0.2 | 0.4 | 0.4 | 0.4 | |
| International | 238 | 278 | 317 | 327 | 320 | 101 | 175 | 250 | 303 | |

## Table A3.1.3. Fuel consumption according to the National Energy balance 2023 in kt (1990–2023)

**(a) 1990–2004**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crude oil | | | | | | | | | | | | | | | |
| Refinery intake (Observed) | 636 | 763 | 727 | 781 | 906 | 828 | 760 | 1043 | 1082 | 1180 | 1173 | 1156 | 1086 | 971 | 279 |
| Refinery losses | 10 | 16 | 3 | 3 | 4 | 2 | 2 | 5 | 6 | 4 | 1 | 5 | 4 | 3 | |
| Refinery gas | | | | | | | | | | | | | | | |
| Refinery fuel | 18 | 17 | 17 | 13 | 24 | 13 | 12 | 16 | 16 | 20 | 19 | 19 | 21 | 21 | 9 |
| LPG | | | | | | | | | | | | | | | |
| Non-ferrous metals | | | | | | | | | | | | | | | |
| Non-metallic minerals | | | | | | | | | | | | | | | |
| Food, beverages and tobacco | | | | | | | | | | | | | | | |
| Not elsewhere specified (Industry) | | | | | | | | | | | | | | | |
| Commercial and public services | | | | | | | | | | | | | | | |
| Residential | 49 | 49 | 55 | 51 | 50 | 51 | 51 | 52 | 50 | 49 | 53 | 53 | 54 | 58 | 56 |
| Agriculture/forestry | | | | | | | | | | | | | | | |
| Not elsewhere specified (Other) | | | | | | | | | | | | | | | |
| Non-biogasoline = GASOLINE | | | | | | | | | | | | | | | |
| Road | 163 | 170 | 172 | 169 | 180 | 183 | 186 | 191 | 195 | 203 | 206 | 219 | 228 | 252 | 282 |
| International aviation | 236 | 280 | 272 | 231 | 237 | 260 | 249 | 245 | 258 | 264 | 268 | 314 | 302 | 323 | 295 |
| Not elsewhere specified (Other) | | | | | | | | | | | | | | | |
| Other kerosene | | | | | | | | | | | | | | | |
| Residential | 12 | 12 | 17 | 16 | 17 | 17 | 18 | 20 | 21 | 20 | 24 | 24 | 31 | 31 | 24 |
| Oil and gas extraction | | | | | | | | | | | | | | | |
| Not elsewhere specified (Industry) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Residential | 12 | 12 | 17 | 16 | 17 | 17 | 18 | 20 | 21 | 20 | 24 | 24 | 31 | 31 | 24 |
| Not elsewhere specified (Industry) | | | | | | | | | | | | | | | |
| Road | | | | | | | | | | | | | | | |
| Non-bio gas/diesel oil = DIESEL | | | | | | | | | | | | | | | |
| International marine bunkers | 24 | 20 | 21 | 14 | 12 | 15 | 25 | 27 | 35 | 46 | 50 | 47 | 33 | 36 | 27 |
| Main activity producer electricity plants | | | 11 | 3 | 2 | 8 | 6 | 6 | 12 | 21 | 19 | 4 | 2 | 5 | 8 |
| Autoproducer electricity plants | | | | | | | | | | | | | | | |
| Road | 210 | 202 | 246 | 255 | 261 | 285 | 298 | 314 | 334 | 340 | 350 | 355 | 341 | 351 | 354 |
| Chemical and petrochemical | | | | | | | | | | | | | | | |
| Non-ferrous metals | 0.52 | 0.60 | 0.67 | 0.75 | 0.75 | 0.82 | 0.82 | 0.90 | 0.97 | 0.97 | 0.97 | 1.05 | 0.97 | 0.97 | 0.90 |
| Non-metallic minerals | | | | | | | | | | | | | | | |
| Mining and Quarrying | | | | | | | | | | | | | | | |
| Food, beverages and tobacco | | | | | | | | | | | | | | | |
| Construction | | | | | | | | | | | | | | | |
| Not elsewhere specified (Industry) | 98 | 109 | 132 | 137 | 141 | 153 | 161 | 169 | 180 | 185 | 191 | 193 | 185 | 190 | 171 |

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commercial and public services | | | | | | | | | | | | | | | |
| Residential | | | | | | | | | | | | | | | |
| Agriculture/forestry | | | | | | | | | | | | | | | |
| Fishing | | | | | | | | | | | | | | | |
| Not elsewhere specified (Other) | | | | | | | | | | | | | | | |
| Total fuel oil | | | | | | | | | | | | | | | |
| International marine bunkers | 34 | 36 | 38 | 36 | 50 | 54 | 65 | 71 | 63 | 108 | 143 | 145 | 105 | 88 | 27 |
| Refinery fuel | 11 | 12 | 13 | 13 | 14 | 17 | 16 | 14 | 15 | 16 | 16 | | | | |
| Main activity producer electricity plants | 540 | 561 | 645 | 697 | 727 | 662 | 703 | 743 | 811 | 856 | 902 | 897 | 932 | 1095 | 1046 |
| Autoproducer electricity plants | | | | | | | | | | | | | | | |
| Autoproducer CHP Plants | | | | | | | | | | | | | | 2 | 5 |
| Chemical and petrochemical | | | | | | | | | | | | | | | |
| Non-metallic minerals | 37 | 124 | 118 | 100 | 110 | 97 | 111 | 70 | 68 | 68 | 70 | 54 | 55 | 62 | 68 |
| Food, beverages and tobacco | | | | | | | | | | | | | | | |
| Paper, pulp and printing | | | | | | | | | | | | | | | |
| Construction | | | | | | | | | | | | | | | |
| Not elsewhere specified (Industry) | | | | | | | | | | | | | | | |
| Commercial and public services | | | | | | | | | | | | | | | |
| White spirit and SPB | | | | | | | | | | | | | | | |
| Not elsewhere specified (Industry) | | | | 1 | | 1 | 1 | 1 | | 1 | | 1 | | | |
| Lubricants | | | | | | | | | | | | | | | |
| International marine bunkers | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Non-energy use: Road | | | | 6 | 8 | 8 | 9 | 8 | 5 | 5 | 5 | 5 | 6 | 6 | 7 |
| Non-energy use: Not elsewhere specified (Industry) | | | | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| Bitumen | | | | | | | | | | | | | | | |
| Construction | | | | | | | | | | | | | | | |
| Non-energy use: Not elsewhere specified (Industry) | 33 | 23 | 50 | 59 | 57 | 54 | 57 | 62 | 75 | 86 | 83 | 81 | 84 | 70 | 65 |
| Pet-coke | | | | | | | | | | | | | | | |
| Non-metallic minerals | | 93 | 85 | 114 | 112 | 125 | 147 | 152 | 150 | 154 | 141 | 133 | 139 | 137 | 146 |
| Other products (liquid) | | | | | | | | | | | | | | | |
| Refinery fuel | | | | | | | | | | | | | 16 | 16 | |
| Not elsewhere specified (Industry) | 40 | 5 | | | | | | 1 | | | | | | | 6 |
| Bituminous Coal | | | | | | | | | | | | | | | |
| Non-metallic minerals | 97 | 97 | 26 | 31 | 27 | 20 | 18 | 19 | 26 | 30 | 49 | 53 | 53 | 53 | 57 |
| Lignite | | | | | | | | | | | | | | | |
| Not elsewhere specified (Other) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Waste (non-biomass fraction)** | | | | | | | | | | | | | | | |
| **Industrial waste (non-renewable) (TJ)** | | | | | | | | | | | | | | | |
| Non-metallic minerals | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 15 | 71 |
| **Municipal waste (non-renewable) TJ** | | | | | | | | | | | | | | | |
| Non-metallic minerals | | | | | | | | | | | | | | | |

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RENEWABLES** | | | | | | | | | | | | | | | |
| **Solid biofuels (TJ)** | | | | | | | | | | | | | | | |
| Charcoal production plants (Transformation) | 112 | 112 | 112 | 112 | 405 | 388 | 328 | 288 | 314 | 281 | 248 | 253 | 235 | 209 | 184 |
| Chemical and petrochemical | | | | | | | | | | | | | | | |
| Non-metallic minerals | | | | | | | | | | | 41 | 70 | 90 | 211 | 127 |
| Food, beverages and tobacco | | | | | | | | | | | | | | | |
| Commercial and public services | | | | | | | | | | | | | | | |
| Residential | | | | | | | | | | | | | | | |
| Agriculture/Forestry | | | | | | | | | | | | | | | |
| Not elsewhere specified (Other) | 145 | 120 | 118 | 117 | 85 | 91 | 136 | 70 | 64 | 88 | 78 | 80 | 74 | 67 | 61 |
| **Charcoal (kt)** | | | | | | | | | | | | | | | |
| Commercial and public services | | | | | | | | | | | | | | | |
| Residential | | | | | | | | | | | | | | | |
| Not elsewhere specified (Other) | 1 | 1 | 1 | 1 | 2 | 7 | 7 | 7 | 8 | 7 | 5 | 5 | 7 | 7 | 8 |
| **Biogases (TJ)** | | | | | | | | | | | | | | | |
| Main activity producer CHP plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer CHP plants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Commercial and public services | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal waste (renewable)** | | | | | | | | | | | | | | | |
| Non-metallic minerals | | | | | | | | | | | | | | | |

**(b) 2005-2023**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crude oil | | | | | | | | | | | | | | | | | | | |
| Refinery intake (Observed) | | | | | | | | | | | | | | | | | | | |
| Refinery losses | | | | | | | | | | | | | | | | | | | |
| Refinery gas | | | | | | | | | | | | | | | | | | | |
| Refinery fuel | | | | | | | | | | | | | | | | | | | |
| LPG | | | | | | | | | | | | | | | | | | | |
| Non-ferrous metals | | 1 | 1 | | 1 | 1 | 1 | 1 | | | 1 | 1 | 0.57 | 0.59 | 0.66 | 0.76 | 0.76 | 0.72 | 0.64 |
| Chemical and Petrochemical | | | | | | | | | | | | | 0.21 | 0.22 | 0.24 | 0.29 | 0.27 | 0.03 | 0.03 |
| Non-metallic minerals | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.38 | 0.39 | 0.43 | 0.71 | 0.65 | 0.53 | 0.46 |
| Food, beverages and tobacco | | 3 | 3 | 3 | 3 | 3 | 4 | 5 | 4 | 4 | 5 | 4 | 5.52 | 5.76 | 6.38 | 5.72 | 5.29 | 5.75 | 5.05 |
| Paper, pulp and printing | | | | | | | | | | | | | 0.29 | 0.30 | 0.33 | 0.14 | 0.13 | 0.05 | 0.04 |
| Wood and wood products | | | | | | | | | | | | | 0.003 | 0.003 | 0.003 | 0.006 | 0.01 | 0.003 | 0.003 |
| Not elsewhere specified (Industry) | | 1 | 1 | 1 | 1 | | | | 0 | 1 | 0 | 0 | 2.424 | 0.237 | 0.263 | 0.137 | 0.129 | 0.132 | 0.12 |
| Commercial and public services | | 13 | 13 | 14 | 13 | 13 | 14 | 14 | 12 | 10 | 11 | 11 | 13.17 | 13.8 | 15.5 | 11.1 | 9.7 | 11.5 | 10.74 |
| Residential | 53 | 35 | 36 | 34 | 36 | 34 | 38 | 37 | 33 | 31 | 34 | 35 | 32.46 | 28.45 | 32.15 | 31.31 | 33.46 | 35.2 | 33.60 |

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | 7 | | | | | | |
| Agriculture/forestry | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 2 | 2.424 | 2.53 | 2.86 | 2.58 | 2.41 | 2.80 | 2.59 |
| Not elsewhere specified (Other) | | | | | | | | | 1 | 1 | 1 | 1 | 1.315 | 0.912 | 1.25 | 1.27 | 1.13 | 1.19 | 1.14 |
| Road | | | | | | | | | | | | 0.441 | 0.477 | 0.399 | 0.458 | 0.399 | 0.458 | 0.501 | 0.42 |
| Non-biogasoline = GASOLINE | | | | | | | | | | | | | | | | | | | |
| Road | 303 | 323 | 352 | 373 | 383 | 390 | 385 | 372 | 349 | 341 | 345 | 354 | 351 | 342 | 337 | 284 | 305 | 310 | 325 |
| Jet Kerosene | | | | | | | | | | | | | | | | | | | |
| International aviation | 291 | 300 | 287 | 286 | 265 | 270 | 294 | 264 | 235 | 231 | 233 | 263 | 298 | 308 | 295 | 90.4 | 149.7 | 251.3 | 291 |
| Domestic aviation | | | | | | | | | | | | | 2 | 1.77 | 1.31 | 1.38 | 1.52 | 2.93 | 2.64 |
| Not elsewhere specified (Other) | | | | | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1.5 | 1.3 | 1.5 | 0.94 |
| Other kerosene | | | | | | | | | | | | | | | | | | | |
| Residential | 13 | 16 | 16 | 14 | 19 | 14 | 16 | 17 | 12 | 9 | 14 | 14 | 14 | 9 | 13 | 13 | 11 | 12 | 8 |
| Oil and gas extraction | | | | | | | | | | 2 | | | | | | | | | |
| Not elsewhere specified (Other) | 3 | | | | | | | | | | | | | | 0.026 | 0.045 | 0.009 | NO | NO |
| Non-metallic minerals | | | | | | | | | | | | | 0.06 | 0.05 | 0.02 | 0.02 | 0 | NO | NO |
| Food, beverages and tobacco | | | | | | | | | | | | | 0.03 | 0.02 | 0.1 | 0.01 | 0.001 | 0.002 | NO |
| Not elsewhere specified (Industry) | | | | | | | | | | 2 | | | | 0.005 | 0.005 | 0.002 | 0 | NO | NO |
| Commercial and Public Services | | | | | | | | | | | | | 0.03 | 1.64 | 2.22 | 2.26 | 2.02 | 2.07 | 2.01 |
| Biodiesel | | | | | | | | | | | | | | | | | | | |
| Road | | | | | | | | | | | | | | | | 27.2 | 27.50 | 26.21 | 24.02 |
| Water-borne navigation | | | 1 | 16 | 17 | 17 | 18 | 18 | 17 | 11 | 11 | 10 | 9.697 | 10.1 | 12.15 | 0.034 | 0.075 | 0.125 | 0.115 |
| Chemical and petrochemical | | | | | | | | | | | | | | | | 0.034 | 0.029 | 0.003 | 0.003 |
| Non-ferrous metals | | | | | | | | | | | | | | | | 0.001 | 0.001 | NO | NO |
| Non-metallic minerals | | | | | | | | | | | | | | | | 0.095 | 0.219 | 0.058 | 0.053 |
| Mining and Quarrying | | | | | | | | | | | | | | | | 0.298 | 0.245 | 0.398 | 0.365 |
| Food, beverages and tobacco | | | | | | | | | | | | | | | | 0.004 | 0.006 | 0.028 | 0.025 |
| Paper, pulp and printing | | | | | | | | | | | | | | | | 0.001 | 0.001 | NO | 0 |
| Machinery | | | | | | | | | | | | | | | | 0.008 | 0.011 | 0.014 | 0.013 |
| Textiles and Leather | | | | | | | | | | | | | | | | 0.001 | 0.000 | NO | 0 |
| Wood and wood products | | | | | | | | | | | | | | | | 0.001 | 0.001 | 0.001 | 0.001 |
| Commercial and public services | | | | | | | | | | | | | | | | 0.105 | 0.169 | 0.146 | 0.133 |
| Not elsewhere specified (Industry) | | | | | | | | | | | | | | | | 0.003 | 0.002 | 0.013 | 0.012 |
| Not elsewhere specified (Other) | | | | | | | | | | | | | | | | 0.214 | 0.197 | 0.222 | 0.339 |
| Non-bio gas/diesel oil = DIESEL | | | | | | | | | | | | | | | | | | | |
| International marine bunkers | 67 | 106 | 104 | 88 | 73 | 53 | 58 | 69 | 83 | 80 | 75 | 95 | 101 | 118 | 124 | 119 | 113 | 123 | 87 |
| Main activity producer electricity plants | 16 | 7 | 16 | 23 | 92 | 158 | 112 | 214 | 236 | 124 | 89 | 150 | 255 | 246 | 259 | 342 | 289 | 320 | 289 |
| Autoproducer electricity plants | | | 1 | | | | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1.75 | 1.91 | 1.5 | 1.6 | 1.4 | 3.7 |
| Road | 346 | 323 | 337 | 330 | 321 | 329 | 313 | 272 | 231 | 224 | 241 | 274 | 292 | 304 | 315 | 283 | 304 | 291 | 306 |
| Chemical and petrochemical | | | | | | | | 1 | 0 | 1 | 1 | 1 | 0.15 | 1.036 | 1.377 | 1.24 | 1.5 | 1.3 | 1.2 |

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-ferrous metals | 0.82 | 0.82 | 0.75 | 0.67 | 0.67 | 0.52 | 0.60 | 0.75 | 0.00 | 0.00 | 0.00 | 0.75 | 0.11 | 0.10 | 0.059 | 0.317 | 0.152 | 0.010 | 0.012 |
| Non-metallic minerals | | | | | | | | 3 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 2.17 | 4.86 | 2.932 | 3.044 |
| Transport Equipment | | | | | | | | | | | | | 0.005 | 0.006 | 0.001 | 0.001 | 0.001 | 0.058 | 0.055 |
| Machinery | | | | | | | | | | | | | 0.257 | 0.224 | 0.248 | 0.278 | 0.272 | 0.314 | 0.352 |
| Mining and Quarrying | | | | | | | | 5 | 2 | 1 | 3 | 2 | 4 | 4 | 7 | 5 | 5.39 | 8.254 | 9.34 |
| Food, beverages and tobacco | | | | | | | | 3 | 2 | 2 | 4 | 3 | 5 | 4 | 4 | 4.65 | 5.39 | 5.572 | 5.245 |
| Textiles and Leather | | | | | | | | | | | | | 0.027 | 0.023 | 0.018 | 0.017 | 0.01 | 0.175 | 0.006 |
| Construction | | | | | | | | 5 | 5 | 6 | 6 | 7 | 9 | 7 | 8 | 8 | 9 | 9 | 9 |
| Not elsewhere specified (Industry) | 47 | 24 | 20 | 18 | 18 | 14 | 16 | 3 | 1 | 1 | 2 | 2 | 2 | 2.18 | 2.245 | 2.05 | 2.399 | 3.069 | 3.709 |
| Commercial and public services | | 19 | 18 | 20 | 19 | 23 | 20 | 16 | 17 | 13 | 13 | 15 | 18 | 10 | 16 | 12 | 14 | 15 | 16 |
| Residential | 83 | 98 | 89 | 78 | 83 | 70 | 80 | 76 | 62 | 57 | 65 | 65 | 65 | 53 | 60 | 60 | 49 | 55 | 45 |
| Agriculture/forestry | 27 | 28 | 28 | 23 | 20 | 19 | 22 | 21 | 21 | 19 | 22 | 21 | 22 | 21 | 22 | 24 | 23 | 21 | 19 |
| Fishing | | | | 3 | 4 | 4 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1.6 | 1.7 | 1.6 |
| Not elsewhere specified (Other) | | 4 | 6 | 13 | 5 | 5 | 6 | 5 | 5 | 9 | 6 | 6 | 6 | 6 | 6 | 5.4 | 4.8 | 4.9 | 5.2 |
| Total fuel oil | | | | | | | | | | | | | | | | | | | |
| International marine bunkers | 225 | 190 | 171 | 165 | 146 | 134 | 141 | 128 | 157 | 153 | 169 | 193 | 154 | 154 | 156 | 158 | 141 | 165 | 148 |
| Refinery fuel | | | | | | | | | | | | | | | | | 8 | | |
| Main activity producer electricity plants | 1104 | 1137 | 1174 | 1219 | 1163 | 1053 | 1058 | 896 | 649 | 793 | 858 | 883 | 778 | 804 | 771 | 603 | 680 | 658 | 674 |
| Autoproducer electricity plants | | | 4 | 3 | 2 | 2 | 2 | | 2 | 4 | | | | | | | | | |
| Autoproducer CHP Plants | 6 | 7 | 14 | 12 | 11 | 8 | 2 | 2 | 2 | 0 | | | 1 | | 0.032 | 0.125 | 0.036 | 0.032 | |
| Chemical and petrochemical | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 0.36 | 1.83 | 2.46 |
| Non-metallic minerals | 37 | 35 | 38 | 38 | 30 | 25 | 15 | 13 | 8 | 7 | 8 | 10 | 13 | 15 | 15 | 13 | 13 | 13 | 10.8 |
| Mining | | | | | | | | | | | | | 0.2 | 0.1 | 0.1 | 0 | 0 | 0 | 0 |
| Food, beverages and tobacco | | | | | | | | 9 | 8 | 8 | 9 | 9 | 12 | 11 | 11 | 10 | 10 | 10 | 5.6 |
| Paper, pulp and printing | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 0.5 | 0.7 | 0.81 | 0.31 | 0.4 |
| Construction | | | | | | | | 1 | 1 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 4.2 |
| Not elsewhere specified (Industry) | 28 | 19 | 27 | 25 | 17 | 20 | 34 | 2 | 2 | 3 | 1 | 2 | 1 | 0.4 | 0.4 | 1 | 0.6 | 1.4 | 0.7 |
| Commercial and public services | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 3 | 4 | 4 | 3 | 4 | 2 | 3 | 4 | 4.5 |
| White spirit and SPB | | | | | | | | | | | | | | | | | | | |
| Not elsewhere specified (Industry) | 1 | 1 | 1 | | | | | | | | | | | | | | | | |
| Lubricants | | | | | | | | | | | | | | | | | | | |
| International marine bunkers | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | |
| Non-energy use: Road | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 |
| Non-energy use: Not elsewhere specified (Industry) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 5 | 5 | 5 | 5 | 5 |
| Bitumen | | | | | | | | | | | | | | | | | | | |
| Construction | 69 | 69 | 57 | 66 | 74 | 83 | 64 | 36 | 24 | 21 | 21 | 37 | 36 | 37 | 34 | 31 | 42 | 33 | 37 |
| Non-energy use: Not elsewhere specified (Industry) | | | | | | | | | | | | | | | | | | | |
| Pet-coke | | | | | | | | | | | | | | | | | | | |

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-metallic minerals | 154 | 146 | 143 | 152 | 144 | 116 | 100 | 94 | 135 | 162 | 128 | 123 | 109 | 74 | 56 | 63 | 13 | 15 | 29 |
| Other products (liquid) | | | | | | | | | | | | | | | | | | | |
| Refinery fuel | | | | | | | | | | | | | | | | | | | |
| Not elsewhere specified (Industry) | | | | | | | | | | | | | | | | | | | |
| Bituminous Coal | | | | | | | | | | | | | | | | | | | |
| Non-metallic minerals | 52 | 54 | 49 | 40 | 21 | 26 | 12 | 0 | 0 | 4 | 6 | 0 | 5 | 23 | 28 | 22 | 66 | 52 | 48 |
| Lignite | | | | | | | | | | | | | | | | | | | |
| Not elsewhere specified (Other) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Waste (non-biomass fraction)** | | | | | | | | | | | | | | | | | | | |
| **Industrial waste (non-renewable) (TJ)** | | | | | | | | | | | | | | | | | | | |
| Non-metallic minerals | 138 | 73 | 288 | 239 | 276 | 299 | 4 | 0 | 0 | 279 | 221 | 94 | 90 | 157 | 165 | 289 | 266 | 219 | 188 |
| **Municipal waste (non-renewable) TJ** | | | | | | | | | | | | | | | | | | | |
| Non-metallic minerals | | | | | | | | 24 | 45 | 37 | 295 | 569 | 812 | 805 | 1123 | 1168 | 1426 | 1729 | 1128 |
| **RENEWABLES** | | | | | | | | | | | | | | | | | | | |
| **Solid biofuels (TJ)** | | | | | | | | | | | | | | | | | | | |
| Charcoal production plants (Transformation) | 174 | 135 | 274 | 211 | 47 | 48 | 45 | 82 | 71 | 58 | 94 | 163 | 172 | 112 | 93 | 80 | 91 | 142 | 77 |
| Chemical and petrochemical | | | | | | | | | | 42 | 52 | 21 | 22 | 18 | 18 | 14 | 11 | 11 | 5 |
| Non-metallic minerals | 38 | 61 | 133 | 281 | 304 | 347 | 306 | 29 | 28 | 116 | 95 | 55 | 86 | 78 | 126 | 205 | 279 | 314 | 264 |
| Food, beverages and tobacco | | | | | | | | | | 44 | 7 | 36 | 51 | 67 | 99 | 69 | 48 | 180 | 130 |
| Commercial and public services | | | 14 | 15 | 15 | 15 | 13 | 16 | 16 | 16 | 15 | 15 | 17 | 17 | 17 | 132 | 126 | 166 | 106 |
| Residential | | 74 | 95 | 123 | 500 | 260 | 339 | 419 | 353 | 249 | 551 | 531 | 691 | 709 | 766 | 644 | 610 | 634 | 538 |
| Agriculture/Forestry | | 5 | | | | | | | | | | | | | | | | | 11 |
| Not elsewhere specified (Other) | 58 | | | | | | | | | | | | | | | | | | |
| **Charcoal (kt)** | | | | | | | | | | | | | | | | | | | |
| Commercial and public services | | 5 | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 6 | 6 | 5 | 6 | 6 | 6 |
| Residential | | 5 | 6 | 6 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 8 | 9 | 9 | 8 | 10 | 9 | 10 | 9 |
| Not elsewhere specified (Other) | 10 | | | | | | | | | | | | | | | | | | |
| **Biogases (TJ)** | | | | | | | | | | | | | | | | | | | |
| Main activity producer CHP plants | 0 | 0 | 0 | 0 | 13 | 21 | 92 | 91 | 118 | 116 | 130 | 130 | 145 | 143 | 136 | 131 | 127 | 108 | 95 |
| Autoproducer CHP plants | 0 | 0 | 9 | 78 | 131 | 148 | 180 | 192 | 171 | 176 | 179 | 182 | 178 | 204 | 208 | 206 | 208 | 210 | 199 |
| Food, beverages and tobacco | | | | | 15 | 30 | 67 | 70 | 68 | 67 | 69 | 68 | 68 | 66 | 65 | 66 | 67 | 65 | 67 |
| Commercial and public services | 0 | 0 | 0 | 0 | 11 | 12 | 11 | 11 | 11 | 12 | 12 | 16 | 17 | 44 | 56 | 20 | 24 | 27 | 37 |
| Agriculture/Forestry | 0 | 0 | 6 | 0 | 54 | 93 | 165 | 182 | 166 | 172 | 151 | 163 | 96 | 442 | 464 | 471 | 469 | 111 | 109 |
| **Municipal waste (renewable)** | | | | | | | | | | | | | | | | | | | |
| Non-metallic minerals | | | | | | | | 88 | 150 | 161 | 325 | 427 | 419 | 442 | 463 | 1378 | 1482 | 1121 | 1128 |

The share of domestic flights to the total fuel consumption is presented in Table A3.1.4. It can be noticed that there is a decreasing trend in the share of domestic flights to the total fuel consumption. The trend for these years can be represented by the equation y=-0.0014x+0.0154. This equation was used to estimate the share of domestic flights to the total for the years 1990–2004 (Table A3.1.5), years for which data is not available for domestic flights. By multiplying the share by the total fuel consumption reported all under international flights by the Statistical Service for 1990–2004, the fuel consumption of domestic flights was estimated. The international flights consumption for 1990–2004 was revised by subtracting the estimated fuel consumption for domestic flights. The resulting fuel consumption for domestic and international flights for the years 1990–2004 is presented in Table A3.1.5. Fuel consumption obtained from the Statistical Service is in kt, and converted to TJ using the default NCV proposed by the 2006 IPCC Guidelines, i.e. 44.1 TJ/Gg (Table 1.2, pg.1.18, vol.2).

**Table A3.1.4. Share of domestic flights to the total fuel consumption, EUROCONTROL data (2005–2023)**

| | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | |
|---|---|---|---|---|---|---|---|---|---|---|
| Share of domestic to total | 1.45% | 1.22% | 1.11% | 1.04% | 0.90% | 0.94% | 0.29% | 0.22% | 0.18% | |
| | | | | | | | | | | |
| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
| Share of domestic to total | 0.14% | 0.16% | 0.09% | 0.12% | 0.09% | 0.04% | 0.16% | 0.23% | 0.14% | 0.11% |

**Table A3.1.5. Share of domestic flights to the total fuel consumption, consumption for domestic and international flights (1990–2004)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| Share of domestic to total | 3.50% | 3.36% | 3.22% | 3.08% | 2.94% | 2.80% | 2.66% | 2.52% |
| Domestic consumption (TJ) | 364 | 415 | 386 | 314 | 307 | 321 | 292 | 272 |
| International consumption (TJ) | 10043 | 11933 | 11609 | 9873 | 10144 | 11145 | 10689 | 10532 |
| TOTAL (TJ) | 10408 | 12348 | 11995 | 10187 | 10452 | 11466 | 10981 | 10805 |
| | | | | | | | | |
| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | |
| Share of domestic to total | 2.38% | 2.24% | 2.10% | 1.96% | 1.82% | 1.68% | 1.54% | |
| Domestic consumption (TJ) | 271 | 261 | 248 | 271 | 242 | 239 | 200 | |
| International consumption (TJ) | 11107 | 11382 | 11571 | 13576 | 13076 | 14005 | 12809 | |
| TOTAL (TJ) | 11378 | 11642 | 11819 | 13847 | 13318 | 14244 | 13010 | |

<u>Other kerosene</u>

(a) Other kerosene consumption was recorded for non-elsewhere specified (industry) only for 2005. For the same year the consumption of residential sector was much lower than other years. The consumption from non-elsewhere specified (industry) of 2005 was moved to residential.

(b) Oil and gas extraction consumption reported only for 2014 was moved to Not elsewhere specified (Industry).

<u>Diesel</u>

According to the energy balance, the consumers of gas-diesel oil are Main activity producer electricity plants, Road, Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco, Construction, Not elsewhere specified (Industry), Commercial and public services, Residential, Agriculture/Forestry and Not elsewhere specified (Other). Consumption data for Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco, Construction is only available for 2012 to 2017.

(a) For the years 2006–2011 all consumption from industrial activities (incl. autoproducers) was included in Not elsewhere specified (Industry). The consumption was allocated to the industrial sectors according to the ratio of 2012 (Table A3.1.6).

**Table A3.1.6. Contribution of different activities to gas-diesel oil consumption (2012) used to allocate consumption to Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco, Construction, Not elsewhere specified (Industry) for 2006–2011**

| Activity | Consumption |
|---|---|
| Chemical and petrochemical | 5% |
| Non-ferrous metals | 5% |
| Non-metallic minerals | 14% |
| Mining and Quarrying | 24% |
| Food, beverages and tobacco | 14% |
| Construction | 24% |
| Not elsewhere specified (Industry) | 14% |

(b) The contribution of fishing consumption to the total for the years 2005–2007 is assumed the same as 2008.

(c) For 2005, consumption is available for Main activity producer electricity plants, road, Residential and Agriculture/forestry. Due to the large increase of the Not elsewhere specified (Industry) compare to 2006–2011, it is assumed that consumption by Commercial and public services, and Not elsewhere specified (Other) is included in the Not elsewhere specified (Industry). The assumed contribution of each sector to the consumption allocated to Not elsewhere specified (Industry) is based on the 2012 consumption ratio for these sectors (Table A3.1.7).

**Table A3.1.7. Contribution of different activities to gas-diesel oil consumption (2012) used to allocate consumption to Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco, Construction, Not elsewhere specified (Industry), Commercial and public services, Not elsewhere specified (Other) from Not elsewhere specified (Industry) for 2005**

| Activity | Consumption |
|---|---|
| Chemical and petrochemical | 2% |
| Non-ferrous metals | 2% |
| Non-metallic minerals | 7% |
| Mining and Quarrying | 12% |
| Food, beverages and tobacco | 7% |
| Construction | 12% |
| Not elsewhere specified (Industry) | 7% |
| Commercial and public services | 38% |
| Not elsewhere specified (Other) | 12% |

(d) To estimate the consumption for the years 1990–2004, the consumption ratio compared to Not elsewhere specified (Industry) is assumed to be the same as 2012 (Table A3.1.8).

**Table A3.1.8. Contribution of different activities to gas-diesel oil consumption (2012) used to allocate consumption to from Not elsewhere specified (Industry) for 1990–2004**

| Activity | Consumption |
|---|---|
| Chemical and petrochemical | 0.7% |
| Non-ferrous metals | 0.7% |
| Non-metallic minerals | 2.11% |
| Mining and Quarrying | 3.52% |
| Food, beverages and tobacco | 2.11% |
| Construction | 3.52% |
| Not elsewhere specified (Industry) | 2.11% |
| Commercial and public services | 11.27% |
| Residential | 53.52% |
| Agriculture/ forestry | 14.79% |
| Fishing | 2.11% |
| Not elsewhere specified (Other) | 3.52% |

(e) Consumption for Water-borne navigation activities is available for the years 1998–2015[88] (Table A3.1.9). The consumption for the period 1990–1997 was estimated assuming that the contribution of the activity to road transport consumption is the same as 1998; the consumption for 2016 was estimated assuming that the contribution of the activity to road transport consumption is the same as 2015.

(f) The consumption for Water-borne navigation activities was subtracted from Road transport. Therefore road transport consumption was revised for the whole reporting period.

**Table A3.1.9. Consumption diesel for Water-borne navigation activities**

| **Year** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** |
|---|---|---|---|---|---|---|---|---|---|
| t | 1097.05 | 1236.84 | 531.915 | 430.208 | 561.862 | 430.478 | 596.723 | 730.847 | 558.887 |
| kt | 1.10 | 1.24 | 0.53 | 0.43 | 0.56 | 0.43 | 0.60 | 0.73 | 0.56 |
| % of road | 0.33% | 0.36% | 0.15% | 0.12% | 0.16% | 0.12% | 0.17% | 0.21% | 0.17% |

| **Year** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|
| t | 626.709 | 757.997 | 1491.21 | 946.597 | 886.776 | 625.631 | 472.399 | 558.96 | 558.96 |
| kt | 0.63 | 0.76 | 1.49 | 0.95 | 0.89 | 0.63 | 0.47 | 0.56 | 0.56 |
| % of road | 0.19% | 0.23% | 0.46% | 0.29% | 0.28% | 0.23% | 0.20% | 0.25% | 0.26% |

RFO

(a) All consumption allocated to Autoproducer electricity and Autoproducer CHP Plants was moved to Not elsewhere specified (Industry).

(b) The consumption for food, beverages and tobacco, is only available for 2012–2021. For 2005–2012 consumption is also reported for non – metallic minerals and commercial and public services.

(c) All consumption during 1990–2004 except Refinery fuel and Main activity producer electricity plants was allocated to non-metallic minerals, food, beverages and tobacco, not elsewhere specified (industry) and commercial and public services.

Bitumen

All bitumen consumption allocated to Non-energy use: Not elsewhere specified (Industry) during 1990–2004 has been moved to construction.

Pet-coke

Pet-coke in Cyprus is consumed only for cement production. According to the information received from the cement installations, pet-coke was consumed in 1990. The energy balance shows that pet-coke was not imported in 1990. To reduce the inconsistency and the impact on the times series, it was decided to move the “other liquid fuels” consumption of 1990 to cement as pet-coke.

Solid biofuels

(a) All consumption of solid biofuels for the period 1990–1999 is reported as non-elsewhere specified (other).

(b) For 2001–2005 consumption is reported as non-elsewhere specified (other) and non-metallic minerals.

(c) Consumption in agriculture is reported only for 2006.

The consumption of agriculture of 2006 was moved to commercial and public services for which consumption is reported for 2007–2015. All the consumption reported as non-elsewhere specified (other) for 1990–2005 was distributed to commercial and public services, and residential sector according to the consumption ratio the two sectors had in 2007 (Table A3.1.10).

[88] Mr. George Ioannou, Statistical Service, Estimation based on fuel expenses assuming that all fuel is road diesel

**Table A3.1.10. Contribution of different activities to solid biofuels consumption (2007) used to allocate consumption to commercial and public services, and residential for 1990–2005**

| Activity | Consumption |
|---|---|
| Commercial and public services | 12.8% |
| Residential | 87.2% |

<u>Charcoal</u>

All charcoal consumption for the period 1990-2005 was reported as non-elsewhere specified (other). For the period 2006-2016, the charcoal consumption is allocated to commercial and public services, and residential sectors using the ratio of 50:50. This ratio was used to allocate charcoal consumption to the two sectors for the period 1990-2005.

<u>Biogases</u>

Biogas consumption is available in Cyprus after 2006, when the first anaerobic digester of the country started it operation. The biogas in Cyprus is consumed onsite to produce electricity and heat through a combined heat power (CHP) generator. Therefore, the biogas consumed by “Main activity producer CHP plants” (2009-2012) and “Autoproducer CHP plants” (2007-2021) was moved to agriculture.

## A.3.2. Solid waste management (5A)

**Historical solid waste production**

The IPCC Waste Model requires MSW and non-MSW activity data to be reported annually going back to the year 1950.

MSW activity data in Cyprus were only recorded between the years of 1996-2016, while the previously reported period of 1990-1995 was linearly extrapolated from the trend observable in years 1996-2009.

In an attempt to determine the historical waste per capita data going back to the year 1950, as recommended during the TERT review, a linear extrapolation from the small sample size of recorded data would not have sufficed, or otherwise been applicable. Therefore, a more pertinent indicator of waste activity was required, and, as such, the national GDP was used to correlate the annual waste activity against the corresponding years.

The methodology used to determine the historical waste per capita data was applied as follows:
(a) The 1960-2014 GDP data[89] was extrapolated backwards, to expand the range to the year 1950.
(b) Waste activity data from 1996-2009 was fitted exponentially to the respective GDP value of each year to provide for a correlation between waste per capita and GDP.
(c) Hence, a hind cast of the annual waste activity was calculated going back to 1950 using the derived relation of waste per capita to GDP.

Regarding non-MSW, the first reference year which data are available is 2014 in accordance with the provisions of the Waste Statistics Regulation (EC) No 2150/2002. No data are available for Cyprus before 2004. The methodology applied is may differ between years, due to the amendment of the Regulation (data 2010 and onwards) and moreover due to improved methods of reporting waste following Eurostat's recommendations. Data revisions were applied from 2012 onwards.

An estimation of the activity data for the years 2013 and 2015 was made by obtaining the average of the years before and after; i.e. 2012 and 2014, 2014 and 2016 respectively.

An extrapolation of the trend available from the years 2012-2016 was used to estimate activity data for 2017, 2018 and 2019.

To estimate the activity data for the years prior to 2012, the annual change of the Gross Domestic Product at Constant market prices of 2005 was used, as published by the Statistical Service in the Statistical Abstract.

GDP data alongside the calculated waste activity derived from the methodology of the model is summarized annually in Table A3.2.1. The aforementioned methodology is described analytically below in conjunction with the relevant data.

**Table A3.2.1. Data used for fitting and extrapolating GDP and waste activity is tabulated by year.**

| | GDP (€m) | Waste (kg/capita) | Food (Gg) | Wood (Gg) | Textile (Gg) | Sludge (Gg) |
|---|---|---|---|---|---|---|
| 1950 | 1052.30 | 457.96 | 0.626018 | 0.369484 | 0.000489 | 0.006176 |
| 1951 | 1103.00 | 458.65 | 0.657707 | 0.388187 | 0.000513 | 0.006489 |
| 1952 | 1156.20 | 459.37 | 0.691037 | 0.407859 | 0.000539 | 0.006818 |
| 1953 | 1211.90 | 460.13 | 0.726013 | 0.428502 | 0.000567 | 0.007163 |
| 1954 | 1270.20 | 460.92 | 0.762704 | 0.450157 | 0.000595 | 0.007525 |
| 1955 | 1331.40 | 461.76 | 0.801312 | 0.472944 | 0.000625 | 0.007905 |
| 1956 | 1395.60 | 462.64 | 0.841909 | 0.496905 | 0.000657 | 0.008306 |
| 1957 | 1462.80 | 463.56 | 0.884498 | 0.522042 | 0.000690 | 0.008726 |
| 1958 | 1533.30 | 464.52 | 0.929286 | 0.548476 | 0.000725 | 0.009168 |

[89] Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy

| | | | | | | |
|---|---|---|---|---|---|---|
| 1959 | 1607.10 | 465.54 | 0.976275 | 0.576210 | 0.000762 | 0.009632 |
| 1960 | 1468.85 | 463.64 | 0.898945 | 0.530569 | 0.000701 | 0.008869 |
| 1961 | 1632.00 | 465.88 | 1.011266 | 0.596862 | 0.000789 | 0.009977 |
| 1962 | 1778.72 | 467.91 | 1.111163 | 0.655822 | 0.000867 | 0.010962 |
| 1963 | 1888.76 | 469.44 | 1.184439 | 0.699070 | 0.000924 | 0.011685 |
| 1964 | 1709.19 | 466.95 | 1.081607 | 0.638378 | 0.000844 | 0.010671 |
| 1965 | 2090.23 | 472.24 | 1.391912 | 0.821524 | 0.001086 | 0.013732 |
| 1966 | 2217.79 | 474.03 | 1.482377 | 0.874917 | 0.001157 | 0.014625 |
| 1967 | 2519.44 | 478.28 | 1.715745 | 1.012654 | 0.001339 | 0.016927 |
| 1968 | 2635.50 | 479.92 | 1.798601 | 1.061557 | 0.001404 | 0.017744 |
| 1969 | 2880.77 | 483.42 | 1.983157 | 1.170484 | 0.001548 | 0.019565 |
| 1970 | 2970.01 | 484.69 | 2.046553 | 1.207901 | 0.001597 | 0.020191 |
| 1971 | 3349.95 | 490.17 | 2.346766 | 1.385090 | 0.001831 | 0.023152 |
| 1972 | 3571.12 | 493.39 | 2.512662 | 1.483004 | 0.001961 | 0.024789 |
| 1973 | 3606.71 | 493.91 | 2.537952 | 1.497931 | 0.001980 | 0.025039 |
| 1974 | 2997.38 | 485.09 | 2.171150 | 1.281440 | 0.001694 | 0.021420 |
| 1975 | 2428.01 | 476.98 | 1.824566 | 1.076881 | 0.001424 | 0.018001 |
| 1976 | 2870.37 | 483.27 | 2.231031 | 1.316782 | 0.001741 | 0.022011 |
| 1977 | 3323.12 | 489.78 | 2.648844 | 1.563381 | 0.002067 | 0.026133 |
| 1978 | 3577.15 | 493.48 | 2.868085 | 1.692779 | 0.002238 | 0.028296 |
| 1979 | 3930.26 | 498.66 | 3.182215 | 1.878183 | 0.002483 | 0.031395 |
| 1980 | 4162.94 | 502.11 | 3.382458 | 1.996369 | 0.002639 | 0.033370 |
| 1981 | 4289.95 | 504 | 3.488906 | 2.059195 | 0.002723 | 0.034420 |
| 1982 | 4546.16 | 508.04 | 3.710514 | 2.189991 | 0.002895 | 0.036607 |
| 1983 | 4802.38 | 511.7 | 3.932122 | 2.320787 | 0.003068 | 0.038793 |
| 1984 | 5227.76 | 518.18 | 4.314268 | 2.546334 | 0.003367 | 0.042563 |
| 1985 | 5478.50 | 522.03 | 4.531619 | 2.674617 | 0.003536 | 0.044707 |
| 1986 | 5675.59 | 525.09 | 4.700727 | 2.774427 | 0.003668 | 0.046376 |
| 1987 | 6078.52 | 531.38 | 5.059956 | 2.986448 | 0.003948 | 0.049920 |
| 1988 | 6583.83 | 539.39 | 5.518732 | 3.257224 | 0.004306 | 0.054446 |
| 1989 | 7117.07 | 547.96 | 6.005091 | 3.544279 | 0.004686 | 0.059244 |
| 1990 | 7650.30 | 556.68 | 6.491450 | 3.831334 | 0.005066 | 0.064043 |
| 1991 | 7703.95 | 557.56 | 6.537297 | 3.858393 | 0.005101 | 0.064495 |
| 1992 | 8428.25 | 569.64 | 7.215691 | 4.258790 | 0.005631 | 0.071188 |
| 1993 | 8487.37 | 570.64 | 7.266668 | 4.288877 | 0.005670 | 0.071691 |
| 1994 | 8987.76 | 579.15 | 7.721924 | 4.557575 | 0.006026 | 0.076182 |
| 1995 | 11386.80 | 600.13 | 10.533582 | 6.217050 | 0.008220 | 0.103921 |
| 1996 | 11528.90 | 605 | 10.666696 | 6.295616 | 0.008324 | 0.105234 |
| 1997 | 11833.40 | 612 | 10.956066 | 6.466406 | 0.008549 | 0.108089 |
| 1998 | 12556.50 | 616 | 11.669128 | 6.887264 | 0.009106 | 0.115124 |
| 1999 | 13184.10 | 620 | 12.283061 | 7.249614 | 0.009585 | 0.121181 |
| 2000 | 13970.60 | 629 | 13.062295 | 7.709528 | 0.010193 | 0.128868 |
| 2001 | 14522.80 | 650 | 13.599840 | 8.026794 | 0.010612 | 0.134172 |
| 2002 | 15063.40 | 655 | 14.125657 | 8.337137 | 0.011023 | 0.139359 |
| 2003 | 15458.60 | 671 | 14.506239 | 8.561762 | 0.011320 | 0.143114 |
| 2004 | 16235.60 | 685 | 15.273959 | 9.014879 | 0.011919 | 0.150688 |
| 2005 | 17023.50 | 688 | 16.052997 | 9.474677 | 0.012527 | 0.158374 |
| 2006 | 17826.00 | 694 | 16.847185 | 9.943417 | 0.013146 | 0.166209 |
| 2007 | 18734.70 | 704 | 17.752119 | 10.477520 | 0.013853 | 0.175137 |
| 2008 | 19418.00 | 729 | 18.424091 | 10.874126 | 0.014377 | 0.181766 |
| 2009 | 19026.60 | 730 | 18.060062 | 10.659272 | 0.014093 | 0.178175 |
| 2010 | 19461.13 | 696 | 18.482155 | 10.908396 | 0.014422 | 0.182339 |
| 2011 | 19542.22 | 694 | 18.559495 | 10.954043 | 0.014483 | 0.183102 |
| 2012 | 18868.53 | 681 | 17.941000 | 10.589000 | 0.014000 | 0.177000 |
| 2013 | 17625.57 | 635 | 14.927000 | 9.679000 | 0.013500 | 0.358000 |
| 2014 | 17312.53 | 618 | 11.913000 | 8.769000 | 0.013000 | 0.539000 |
| 2015 | 17904.43 | 640 | 11.173500 | 7.092000 | 0.013000 | 0.605500 |
| 2016 | 19081.39 | 651 | 10.434000 | 5.415000 | 0.013000 | 0.672000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2017 | 20175.42 | 641 | 10.023500 | 4.920500 | 0.012500 | 0.441500 |
| 2018 | 21314.90 | 661 | 9.613000 | 4.426000 | 0.012000 | 0.211000 |
| 2019 | 22495.12 | 665 | 7.544500 | 2.213000 | 0.006000 | 0.105500 |
| 2020 | 21732.34 | 625 | 5.476000 | 0.000000 | 0.000000 | 0.000000 |
| 2021 | 23886.30 | 650 | 4.525264 | 0.000000 | 0.000000 | 0.000000 |
| 2022 | 25094.50 | 673 | 3.229305 | 0.000000 | 0.000000 | 0.000000 |
| 2023 | | 674 | 1.933347 | 0.000000 | 0.000000 | 0.000000 |

(a) Reliable national GDP data is available, courtesy of the Statistical Service of Cyprus (CYSTAT), starting from 1960 – marked by the establishment of the Republic of Cyprus, and using constant market prices of 2005.

GDP data between the years of 1950-59 was extrapolated exponentially to allow for the waste activity to be fitted to that period as well, as shown in Figure; not much growth was to be expected during those years due to the British rule and Cyprus Emergency, and the fitted model is shown to be in accord. The GDP data appear to effectively gauge the socio-political economics of the time period, as they factor in any fluctuations in the market that may economically influence waste activity, as well as by modelling the situation in the aftermath of a war, such as the Turkish invasion of 1974.

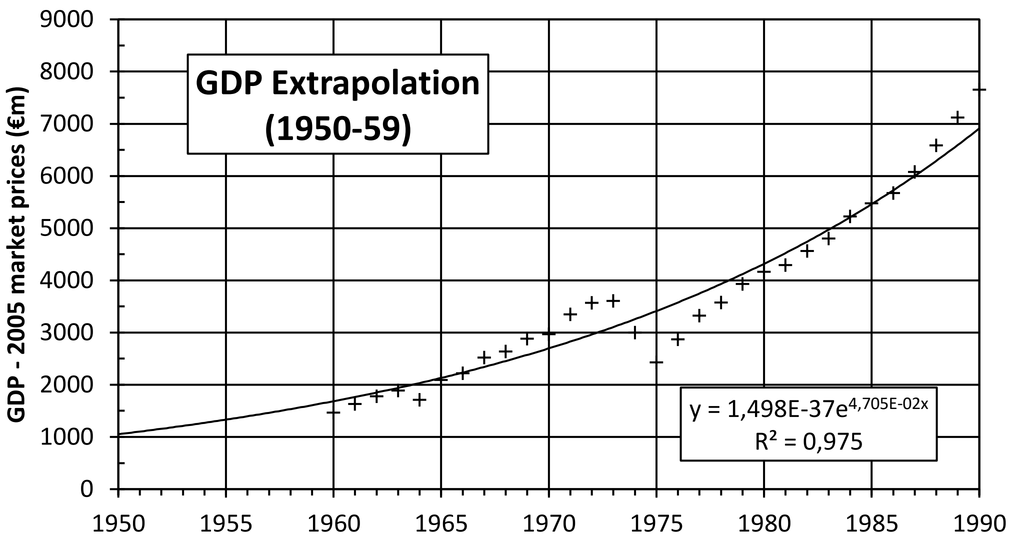


**Figure A.3.2.1. GDP data 1960-2014 (CYSTAT) extrapolated for the years of 1950-59.**

(b) As illustrated in Figure, the waste activity data showing a linear trend between the years 1996-2009 was used to fit waste per capita to GDP exponentially, and, by association, correlate waste activity with each corresponding year.

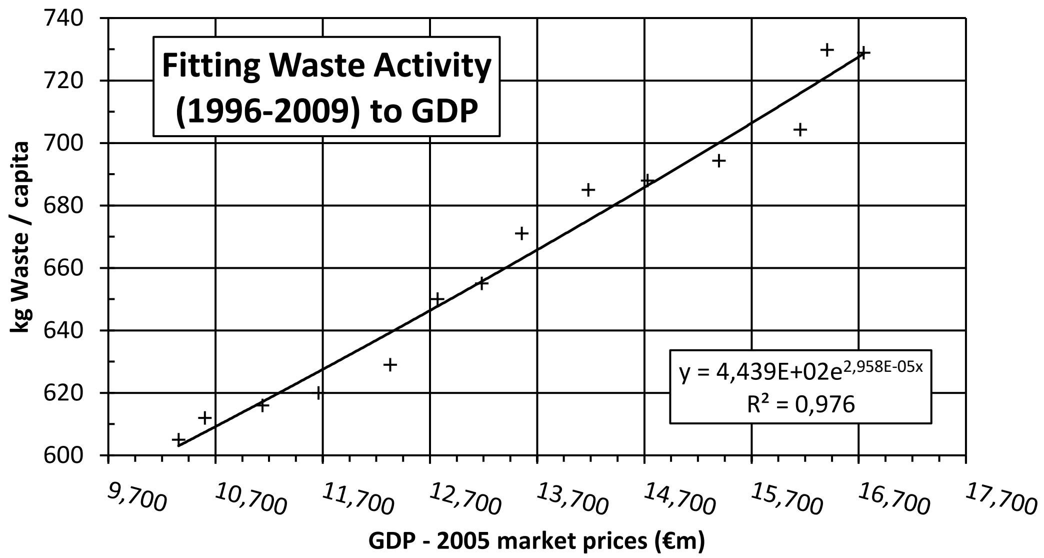


**Figure A.3.2.2. Plotting the linear period of waste activity data from 1996-2009 against their corresponding annual GDP, and fitting to an exponential model.**

(c) The GDP data from 1950-2014 could now be normalized to waste activity data by relation to the exponential fit determined from plotting waste activity to GDP for 1996-2009 in Figure. Hence, the waste activity data can be hind cast for each year going back to 1950 through a correlation to the annual GDP, as in Figure A.3.2.3.

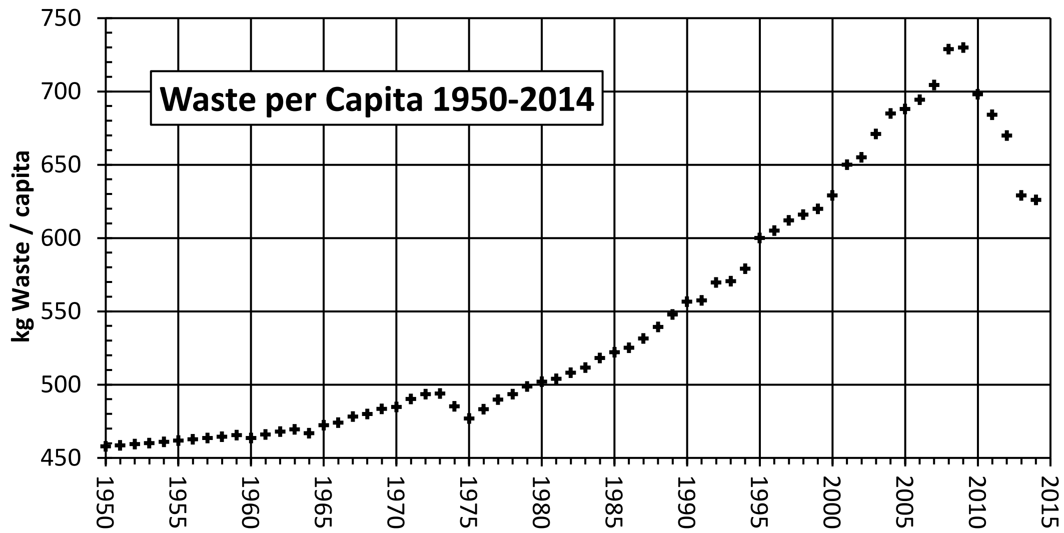


**Figure A.3.2.3. Waste per capita derived from annual GDP data and hind casts.**

# Annex 4: The national energy balance for the most recent inventory year (2021)

The national energy balance prepared by the Statistical Service of Cyprus according to the requirements of Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics (OJ L 304, 14.11.2008, p. 1–62) is presented in the tables that follow.

**Table A.4.1. Energy balance 2023 - Liquid Fuels (LPG, Non-bio gasoline, Non-bio jet kerosene, Other kerosene, Road diesel, Heating and other gas oil, Total gas/diesel oil, Biodiesel), in kt**

| Flow | LPG | Non-bio gasoline | Non-bio jet kerosene | Other kerosene | Road Diesel | Heating and other gas oil | Total gas/diesel oil | Biodiesel |
|---|---|---|---|---|---|---|---|---|
| Indigenous production | | | | | | | | |
| Receipts from other sources | | | | | | | | |
| *Solid fuels* | | | | | | | | |
| *Natural gas* | | | | | | | | |
| *Renewables* | | | | | | | | |
| Backflows | - | - | - | - | - | - | - | - |
| Of which: backflows for direct export or sale | - | - | - | - | - | - | - | - |
| Primary product receipts | - | - | - | - | 8.846 | - | 8.846 | 8.846 |
| Refinery gross output | - | - | - | - | - | - | - | - |
| Recycled products | - | - | - | - | - | - | - | - |
| Refinery fuel | - | - | - | - | - | - | - | - |
| Imports (Balance) | 57.583 | 348.519 | 313.391 | 7.479 | 409.054 | 429.214 | 838.268 | 18.611 |
| Exports (Balance) | 0.000 | - | - | - | - | - | - | - |
| International marine bunkers | 0.000 | - | - | - | - | 87.129 | 87.129 | - |
| Interproduct transfers | 0.000 | - | -2.712 | 2.712 | -26.867 | 26.867 | - | - |
| Products transferred | 0.000 | - | - | - | - | - | - | - |
| Direct use | -0.868 | | | | | | | |
| Stock changes | 56.715 | -29.387 | -11.923 | 0.710 | -16.147 | 8.168 | -7.979 | -2.373 |
| Refinery intake (Calculated) | 1.591 | | | | | | | |
| Gross inland deliveries (Calculated) | 55.124 | **319.132** | **298.756** | **10.901** | **374.886** | **377.120** | **752.006** | **25.084** |
| Statistical difference | | *-5.459* | *4.187* | *0.844* | *8.670* | *2.116* | *10.786* | *0.001* |
| **Gross inland deliveries (Observed)** | 3.133 | **324.591** | **294.569** | **10.057** | **366.216** | **375.004** | **741.220** | **25.083** |
| **Refinery intake (Observed)** | 4.001 | | | | | | | |
| Opening stock level (National territory) | | 75.243 | 31.370 | 3.959 | 118.174 | 82.686 | 200.860 | 1.664 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Closing stock level (National territory) | 0.000 | 104.630 | 43.293 | 3.249 | 134.321 | 74.518 | 208.839 | 4.037 |
| Average net calorific value of Production | 0.000 | | | | | | | |
| Average net calorific value of Imports | 0.000 | | | | | | | |
| Average net calorific value of Exports | | | | | | | | |
| Average net calorific value of Average | 47,300.000 | 44,300.000 | 44,100.000 | 43,800.000 | 42,588.673 | 42,755.576 | 42,673.120 | 37,000.000 |
| *Refinery fuel used for Electricity generation* | - | - | - | - | - | - | - | - |
| *Refinery fuel used CHP production* | - | - | - | - | - | - | - | - |
| *Refinery fuel used Heat production* | - | - | - | - | - | - | - | - |
| Stock changes at Main activity plants | - | - | - | - | - | - | - | - |
| Refinery losses | | - | - | | - | - | 0.000 | - |
| Gross deliveries to Petrochemical industry | - | - | - | - | - | - | - | - |
| Energy use in Petrochemical industry | - | - | - | - | - | - | - | - |
| Non-energy use in Petrochemical industry | - | - | - | - | - | - | - | - |
| Net deliveries of Total products | | - | - | | - | - | 0.000 | - |
| Net deliveries to the Petrochemical industry | | | | | | | | |
| **Gross inland deliveries for energy use** | **55.124** | **324.591** | **294.569** | **10.057** | **366.216** | **375.004** | **741.220** | **25.083** |
| Transformation sector | **0.000** | **0.000** | 0.000 | **0.000** | **0.000** | **291.853** | **291.853** | **0.000** |
| Main activity producer electricity | - | - | - | - | - | 289.854 | 289.854 | - |
| Autoproducer electricity | - | - | - | - | - | 1.999 | 1.999 | - |
| Main activity producer CHP | - | - | - | - | - | - | - | - |
| Autoproducer CHP Plants | - | - | - | - | - | - | - | - |
| Main activity producer heat | - | - | - | - | - | - | - | - |
| Autoproducer heat | - | - | - | - | - | - | - | - |
| Gas works (and other conversion to gases) | - | - | - | - | - | - | - | - |
| Natural gas blending plants | - | - | - | - | - | - | - | - |
| Coke ovens (Transformation) | - | - | - | - | - | - | - | - |
| Blast furnaces (Transformation) | - | - | - | - | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Petrochemical industry | - | - | - | - | - | - | - | - |
| Patent fuel plants (Transformation) | - | - | - | - | - | - | - | - |
| Not elsewhere specified (Transformation) | - | - | - | - | - | - | - | - |
| Energy sector | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Coal mines | - | - | - | - | - | - | 1.810 | - |
| Oil and gas extraction | - | - | - | - | - | - | - | - |
| Coke ovens (Energy) | - | - | - | - | - | - | 1.810 | - |
| Blast furnaces (Energy) | - | - | - | - | - | - | - | - |
| Gas works (Energy) | - | - | - | - | - | - | - | - |
| Electricity, CHP and Heat | - | - | - | - | - | - | - | - |
| Non elsewhere specified (Energy) | - | - | - | - | - | - | - | - |
| Distribution losses | - | - | - | - | - | - | - | - |
| **Total final energy consumption** | **55.124** | **324.591** | **294.569** | **10.057** | **366.216** | **83.151** | **449.367** | **25.083** |
| Transport sector | **0.424** | **324.591** | **293.631** | **0.000** | **331.467** | **0.000** | **331.467** | **24.139** |
| International aviation | - | - | 290.993 | - | - | - | - | - |
| Domestic aviation | - | - | 2.638 | - | - | - | - | - |
| Road | 0.424 | 324.591 | - | - | 329.532 | - | 329.532 | 24.024 |
| Rail | - | - | - | - | - | - | - | |
| Domestic navigation | - | - | - | - | 1.935 | - | 1.935 | 0.115 |
| Pipeline transport | - | - | - | - | - | - | - | - |
| Non elsewhere specified (Transport) | - | - | - | - | - | - | - | - |
| Industry sector | 6.637 | **0.000** | **0.000** | **0.000** | **7.902** | **22.741** | **30.643** | **0.472** |
| Iron and steel | - | - | - | - | 0.004 | 0.003 | 0.007 | - |
| Chemical and petrochemical | 0.029 | - | - | - | 0.055 | 1.210 | 1.265 | 0.003 |
| Non-ferrous metals | 0.636 | - | - | - | 0.008 | 0.004 | 0.012 | - |
| Non-metallic minerals | 0.464 | - | - | - | 0.948 | 2.149 | 3.097 | 0.053 |
| Transport equipment | 0.033 | - | - | - | 0.001 | 0.054 | 0.055 | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Machinery | 0.170 | - | - | | 0.218 | 0.147 | 0.365 | 0.013 |
| Mining and Quarrying | 0.095 | - | - | - | 6.096 | 3.609 | 9.705 | 0.365 |
| Food, beverages and tobacco | 5.049 | - | - | - | 0.316 | 4.954 | 5.270 | 0.025 |
| Paper, pulp and printing | 0.040 | - | - | - | - | 0.165 | 0.165 | - |
| Wood and wood products | 0.003 | - | - | - | 0.013 | 0.025 | 0.038 | 0.001 |
| Construction | - | - | - | - | - | 8.936 | 8.936 | - |
| Textiles and leather | 0.002 | - | - | - | - | 0.006 | 0.006 | - |
| Not elsewhere specified (Industry) | 0.116 | - | - | - | 0.243 | 1.479 | 1.722 | 0.012 |
| Other sectors | 48.063 | **0.000** | **0.938** | **10.057** | **26.847** | **60.410** | **87.257** | **0.472** |
| Commercial and public services | 10.741 | - | - | 2.011 | 1.804 | 14.330 | 16.134 | 0.133 |
| Residential | 33.597 | - | - | 8.046 | - | 45.311 | 45.311 | - |
| Agriculture/forestry | 2.588 | - | - | | 18.650 | | 18.650 | - |
| Fishing | - | - | - | | 1.575 | | 1.575 | - |
| Not elsewhere specified (Other) | 1.137 | - | **0.938** | - | 4.818 | 0.769 | 5.587 | 0.339 |
| **Gross inland deliveries for non energy use** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Transformation Sector | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Main activity producer electricity | - | - | - | - | - | - | - | - |
| Autoproducer electricity | - | - | - | - | - | - | - | - |
| Main activity producer CHP | - | - | - | - | - | - | - | - |
| Autoproducer CHP Plants | - | - | - | - | - | - | - | - |
| Main activity producer heat | - | - | - | - | - | - | - | - |
| Autoproducer heat | - | - | - | - | - | - | - | - |
| Gas works (and other conversion to gases) | - | - | - | - | - | - | - | - |
| Natural gas blending plants | - | - | - | - | - | - | - | - |
| Coke ovens (Transformation) | - | - | - | - | - | - | - | - |
| Blast furnaces (Transformation) | - | - | - | - | - | - | - | - |
| Petrochemical industry | - | - | - | - | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Patent fuel plants (Transformation) | - | - | - | - | - | - | - | - |
| Not elsewhere specified (Transformation) | - | - | - | - | - | - | - | - |
| Energy sector | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Coal mines | - | - | - | - | - | - | - | - |
| Oil and gas extraction | - | - | - | - | - | - | - | - |
| Coke ovens (Energy) | - | - | - | - | - | - | - | - |
| Blast furnaces (Energy) | - | - | - | - | - | - | - | - |
| Gas works (Energy) | - | - | - | - | - | - | - | - |
| Electricity, CHP and Heat | - | - | - | - | - | - | - | - |
| Non elsewhere specified (Energy) | - | - | - | - | - | - | - | - |
| Distribution losses | - | - | - | - | - | - | - | - |
| **Total final non energy use consumption** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Transport sector | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| International aviation | - | - | - | - | - | - | - | - |
| Domestic aviation | - | - | - | - | - | - | - | - |
| Road | - | - | - | - | - | - | - | - |
| Rail | - | - | - | - | - | - | - | - |
| Domestic navigation | - | - | - | - | - | - | - | - |
| Pipeline transport | - | - | - | - | - | - | - | - |
| Non elsewhere specified (Transport) | - | - | - | - | - | - | - | - |
| Industry sector | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Iron and steel | - | - | - | - | - | - | - | - |
| Chemical and petrochemical | - | - | - | - | - | - | - | - |
| Non-ferrous metals | - | - | - | - | - | - | - | - |
| Non-metallic minerals | - | - | - | - | - | - | - | - |
| Transport equipment | - | - | - | - | - | - | - | - |
| Machinery | - | - | - | - | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mining and Quarrying | - | - | - | - | - | - | - | - |
| Food, beverages and tobacco | - | - | - | - | - | - | - | - |
| Paper, pulp and printing | - | - | - | - | - | - | - | - |
| Wood and wood products | - | - | - | - | - | - | - | - |
| Construction | - | - | - | - | - | - | - | - |
| Textiles and leather | - | - | - | - | - | - | - | - |
| Not elsewhere specified (Industry) | - | - | - | - | - | - | - | - |
| Other sectors | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Commercial and public services | - | - | - | - | - | - | - | - |
| Residential | - | - | - | - | - | - | - | - |
| Agriculture/forestry | - | - | - | - | - | - | - | - |
| Fishing | - | - | - | - | - | - | - | - |
| Not elsewhere specified (Other) | - | - | - | - | - | - | - | - |

**Table A.4.2. Energy balance 2023 - Liquid Fuels (Non-bio gas/diesel oil, Total fuel oil, Lubricants, Bitumen, Pet-coke), in kt**

| **Flow** | **Non bio-gas Diesel Oil** | **Total fuel oil** | **Lubricants** | **Bitumen** | **Pet-Coke** |
|---|---|---|---|---|---|
| Indigenous production | | | | | |
| Receipts from other sources | | | | | |
| *Solid fuels* | | | | | |
| *Natural gas* | | | | | |
| *Renewables* | | | | | |
| Backflows | - | 0.000 | - | - | - |
| Of which: backflows for direct export or sale | - | 0.000 | - | - | - |
| Primary product receipts | - | 0.000 | - | - | - |
| Refinery gross output | - | 0.000 | - | - | - |
| Recycled products | - | 6.721 | - | - | - |
| Refinery fuel | - | 0.000 | - | - | - |
| Imports (Balance) | 819.657 | 873.923 | 8.314 | 39.437 | 21.041 |
| Exports (Balance) | - | 0.000 | - | - | - |
| International marine bunkers | 87.129 | 147.806 | - | - | - |
| Interproduct transfers | - | 0.000 | - | - | - |
| Products transferred | - | 0.000 | - | - | - |
| Direct use | | | | | |
| Stock changes | -5.606 | -24.448 | -0.114 | -1.528 | 8.292 |
| Refinery intake (Calculated) | | | | | |
| Gross inland deliveries (Calculated) | 726.922 | **708.390** | **8.200** | **37.909** | **29.333** |
| Statistical difference | 10.785 | *5.359* | *0.000* | *0.625* | *0.591* |
| **Gross inland deliveries (Observed)** | 716.137 | **703.031** | **8.200** | **37.284** | **28.742** |
| **Refinery intake (Observed)** | | | | | |
| Opening stock level (National territory) | 199.196 | 114.206 | 0.603 | 3.789 | 14.308 |

| | | | | | |
|---|---|---|---|---|---|
| Closing stock level (National territory) | 204.802 | 138.654 | 0.717 | 5.317 | 6.016 |
| Average net calorific value of Production | | | | | |
| Average net calorific value of Imports | | | | | |
| Average net calorific value of Exports | | | | | |
| Average net calorific value of Average | 42,871.995 | 40,421.748 | 40,200.000 | 40,200.000 | 32,423.000 |
| *Refinery fuel used for Electricity generation* | - | 0.000 | - | - | - |
| *Refinery fuel used CHP production* | - | 0.000 | - | - | - |
| *Refinery fuel used Heat production* | - | 0.000 | - | - | - |
| Stock changes at Main activity plants | - | 0.000 | - | - | - |
| Refinery losses | - | 0.000 | | | - |
| Gross deliveries to Petrochemical industry | | | - | - | |
| Energy use in Petrochemical industry | - | 0.000 | - | - | - |
| Non-energy use in Petrochemical industry | - | 0.000 | - | - | - |
| Net deliveries of Total products | - | 0.000 | | | - |
| Net deliveries to the Petrochemical industry | | | | | |
| **Gross inland deliveries for energy use** | **716.137** | **703.031** | **0.000** | **0.000** | **28.742** |
| Transformation sector | **291.853** | **674.255** | **0.000** | **0.000** | **0.000** |
| Main activity producer electricity | 289.854 | 674.255 | - | - | - |
| Autoproducer electricity | 1.999 | - | - | - | - |
| Main activity producer CHP | - | 0.000 | - | - | - |
| Autoproducer CHP Plants | - | 0.000 | - | - | - |
| Main activity producer heat | - | 0.000 | - | - | - |
| Autoproducer heat | - | 0.000 | - | - | - |
| Gas works (and other conversion to gases) | - | 0.000 | - | - | - |
| Natural gas blending plants | - | 0.000 | - | - | - |
| Coke ovens (Transformation) | - | 0.000 | - | - | - |
| Blast furnaces (Transformation) | - | 0.000 | - | - | - |

| | | | | | |
|---|---|---|---|---|---|
| Petrochemical industry | - | 0.000 | - | - | - |
| Patent fuel plants (Transformation) | - | 0.000 | - | - | - |
| Not elsewhere specified (Transformation) | - | 0.000 | - | - | - |
| Energy sector | **0.000** | 0.000 | **0.000** | **0.000** | **0.000** |
| Coal mines | - | 0.032 | - | - | - |
| Oil and gas extraction | - | 0.000 | - | - | - |
| Coke ovens (Energy) | - | 0.000 | - | - | - |
| Blast furnaces (Energy) | - | 0.000 | - | - | - |
| Gas works (Energy) | - | 0.000 | - | - | - |
| Electricity, CHP and Heat | - | 0.000 | - | - | - |
| Non elsewhere specified (Energy) | - | 0.032 | - | - | - |
| Distribution losses | - | 0.000 | - | - | - |
| **Total final energy consumption** | **424.284** | **28.776** | **0.000** | **0.000** | **28.742** |
| Transport sector | **307.328** | **0.000** | **0.000** | **0.000** | **0.000** |
| International aviation | - | 0.000 | - | - | - |
| Domestic aviation | - | 0.000 | - | - | - |
| Road | 305.508 | 0.000 | - | - | - |
| Rail | - | 0.000 | - | - | - |
| Domestic navigation | 1.820 | 0.000 | - | - | - |
| Pipeline transport | - | 0.000 | - | - | - |
| Non elsewhere specified (Transport) | - | 0.000 | - | - | - |
| Industry sector | **30.171** | **24.310** | **0.000** | **0.000** | **28.742** |
| Iron and steel | 0.007 | 0.000 | - | - | - |
| Chemical and petrochemical | 1.262 | 2.461 | - | - | - |
| Non-ferrous metals | 0.012 | 0.004 | - | - | - |
| Non-metallic minerals | 3.044 | 10.849 | - | - | 28.742 |
| Transport equipment | 0.055 | 0.000 | - | - | - |

| | | | | | |
|---|---|---|---|---|---|
| Machinery | 0.352 | 0.000 | - | - | - |
| Mining and Quarrying | 9.340 | 0.000 | - | - | - |
| Food, beverages and tobacco | 5.245 | 5.614 | - | - | - |
| Paper, pulp and printing | 0.165 | 0.426 | - | - | - |
| Wood and wood products | 0.037 | 0.000 | - | - | - |
| Construction | 8.936 | 4.234 | - | - | - |
| Textiles and leather | 0.006 | 0.000 | - | - | - |
| Not elsewhere specified (Industry) | 1.710 | 0.722 | - | - | - |
| Other sectors | **86.785** | **4.466** | **0.000** | **0.000** | **0.000** |
| Commercial and public services | 16.001 | 4.466 | - | - | - |
| Residential | 45.311 | 0.000 | - | - | - |
| Agriculture/forestry | 18.650 | 0.000 | - | - | - |
| Fishing | 1.575 | 0.000 | - | - | - |
| Not elsewhere specified (Other) | 5.248 | 0.000 | - | - | - |
| **Gross inland deliveries for non energy use** | **0.000** | **0.000** | **8.200** | **37.284** | **0.000** |
| Transformation Sector | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Main activity producer electricity | - | - | - | - | - |
| Autoproducer electricity | - | - | - | - | - |
| Main activity producer CHP | - | - | - | - | - |
| Autoproducer CHP Plants | - | - | - | - | - |
| Main activity producer heat | - | - | - | - | - |
| Autoproducer heat | - | - | - | - | - |
| Gas works (and other conversion to gases) | - | - | - | - | - |
| Natural gas blending plants | - | - | - | - | - |
| Coke ovens (Transformation) | - | - | - | - | - |
| Blast furnaces (Transformation) | - | - | - | - | - |
| Petrochemical industry | - | - | - | - | - |

| | | | | | |
|---|---|---|---|---|---|
| Patent fuel plants (Transformation) | - | - | - | - | - |
| Not elsewhere specified (Transformation) | - | - | - | - | - |
| Energy sector | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Coal mines | - | - | - | - | - |
| Oil and gas extraction | - | - | - | - | - |
| Coke ovens (Energy) | - | - | - | - | - |
| Blast furnaces (Energy) | - | - | - | - | - |
| Gas works (Energy) | - | - | - | - | - |
| Electricity, CHP and Heat | - | - | - | - | - |
| Non elsewhere specified (Energy) | - | - | - | - | - |
| Distribution losses | - | - | - | - | - |
| **Total final non energy use consumption** | **0.000** | **0.000** | **8.200** | **37.284** | **0.000** |
| Transport sector | **0.000** | **0.000** | **2.934** | **0.000** | **0.000** |
| International aviation | - | - | | | - |
| Domestic aviation | - | - | - | - | - |
| Road | - | - | 2.934 | - | - |
| Rail | - | - | - | - | - |
| Domestic navigation | - | - | - | - | - |
| Pipeline transport | - | - | - | - | - |
| Non elsewhere specified (Transport) | - | - | - | - | - |
| Industry sector | **0.000** | **0.000** | **5.266** | **37.284** | **0.000** |
| Iron and steel | - | - | - | - | - |
| Chemical and petrochemical | - | - | - | - | - |
| Non-ferrous metals | - | - | - | - | - |
| Non-metallic minerals | - | - | - | - | - |
| Transport equipment | - | - | - | - | - |
| Machinery | - | - | - | - | - |

| | | | | | |
|---|---|---|---|---|---|
| Mining and Quarrying | - | - | - | - | - |
| Food, beverages and tobacco | - | - | - | - | - |
| Paper, pulp and printing | - | - | - | - | - |
| Wood and wood products | - | - | - | - | - |
| Construction | - | - | - | 37.284 | - |
| Textiles and leather | - | - | - | - | - |
| Not elsewhere specified (Industry) | - | - | 5.266 | - | - |
| Other sectors | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| Commercial and public services | - | - | - | - | - |
| Residential | - | - | - | - | - |
| Agriculture/forestry | - | - | - | - | - |
| Fishing | - | - | - | - | - |
| Not elsewhere specified (Other) | - | - | - | - | - |

**Table A.4.3. Energy balance 2023 – Industrial waste (non-renewable), Municipal waste (renewable), Municipal waste (non-renewable), Solid biofuels, Charcoal, Biogases, in TJ**

| | Industrial Waste (non-renewable) | Municipal Waste (renewable) | Municipal Waste (non-renewable) | Solid Biofuels | Charcoal | Biogases |
|---|---|---|---|---|---|---|
| Indigenous production | **188.526** | **127.428** | **201.342** | **1,065.043** | **1.119** | **508.433** |
| Total imports (balance) | - | 938.486 | 1,423.232 | 68.273 | 13.655 | - |
| Total exports (balance) | - | - | - | - | - | - |
| Stock changes (national territory) | - | 62.452 | 109.180 | -1.623 | - | - |
| Inland consumption (calculated) | **189** | **1,128** | **1,734** | **1,132** | **15** | **508** |
| Statistical differences | 0.201 | - | - | -0.075 | - | 0.105 |
| **Transformation sector** | **-** | **-** | **-** | **77.244** | **-** | **294.444** |
| Main activity producer electricity | - | - | - | - | - | - |
| Main activity producer CHP | - | - | - | - | - | 94.949 |
| Main activity producer heat | - | - | - | - | - | - |
| Autoproducer electricity | - | - | - | - | - | - |
| Autoproducer CHP | - | - | - | - | - | 199.495 |
| Autoproducer heat | - | - | - | - | - | - |
| Patent fuel plants (Transformation) | - | - | - | - | - | - |
| BKB plants (Transformation) | - | - | - | - | - | - |
| Gas works (Transformation) | - | - | - | - | - | - |
| Blast furnaces (Transformation) | - | - | - | - | - | - |
| Natural gas blending plants | - | - | - | - | - | - |
| For blending with Motor gasoline/Diesel/Kerosene | - | - | - | - | - | - |
| Charcoal production plants (Transformation) | - | - | - | 77.244 | - | - |
| Not elsewhere specified (Transformation) | - | - | - | - | - | - |
| **Energy sector** | **-** | **-** | **-** | **-** | **-** | **-** |
| Gasification plants for Biogas | - | - | - | - | - | - |
| Own use in electricity, CHP and heat | - | - | - | - | - | - |
| Coal mines | - | - | - | - | - | - |
| Patent fuel plants (Energy) | - | - | - | - | - | - |
| Coke ovens (Energy) | - | - | - | - | - | - |
| Oil refineries | - | - | - | - | - | - |
| BKB plants (Energy) | - | - | - | - | - | - |
| Gas works (Energy) | - | - | - | - | - | - |
| Blast furnaces (Energy) | - | - | - | - | - | - |
| Charcoal production plants (energy) | - | - | - | - | - | - |
| Not elsewhere specified (Energy) | - | - | - | - | - | - |
| **Distribution losses** | - | - | - | - | - | - |
| **Total final consumption** | **188.325** | **1,128.366** | **1,733.754** | **1,054.524** | **14.774** | **213.884** |
| **Final energy consumption** | **188.325** | **1,128.366** | **1,733.754** | **1,054.524** | **14.774** | **213.884** |
| **Industry sector** | **188.325** | **1,128.366** | **1,733.754** | **399.068** | **-** | **67.437** |
| Iron and steel | - | - | - | - | - | - |
| Chemical and petrochemical | - | - | - | 5.311 | - | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| Non-ferrous metals | - | - | - | - | - | - |
| Non-metallic minerals | 188.325 | 1,128.366 | 1,733.754 | 263.791 | - | - |
| Transport equipment | - | - | - | - | - | - |
| Machinery | - | - | - | - | - | - |
| Mining and quarrying | - | - | - | - | - | - |
| Food, beverages and tobacco | - | - | - | 129.966 | - | 67.437 |
| Paper, pulp and printing | - | - | - | - | - | - |
| Wood and wood products | - | - | - | - | - | - |
| Construction | - | - | - | - | - | - |
| Textiles and leather | - | - | - | - | - | - |
| Not elsewhere specified (Industry) | - | - | - | - | - | - |
| **Transport sector** | **-** | **-** | **-** | **-** | **-** | **-** |
| Rail | - | - | - | - | - | - |
| Road | - | - | - | - | - | - |
| Domestic navigation | - | - | - | - | - | - |
| Not elsewhere specified (Transport) | - | - | - | - | - | - |
| **Other sectors** | **-** | **-** | **-** | **655.456** | **14.774** | **146.447** |
| Commercial and public services | - | - | - | 106.425 | 5.910 | 37.081 |
| Residential | - | - | - | 538.432 | 8.864 | - |
| Agriculture/Forestry | - | - | - | 10.599 | - | 109.366 |
| Fishing | - | - | - | - | - | - |
| Not elsewhere specified (Other) | - | - | - | - | - | - |

# Annex 5: Indirect greenhouse gases and $SO_2$

The role of carbon monoxide (CO), nitrogen oxides ($NO_x$) and non-methane organic volatile compounds (NMVOC) is important for climate change as these gases act as precursors of tropospheric ozone. In this way, they contribute to ozone formation and alter the atmospheric lifetimes of other greenhouse gases. For example, CO interacts with the hydroxyl radical (OH), the major atmospheric sink for methane, to form carbon dioxide. Therefore, increased atmospheric concentration of CO limits the number of OH compounds available to destroy methane, thus increasing the atmospheric lifetime of methane.

These gases are generated through a variety of anthropogenic activities. Emissions for indirect greenhouse gases and $SO_2$ are presented in the tables that follow. The emissions have been estimated by the Department of Labour Inspection that is the competent authority for the preparation of air pollutants inventories under Directive 2001/81/EC.

Sectors which are not presented in the tables are reported NO or IE or NA.

**Table A5.1.$NO_x$ emissions 1990-2023 (as Gg $NO_x$)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 3.2129 | 3.3323 | 3.8327 | 4.1307 | 4.3188 | 3.9313 | 4.1767 | 4.4168 |
| 1A1b | 0.1300 | 0.1400 | 0.1400 | 0.1400 | 0.1700 | 0.1600 | 0.1500 | 0.1600 |
| 1A2a | 0.0024 | 0.0024 | 0.0021 | 0.0021 | 0.0021 | 0.0021 | 0.0021 | 0.0019 |
| 1A2b | 0.0816 | 0.0838 | 0.0881 | 0.0891 | 0.0902 | 0.0902 | 0.0902 | 0.0945 |
| 1A2c | 0.0279 | 0.0290 | 0.0300 | 0.0301 | 0.0310 | 0.0344 | 0.0365 | 0.0387 |
| 1A2d | 0.0140 | 0.0161 | 0.0183 | 0.0193 | 0.0226 | 0.0236 | 0.0247 | 0.0258 |
| 1A2e | 0.2320 | 0.2470 | 0.2578 | 0.2685 | 0.2792 | 0.2900 | 0.3007 | 0.3114 |
| 1A2f | 1.6213 | 1.5288 | 1.6518 | 1.8062 | 1.8862 | 1.8070 | 1.9436 | 1.8704 |
| 1A2gvii | 0.4039 | 0.4046 | 0.4046 | 0.4053 | 0.4066 | 0.4072 | 0.4079 | 0.4085 |
| 1A2gviii | 0.4940 | 0.4979 | 0.4963 | 0.4988 | 0.5037 | 0.5065 | 0.5069 | 0.5091 |
| 1A3ai(i) | 0.3100 | 0.3138 | 0.3177 | 0.3215 | 0.3253 | 0.3291 | 0.3330 | 0.3368 |
| 1A3aii(i) | 0.0069 | 0.0069 | 0.0084 | 0.0087 | 0.0092 | 0.0097 | 0.0095 | 0.0100 |
| 1A3bi | 2.7423 | 2.6300 | 2.4228 | 2.2961 | 2.3488 | 2.2079 | 2.3870 | 2.3474 |
| 1A3bii | 3.3178 | 3.2882 | 4.0723 | 4.2232 | 4.3715 | 4.6312 | 4.2228 | 4.2392 |
| 1A3biii | 3.0051 | 2.8121 | 3.4485 | 3.4648 | 3.4351 | 3.6713 | 3.6034 | 3.7758 |
| 1A3biv | 0.0349 | 0.0336 | 0.0327 | 0.0304 | 0.0309 | 0.0302 | 0.0289 | 0.0298 |
| 1A3dii | 0.0265 | 0.0255 | 0.0310 | 0.0322 | 0.0329 | 0.0359 | 0.0376 | 0.0396 |
| 1A4bi | 0.2191 | 0.2329 | 0.2786 | 0.2851 | 0.3202 | 0.3052 | 0.3191 | 0.3343 |
| 1A4ci | 0.1577 | 0.1696 | 0.2046 | 0.2079 | 0.2364 | 0.2247 | 0.2359 | 0.2475 |
| 1A4cii | 0.2121 | 0.2281 | 0.2751 | 0.2796 | 0.3178 | 0.3022 | 0.3171 | 0.3328 |
| 1A4ciii | 0.1331 | 0.1480 | 0.1793 | 0.1860 | 0.1915 | 0.2078 | 0.2186 | 0.2295 |
| 1B2aiv | 0.1525 | 0.1621 | 0.1694 | 0.1838 | 0.1897 | 0.1987 | 0.1825 | 0.2502 |
| 1B2c | 0.0404 | 0.0429 | 0.0448 | 0.0486 | 0.0502 | 0.0526 | 0.0483 | 0.0662 |
| 2G | 0.0069 | 0.0069 | 0.0075 | 0.0021 | 0.0021 | 0.0061 | 0.0064 | 0.0072 |
| 3B1a | 0.0164 | 0.0169 | 0.0175 | 0.0188 | 0.0202 | 0.0216 | 0.0200 | 0.0186 |
| 3B1b | 0.0131 | 0.0130 | 0.0132 | 0.0144 | 0.0147 | 0.0154 | 0.0173 | 0.0143 |
| 3B2 | 0.0202 | 0.0205 | 0.0199 | 0.0192 | 0.0178 | 0.0174 | 0.0176 | 0.0171 |
| 3B3 | 0.0048 | 0.0052 | 0.0060 | 0.0064 | 0.0063 | 0.0066 | 0.0069 | 0.0073 |
| 3B4d | 0.0248 | 0.0248 | 0.0242 | 0.0240 | 0.0255 | 0.0267 | 0.0291 | 0.0366 |
| 3B4e | 0.000267 | 0.0003 | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0003 | 0.0004 |
| 3B4f | 0.0014 | 0.0013 | 0.0011 | 0.0010 | 0.0009 | 0.0008 | 0.0008 | 0.0007 |
| 3B4gi | 0.0091 | 0.0088 | 0.0085 | 0.0110 | 0.0107 | 0.0108 | 0.0113 | 0.0105 |
| 3B4gii | 0.0218 | 0.0199 | 0.0232 | 0.0272 | 0.0256 | 0.0264 | 0.0283 | 0.0293 |
| 3B4giii | 0.0015 | 0.0011 | 0.0013 | 0.0010 | 0.0012 | 0.0016 | 0.0015 | 0.0014 |
| 3B4giv | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 3Da1 | 0.5160 | 0.4920 | 0.6320 | 0.5640 | 0.5440 | 0.4960 | 0.5240 | 0.3760 |
| 3Da2a | 0.4006 | 0.4076 | 0.4249 | 0.4477 | 0.4515 | 0.4693 | 0.4850 | 0.4955 |
| 3Da2b | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0013 |
| 3Da3 | 0.1865 | 0.1880 | 0.1826 | 0.1785 | 0.1780 | 0.1812 | 0.1913 | 0.2185 |
| 3F | 0.0794 | 0.0771 | 0.0809 | 0.0811 | 0.0701 | 0.0630 | 0.0569 | 0.0520 |
| 5C1biii | 0.0010 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0011 | 0.0011 |
| 5C2 | 0.0015 | 0.0015 | 0.0016 | 0.0016 | 0.0016 | 0.0017 | 0.0017 | 0.0017 |
| TOTAL | 17.8848 | 17.6629 | 19.8535 | 20.3585 | 20.9428 | 20.8062 | 20.9841 | 21.3659 |

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 4.8215 | 5.0901 | 5.3539 | 5.3139 | 5.5342 | 5.9476 | 6.1958 | 6.5557 |
| 1A1b | 0.1700 | 0.1900 | 0.2100 | 0.2000 | 0.1700 | 0.0800 | 0.0400 | NO |
| 1A2a | 0.0017 | 0.0017 | 0.0017 | 0.0009 | 0.0009 | 0.0006 | 0.0004 | 0.0002 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A2b | 0.0945 | 0.0945 | 0.0945 | 0.0967 | 0.0967 | 0.0967 | 0.0967 | 0.0966 |
| 1A2c | 0.0408 | 0.0430 | 0.0451 | 0.0473 | 0.0473 | 0.0432 | 0.0430 | 0.0408 |
| 1A2d | 0.0279 | 0.0279 | 0.0290 | 0.0290 | 0.0279 | 0.0258 | 0.0258 | 0.0236 |
| 1A2e | 0.3179 | 0.3265 | 0.3351 | 0.3394 | 0.3437 | 0.3523 | 0.3566 | 0.3624 |
| 1A2f | 1.7690 | 1.7775 | 1.8309 | 1.7914 | 1.8520 | 1.8292 | 1.9781 | 1.9405 |
| 1A2gvii | 0.4163 | 0.4177 | 0.4242 | 0.4274 | 0.4291 | 0.4307 | 0.4323 | 0.4340 |
| 1A2gviii | 0.5099 | 0.5101 | 0.5103 | 0.5106 | 0.5107 | 0.5108 | 0.5110 | 0.5131 |
| 1A3ai(i) | 0.3406 | 0.3444 | 0.3483 | 0.3521 | 0.3559 | 0.3597 | 0.3636 | 0.3744 |
| 1A3aii(i) | 0.0103 | 0.0108 | 0.0116 | 0.0127 | 0.0126 | 0.0127 | 0.0132 | 0.0350 |
| 1A3bi | 2.2447 | 2.0965 | 1.9542 | 1.8157 | 1.7667 | 1.7366 | 1.6655 | 1.5254 |
| 1A3bii | 4.3911 | 4.3561 | 4.0694 | 4.2821 | 3.9172 | 3.9388 | 3.8277 | 3.6401 |
| 1A3biii | 3.7126 | 3.7565 | 4.1497 | 4.0817 | 3.8281 | 3.8991 | 3.8287 | 3.7180 |
| 1A3biv | 0.0307 | 0.0336 | 0.0345 | 0.0396 | 0.0436 | 0.0493 | 0.0499 | 0.0470 |
| 1A3dii | 0.0421 | 0.0475 | 0.0204 | 0.0165 | 0.0216 | 0.0165 | 0.0229 | 0.0281 |
| 1A4bi | 0.3515 | 0.3638 | 0.3714 | 0.3759 | 0.3891 | 0.3721 | 0.4222 | 0.5312 |
| 1A4ci | 0.2612 | 0.2707 | 0.2771 | 0.2798 | 0.2906 | 0.2783 | 0.2427 | 0.2522 |
| 1A4cii | 0.3513 | 0.3640 | 0.3727 | 0.3763 | 0.3908 | 0.3743 | 0.3091 | 0.3072 |
| 1A4ciii | 0.2444 | 0.2512 | 0.2594 | 0.2603 | 0.2495 | 0.2563 | 0.2306 | 0.1957 |
| 1B2aiv | 0.2599 | 0.2831 | 0.2816 | 0.2774 | 0.2607 | 0.2328 | 0.0669 | NO |
| 1B2c | 0.0688 | 0.0749 | 0.0745 | 0.0734 | 0.0690 | 0.0616 | 0.0177 | NO |
| 2G | 0.0073 | 0.0102 | 0.0193 | 0.0059 | 0.0055 | 0.0040 | 0.0059 | 0.0052 |
| 3B1a | 0.0174 | 0.0176 | 0.0172 | 0.0178 | 0.0192 | 0.0195 | 0.0191 | 0.0180 |
| 3B1b | 0.0125 | 0.0115 | 0.0114 | 0.0114 | 0.0123 | 0.0119 | 0.0126 | 0.0124 |
| 3B2 | 0.0167 | 0.0162 | 0.0171 | 0.0207 | 0.0205 | 0.0184 | 0.0194 | 0.0187 |
| 3B3 | 0.0074 | 0.0071 | 0.0072 | 0.0078 | 0.0084 | 0.0083 | 0.0079 | 0.0073 |
| 3B4d | 0.0390 | 0.0419 | 0.0459 | 0.0518 | 0.0557 | 0.0494 | 0.0458 | 0.0399 |
| 3B4e | 0.0004 | 0.0005 | 0.0005 | 0.0006 | 0.0006 | 0.0007 | 0.0006 | 0.0006 |
| 3B4f | 0.0006 | 0.0006 | 0.0005 | 0.0005 | 0.0004 | 0.0004 | 0.0003 | 0.0003 |
| 3B4gi | 0.0119 | 0.0102 | 0.0078 | 0.0085 | 0.0085 | 0.0085 | 0.0115 | 0.0092 |
| 3B4gii | 0.0291 | 0.0294 | 0.0306 | 0.0306 | 0.0318 | 0.0317 | 0.0269 | 0.0272 |
| 3B4giii | 0.0015 | 0.0014 | 0.0018 | 0.0016 | 0.0017 | 0.0016 | 0.0012 | 0.0009 |
| 3B4giv | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |
| 3Da1 | 0.4080 | 0.4160 | 0.3400 | 0.3240 | 0.3120 | 0.3880 | 0.3960 | 0.2560 |
| 3Da2a | 0.4934 | 0.4889 | 0.5016 | 0.5469 | 0.5801 | 0.5550 | 0.5402 | 0.4998 |
| 3Da2b | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0015 |
| 3Da3 | 0.2265 | 0.2357 | 0.2551 | 0.2937 | 0.3082 | 0.2747 | 0.2650 | 0.2388 |
| 3F | 0.0489 | 0.0447 | 0.0355 | 0.0348 | 0.0327 | 0.0351 | 0.0275 | 0.0214 |
| 5C1biii | 0.0012 | 0.0012 | 0.0012 | 0.0012 | 0.0012 | 0.0003 | NO | NO |
| 5C2 | 0.0018 | 0.0018 | 0.0018 | 0.0018 | 0.0018 | 0.0019 | 0.0019 | 0.0019 |
| TOTAL | 21.8039 | 22.0686 | 22.3556 | 22.3611 | 22.0100 | 22.3161 | 22.1241 | 21.7806 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 6.7618 | 6.9844 | 6.3209 | 7.4322 | 6.3266 | 9.7045 | 10.9561 | 6.3250 |
| 1A1b | NO | NO | NO | NO | NO | NO | NO | NO |
| 1A2a | NO | NO | 0.0086 | 0.0081 | 0.0107 | 0.0098 | NO | NO |
| 1A2b | 0.0965 | 0.0967 | 0.0943 | 0.0593 | 0.0602 | 0.0721 | 0.0414 | 0.0676 |
| 1A2c | 0.0406 | 0.0309 | 0.0188 | 0.0304 | 0.0407 | 0.0598 | 0.0504 | 0.0337 |
| 1A2d | 0.0229 | 0.0196 | 0.0229 | 0.0210 | 0.0205 | 0.0189 | 0.0190 | 0.0206 |
| 1A2e | 0.3668 | 0.3728 | 0.3615 | 0.3542 | 0.3463 | 0.3589 | 0.3770 | 0.3427 |
| 1A2f | 2.0215 | 1.9912 | 2.1254 | 1.8067 | 1.5821 | 1.4641 | 0.6743 | 0.9229 |
| 1A2gvii | 0.4356 | 0.4370 | 0.3443 | 0.2941 | 0.3173 | 0.2876 | 0.1714 | 0.1084 |
| 1A2gviii | 0.5164 | 0.5049 | 0.1336 | 0.0877 | 0.0708 | 0.1141 | 0.0658 | 0.0939 |
| 1A3ai(i) | 0.3714 | 0.3793 | 0.3923 | 0.3815 | 0.3806 | 0.3705 | 0.3583 | 0.3409 |
| 1A3aii(i) | 0.0295 | 0.0264 | 0.0258 | 0.0219 | 0.0180 | 0.0046 | 0.0026 | 0.0004 |
| 1A3bi | 1.4075 | 1.4012 | 1.3143 | 1.2276 | 1.1948 | 1.1138 | 1.0371 | 0.9245 |
| 1A3bii | 3.2510 | 2.7366 | 2.6461 | 2.4690 | 2.5285 | 2.3502 | 2.0027 | 1.7212 |
| 1A3biii | 3.4661 | 3.6634 | 3.5264 | 3.3673 | 3.4398 | 3.2037 | 2.8059 | 2.2854 |
| 1A3biv | 0.0506 | 0.0529 | 0.0491 | 0.0457 | 0.0407 | 0.0364 | 0.0332 | 0.0294 |
| 1A3dii | 0.0215 | 0.0241 | 0.0290 | 0.0568 | 0.0356 | 0.0330 | 0.0230 | 0.0171 |
| 1A4bi | 0.5289 | 0.4777 | 0.4700 | 0.4497 | 0.3830 | 0.4216 | 0.4155 | 0.3546 |
| 1A4ci | 0.2626 | 0.2414 | 0.2351 | 0.2083 | 0.2052 | 0.2144 | 0.2000 | 0.1970 |
| 1A4cii | 0.3049 | 0.3161 | 0.3070 | 0.2750 | 0.2712 | 0.2803 | 0.2690 | 0.2649 |
| 1A4ciii | 0.1896 | 0.1942 | 0.1916 | 0.2557 | 0.2555 | 0.1918 | 0.1922 | 0.1286 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | 0.0066 |
| 2G | 0.0032 | 0.0034 | 0.0033 | 0.0036 | 0.0039 | 0.0032 | 0.0035 | 0.0027 |
| 3B1a | 0.0175 | 0.0173 | 0.0173 | 0.0170 | 0.0171 | 0.0176 | 0.0176 | 0.0181 |
| 3B1b | 0.0121 | 0.0119 | 0.0117 | 0.0114 | 0.0115 | 0.0118 | 0.0111 | 0.0108 |
| 3B2 | 0.0190 | 0.0181 | 0.0186 | 0.0209 | 0.0229 | 0.0248 | 0.0242 | 0.0218 |
| 3B3 | 0.0076 | 0.0078 | 0.0076 | 0.0075 | 0.0074 | 0.0069 | 0.0062 | 0.0056 |
| 3B4d | 0.0418 | 0.0446 | 0.0386 | 0.0340 | 0.0373 | 0.0352 | 0.0329 | 0.0295 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3B4e | 0.0006 | 0.0005 | 0.0005 | 0.0005 | 0.0004 | 0.0004 | 0.0004 | 0.0003 |
| 3B4f | 0.0003 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| 3B4gi | 0.0089 | 0.0080 | 0.0082 | 0.0081 | 0.0072 | 0.0077 | 0.0082 | 0.0080 |
| 3B4gii | 0.0221 | 0.0239 | 0.0226 | 0.0218 | 0.0216 | 0.0204 | 0.0184 | 0.0157 |
| 3B4giii | 0.0009 | 0.0006 | 0.0005 | 0.0004 | 0.0004 | 0.0003 | 0.0002 | 0.0002 |
| 3B4giv | 0.0001 | 0.0001 | 0.0000 | NO | NO | NO | NO | NO |
| 3Da1 | 0.3520 | 0.2400 | 0.2560 | 0.2120 | 0.2160 | 0.2000 | 0.2080 | 0.2240 |
| 3Da2a | 0.5054 | 0.5141 | 0.4953 | 0.4857 | 0.5024 | 0.4963 | 0.4711 | 0.4408 |
| 3Da2b | 0.0015 | 0.0015 | 0.0016 | 0.0016 | 0.0016 | 0.0017 | 0.0017 | 0.0017 |
| 3Da3 | 0.2473 | 0.2543 | 0.2332 | 0.2255 | 0.2470 | 0.2472 | 0.2353 | 0.2118 |
| 3F | 0.0163 | 0.0090 | 0.0053 | 0.0043 | 0.0045 | 0.0050 | 0.0052 | 0.0043 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0019 | 0.0020 | 0.0020 | 0.0021 | 0.0021 | 0.0022 | 0.0022 | 0.0023 |
| TOTAL | 21.4045 | 21.1085 | 19.7398 | 19.9092 | 18.6323 | 21.3915 | 20.7418 | 15.183780 |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 6.9664 | 4.8595 | 4.0555 | 3.6551 | 3.6261 | 3.9056 | 2.9249 | 2.9358 |
| 1A1b | NO | NO | NO | NO | NO | NO | NO | NO |
| 1A2a | 0.0001 | NO | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 1A2b | 0.0969 | 0.0401 | 0.0237 | 0.0416 | 0.0274 | 0.0320 | 0.0260 | 0.0226 |
| 1A2c | 0.0435 | 0.0383 | 0.0412 | 0.0391 | 0.0396 | 0.0476 | 0.0508 | 0.0684 |
| 1A2d | 0.0213 | 0.0176 | 0.0181 | 0.0153 | 0.0175 | 0.0154 | 0.0191 | 0.0076 |
| 1A2e | 0.4602 | 0.3776 | 0.4087 | 0.4174 | 0.3846 | 0.4572 | 0.4425 | 0.4548 |
| 1A2f | 1.1183 | 1.0547 | 1.0094 | 1.0680 | 0.9937 | 0.9569 | 1.0051 | 1.0428 |
| 1A2gvii | 0.1073 | 0.0910 | 0.1021 | 0.1218 | 0.1389 | 0.1637 | 0.2002 | 0.2108 |
| 1A2gviii | 0.1086 | 0.0454 | 0.0503 | 0.0693 | 0.2007 | 0.2353 | 0.0702 | 0.1278 |
| 1A3ai(i) | 0.3471 | 0.3499 | 0.4056 | 0.4691 | 0.4857 | 0.4738 | 0.1536 | 0.2650 |
| 1A3aii(i) | 0.0002 | 0.0009 | 0.0008 | 0.0004 | 0.0003 | 0.0002 | 0.0001 | 0.0008 |
| 1A3bi | 0.9477 | 1.0116 | 1.1476 | 1.3125 | 1.4259 | 1.3858 | 1.6156 | 1.7051 |
| 1A3bii | 1.6009 | 1.6813 | 1.8172 | 1.8230 | 1.8083 | 1.5090 | 1.6420 | 1.7191 |
| 1A3biii | 2.0697 | 2.0308 | 2.1790 | 2.1643 | 1.6943 | 2.6481 | 1.7231 | 1.7613 |
| 1A3biv | 0.0283 | 0.0265 | 0.0232 | 0.0216 | 0.0199 | 0.0177 | 0.0133 | 0.0132 |
| 1A3dii | 0.0199 | 0.0221 | 0.0163 | 0.0231 | 0.0224 | 0.0294 | 0.0133 | 0.0271 |
| 1A4bi | 0.3042 | 0.3596 | 0.3793 | 0.3771 | 0.3582 | 0.3963 | 0.3627 | 0.3122 |
| 1A4ci | 0.1812 | 0.1998 | 0.2021 | 0.2123 | 0.1975 | 0.2071 | 0.2107 | 0.2020 |
| 1A4cii | 0.2437 | 0.2687 | 0.2619 | 0.2753 | 0.2559 | 0.2730 | 0.2785 | 0.2606 |
| 1A4ciii | 0.1283 | 0.1279 | 0.1279 | 0.1186 | 0.1145 | 0.1224 | 0.0948 | 0.1034 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | NO |
| 2G | 0.0011 | 0.0020 | 0.0019 | 0.0021 | 0.0018 | 0.0019 | 0.0016 | 0.0017 |
| 3B1a | 0.0185 | 0.0191 | 0.0208 | 0.0220 | 0.0233 | 0.0256 | 0.0289 | 0.0284 |
| 3B1b | 0.0115 | 0.0110 | 0.0117 | 0.0122 | 0.0133 | 0.0130 | 0.0147 | 0.0154 |
| 3B2 | 0.0225 | 0.0207 | 0.0212 | 0.0224 | 0.0217 | 0.0226 | 0.0229 | 0.0244 |
| 3B3 | 0.0054 | 0.0055 | 0.0054 | 0.0054 | 0.0055 | 0.0053 | 0.0055 | 0.0054 |
| 3B4d | 0.0281 | 0.0283 | 0.0299 | 0.0312 | 0.0304 | 0.0304 | 0.0316 | 0.0312 |
| 3B4e | 0.0003 | 0.0003 | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0004 | 0.0003 |
| 3B4f | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0004 | 0.0003 | 0.0004 |
| 3B4gi | 0.0072 | 0.0067 | 0.0068 | 0.0066 | 0.0064 | 0.0070 | 0.0068 | 0.0073 |
| 3B4gii | 0.0193 | 0.0162 | 0.0162 | 0.0166 | 0.0169 | 0.0174 | 0.0173 | 0.0173 |
| 3B4giii | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0002 | 0.0003 | 0.0002 | 0.0002 |
| 3B4giv | NO | NO | NO | NO | NO | NO | NO | NO |
| 3Da1 | 0.3160 | 0.2640 | 0.3000 | 0.2800 | 0.3480 | 0.3480 | 0.3760 | 0.3200 |
| 3Da2a | 0.4437 | 0.4382 | 0.4549 | 0.4718 | 0.4816 | 0.4921 | 0.5205 | 0.5257 |
| 3Da2b | 0.0017 | 0.0017 | 0.0017 | 0.0017 | 0.0017 | 0.0018 | 0.0018 | 0.0018 |
| 3Da3 | 0.2092 | 0.2023 | 0.2106 | 0.2211 | 0.2144 | 0.2189 | 0.2246 | 0.2298 |
| 3F | 0.0035 | 0.0046 | 0.0033 | 0.0028 | 0.0033 | 0.0032 | 0.0037 | 0.0036 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0022 | 0.0022 | 0.0022 | 0.0022 | 0.0022 | 0.0023 | 0.0023 | 0.0023 |
| TOTAL | 15.8853 | 13.6275 | 13.3584 | 13.3251 | 12.9840 | 14.0680 | 12.1067 | 12.4568 |

| | 2022 | 2023 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 2.7949 | 2.8897 | | | | | | |
| 1A1b | NO | NO | | | | | | |
| 1A2a | 0.0000 | 0.0000 | | | | | | |
| 1A2b | 0.0235 | 0.0235 | | | | | | |
| 1A2c | 0.1033 | 0.1033 | | | | | | |
| 1A2d | 0.0060 | 0.0060 | | | | | | |
| 1A2e | 0.3971 | 0.3971 | | | | | | |
| 1A2f | 1.0052 | 1.0764 | | | | | | |
| 1A2gvii | 0.1861 | 0.1861 | | | | | | |
| 1A2gviii | 0.2932 | 0.2932 | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A3ai(i) | 0.3620 | 0.4542 | | | | | | |
| 1A3aii(i) | 0.0023 | 0.0011 | | | | | | |
| 1A3bi | 1.6032 | 1.7570 | | | | | | |
| 1A3bii | 1.5844 | 1.5706 | | | | | | |
| 1A3biii | 1.6452 | 1.4696 | | | | | | |
| 1A3biv | 0.0127 | 0.0116 | | | | | | |
| 1A3dii | 0.0497 | 0.0635 | | | | | | |
| 1A4bi | 0.3423 | 0.2969 | | | | | | |
| 1A4ci | 0.1899 | 0.1681 | | | | | | |
| 1A4cii | 0.2426 | 0.2142 | | | | | | |
| 1A4ciii | 0.1054 | 0.1006 | | | | | | |
| 1B2aiv | NO | NO | | | | | | |
| 1B2c | NO | NO | | | | | | |
| 2G | 0.0016 | 0.0015 | | | | | | |
| 3B1a | 0.0279 | 0.0283 | | | | | | |
| 3B1b | 0.0148 | 0.0149 | | | | | | |
| 3B2 | 0.0239 | 0.0246 | | | | | | |
| 3B3 | 0.0049 | 0.0047 | | | | | | |
| 3B4d | 0.0308 | 0.0284 | | | | | | |
| 3B4e | 0.0003 | 0.0003 | | | | | | |
| 3B4f | 0.0004 | 0.0004 | | | | | | |
| 3B4gi | 0.0062 | 0.0066 | | | | | | |
| 3B4gii | 0.0175 | 0.0178 | | | | | | |
| 3B4giii | 0.0002 | 0.0001 | | | | | | |
| 3B4giv | NO | NO | | | | | | |
| 3Da1 | 0.1600 | 0.1600 | | | | | | |
| 3Da2a | 0.5056 | 0.4977 | | | | | | |
| 3Da2b | 0.0018 | 0.0018 | | | | | | |
| 3Da3 | 0.2263 | 0.2197 | | | | | | |
| 3F | 0.0034 | 0.0032 | | | | | | |
| 5C1biii | NO | NO | | | | | | |
| 5C2 | 0.0024 | 0.0024 | | | | | | |
| TOTAL | 11.9782 | 12.0960 | | | | | | |

**Table A5.2. CO emissions 1990–2023 (Gg)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.34 | 0.35 | 0.41 | 0.44 | 0.46 | 0.42 | 0.44 | 0.47 |
| 1A2a | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0002 |
| 1A2b | 0.0105 | 0.0108 | 0.0113 | 0.0115 | 0.0116 | 0.0116 | 0.0116 | 0.0122 |
| 1A2c | 0.0036 | 0.0037 | 0.0039 | 0.0039 | 0.0040 | 0.0044 | 0.0047 | 0.0050 |
| 1A2d | 0.0018 | 0.0021 | 0.0023 | 0.0025 | 0.0029 | 0.0030 | 0.0032 | 0.0033 |
| 1A2e | 0.0298 | 0.0318 | 0.0332 | 0.0345 | 0.0359 | 0.0373 | 0.0387 | 0.0401 |
| 1A2f | 1.8930 | 1.7847 | 1.9300 | 2.1101 | 2.2055 | 2.1117 | 2.2723 | 2.1874 |
| 1A2gvii | 0.1334 | 0.1336 | 0.1336 | 0.1338 | 0.1342 | 0.1345 | 0.1347 | 0.1349 |
| 1A2gviii | 0.0636 | 0.0641 | 0.0639 | 0.0642 | 0.0648 | 0.0652 | 0.0652 | 0.0655 |
| 1A3ai(i) | 0.1224 | 0.1039 | 0.1258 | 0.1298 | 0.1377 | 0.1448 | 0.1423 | 0.1494 |
| 1A3aii(i) | 0.0027 | 0.0023 | 0.0028 | 0.0028 | 0.0030 | 0.0032 | 0.0031 | 0.0033 |
| 1A3bi | 26.6474 | 25.4693 | 23.6037 | 22.1037 | 22.4397 | 21.1206 | 20.4807 | 19.5224 |
| 1A3bii | 6.8313 | 6.9897 | 7.2838 | 7.0123 | 7.1242 | 6.9449 | 6.4370 | 6.1907 |
| 1A3biii | 1.0449 | 0.9797 | 1.2268 | 1.2234 | 1.2231 | 1.2802 | 1.2445 | 1.2681 |
| 1A3biv | 4.5538 | 4.4485 | 4.3877 | 4.1377 | 4.2636 | 4.1806 | 4.0220 | 3.8158 |
| 1A3dii | 0.0137 | 0.0131 | 0.0160 | 0.0166 | 0.0170 | 0.0185 | 0.0194 | 0.0204 |
| 1A4bi | 0.3902 | 0.3215 | 0.3052 | 0.3810 | 0.2942 | 0.3062 | 0.2785 | 0.2701 |
| 1A4ci | 0.0479 | 0.0515 | 0.0622 | 0.0632 | 0.0718 | 0.0683 | 0.0717 | 0.0752 |
| 1A4cii | 0.0706 | 0.0759 | 0.0916 | 0.0931 | 0.1058 | 0.1006 | 0.1056 | 0.1108 |
| 1A4ciii | 0.0153 | 0.0170 | 0.0206 | 0.0214 | 0.0220 | 0.0239 | 0.0252 | 0.0264 |
| 1B2aiv | 0.0572 | 0.0608 | 0.0635 | 0.0689 | 0.0711 | 0.0745 | 0.0684 | 0.0938 |
| 1B2c | 0.0090 | 0.0095 | 0.0100 | 0.0108 | 0.0112 | 0.0117 | 0.0107 | 0.0147 |
| 2D3c | 0.0024 | 0.0024 | 0.0024 | 0.0024 | 0.0024 | 0.0024 | 0.0024 | 0.0024 |
| 2G | 0.2114 | 0.2114 | 0.2299 | 0.0637 | 0.0637 | 0.1860 | 0.1974 | 0.2203 |
| 3F | 2.3012 | 2.2351 | 2.3451 | 2.3506 | 2.0330 | 1.8270 | 1.6511 | 1.5093 |
| 5C1biii | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 5C2 | 0.0262 | 0.0268 | 0.0276 | 0.0283 | 0.0289 | 0.0295 | 0.0300 | 0.0304 |
| TOTAL | 44.8253 | 43.4041 | 42.3908 | 40.5096 | 40.8310 | 39.1089 | 37.7648 | 36.2419 |

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.51 | 0.54 | 0.57 | 0.57 | 0.59 | 0.63 | 0.66 | 0.70 |
| 1A2a | 0.0002 | 0.0002 | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| 1A2b | 0.0122 | 0.0122 | 0.0122 | 0.0124 | 0.0124 | 0.0124 | 0.0124 | 0.0124 |
| 1A2c | 0.0053 | 0.0055 | 0.0058 | 0.0061 | 0.0061 | 0.0056 | 0.0055 | 0.0053 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A2d | 0.0036 | 0.0036 | 0.0037 | 0.0037 | 0.0036 | 0.0033 | 0.0033 | 0.0030 |
| 1A2e | 0.0409 | 0.0420 | 0.0431 | 0.0437 | 0.0442 | 0.0453 | 0.0459 | 0.0561 |
| 1A2f | 2.0685 | 2.0780 | 2.1413 | 2.0954 | 2.1668 | 2.1390 | 2.3103 | 2.2666 |
| 1A2gvii | 0.1375 | 0.1379 | 0.1401 | 0.1411 | 0.1417 | 0.1422 | 0.1428 | 0.1433 |
| 1A2gviii | 0.0656 | 0.0656 | 0.0657 | 0.0657 | 0.0657 | 0.0657 | 0.0657 | 0.0803 |
| 1A3ai(i) | 0.1543 | 0.1626 | 0.1736 | 0.1910 | 0.1885 | 0.1909 | 0.1972 | 0.2007 |
| 1A3aii(i) | 0.0034 | 0.0036 | 0.0038 | 0.0042 | 0.0041 | 0.0042 | 0.0043 | 0.0111 |
| 1A3bi | 18.2305 | 16.8615 | 14.9171 | 14.0976 | 13.3887 | 12.8052 | 12.3487 | 11.5621 |
| 1A3bii | 5.8925 | 5.6208 | 5.0920 | 5.0741 | 4.5087 | 4.5130 | 4.0226 | 3.7203 |
| 1A3biii | 1.2228 | 1.2013 | 1.2403 | 1.1740 | 1.0788 | 1.0839 | 1.0526 | 1.0150 |
| 1A3biv | 3.5560 | 3.3479 | 3.0716 | 3.0568 | 2.8605 | 2.9108 | 2.6244 | 2.3876 |
| 1A3dii | 0.0217 | 0.0245 | 0.0105 | 0.0085 | 0.0111 | 0.0085 | 0.0118 | 0.0145 |
| 1A4bi | 0.2375 | 0.2315 | 0.1977 | 0.2318 | 0.1926 | 0.1636 | 0.1371 | 0.2081 |
| 1A4ci | 0.0794 | 0.0823 | 0.0842 | 0.0850 | 0.0883 | 0.0846 | 0.0738 | 0.0766 |
| 1A4cii | 0.1169 | 0.1211 | 0.1240 | 0.1252 | 0.1301 | 0.1246 | 0.1029 | 0.1023 |
| 1A4ciii | 0.0281 | 0.0289 | 0.0299 | 0.0302 | 0.0289 | 0.0297 | 0.0267 | 0.0227 |
| 1B2aiv | 0.0975 | 0.1062 | 0.1056 | 0.1040 | 0.0978 | 0.0873 | 0.0251 | NO |
| 1B2c | 0.0153 | 0.0166 | 0.0166 | 0.0163 | 0.0153 | 0.0137 | 0.0039 | NO |
| 2D3c | 0.0024 | 0.0024 | 0.0027 | 0.0022 | 0.0024 | 0.0022 | 0.0027 | 0.0021 |
| 2G | 0.2242 | 0.3139 | 0.5896 | 0.1817 | 0.1701 | 0.1226 | 0.1822 | 0.1588 |
| 3F | 1.4189 | 1.2973 | 1.0301 | 1.0080 | 0.9477 | 1.0183 | 0.7972 | 0.6213 |
| 5C1biii | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | NO | NO |
| 5C2 | 0.0309 | 0.0312 | 0.0316 | 0.0319 | 0.0322 | 0.0326 | 0.0330 | 0.0335 |
| TOTAL | 34.1788 | 32.3400 | 29.7024 | 28.3559 | 26.7750 | 26.2417 | 24.8911 | 23.4009 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.72 | 0.74 | 0.25 | 0.47 | 0.46 | 0.57 | 0.56 | 0.43 |
| 1A2a | NO | NO | 0.0011 | 0.0010 | 0.0014 | 0.0013 | NO | NO |
| 1A2b | 0.0124 | 0.0124 | 0.0121 | 0.0076 | 0.0077 | 0.0093 | 0.0053 | 0.0087 |
| 1A2c | 0.0052 | 0.0040 | 0.0024 | 0.0039 | 0.0052 | 0.0354 | 0.0398 | 0.0479 |
| 1A2d | 0.0029 | 0.0025 | 0.0029 | 0.0027 | 0.0026 | 0.0024 | 0.0024 | 0.0027 |
| 1A2e | 0.0575 | 0.0589 | 0.0674 | 0.0664 | 0.0678 | 0.0535 | 0.0499 | 0.0486 |
| 1A2f | 2.3613 | 2.3250 | 2.3739 | 1.9567 | 1.6389 | 1.5843 | 1.4405 | 2.1005 |
| 1A2gvii | 0.1438 | 0.1443 | 0.1137 | 0.0971 | 0.1048 | 0.0950 | 0.0566 | 0.0358 |
| 1A2gviii | 0.0981 | 0.1129 | 0.0176 | 0.0113 | 0.0210 | 0.0147 | 0.0085 | 0.0121 |
| 1A3ai(i) | 0.1953 | 0.1839 | 0.1831 | 0.1610 | 0.2039 | 0.2206 | 0.2192 | 0.1950 |
| 1A3aii(i) | 0.0094 | 0.0085 | 0.0077 | 0.0058 | 0.0058 | 0.0038 | 0.0023 | 0.0004 |
| 1A3bi | 10.7247 | 9.6605 | 8.5108 | 7.6975 | 7.4667 | 6.6192 | 6.1445 | 5.4228 |
| 1A3bii | 3.0862 | 2.0458 | 1.8044 | 1.6264 | 1.5868 | 1.3172 | 1.0902 | 0.9397 |
| 1A3biii | 0.9394 | 0.9055 | 0.8667 | 0.8337 | 0.8549 | 0.7994 | 0.7024 | 0.5699 |
| 1A3biv | 1.9859 | 2.1729 | 1.8758 | 1.6302 | 1.4689 | 1.2652 | 1.1520 | 1.0311 |
| 1A3dii | 0.0111 | 0.0124 | 0.0150 | 0.0294 | 0.0186 | 0.0173 | 0.0122 | 0.0092 |
| 1A4bi | 0.1846 | 0.3202 | 0.2931 | 0.2098 | 0.1556 | 0.1550 | 0.2908 | 0.2471 |
| 1A4ci | 0.0803 | 0.0738 | 0.0721 | 0.0636 | 0.0627 | 0.0657 | 0.0608 | 0.0599 |
| 1A4cii | 0.1015 | 0.1052 | 0.1022 | 0.0915 | 0.0903 | 0.0933 | 0.0895 | 0.0882 |
| 1A4ciii | 0.0220 | 0.0225 | 0.0222 | 0.0296 | 0.0296 | 0.0222 | 0.0223 | 0.0149 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | 0.0295 |
| 2D3c | 0.0019 | 0.0018 | 0.0017 | 0.0029 | 0.0039 | 0.0038 | 0.0029 | 0.0016 |
| 2G | 0.0993 | 0.1034 | 0.1006 | 0.1119 | 0.1195 | 0.0974 | 0.1060 | 0.0831 |
| 3F | 0.4738 | 0.2617 | 0.1549 | 0.1249 | 0.1317 | 0.1437 | 0.1513 | 0.1233 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0340 | 0.0346 | 0.0355 | 0.0364 | 0.0374 | 0.0384 | 0.0394 | 0.0396 |
| TOTAL | 21.3498 | 19.3161 | 16.8893 | 15.2702 | 14.5453 | 13.2293 | 12.2501 | 11.5394 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.58 | 0.4440 | 0.4478 | 0.3656 | 0.3172 | 0.3779 | 0.3603 | 0.4004 |
| 1A2a | 0.0000 | NO | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1A2b | 0.0125 | 0.0052 | 0.0031 | 0.0054 | 0.0035 | 0.0041 | 0.0033 | 0.0029 |
| 1A2c | 0.0238 | 0.0279 | 0.0148 | 0.0130 | 0.0130 | 0.0125 | 0.0113 | 0.0136 |
| 1A2d | 0.0027 | 0.0023 | 0.0023 | 0.0020 | 0.0023 | 0.0020 | 0.0025 | 0.0010 |
| 1A2e | 0.0725 | 0.0511 | 0.0712 | 0.0812 | 0.0665 | 0.0725 | 0.0654 | 0.0725 |
| 1A2f | 2.6854 | 2.4266 | 2.4349 | 2.5460 | 2.3702 | 2.2447 | 2.4795 | 2.4644 |
| 1A2gvii | 0.0354 | 0.0300 | 0.0337 | 0.0402 | 0.0459 | 0.0541 | 0.0661 | 0.0696 |
| 1A2gviii | 0.0140 | 0.0058 | 0.0065 | 0.0121 | 0.0301 | 0.0331 | 0.0105 | 0.0250 |
| 1A3ai(i) | 0.2017 | 0.1862 | 0.2315 | 0.2651 | 0.2845 | 0.2784 | 0.0906 | 0.1403 |
| 1A3aii(i) | 0.0003 | 0.0005 | 0.0006 | 0.0004 | 0.0005 | 0.0003 | 0.0004 | 0.0006 |
| 1A3bi | 5.2157 | 5.0420 | 4.9533 | 4.7393 | 4.4500 | 4.2182 | 3.4662 | 3.6157 |
| 1A3bii | 0.8503 | 0.8486 | 0.8665 | 0.8158 | 0.7911 | 0.6399 | 0.6097 | 0.6166 |
| 1A3biii | 0.5205 | 0.4975 | 0.5343 | 0.5209 | 0.4108 | 0.6282 | 0.4097 | 0.4193 |
| 1A3biv | 0.9802 | 0.9306 | 0.7917 | 0.7339 | 0.6895 | 0.6177 | 0.4744 | 0.4697 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A3dii | 0.0108 | 0.0121 | 0.0090 | 0.0128 | 0.0125 | 0.0165 | 0.0076 | 0.0153 |
| 1A4bi | 0.2140 | 0.3169 | 0.4199 | 0.3843 | 0.2685 | 0.2428 | 0.2118 | 0.2252 |
| 1A4ci | 0.0551 | 0.0607 | 0.0621 | 0.0652 | 0.0607 | 0.0633 | 0.0644 | 0.0621 |
| 1A4cii | 0.0811 | 0.0894 | 0.0872 | 0.0916 | 0.0852 | 0.0909 | 0.0927 | 0.0867 |
| 1A4ciii | 0.0149 | 0.0148 | 0.0148 | 0.0137 | 0.0133 | 0.0142 | 0.0110 | 0.0120 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | NO |
| 2D3c | 0.0007 | 0.0006 | 0.0006 | 0.0008 | 0.0011 | 0.0008 | 0.0007 | 0.0008 |
| 2G | 0.0331 | 0.0615 | 0.0577 | 0.0644 | 0.0570 | 0.0590 | 0.0499 | 0.0536 |
| 3F | 0.1013 | 0.1336 | 0.0952 | 0.0809 | 0.0961 | 0.0923 | 0.1061 | 0.1047 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0392 | 0.0387 | 0.0388 | 0.0391 | 0.0395 | 0.0400 | 0.0406 | 0.0409 |
| TOTAL | 11.7498 | 11.2269 | 11.1775 | 10.8936 | 10.1087 | 9.8034 | 8.6346 | 8.9130 |

| | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.4124 | 0.3492 | | | | | | |
| 1A2a | 0.0000 | 0.0000 | | | | | | |
| 1A2b | 0.0030 | 0.0030 | | | | | | |
| 1A2c | 0.0133 | 0.0133 | | | | | | |
| 1A2d | 0.0008 | 0.0008 | | | | | | |
| 1A2e | 0.0614 | 0.0614 | | | | | | |
| 1A2f | 2.4388 | 2.6143 | | | | | | |
| 1A2gvii | 0.0614 | 0.0614 | | | | | | |
| 1A2gviii | 0.0387 | 0.0387 | | | | | | |
| 1A3ai(i) | 0.1906 | 0.2446 | | | | | | |
| 1A3aii(i) | 0.0012 | 0.0009 | | | | | | |
| 1A3bi | 3.5647 | 3.5921 | | | | | | |
| 1A3bii | 0.5657 | 0.5206 | | | | | | |
| 1A3biii | 0.3919 | 0.3478 | | | | | | |
| 1A3biv | 0.4464 | 0.4236 | | | | | | |
| 1A3dii | 0.0282 | 0.0360 | | | | | | |
| 1A4bi | 0.3253 | 0.2033 | | | | | | |
| 1A4ci | 0.0586 | 0.0519 | | | | | | |
| 1A4cii | 0.0807 | 0.0713 | | | | | | |
| 1A4ciii | 0.0122 | 0.0117 | | | | | | |
| 1B2aiv | NO | NO | | | | | | |
| 1B2c | NO | NO | | | | | | |
| 2D3c | 0.0001 | 0.0001 | | | | | | |
| 2G | 0.0503 | 0.0469 | | | | | | |
| 3F | 0.0998 | 0.0936 | | | | | | |
| 5C1biii | NO | NO | | | | | | |
| 5C2 | 0.0413 | 0.0421 | | | | | | |
| TOTAL | 8.8868 | 8.8286 | | | | | | |

## Table A5.3.NMVOCs emissions 1990-2023 (Gg)

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.0520 | 0.0540 | 0.0621 | 0.0669 | 0.0700 | 0.0637 | 0.0677 | 0.0715 |
| 1A1b | 0.4100 | 0.4900 | 0.4600 | 0.5000 | 0.5700 | 0.5300 | 0.4900 | 0.6700 |
| 1A2a | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 1A2b | 0.0040 | 0.0041 | 0.0043 | 0.0043 | 0.0044 | 0.0044 | 0.0044 | 0.0046 |
| 1A2c | 0.0014 | 0.0014 | 0.0015 | 0.0015 | 0.0015 | 0.0017 | 0.0018 | 0.0019 |
| 1A2d | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0011 | 0.0012 | 0.0012 | 0.0013 |
| 1A2e | 0.0113 | 0.0120 | 0.0126 | 0.0131 | 0.0136 | 0.0141 | 0.0147 | 0.0152 |
| 1A2f | 0.0398 | 0.0378 | 0.0377 | 0.0425 | 0.0419 | 0.0406 | 0.0419 | 0.0402 |
| 1A2gvii | 0.0418 | 0.0419 | 0.0419 | 0.0419 | 0.0421 | 0.0421 | 0.0422 | 0.0423 |
| 1A2gviii | 0.0241 | 0.0243 | 0.0242 | 0.0243 | 0.0245 | 0.0247 | 0.0247 | 0.0248 |
| 1A3ai(i) | 0.0126 | 0.0107 | 0.0130 | 0.0134 | 0.0142 | 0.0149 | 0.0147 | 0.0154 |
| 1A3aii(i) | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0003 | 0.0003 |
| 1A3bi | 2.8649 | 2.7616 | 2.5818 | 2.4368 | 2.4917 | 2.3689 | 2.3477 | 2.2410 |
| 1A3bii | 0.6388 | 0.6524 | 0.6871 | 0.6649 | 0.6764 | 0.6830 | 0.6456 | 0.6393 |
| 1A3biii | 0.4798 | 0.4504 | 0.5757 | 0.5678 | 0.5726 | 0.5874 | 0.5661 | 0.5669 |
| 1A3biv | 1.7787 | 1.7540 | 1.7513 | 1.6684 | 1.7370 | 1.7093 | 1.6506 | 1.5586 |
| 1A3bv | 1.4897 | 1.4433 | 1.3769 | 1.3317 | 1.3411 | 1.2891 | 1.2547 | 1.2327 |
| 1A3dii | 0.0051 | 0.0049 | 0.0060 | 0.0062 | 0.0064 | 0.0070 | 0.0073 | 0.0077 |
| 1A4bi | 0.0485 | 0.0397 | 0.0375 | 0.0471 | 0.0359 | 0.0375 | 0.0339 | 0.0328 |
| 1A4ci | 0.0103 | 0.0111 | 0.0134 | 0.0136 | 0.0154 | 0.0147 | 0.0154 | 0.0162 |
| 1A4cii | 0.0218 | 0.0234 | 0.0283 | 0.0287 | 0.0327 | 0.0311 | 0.0326 | 0.0342 |
| 1A4ciii | 0.0066 | 0.0073 | 0.0089 | 0.0092 | 0.0095 | 0.0103 | 0.0108 | 0.0113 |
| 1B2aiv | 0.1271 | 0.1351 | 0.1412 | 0.1532 | 0.1581 | 0.1656 | 0.1521 | 0.2085 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1B2av | 0.7159 | 0.7083 | 0.7588 | 0.7662 | 0.7843 | 0.8057 | 0.8188 | 0.8397 |
| 1B2c | 0.0015 | 0.0016 | 0.0017 | 0.0018 | 0.0019 | 0.0019 | 0.0018 | 0.0025 |
| 2C1 | 0.0003 | 0.0002 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0002 | 0.0002 |
| 2D3a | 0.5472 | 0.5611 | 0.5763 | 0.5917 | 0.6048 | 0.6167 | 0.6272 | 0.6367 |
| 2D3b | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 |
| 2D3c | 0.0325 | 0.0325 | 0.0325 | 0.0325 | 0.0325 | 0.0325 | 0.0325 | 0.0325 |
| 2D3d | 1.7387 | 1.4241 | 1.5170 | 1.5202 | 1.7083 | 1.4102 | 1.4097 | 1.5604 |
| 2D3f | 0.2002 | 0.2003 | 0.2003 | 0.2004 | 0.2005 | 0.2006 | 0.2007 | 0.2008 |
| 2D3g | 0.4134 | 0.4239 | 0.4354 | 0.4470 | 0.4569 | 0.4659 | 0.4738 | 0.4810 |
| 2D3h | 0.2920 | 0.2920 | 0.2920 | 0.2920 | 0.2920 | 0.2920 | 0.2920 | 0.2920 |
| 2D3i | 0.0867 | 0.0889 | 0.0914 | 0.0938 | 0.0959 | 0.0978 | 0.0994 | 0.1009 |
| 2G | 0.0185 | 0.0185 | 0.0202 | 0.0056 | 0.0056 | 0.0163 | 0.0173 | 0.0193 |
| 2H2 | 0.2599 | 0.2902 | 0.3244 | 0.3288 | 0.3350 | 0.3498 | 0.3534 | 0.3439 |
| 3B1a | 0.4020 | 0.4147 | 0.4286 | 0.4600 | 0.4946 | 0.5288 | 0.4900 | 0.4572 |
| 3B1b | 0.2873 | 0.2841 | 0.2841 | 0.3156 | 0.3275 | 0.3440 | 0.3807 | 0.3288 |
| 3B2 | 0.0490 | 0.0499 | 0.0482 | 0.0465 | 0.0431 | 0.0423 | 0.0426 | 0.0414 |
| 3B3 | 0.1921 | 0.2065 | 0.2373 | 0.2538 | 0.2517 | 0.2619 | 0.2765 | 0.2900 |
| 3B4d | 0.1111 | 0.1111 | 0.1084 | 0.1073 | 0.1138 | 0.1192 | 0.1301 | 0.1637 |
| 3B4e | 0.0020 | 0.0018 | 0.0017 | 0.0016 | 0.0015 | 0.0019 | 0.0023 | 0.0027 |
| 3B4f | 0.0071 | 0.0064 | 0.0058 | 0.0052 | 0.0047 | 0.0043 | 0.0039 | 0.0035 |
| 3B4gi | 0.1057 | 0.1025 | 0.0983 | 0.1277 | 0.1246 | 0.1261 | 0.1316 | 0.1224 |
| 3B4gii | 0.3232 | 0.2953 | 0.3438 | 0.4027 | 0.3783 | 0.3913 | 0.4196 | 0.4334 |
| 3B4giii | 0.0033 | 0.0035 | 0.0048 | 0.0050 | 0.0049 | 0.0065 | 0.0051 | 0.0060 |
| 3B4giv | 0.0263 | 0.0198 | 0.0238 | 0.0183 | 0.0217 | 0.0287 | 0.0275 | 0.0244 |
| 3De | 0.0495 | 0.0506 | 0.0560 | 0.0594 | 0.0546 | 0.0523 | 0.0507 | 0.0499 |
| 3F | 0.0173 | 0.0168 | 0.0176 | 0.0176 | 0.0152 | 0.0137 | 0.0124 | 0.0113 |
| 5A | 0.1669 | 0.1699 | 0.1731 | 0.1768 | 0.1806 | 0.1846 | 0.1893 | 0.1941 |
| 5C1biii | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| 5C2 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0007 | 0.0007 |
| 5D1 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| TOTAL | 14.128 | 13.744 | 13.957 | 13.924 | 14.404 | 14.046 | 13.918 | 14.084 |

| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.0781 | 0.0824 | 0.0867 | 0.0861 | 0.0896 | 0.0963 | 0.1004 | 0.1062 |
| 1A1b | 0.6900 | 0.7500 | 0.6900 | 0.7300 | 0.6800 | 0.7300 | 0.2500 | NO |
| 1A2a | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1A2b | 0.0046 | 0.0046 | 0.0046 | 0.0047 | 0.0047 | 0.0047 | 0.0047 | 0.0047 |
| 1A2c | 0.0020 | 0.0021 | 0.0022 | 0.0023 | 0.0023 | 0.0021 | 0.0021 | 0.0020 |
| 1A2d | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0013 | 0.0013 | 0.0012 |
| 1A2e | 0.0155 | 0.0159 | 0.0163 | 0.0165 | 0.0167 | 0.0172 | 0.0174 | 0.0227 |
| 1A2f | 0.0376 | 0.0396 | 0.0405 | 0.0386 | 0.0423 | 0.0448 | 0.0516 | 0.0489 |
| 1A2gvii | 0.0431 | 0.0432 | 0.0439 | 0.0442 | 0.0444 | 0.0446 | 0.0447 | 0.0449 |
| 1A2gviii | 0.0248 | 0.0249 | 0.0249 | 0.0249 | 0.0249 | 0.0249 | 0.0249 | 0.0326 |
| 1A3ai(i) | 0.0159 | 0.0168 | 0.0179 | 0.0197 | 0.0195 | 0.0197 | 0.0204 | 0.0305 |
| 1A3aii(i) | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0004 | 0.0012 |
| 1A3bi | 2.0956 | 1.9386 | 1.7308 | 1.6267 | 1.5454 | 1.4696 | 1.3592 | 1.2105 |
| 1A3bii | 0.6504 | 0.6472 | 0.6165 | 0.6258 | 0.5663 | 0.5660 | 0.5203 | 0.4867 |
| 1A3biii | 0.5404 | 0.5193 | 0.5118 | 0.4681 | 0.4198 | 0.4042 | 0.3763 | 0.3500 |
| 1A3biv | 1.4401 | 1.3375 | 1.2244 | 1.1915 | 1.0239 | 1.0387 | 0.9271 | 0.8538 |
| 1A3bv | 1.1938 | 1.1490 | 1.0864 | 1.0502 | 1.0191 | 1.0260 | 1.0344 | 1.0097 |
| 1A3dii | 0.0082 | 0.0092 | 0.0040 | 0.0032 | 0.0042 | 0.0032 | 0.0044 | 0.0054 |
| 1A4bi | 0.0286 | 0.0278 | 0.0234 | 0.0278 | 0.0227 | 0.0191 | 0.0156 | 0.0221 |
| 1A4ci | 0.0171 | 0.0177 | 0.0181 | 0.0183 | 0.0190 | 0.0182 | 0.0159 | 0.0165 |
| 1A4cii | 0.0361 | 0.0374 | 0.0383 | 0.0387 | 0.0545 | 0.0385 | 0.0318 | 0.0316 |
| 1A4ciii | 0.0121 | 0.0124 | 0.0128 | 0.0129 | 0.0124 | 0.0127 | 0.0115 | 0.0097 |
| 1B2aiv | 0.2166 | 0.2359 | 0.2347 | 0.2312 | 0.2173 | 0.1940 | 0.0558 | NO |
| 1B2av | 0.8621 | 0.8918 | 0.9084 | 0.9627 | 1.0075 | 1.1418 | 1.2437 | 1.3311 |
| 1B2c | 0.0025 | 0.0028 | 0.0028 | 0.0027 | 0.0026 | 0.0023 | 0.0007 | NO |
| 2C1 | 0.0003 | 0.0003 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| 2D3a | 0.6452 | 0.6525 | 0.6598 | 0.6666 | 0.6742 | 0.6820 | 0.6908 | 0.7005 |
| 2D3b | 0.0075 | 0.0075 | 0.0084 | 0.0069 | 0.0075 | 0.0071 | 0.0085 | 0.0068 |
| 2D3c | 0.0325 | 0.0325 | 0.0366 | 0.0298 | 0.0324 | 0.0308 | 0.0368 | 0.0293 |
| 2D3d | 1.4476 | 1.4578 | 1.6020 | 1.4785 | 2.2579 | 2.8364 | 3.5522 | 3.8150 |
| 2D3f | 0.2009 | 0.2012 | 0.2021 | 0.2005 | 0.2004 | 0.2001 | 0.1998 | 0.1930 |
| 2D3g | 0.4874 | 0.4930 | 0.4985 | 0.5036 | 0.5093 | 0.5152 | 0.5219 | 0.5292 |
| 2D3h | 0.2920 | 0.3273 | 0.3355 | 0.3801 | 0.3075 | 0.2884 | 0.3399 | 0.3446 |
| 2D3i | 0.1023 | 0.1034 | 0.1046 | 0.1057 | 0.1069 | 0.1081 | 0.1095 | 0.1110 |
| 2G | 0.0197 | 0.0275 | 0.0518 | 0.0159 | 0.0149 | 0.0107 | 0.0160 | 0.0139 |
| 2H2 | 0.3154 | 0.3168 | 0.2911 | 0.2805 | 0.2746 | 0.2747 | 0.2529 | 0.2569 |
| 3B1a | 0.4273 | 0.4314 | 0.4217 | 0.4370 | 0.4705 | 0.4773 | 0.4678 | 0.4410 |
| 3B1b | 0.2850 | 0.2688 | 0.2730 | 0.2588 | 0.2842 | 0.2840 | 0.3047 | 0.2937 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3B2 | 0.0406 | 0.0394 | 0.0416 | 0.0501 | 0.0497 | 0.0447 | 0.0471 | 0.0454 |
| 3B3 | 0.2951 | 0.2815 | 0.2851 | 0.3129 | 0.3357 | 0.3330 | 0.3189 | 0.2951 |
| 3B4d | 0.1745 | 0.1875 | 0.2052 | 0.2315 | 0.2490 | 0.2211 | 0.2049 | 0.1785 |
| 3B4e | 0.0030 | 0.0034 | 0.0038 | 0.0042 | 0.0046 | 0.0050 | 0.0047 | 0.0045 |
| 3B4f | 0.0032 | 0.0029 | 0.0026 | 0.0023 | 0.0021 | 0.0019 | 0.0017 | 0.0016 |
| 3B4gi | 0.1389 | 0.1191 | 0.0908 | 0.0990 | 0.0990 | 0.0990 | 0.1337 | 0.1070 |
| 3B4gii | 0.4304 | 0.4358 | 0.4536 | 0.4536 | 0.4709 | 0.4687 | 0.3977 | 0.4025 |
| 3B4giii | 0.0065 | 0.0069 | 0.0073 | 0.0071 | 0.0078 | 0.0073 | 0.0054 | 0.0050 |
| 3B4giv | 0.0266 | 0.0251 | 0.0318 | 0.0284 | 0.0298 | 0.0293 | 0.0215 | 0.0161 |
| 3De | 0.0508 | 0.0507 | 0.0443 | 0.0481 | 0.0509 | 0.0625 | 0.0571 | 0.0534 |
| 3F | 0.0106 | 0.0097 | 0.0077 | 0.0076 | 0.0071 | 0.0076 | 0.0060 | 0.0047 |
| 5A | 0.1990 | 0.2039 | 0.2089 | 0.2140 | 0.2196 | 0.2253 | 0.2313 | 0.2375 |
| 5C1biii | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0001 | NO | NO |
| 5C2 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 |
| 5D1 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| TOTAL | 13.660 | 13.495 | 13.210 | 13.053 | 13.509 | 14.142 | 14.046 | 13.709 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.1095 | 0.1132 | 0.1176 | 0.1108 | 0.1009 | 0.1800 | 0.2855 | 0.0640 |
| 1A1b | NO | NO | NO | NO | NO | NO | NO | NO |
| 1A2a | NO | NO | 0.0004 | 0.0004 | 0.0005 | 0.0005 | NO | NO |
| 1A2b | 0.0047 | 0.0047 | 0.0046 | 0.0029 | 0.0029 | 0.0035 | 0.0020 | 0.0033 |
| 1A2c | 0.0020 | 0.0015 | 0.0009 | 0.0015 | 0.0020 | 0.0176 | 0.0201 | 0.0247 |
| 1A2d | 0.0011 | 0.0010 | 0.0011 | 0.0010 | 0.0010 | 0.0009 | 0.0009 | 0.0010 |
| 1A2e | 0.0233 | 0.0240 | 0.0287 | 0.0283 | 0.0292 | 0.0214 | 0.0191 | 0.0191 |
| 1A2f | 0.0488 | 0.0489 | 0.0620 | 0.0533 | 0.0517 | 0.0355 | 0.0301 | 0.0351 |
| 1A2gvii | 0.0451 | 0.0452 | 0.0356 | 0.0304 | 0.0328 | 0.0298 | 0.0177 | 0.0112 |
| 1A2gviii | 0.0420 | 0.0500 | 0.0067 | 0.0043 | 0.0097 | 0.0056 | 0.0032 | 0.0046 |
| 1A3ai(i) | 0.0256 | 0.0193 | 0.0193 | 0.0164 | 0.0225 | 0.0242 | 0.0249 | 0.0222 |
| 1A3aii(i) | 0.0010 | 0.0008 | 0.0008 | 0.0005 | 0.0004 | 0.0004 | 0.0002 | 0.0000 |
| 1A3bi | 1.0900 | 0.9480 | 0.8032 | 0.7240 | 0.6857 | 0.6013 | 0.5543 | 0.4836 |
| 1A3bii | 0.4122 | 0.3220 | 0.2865 | 0.2520 | 0.2482 | 0.2013 | 0.1643 | 0.1373 |
| 1A3biii | 0.3116 | 0.2293 | 0.2094 | 0.1876 | 0.1824 | 0.1600 | 0.1379 | 0.1105 |
| 1A3biv | 0.6679 | 0.8861 | 0.7833 | 0.6883 | 0.6145 | 0.5340 | 0.4828 | 0.4241 |
| 1A3bv | 0.9914 | 1.1845 | 1.1670 | 1.1403 | 1.1160 | 1.0872 | 1.0389 | 1.0020 |
| 1A3dii | 0.0042 | 0.0047 | 0.0056 | 0.0110 | 0.0069 | 0.0064 | 0.0044 | 0.0033 |
| 1A4bi | 0.0191 | 0.0365 | 0.0332 | 0.0228 | 0.0165 | 0.0160 | 0.0334 | 0.0283 |
| 1A4ci | 0.0185 | 0.0172 | 0.0171 | 0.0145 | 0.0143 | 0.0155 | 0.0131 | 0.0129 |
| 1A4cii | 0.0313 | 0.0325 | 0.0316 | 0.0283 | 0.0279 | 0.0288 | 0.0276 | 0.0272 |
| 1A4ciii | 0.0094 | 0.0097 | 0.0095 | 0.0127 | 0.0127 | 0.0095 | 0.0096 | 0.0064 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2av | 0.8722 | 0.9500 | 1.0874 | 1.1192 | 1.1003 | 1.0844 | 0.9899 | 0.8577 |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | 0.0084 |
| 2C1 | NO | NO | NO | NO | NO | NO | NO | NO |
| 2D3a | 0.7110 | 0.7243 | 0.7419 | 0.7615 | 0.7828 | 0.8025 | 0.8237 | 1.2035 |
| 2D3b | 0.0061 | 0.0057 | 0.0054 | 0.0091 | 0.0122 | 0.0119 | 0.0093 | 0.0049 |
| 2D3c | 0.0265 | 0.0246 | 0.0233 | 0.0396 | 0.0529 | 0.0516 | 0.0403 | 0.0213 |
| 2D3d | 4.0272 | 4.3205 | 3.3507 | 3.1421 | 3.4997 | 1.1160 | 1.1342 | 0.9821 |
| 2D3f | 0.1100 | 0.1110 | 0.0789 | 0.0602 | 0.0605 | 0.0600 | 0.0539 | 0.0265 |
| 2D3g | 0.5371 | 0.5472 | 0.5604 | 0.5753 | 0.5914 | 0.6062 | 0.6223 | 2.0852 |
| 2D3h | 0.3628 | 0.3195 | 0.4469 | 0.3260 | 0.2464 | 0.3347 | 0.2658 | 0.2072 |
| 2D3i | 0.1127 | 0.1148 | 0.1176 | 0.1207 | 0.1241 | 0.1272 | 0.1306 | 0.0029 |
| 2G | 0.0087 | 0.0091 | 0.0088 | 0.0098 | 0.0105 | 0.0086 | 0.0093 | 0.0073 |
| 2H2 | 0.2380 | 0.2385 | 0.2351 | 0.2116 | 0.2099 | 0.2082 | 0.1862 | 0.1607 |
| 3B1a | 0.4293 | 0.4251 | 0.4240 | 0.4160 | 0.4201 | 0.4317 | 0.4323 | 0.4430 |
| 3B1b | 0.2864 | 0.2776 | 0.2853 | 0.2751 | 0.2786 | 0.2924 | 0.2922 | 0.2896 |
| 3B2 | 0.0460 | 0.0438 | 0.0452 | 0.0507 | 0.0556 | 0.0602 | 0.0586 | 0.0530 |
| 3B3 | 0.3105 | 0.3196 | 0.3119 | 0.3095 | 0.3089 | 0.2887 | 0.2594 | 0.2376 |
| 3B4d | 0.1870 | 0.1995 | 0.1726 | 0.1522 | 0.1666 | 0.1573 | 0.1470 | 0.1318 |
| 3B4e | 0.0042 | 0.0040 | 0.0037 | 0.0035 | 0.0032 | 0.0030 | 0.0027 | 0.0025 |
| 3B4f | 0.0014 | 0.0013 | 0.0012 | 0.0010 | 0.0009 | 0.0009 | 0.0010 | 0.0012 |
| 3B4gi | 0.1054 | 0.0957 | 0.1003 | 0.0998 | 0.0916 | 0.0980 | 0.1072 | 0.1058 |
| 3B4gii | 0.3346 | 0.3640 | 0.3523 | 0.3428 | 0.3482 | 0.3320 | 0.3056 | 0.2636 |
| 3B4giii | 0.0031 | 0.0026 | 0.0012 | NO | NO | NO | NO | NO |
| 3B4giv | 0.0157 | 0.0107 | 0.0097 | 0.0072 | 0.0069 | 0.0052 | 0.0042 | 0.0045 |
| 3De | 0.0509 | 0.0375 | 0.0333 | 0.0268 | 0.0283 | 0.0309 | 0.0325 | 0.0265 |
| 3F | 0.0036 | 0.0020 | 0.0012 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0009 |
| 5A | 0.2437 | 0.2505 | 0.2576 | 0.2650 | 0.2724 | 0.2795 | 0.2859 | 0.2931 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0007 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0009 | 0.0009 |
| 5D1 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0004 | 0.0004 | 0.0004 | 0.0004 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TOTAL | 12.894 | 13.379 | 12.2808 | 11.658 | 11.853 | 9.373 | 9.067 | 9.843 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.0766 | 0.0828 | 0.0852 | 0.0762 | 0.0784 | 0.0757 | 0.0608 | 0.0676 |
| 1A1b | NO | NO | NO | NO | NO | NO | NO | NO |
| 1A2a | 0.0000 | NO | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1A2b | 0.0047 | 0.0020 | 0.0012 | 0.0020 | 0.0013 | 0.0016 | 0.0013 | 0.0011 |
| 1A2c | 0.0118 | 0.0140 | 0.0070 | 0.0061 | 0.0061 | 0.0057 | 0.0050 | 0.0059 |
| 1A2d | 0.0010 | 0.0009 | 0.0009 | 0.0007 | 0.0009 | 0.0008 | 0.0009 | 0.0004 |
| 1A2e | 0.0295 | 0.0197 | 0.0298 | 0.0349 | 0.0277 | 0.0295 | 0.0261 | 0.0296 |
| 1A2f | 0.0410 | 0.0394 | 0.0380 | 0.0412 | 0.0383 | 0.0388 | 0.0393 | 0.0418 |
| 1A2gvii | 0.0111 | 0.0094 | 0.0106 | 0.0126 | 0.0144 | 0.0169 | 0.0207 | 0.0218 |
| 1A2gviii | 0.0053 | 0.0022 | 0.0025 | 0.0051 | 0.0120 | 0.0130 | 0.0042 | 0.0107 |
| 1A3ai(i) | 0.0237 | 0.0212 | 0.0278 | 0.0313 | 0.0324 | 0.0288 | 0.0093 | 0.0163 |
| 1A3aii(i) | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0001 |
| 1A3bi | 0.4631 | 0.4420 | 0.4276 | 0.4027 | 0.3735 | 0.3517 | 0.2843 | 0.2925 |
| 1A3bii | 0.1236 | 0.1239 | 0.1296 | 0.1203 | 0.1149 | 0.0911 | 0.0928 | 0.0948 |
| 1A3biii | 0.1033 | 0.0915 | 0.0985 | 0.0884 | 0.0681 | 0.0930 | 0.0614 | 0.0620 |
| 1A3biv | 0.3964 | 0.3791 | 0.3125 | 0.2902 | 0.2702 | 0.2381 | 0.1718 | 0.1631 |
| 1A3bv | 1.0119 | 0.9671 | 0.9638 | 0.9493 | 0.9380 | 0.9315 | 0.8698 | 0.7567 |
| 1A3dii | 0.0038 | 0.0042 | 0.0031 | 0.0044 | 0.0042 | 0.0056 | 0.0025 | 0.0051 |
| 1A4bi | 0.0243 | 0.0371 | 0.0502 | 0.0456 | 0.0310 | 0.0273 | 0.0237 | 0.0258 |
| 1A4ci | 0.0118 | 0.0131 | 0.0150 | 0.0157 | 0.0147 | 0.0145 | 0.0147 | 0.0152 |
| 1A4cii | 0.0251 | 0.0276 | 0.0269 | 0.0283 | 0.0263 | 0.0281 | 0.0286 | 0.0268 |
| 1A4ciii | 0.0064 | 0.0064 | 0.0064 | 0.0059 | 0.0057 | 0.0061 | 0.0047 | 0.0051 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2av | 0.7972 | 0.7822 | 0.6591 | 0.5892 | 0.4478 | 0.4193 | 0.3559 | 0.3821 |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | NO |
| 2C1 | NO | NO | NO | NO | NO | NO | NO | NO |
| 2D3a | 1.1925 | 1.2378 | 0.9291 | 0.9011 | 0.9794 | 1.0068 | 1.8700 | 1.4268 |
| 2D3b | 0.0023 | 0.0020 | 0.0020 | 0.0026 | 0.0033 | 0.0026 | 0.0024 | 0.0024 |
| 2D3c | 0.0098 | 0.0086 | 0.0089 | 0.0111 | 0.0145 | 0.0112 | 0.0103 | 0.0103 |
| 2D3d | 0.8677 | 1.0721 | 1.1182 | 1.2681 | 1.4052 | 1.4971 | 1.4389 | 1.5295 |
| 2D3f | 0.0262 | 0.0527 | 0.0261 | 0.0132 | 0.0262 | 0.0267 | 0.0265 | 0.0269 |
| 2D3g | 2.0662 | 2.0397 | 0.0645 | 0.9791 | 0.3118 | 0.1231 | 0.2009 | 0.1872 |
| 2D3h | 0.2618 | 0.2526 | 0.2650 | 0.2655 | 0.2273 | 0.2458 | 0.1560 | 0.1604 |
| 2D3i | 0.0029 | 0.1548 | 0.2332 | 0.2131 | 0.3030 | 0.1910 | 0.2503 | 0.2967 |
| 2G | 0.0029 | 0.0054 | 0.0051 | 0.0056 | 0.0049 | 0.0051 | 0.0044 | 0.0047 |
| 2H2 | 0.1561 | 0.1535 | 0.1572 | 0.1668 | 0.1655 | 0.1769 | 0.1609 | 0.1475 |
| 3B1a | 0.4543 | 0.4698 | 0.5112 | 0.5406 | 0.5718 | 0.6281 | 0.7084 | 0.6981 |
| 3B1b | 0.3046 | 0.2908 | 0.3075 | 0.3258 | 0.3462 | 0.3459 | 0.3864 | 0.4003 |
| 3B2 | 0.0545 | 0.0502 | 0.0514 | 0.0543 | 0.0526 | 0.0548 | 0.0555 | 0.0592 |
| 3B3 | 0.2277 | 0.2344 | 0.2319 | 0.2312 | 0.2385 | 0.2282 | 0.2352 | 0.2344 |
| 3B4d | 0.1258 | 0.1268 | 0.1337 | 0.1396 | 0.1357 | 0.1361 | 0.1413 | 0.1394 |
| 3B4e | 0.0022 | 0.0020 | 0.0017 | 0.0017 | 0.0018 | 0.0030 | 0.0026 | 0.0028 |
| 3B4f | 0.0013 | 0.0014 | 0.0015 | 0.0017 | 0.0018 | 0.0019 | 0.0017 | 0.0018 |
| 3B4gi | 0.0980 | 0.0915 | 0.0950 | 0.0941 | 0.0926 | 0.1019 | 0.0990 | 0.1063 |
| 3B4gii | 0.3320 | 0.2813 | 0.2890 | 0.3000 | 0.3136 | 0.3225 | 0.3207 | 0.3209 |
| 3B4giii | NO | NO | NO | NO | NO | NO | NO | NO |
| 3B4giv | 0.0047 | 0.0048 | 0.0047 | 0.0058 | 0.0049 | 0.0059 | 0.0043 | 0.0046 |
| 3De | 0.0218 | 0.0287 | 0.0205 | 0.0174 | 0.0206 | 0.0198 | 0.0228 | 0.0225 |
| 3F | 0.0008 | 0.0010 | 0.0007 | 0.0006 | 0.0007 | 0.0007 | 0.0008 | 0.0008 |
| 5A | 0.2982 | 0.3016 | 0.3054 | 0.3095 | 0.3133 | 0.3170 | 0.3206 | 0.3229 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |
| 5D1 | 0.0004 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0006 | 0.0006 | 0.0006 |
| TOTAL | 9.687 | 9.930 | 7.660 | 8.600 | 8.043 | 7.871 | 8.499 | 8.132 |

| | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 0.0664 | 0.0670 | | | | | | |
| 1A1b | NO | NO | | | | | | |
| 1A2a | 0.0000 | 0.0000 | | | | | | |
| 1A2b | 0.0011 | 0.0011 | | | | | | |
| 1A2c | 0.0050 | 0.0050 | | | | | | |
| 1A2d | 0.0003 | 0.0003 | | | | | | |
| 1A2e | 0.0248 | 0.0248 | | | | | | |
| 1A2f | 0.0400 | 0.0430 | | | | | | |
| 1A2gvii | 0.0193 | 0.0193 | | | | | | |
| 1A2gviii | 0.0148 | 0.0148 | | | | | | |
| 1A3ai(i) | 0.0209 | 0.0258 | | | | | | |
| 1A3aii(i) | 0.0002 | 0.0002 | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A3bi | 0.2858 | 0.2824 | | | | | | |
| 1A3bii | 0.0855 | 0.0781 | | | | | | |
| 1A3biii | 0.0569 | 0.0480 | | | | | | |
| 1A3biv | 0.1500 | 0.1358 | | | | | | |
| 1A3bv | 0.7574 | 0.7642 | | | | | | |
| 1A3dii | 0.0094 | 0.0120 | | | | | | |
| 1A4bi | 0.0383 | 0.0230 | | | | | | |
| 1A4ci | 0.0147 | 0.0131 | | | | | | |
| 1A4cii | 0.0249 | 0.0220 | | | | | | |
| 1A4ciii | 0.0052 | 0.0050 | | | | | | |
| 1B2aiv | NO | NO | | | | | | |
| 1B2av | 0.3880 | 0.4061 | | | | | | |
| 1B2c | NO | NO | | | | | | |
| 2C1 | NO | NO | | | | | | |
| 2D3a | 0.8503 | 0.8808 | | | | | | |
| 2D3b | 0.0003 | 0.0003 | | | | | | |
| 2D3c | 0.0011 | 0.0011 | | | | | | |
| 2D3d | 1.5430 | 1.6967 | | | | | | |
| 2D3f | 0.0239 | 0.0367 | | | | | | |
| 2D3g | 0.0760 | 0.1112 | | | | | | |
| 2D3h | 0.1623 | 0.1632 | | | | | | |
| 2D3i | 0.1055 | 0.1297 | | | | | | |
| 2G | 0.0044 | 0.0041 | | | | | | |
| 2H2 | 0.1604 | 0.1604 | | | | | | |
| 3B1a | 0.6856 | 0.6935 | | | | | | |
| 3B1b | 0.3843 | 0.3873 | | | | | | |
| 3B2 | 0.0581 | 0.0597 | | | | | | |
| 3B3 | 0.2134 | 0.2009 | | | | | | |
| 3B4d | 0.1378 | 0.1268 | | | | | | |
| 3B4e | 0.0030 | 0.0030 | | | | | | |
| 3B4f | 0.0019 | 0.0019 | | | | | | |
| 3B4gi | 0.0907 | 0.0959 | | | | | | |
| 3B4gii | 0.3233 | 0.3296 | | | | | | |
| 3B4giii | NO | NO | | | | | | |
| 3B4giv | 0.0044 | 0.0026 | | | | | | |
| 3De | 0.0214 | 0.0201 | | | | | | |
| 3F | 0.0007 | 0.0007 | | | | | | |
| 5A | 0.3248 | 0.3224 | | | | | | |
| 5C1biii | NO | NO | | | | | | |
| 5C2 | 0.0009 | 0.0009 | | | | | | |
| 5D1 | 0.0006 | 0.0006 | | | | | | |
| TOTAL | 7.187 | 7.421 | | | | | | |

**Table A5.4.** $SO_x$ **emissions 1990–2023 (as Gg** $SO_2$**)**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 21.6153 | 22.4186 | 25.8482 | 27.8109 | 29.0674 | 26.4977 | 28.1351 | 29.7495 |
| 1A1b | 0.5900 | 0.6000 | 0.6200 | 0.6200 | 0.7500 | 0.7000 | 0.6600 | 0.7200 |
| 1A2a | 0.0055 | 0.0055 | 0.0050 | 0.0050 | 0.0050 | 0.0050 | 0.0050 | 0.0045 |
| 1A2b | 0.1900 | 0.1950 | 0.2050 | 0.2075 | 0.2100 | 0.2100 | 0.2100 | 0.2200 |
| 1A2c | 0.0650 | 0.0675 | 0.0699 | 0.0700 | 0.0723 | 0.0800 | 0.0850 | 0.0900 |
| 1A2d | 0.0325 | 0.0375 | 0.0425 | 0.0450 | 0.0525 | 0.0550 | 0.0575 | 0.0600 |
| 1A2e | 0.5400 | 0.5750 | 0.6000 | 0.6250 | 0.6500 | 0.6750 | 0.7000 | 0.7250 |
| 1A2f | 0.4825 | 0.4549 | 0.4927 | 0.5382 | 0.5628 | 0.5392 | 0.5805 | 0.5586 |
| 1A2gvii | 0.2476 | 0.2480 | 0.2480 | 0.2484 | 0.2492 | 0.2496 | 0.2500 | 0.2504 |
| 1A2gviii | 1.1500 | 1.1590 | 1.1554 | 1.1611 | 1.1726 | 1.1791 | 1.1800 | 1.1850 |
| 1A3ai(i) | 0.0263 | 0.0260 | 0.0257 | 0.0254 | 0.0250 | 0.0247 | 0.0244 | 0.0241 |
| 1A3aii(i) | 0.0004 | 0.0003 | 0.0004 | 0.0004 | 0.0005 | 0.0005 | 0.0005 | 0.0005 |
| 1A3bi | 0.7470 | 0.7457 | 0.6395 | 0.6443 | 0.6781 | 0.6101 | 1.1165 | 1.1762 |
| 1A3bii | 2.3925 | 2.3541 | 3.0220 | 3.1761 | 3.2979 | 3.7039 | 3.4796 | 3.6226 |
| 1A3biii | 1.5426 | 1.4437 | 1.7653 | 1.7762 | 1.7697 | 1.9122 | 1.8863 | 2.0007 |
| 1A3biv | 0.0238 | 0.0232 | 0.0226 | 0.0212 | 0.0216 | 0.0208 | 0.0194 | 0.0182 |
| 1A3dii | 0.0028 | 0.0027 | 0.0032 | 0.0034 | 0.0034 | 0.0037 | 0.0039 | 0.0041 |
| 1A4bi | 1.4175 | 1.5237 | 1.8377 | 1.8679 | 2.1227 | 2.0182 | 2.1181 | 2.2226 |
| 1A4ci | 0.2462 | 0.2648 | 0.3194 | 0.3246 | 0.3690 | 0.3508 | 0.3682 | 0.3863 |
| 1A4cii | 0.1231 | 0.1324 | 0.1597 | 0.1623 | 0.1845 | 0.1754 | 0.1841 | 0.1932 |
| 1A4ciii | 0.0083 | 0.0092 | 0.0112 | 0.0116 | 0.0119 | 0.0129 | 0.0136 | 0.0143 |
| 1B2aiv | 0.3940 | 0.4188 | 0.4376 | 0.4748 | 0.4901 | 0.5134 | 0.4714 | 0.6464 |
| 1B2c | 0.0575 | 0.0612 | 0.0639 | 0.0693 | 0.0716 | 0.0750 | 0.0688 | 0.0944 |
| 2G | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 3F | 0.0173 | 0.0168 | 0.0176 | 0.0176 | 0.0152 | 0.0137 | 0.0124 | 0.0113 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5C1biii | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| 5C2 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| TOTAL | 31.9181 | 32.7839 | 37.6128 | 39.9065 | 41.8535 | 39.6264 | 41.6308 | 43.9785 |

| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 32.5070 | 34.3284 | 32.7969 | 29.8277 | 30.3351 | 32.8993 | 31.3996 | 34.0730 |
| 1A1b | 0.7500 | 0.8500 | 0.6600 | 0.9800 | 1.0600 | 0.7200 | 0.3200 | NO |
| 1A2a | 0.0040 | 0.0040 | 0.0040 | 0.0020 | 0.0020 | 0.0015 | 0.0010 | 0.0005 |
| 1A2b | 0.2200 | 0.2200 | 0.2200 | 0.2250 | 0.2250 | 0.2250 | 0.2250 | 0.2249 |
| 1A2c | 0.0950 | 0.1000 | 0.1050 | 0.1100 | 0.1100 | 0.1005 | 0.1000 | 0.0950 |
| 1A2d | 0.0650 | 0.0650 | 0.0675 | 0.0675 | 0.0650 | 0.0600 | 0.0600 | 0.0550 |
| 1A2e | 0.7400 | 0.7600 | 0.7800 | 0.7900 | 0.8000 | 0.8200 | 0.8300 | 0.8402 |
| 1A2f | 0.5286 | 0.5304 | 0.5468 | 0.5347 | 0.5519 | 0.5442 | 0.5873 | 0.5754 |
| 1A2gvii | 0.2552 | 0.2560 | 0.2600 | 0.2620 | 0.2630 | 0.2640 | 0.0093 | 0.0013 |
| 1A2gviii | 1.1870 | 1.1875 | 1.1880 | 1.1885 | 1.1888 | 1.1890 | 1.1895 | 1.1893 |
| 1A3ai(i) | 0.0238 | 0.0235 | 0.0231 | 0.0228 | 0.0225 | 0.0222 | 0.0219 | 0.0206 |
| 1A3aii(i) | 0.0005 | 0.0005 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0007 | 0.0017 |
| 1A3bi | 1.1727 | 1.1091 | 1.0792 | 0.9910 | 0.9993 | 0.9160 | 0.3942 | 0.0326 |
| 1A3bii | 4.0276 | 4.1651 | 3.6515 | 4.0042 | 3.6603 | 3.5085 | 1.2834 | 0.0211 |
| 1A3biii | 1.9893 | 2.0266 | 2.0131 | 2.0510 | 1.8798 | 1.8499 | 0.6798 | 0.0110 |
| 1A3biv | 0.0167 | 0.0156 | 0.0139 | 0.0137 | 0.0127 | 0.0096 | 0.0042 | 0.0006 |
| 1A3dii | 0.0044 | 0.0049 | 0.0021 | 0.0017 | 0.0022 | 0.0017 | 0.0024 | 0.0029 |
| 1A4bi | 2.3457 | 2.4304 | 2.4883 | 2.5126 | 2.6094 | 2.4990 | 2.4356 | 0.5662 |
| 1A4ci | 0.4078 | 0.4225 | 0.4326 | 0.4368 | 0.4537 | 0.4345 | 0.3789 | 0.0787 |
| 1A4cii | 0.2039 | 0.2113 | 0.2163 | 0.2184 | 0.2268 | 0.2172 | 0.1794 | 0.0357 |
| 1A4ciii | 0.0152 | 0.0156 | 0.0161 | 0.0163 | 0.0156 | 0.0161 | 0.0145 | 0.0123 |
| 1B2aiv | 0.6714 | 0.7314 | 0.7274 | 0.7167 | 0.6735 | 0.6015 | 0.1729 | NO |
| 1B2c | 0.0980 | 0.1068 | 0.1062 | 0.1046 | 0.0983 | 0.0878 | 0.0252 | NO |
| 2G | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 3F | 0.0106 | 0.0097 | 0.0077 | 0.0076 | 0.0071 | 0.0076 | 0.0060 | 0.0047 |
| 5C1biii | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0001 | NO | NO |
| 5C2 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| TOTAL | 47.3398 | 49.5748 | 47.4071 | 45.0860 | 45.2632 | 46.9960 | 40.3208 | 37.8427 |

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 27.5192 | 25.5145 | 20.5216 | 16.0816 | 20.3445 | 19.3755 | 14.7525 | 12.0961 |
| 1A1b | NO | NO | NO | NO | NO | NO | NO | NO |
| 1A2a | NO | NO | 0.0080 | 0.0075 | 0.0099 | 0.0091 | NO | NO |
| 1A2b | 0.2247 | 0.2250 | 0.0878 | 0.0552 | 0.0560 | 0.0671 | 0.0386 | 0.0630 |
| 1A2c | 0.0945 | 0.0720 | 0.0175 | 0.0283 | 0.0379 | 0.0520 | 0.0425 | 0.0257 |
| 1A2d | 0.0533 | 0.0457 | 0.0213 | 0.0196 | 0.0191 | 0.0176 | 0.0177 | 0.0192 |
| 1A2e | 0.8502 | 0.8639 | 0.3339 | 0.3271 | 0.3194 | 0.3332 | 0.3508 | 0.3185 |
| 1A2f | 0.6002 | 0.5908 | 0.7006 | 0.6364 | 0.6065 | 0.5148 | 0.4625 | 0.6377 |
| 1A2gvii | 0.0013 | 0.0013 | 0.0011 | 0.0002 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |
| 1A2gviii | 1.1906 | 1.1581 | 0.1244 | 0.0817 | 0.0643 | 0.0634 | 0.0613 | 0.0612 |
| 1A3ai(i) | 0.0204 | 0.0207 | 0.0211 | 0.0201 | 0.0218 | 0.0220 | 0.0214 | 0.0197 |
| 1A3aii(i) | 0.0014 | 0.0013 | 0.0012 | 0.0011 | 0.0010 | 0.0003 | 0.0002 | 0.0000 |
| 1A3bi | 0.0344 | 0.0373 | 0.0398 | 0.0082 | 0.0083 | 0.0083 | 0.0080 | 0.0075 |
| 1A3bii | 0.0195 | 0.0191 | 0.0185 | 0.0036 | 0.0036 | 0.0034 | 0.0029 | 0.0025 |
| 1A3biii | 0.0105 | 0.0122 | 0.0116 | 0.0023 | 0.0023 | 0.0022 | 0.0019 | 0.0016 |
| 1A3biv | 0.0006 | 0.0008 | 0.0008 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 1A3dii | 0.0022 | 0.0025 | 0.0015 | 0.0030 | 0.0019 | 0.0018 | 0.0013 | 0.0010 |
| 1A4bi | 0.5654 | 0.4904 | 0.2687 | 0.2636 | 0.2183 | 0.2416 | 0.2371 | 0.1936 |
| 1A4ci | 0.0803 | 0.0736 | 0.0356 | 0.0320 | 0.0315 | 0.0326 | 0.0312 | 0.0307 |
| 1A4cii | 0.0354 | 0.0367 | 0.0178 | 0.0160 | 0.0157 | 0.0163 | 0.0156 | 0.0154 |
| 1A4ciii | 0.0119 | 0.0122 | 0.0060 | 0.0080 | 0.0080 | 0.0060 | 0.0060 | 0.0040 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | 0.0001 |
| 2G | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0000 |
| 3F | 0.0036 | 0.0020 | 0.0012 | 0.0009 | 0.0010 | 0.0011 | 0.0011 | 0.0009 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| TOTAL | 31.3198 | 29.1801 | 22.2402 | 17.5964 | 21.7717 | 20.7689 | 16.0531 | 13.4987 |

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 15.0454 | 11.3598 | 14.5972 | 14.7243 | 15.3730 | 14.1945 | 10.0698 | 8.4090 |
| 1A1b | NO | NO | NO | NO | NO | NO | NO | NO |
| 1A2a | 0.0001 | NO | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 1A2b | 0.0902 | 0.0374 | 0.0221 | 0.0388 | 0.0255 | 0.0298 | 0.0242 | 0.0211 |
| 1A2c | 0.0381 | 0.0326 | 0.0371 | 0.0354 | 0.0358 | 0.0435 | 0.0467 | 0.0631 |
| 1A2d | 0.0198 | 0.0164 | 0.0168 | 0.0142 | 0.0163 | 0.0144 | 0.0178 | 0.0071 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A2e | 0.4268 | 0.3512 | 0.3781 | 0.3850 | 0.3558 | 0.4239 | 0.4109 | 0.4216 |
| 1A2f | 0.7607 | 0.7272 | 0.6809 | 0.7191 | 0.6656 | 0.6365 | 0.6610 | 0.6948 |
| 1A2gvii | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 1A2gviii | 0.0476 | 0.04226 | 0.04684 | 0.06415 | 0.18627 | 0.21868 | 0.06516 | 0.11784 |
| 1A3ai(i) | 0.0200 | 0.0201 | 0.0233 | 0.0268 | 0.0281 | 0.0275 | 0.0090 | 0.0145 |
| 1A3aii(i) | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1A3bi | 0.0075 | 0.0077 | 0.0082 | 0.0086 | 0.0087 | 0.0085 | 0.0080 | 0.0086 |
| 1A3bii | 0.0023 | 0.0025 | 0.0027 | 0.0027 | 0.0028 | 0.0023 | 0.0025 | 0.0026 |
| 1A3biii | 0.0014 | 0.0015 | 0.0016 | 0.0017 | 0.0014 | 0.0022 | 0.0015 | 0.0015 |
| 1A3biv | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| 1A3dii | 0.0011 | 0.0013 | 0.0009 | 0.0014 | 0.0013 | 0.0018 | 0.0008 | 0.0017 |
| 1A4bi | 0.1586 | 0.1938 | 0.2104 | 0.2082 | 0.1961 | 0.2180 | 0.2020 | 0.1713 |
| 1A4ci | 0.0283 | 0.0312 | 0.0305 | 0.0320 | 0.0298 | 0.0317 | 0.0324 | 0.0303 |
| 1A4cii | 0.0141 | 0.0156 | 0.0152 | 0.0160 | 0.0149 | 0.0158 | 0.0162 | 0.0151 |
| 1A4ciii | 0.0040 | 0.0040 | 0.0040 | 0.0037 | 0.0036 | 0.0038 | 0.0030 | 0.0032 |
| 1B2aiv | NO | NO | NO | NO | NO | NO | NO | NO |
| 1B2c | NO | NO | NO | NO | NO | NO | NO | NO |
| 2G | 0.0001 | 0.00006 | 0.00007 | 0.00003 | 0.00029 | 0.00026 | 0.00010 | 0.00003 |
| 3F | 0.0008 | 0.0010 | 0.0007 | 0.0006 | 0.0007 | 0.0007 | 0.0008 | 0.0008 |
| 5C1biii | NO | NO | NO | NO | NO | NO | NO | NO |
| 5C2 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| TOTAL | 16.6673 | 12.8459 | 16.0770 | 16.2828 | 16.9461 | 15.8743 | 11.5719 | 9.9846 |

| | **2022** | **2023** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1A1a | 9.6458 | 8.4609 | | | | | | |
| 1A1b | NO | NO | | | | | | |
| 1A2a | 0.0000 | 0.0000 | | | | | | |
| 1A2b | 0.0219 | 0.0219 | | | | | | |
| 1A2c | 0.0962 | 0.0962 | | | | | | |
| 1A2d | 0.0056 | 0.0056 | | | | | | |
| 1A2e | 0.3683 | 0.3683 | | | | | | |
| 1A2f | 0.6633 | 0.7077 | | | | | | |
| 1A2gvii | 0.0001 | 0.0001 | | | | | | |
| 1A2gviii | 0.27287 | 0.27287 | | | | | | |
| 1A3ai(i) | 0.0201 | 0.0250 | | | | | | |
| 1A3aii(i) | 0.0001 | 0.0001 | | | | | | |
| 1A3bi | 0.0085 | 0.0092 | | | | | | |
| 1A3bii | 0.0025 | 0.0025 | | | | | | |
| 1A3biii | 0.0015 | 0.0013 | | | | | | |
| 1A3biv | 0.0001 | 0.0001 | | | | | | |
| 1A3dii | 0.0030 | 0.0039 | | | | | | |
| 1A4bi | 0.1858 | 0.0358 | | | | | | |
| 1A4ci | 0.0282 | 0.0249 | | | | | | |
| 1A4cii | 0.0141 | 0.0124 | | | | | | |
| 1A4ciii | 0.0033 | 0.0032 | | | | | | |
| 1B2aiv | NO | NO | | | | | | |
| 1B2c | NO | NO | | | | | | |
| 2G | 0.00006 | 0.00006 | | | | | | |
| 3F | 0.0007 | 0.0007 | | | | | | |
| 5C1biii | NO | NO | | | | | | |
| 5C2 | 0.0001 | 0.0001 | | | | | | |
| TOTAL | 11.3424 | 10.0528 | | | | | | |

# Annex 6: Implementation of recommendations and adjustments

## A6.1. EU review Process

**Table A6.1.Summary of Recommendations from the TERT and status of implementation**

| CRT category/ issue | Review recommendation | Status of implementation |
|---|---|---|
| 1A2b Non-ferrous metals | The TERT noted that Cyprus reports identical CH4 and N2O emissions for years 2022 as for year 2021 under subcategory 1.A.2.b for Biomass and Other Fossil Fuels. Please could you provide explanation for the use of identical values? In NIR (January 2024 submission) no information was provided. | Resolved in March 2024 submission |
| 1A2d Pulp, paper and print | The TERT noted that Cyprus has NO for CO2 and CH4 emissions for year 2022 under subcategory 1.A.2.d for Biomass. Please could you provide explanation for the use of NO for consumption in year 2022 while for years 2020 and 2021 you have value 0.04 TJ? | Resolved |
| 1A3b Road transportation | Follow up from previous year, CY-1A3b-2023-0004. For category 1.A.3.b.iii Heavy duty trucks and buses, Other Fossil Fuel, all gases, all years (where relevant), the TERT had noted that the notation key NO was used in the CRF tables (March 2023 submission). In response to a question raised during the 2023 review, Cyprus answered that everything is included in Cars since for this category there are not enough activity data, hence, Cyprus accepted the recommendation of the TERT to change the notation key from NO to IE. The TERT checked the January 2024 CRF tables and found that although the notation key for emission values has changed to IE, the notation key NO is still used for activity data. In order to improve the consistency of the inventory, could Cyprus please provide an explanation for the usage of the notation key NO or else change to IE similarly to emissions? | Resolved in March 2024 submission |
| 2A4 Other process uses of carbonates | We compared the information on methods and emission factors used as included in Annex IX (available on the share point) with the information included in the latest XML and identified the following differences: Method for CO2 from other process uses of carbonates in Annex IX: CS, T1; Method in the XML: CS, T2. Note that consistency of this information is important for the preparation of the EU GHG NIR because we will use the information included in the XML in the relevant tables of the EU NIR. Please correct the information on methods/emission factors in the XML file in the March submission. If the information in the XML file is already up-to-date, please submit a corrected Annex IX. You may also make updates directly in the table of methods and emission factors on the sharepoint under the following | Resolved in March 2024 submission |

| | | |
|---|---|---|
| | link: https://eea1.sharepoint.com/teams/esdreviewimprovements/EUInventoryMethodology/Shared%20Documents/Forms/AllItems.aspx?id=%2Fteams%2Fesdreviewimprovements%2FEUInventoryMethodology%2FShared%20Documents%2FAnnexes%202024 | |
| 2F1 Refrigeration and air conditioning | For Cyprus as an island, besides land based transport also maritime transport is of relevance. Are emissions from refrigeration and AC equipment on ships included in Category 2.F.1.d transport or 2.F.1.e. MACs? If so, would you please briefly explain the assumptions made for estimating emissions? | Partly resolved. investigate and report in future submissions about this issue. |
| 2F4 Aerosols | THe TERT noted that for HFC-134a emissions from MDIs, the product life factor is reported as "NE". Would you please clarify why the PLF is not reported? | Unresolved. it is in our plans in future submissions to introduce a methodology reflecting national circumstances related to estimating emissions from MDIs (2F4). |
| 2G Other product manufacture and use | The TERT noted that in Table2(II)B-Hs2 for SF6 emissions from stocks of sub category 2.G.1 Electrical equipment identical values are reported for 2021 and 2022. Would you please check and clarify? | Resolved in March 2024 submission |
| 2G Other product manufacture and use | The TERT noted that in CRF Table2(II)B-Hs2 neither emissions nor notation keys are reported for 2.G.2 (grey cells). However, it seems that emission sources might exist in Cyprus, e.g. electron microscopes and particle accelerators for cancer treatment in hospitals (https://www.cyi.ac.cy/index.php/cyi-news/state-of-the-art-scanning-electron-microscope-sem-installed-at-starc.html; https://www.goc.com.cy/en/). Such units typically contain SF6, which also leads to SF6 emissions. Would you please inform about investigations carried out regarding SF6 from other product use? | Partly resolved. Investigate and report in future submissions about this issue. |
| 3 Agriculture | We compared the information on methods and emission factors used as included in Annex IX (available on the share point) with the information included in the latest Xml and identified the following differences: 3.B.1 CH4 Emissions: Farming (CH4) - Annex IX: T2 / D ; XML: T1,T2 / D ; 3.D.1 Agricultural Soils: Direct N2O Emissions From Managed Soils (N2O) - Annex IX: T1 / D ; XML: T1,T2 / CS,D ; 3.G.1 Limestone CaCO3: Farming (CO2) - Annex IX: NA / Empty cell ; XML: NA / NA. Note that consistency of this information is important for the preparation of the EU GHG NIR because we will use the information included in the XML in the relevant tables of the EU NIR. Please correct the information on | Resolved in March 2024 submission |

| | | |
|---|---|---|
| | methods/emission factors in the XML file in the March submission. If the information in the XML file is already up-to-date, please submit a corrected Annex IX. You may also make updates directly in the table of methods and emission factors on the sharepoint under the following link: https://eea1.sharepoint.com/:x:/r/teams/esdreviewimprovements/EUInventoryMethodology/_layouts/15/Doc.aspx?sourcedoc=%7BCF27B356-D788-4C9C-966C-F10A0F5240A3%7D&file=Art11_AnnexIX_Methods%20Emission%20Factors%20and%20Methodological%20Descriptions_Autumn2023.xlsx&action=default&mobileredirect=true | |
| 3A Enteric fermentation | For CH4 emissions from category 3A1 Enteric Fermentation Dairy Cattle, the previous TERT in 2022 and 2023 recommended that Cyprus uses year specific values for the digestibility of feed in its emissions calculations or provides clear justification for the use of a constant value across the time series. During the previous review, Cyprus indicated that efforts will be made with the Department of Rural Development and the Agricultural Research Institute, in order to obtain the data. The TERT noted this year that the digestibility reported by Cyprus is still constant over time. Could you please inform how the recommendation has been treated or implemented? | Partly resolved. Investigate and report in future submissions about this issue. |
| 3D1 Direct N2O emissions from managed soils | For category 3.D.1.5 Mineralization of Soil Organic Matter, for N2O, the TERT noted that the emissions for 2022 are identical to the emissions for 2021. Could you please provide information if updated data will be included in the 15th march submission? | Resolved in March 2024 submission |
| 3D1 Direct N2O emissions from managed soils | For category 3.D.1.1 Direct N2O emissions from inorganic fertilizers and 3.D.1.2.a Direct N2O emissions from animal manure, the TERT noted that Cyprus updated the emission factor for the whole period (from 1% to 0.3%). The impact of this recalculation is above the threshold of 0.05 % of the total emissions of the country. Please could you provide information on the reason for this recalculation? | Resolved. |
| 3D2 Indirect N2O emissions from | For category 3.D.2.2 Indirect N2O from Nitrogen Leaching and Run-off, the TERT noted that the emissions for 2022 are identical to the emissions for 2021. Could you please provide information if | Resolved in March 2024 submission |

| | | |
|---|---|---|
| managed soils | updated data will be included in the 15th march submission? | |
| 4.B.1. Cropland remaining cropland | Thank you for sharing your improvement plan. It was not possible to find information on your 2025 January submission to assess the status of this partially resolved issue from 2024 QAQC (i.e. tier 1 in living biomass in perennial crops) . Could you please comment on whether the improvement plan has allowed to increase the tier methods used for the pools raised on the above mentioned observation? | Unresolved. Until now tier 1 methodology is applied. We are currently analysing different options for moving to tier 2 level. As a first step we are planning to use region-specific stock change factors in living biomass while in the long-term planning there is the development of country-specific ones. |
| LULUCF – Blank cells | Cyprus reports blank cells for the full time series in table 4, row 30 Other, table 4(I), row 68 Other, table 4(IV) for units in column E and row 72 Other. And for 2001 two blank cells in table 4A settlements converted to forests. Can you please check and add values or NKs as appropriate? | Resolved |
| 5C Incineration and open burning of waste | The TERT noted that, in CRF 5C1 – Incineration of waste, the notation key “NO” is reported whereas there is a UNFCCC observation (FCCC/ARR/2023/CYP (W.1) recommending to “estimate and report emissions from waste incineration without energy recovery”. In annex VIII, Cyprus indicated that “this will be addressed in future submissions”. As page 240 of the 2023 NIR it was indicated that “incineration […] of waste does not take place in Cyprus, could you please provide further information on waste incinerated without energy recovery (type of waste, origin, type of installation, period concerned). Moreover, could you indicate if you plan to report these emissions in your March 2024 submission? If not, please provide the reason for non-implementation, your action plan for the implementation of this improvement and a rough estimate to demonstrate that missing emissions are below the threshold of significance (0.05% of total national emissions). | Partly resolved. Investigate and report in future submissions about this issue. |
| 5C Incineration and open | The TERT noted that, in CRF 5C2 – open burning of waste, the notation key “NO” is reported with a short legal justification in the NIR 2023 (Fire Prevention of Outdoors Law of 1988 (220/1988) as | Partly resolved. Investigate and report in future submissions about this issue. |

| | | |
|---|---|---|
| burning of waste | amended by 109(I)2002 prohibits any open burning of waste). The TERT also noted that there is a UNFCCC observation (FCCC/ARR/2023/CYP (W.5)) recommending to "provide a justification for the use of this "NO" notation key in its NIR". In annex VIII, Cyprus indicated that "NIR 2024 for the March 2024 submission". Could you please confirm that the March 2024 NIR will include a justification over the complete time series and specifically will provide evidence that the Fire prevention law addresses orchard, olive and vineyard waste and domestic and municipal green waste (park and garden). | |
| 5D Wastewater treatment and discharge | The TERT noted that in CRF 5D2 – Industrial wastewater treatment, CH4 emissions reported for year 2022 are identical to the values reported for year 2021. The TERT imagines that activity data were not yet available and agrees that the impact is far below the threshold of significance. Anyway, could you please confirm that you are planning to update your 2022 estimate in your March 2024 submission? | Resolved |

## A6.2. UNFCCC/KP review Process

**Table A6.2.Summary of Recommendations from the ERT and status of implementation**

| CRT category / issue | Review recommendation | Status of implementation |
|---|---|---|
| "Uncertainty analysis<br><br>(G.11, 2022) (G.8, 2020) (G.20, 2019) (G.14, 2017) (G.6, 2016) (G.6, 2015)" | The Party included the LULUCF sector in its uncertainty analysis, associated elements being presented in NIR's Section 1.5, in Chapter 6 in the uncertainties related subsectoral sections and in Annex 2.Conduct an uncertainty analysis for LULUCF after the LULUCF reporting has been completed. | Resolved |
| 1.A Fuel combustion – sectoral approach – solid biomass – CO2, CH4 and N2O | The Party reported in NIR table 3.29 (p.96) that the apparent consumption for solid biomass in 2017 is 1,838 TJ, however it reported in CRF table 1.A(b) that the apparent consumption for solid biomass in 2017 is 1,535.59 TJ. The ERT noted that both these figures differed to the apparent consumption for solid biomass reported by the IEA in 2017 of 1,037 TJ. No further explanation has been provided in the NIR. During the review, the Party clarified that the figure reported in CRF table 1.A(b) is correct, as it is the solid biomass consumption reported by the IEA of 1,037 TJ adjusted for charcoal production (indigenous production is 73.49 TJ and the imports 390.049 TJ). The Party indicated that there is, however, an issue with the sign of | Resolved. |

| | | |
|---|---|---|
| | the stock change in the CRF table 1.A(b), which should be '+' instead of '–', and that this will be fixed in the next submissions. The Party has not reported the correct sign for the stock change in CRF table 1.A(b), and it has not reported the revised figures in table 3.29 or the impact of the correction in the NIR. Revise the estimates of CO2, CH4 and N2O emissions from solid biomass in 2017 on the basis of the correct AD and report the impact of the correction in the NIR. Revise the estimates of CO2, CH4 and N2O emissions from solid biomass in 2017 on the basis of the correct AD and report the impact of the correction in the NIR. | |
| 1.A.3.b.ii Light-duty trucks – liquid fuels – N2O | The Party reported in its NIR in section 3.2.5.1 (p. 80) that the N2O emissions from diesel consumption by light-duty trucks were estimated using the COPERT V model on the entire time-series, but did not explain how the previous recommendation has been implemented and how the N2O emissions were estimated and reported for 1990-1995 years. During the review the Party indicated that in this submission the N2O emissions from light-duty vehicles have been estimated for 1990 – 1995 period by extrapolation of the existing trend, as calculated by the COPERT V model for the rest of the time-series. The Party mentioned that there is a fault that has not yet been corrected in the COPERT V model that generated the above issue for the 1990-1995 period and that it will provide the necessary explanation in the next NIR, if the COPERT issue will persist. The Party did not explain how it has estimated its N2O emissions from diesel consumption by light-duty trucks for 1990–1995 in the NIR. Correct the estimates of N2O emissions from diesel consumption by light-duty trucks for 1990–1999. | Resolved. |
| 1.A.3.d Domestic navigation – liquid fuels – CO2, CH4 and N2O | The Party reported in its NIR (Domestic water-borne navigation in section 3.2.5.2, p.85) that the fuel consumption for the period 1990-1997 was estimated assuming that the contribution of domestic water-borne navigation activities to road transport remained the same as 1998 (0.33 per cent). During the review, the Party clarified that there was no update on the status of this recommendation since no further data was obtained. Also, the Party clarified that in the energy balance, only one value was available for total transport (equal to the road transport one) without breakdown, and that total was excluding international navigation. That is why, before 1998, the consumption of domestic navigation was calculated with the contribution to road transport (equal to total transport due to the lack of disaggregated data). Regarding the emissions | Resolved. COPERT produced emissions for the entire timeseries of N2O from light-duty trucks running on diesel. |

| | | |
|---|---|---|
| | for the period 1990-1997 the ERT considers the issue is resolved as no further data was obtained and recalculations are not needed as they wouldn't have significant impacts. The rationale of using the contribution of domestic navigation to road transport is not clear enough. The ERT suggest that including in the NIR the clarification that road transport equals to total transport due to the lack of breakdown would fully resolve this issue. Report in the NIR on any progress achieved in improving the consistency of the time series. | |
| 1.A Fuel combustion – sectoral approach – biomass, other fossil fuels – CO2, CH4, N2O | "The Party reported in its NIR (section 3.2) that biodiesel consumption has been reported for the first time with data included for the years 2020 and 2021. The ERT noted that the Party provided that the emissions from biodiesel have been calculated for both fossil and biogenic parts, and that this is achieved in the sectoral approach energy CRF tables through use of the "biomass" and "other fossil fuels" sub-categories, however the methodology for splitting the biodiesel AD between fossil and biogenic parts was not clear in the NIR. The ERT also noted that where the Party has included AD in the ""other fossil fuels" category of the sectoral approach energy CRF tables the accompanying notes did not clearly specify the cases where the AD relates to the fossil component of biodiesel. | Resolved. The clarification that ERT suggested be added in the NIR has been included. |
| 1.A Fuel combustion – sectoral approach – biomass, other fossil fuels – CO2 | During the review, the Party clarified that it has assessed the origins of all biofuels to separate fossil and biogenic feedstocks in line with the 2006 IPCC guidelines. The fuels used to replace biodiesel include hydrotreated vegetable oil (HVO) and fatty acid methyl esters (FAME). The Party provided that HVO is produced through the hydro-treatment of the triglyceride-containing feedstocks (vegetable oil or animal fat) therefore it is 100% biogenic, and that FAME is produced by reacting animal fats with methanol therefore it contains both biogenic origin (animal fats) and fossil origin (methanol) parts. The Party provided that it uses country specific information where available to separate the HVO and FAME quantities, determine the total carbon content of the FAME, then separate the biogenic and fossil carbon components of the FAME. | Resolved. A note has been added to the attachment in the intro of energy sector of the NIR. |
| 1.A.2.d Pulp, paper and print – biomass, other fossil fuels CH4 | Update the NIR with information about the method that has been used to split the reporting of biofuel AD between fossil and biogenic parts. This could be achieved by attaching the document provided to the ERT during the review titled "Note on fossil carbon content in fuels" to the NIR and referring to it in each section of the | Resolved |

| | | |
|---|---|---|
| | NIR where the use of biofuels is described. Update the notes in the sectoral approach energy CRF tables in cases where the “other fossil fuels” category has been used for biofuels to clearly specify that the AD is for the fossil component of biofuels." | |
| 1.A Fuel combustion – sectoral approach – biomass, other fossil fuels – CH4,and N2O | "The Party reported in its NIR (section 3.2) that biodiesel consumption has been reported for the first time with data included for the years 2020 and 2021. The ERT noted that the Party provided that the emissions from biodiesel have been calculated for both fossil and biogenic parts, and that this is achieved in the sectoral approach energy CRF tables through use of the “biomass” and “other fossil fuels” sub-categories. The ERT additionally noted that some sub-categories in CRF Table 1.A(a) (sheet 2) and CRF Table 1.A(a) (sheet3) for the years 2020 and 2021 appear to primarily relate to biodiesel however have CO2 IEF values that are outside of the lower and upper limits provided by the IPCC Guidelines for biodiesel (70.8 – 84.3 tCO2/TJ): 1.A.2.g.i manufacturing of machinery (in 2021 “other fossil fuels” is 25.14 tCO2/TJ and “biomass” is 53.10 tCO2/TJ; and in 2020 the “other fossil fuels” is 42.15 tCO2/TJ and “biomass is 89.02 tCO2/TJ), 1.A.2.g.iii mining (excluding fuels) and quarrying (in 2021 “other fossil fuels” is 22.47 tCO2/TJ and “biomass” is 47.46 tCO2/TJ, and in 2020 “other fossil fuels” is 13.44 tCO2/TJ and “biomass” is 28.38 tCO2/TJ), 1.A.2.g.iv wood and wood products (in 2021 “other fossil fuels” is 5,505.51 tCO2/TJ and “biomass” is 11,627.91 tCO2/TJ, and in 2020 “other fossil fuels is 4,004 tCO2/TJ and “biomass” is 8,456.66 tCO2/TJ), 1.A.2.g.vi. textile and leather (in 2021 there is no data, in 2020 “other fossil fuels” is 4,004 tCO2/TJ, and “biomass” is 8,456.66 tCO2/TJ), and 1.A.3.d. domestic navigation (in 2021 “biomass” is 155.04 tCO2/TJ, and in 2020 “biomass” is 248.73 tCO2/TJ). | Resolved |
| 1.A.2.a Iron and steel – all fuels – CO2, CH4, N2O | During the review, the Party clarified that incorrect EF values have been used, leading to an overestimation in emissions, and these will be corrected in the next submission. The Party has advised that it calculates CO2 emissions for biodiesel using a carbon content factor that it has determined based upon the composition of FAME in Cyprus (the carbon content factor is 76.5%, with the fossil part of the resulting carbon content being 5.4%). | Resolved |
| 1.A.2.g Other (manufacturing industries and construction) – | Update the CO2 EF values used to estimate the CO2 emissions for biodiesel in CRF Table 1.A(a) | Resolved |

| | | |
|---|---|---|
| liquid fuels – $CO_2$, $CH_4$, $N_2O$ | (sheet 2) and CRF Table 1.A(a) (sheet3) for the years 2020 and 2021 and include the related information in the next NIR." | |
| 1.A.3.b Road transportation – gas diesel oil – $CO_2$, $N_2O$ and $CH_4$ | "The Party reported in its NIR (section 3.2) that biodiesel consumption has been reported for the first time with data included for the years 2020 and 2021, and that $CH_4$ emissions have been calculated using the EFs provided by the 2006 IPCC Guidelines. The ERT noted that the Party provided that the emissions from biodiesel have been calculated for both fossil and biogenic parts, and that this is achieved in the sectoral approach energy CRF tables through use of the “biomass” and “other fossil fuels” sub-categories. The ERT additionally noted that the category 1.A.2.d pulp, paper and print in CRF Table 1.A(a) (sheet 2) for the years 2020 and 2021 appears to primarily relate to biodiesel however has a $CH_4$ IEF value (0.22 kg $CH_4$/TJ) below the lower limit provided by the IPCC Guidelines for biodiesel (1 kg $CH_4$/TJ). | Resolved |
| 1.B.2.a Oil – secondary liquid fuels $CO_2$ and $CH_4$ | During the review, the Party clarified that an incorrect EF value has been used, however the impact is insignificant, and this will be corrected in the next submission. | Resolved |
| 1.B.2.a Oil –and 1.B.2.b Natural Gas -$CO_2$, $CH_4$, $N_2O$ | Update the $CH_4$ EF value used to estimate the $CH_4$ emissions for the category 1.A.2.d pulp, paper and print in CRF Table 1.A(a) (sheet 2) for the years 2020 and 2021 in line with the 2006 IPCC GL and include the related information in the next NIR." | With the EUROCONTROL data, it should be possible to have a TIER 2 metohodolgy. This will be implemented for the 2025 submission |
| 1.B.2.a Oil –and 1.B.2.b Natural Gas -$CO_2$, $CH_4$, $N_2O$ | "The Party reported in its NIR (section 3.2) that biodiesel consumption has been reported for the first time with data included for the years 2020 and 2021, and that $CH_4$ and $N_2O$ emissions have been calculated using the EFs provided by the 2006 IPCC Guidelines. The ERT noted that the Party provided that the emissions from biodiesel have been calculated for both fossil and biogenic parts, and that this is achieved in the sectoral approach energy CRF tables through use of the “biomass” and “other fossil fuels” sub-categories. The ERT additionally noted that the $CH_4$ and $N_2O$ EF values reported for biodiesel in the NIR (3.8 kg $CH_4$/TJ and 5.7 kg $N_2O$/TJ) appear to corresponded to the EF values listed for motor gasoline (mobile combustion) in the 2006 IPCC GL (vol. 2, chap. 3, table 3.2.2, p.21). The ERT also noted that these EF values appear to have been used in CRF Table 1.A(a) (sheet 2) for the | This will be addressed in future submissions |

| | | |
|---|---|---|
| | years 2020 and 2021 for the stationary combustion categories 1.A.2.b non-ferrous metals, 1.A.2.c chemicals, 1.A.2.d pulp, paper and print, 1.A.2.e food processing, beverages and tobacco, 1.A.2.f non-metallic minerals, 1.A.2.g.i manufacturing of machinery, 1.A.2.g.ii manufacturing of transport equipment, 1.A.2.g.iii mining (excluding fuels) and quarrying, 1.A.2.g.iv wood and wood products, 1.A.2.g.vi textile and leather, 1.A.2.g.viii other, and in CRF Table 1.A(a) (sheet 3) for the years 2020 and 2021 for the mobile combustion categories 1.A.3.b road transportation and 1.A.3.d domestic navigation. | |
| 2. General (IPPU) – all gases | During the review, the Party clarified that the motor gasoline (mobile combustion) EF values has been incorrectly used instead of those corresponding to biodiesel to calculate CH4 and N2O emissions for biodiesel in CRF Table 1.A(a) (sheet 2) and CRF Table 1.A(a) (sheet 3) for the years 2020 and 2021, leading to an overestimation in emissions, and this will be corrected in the next submission. | This will be addressed in future submissions |
| 2.G Other product manufacture and use – N2O and SF6 | Update the CH4 and N2O EF values used to estimate the CH4 and N2O emissions for biodiesel in CRF Table 1.A(a) (sheet 2) and CRF Table 1.A(a) (sheet 3) for the years 2020 and 2021 in line with the relevant stationary or mobile combustion chapter of the 2006 IPCC GL and include the related information in the next NIR. At a minimum the information in the NIR should specify where the EF values have been sourced from (for example the 2006 IPCC GL source table), and in cases where there is not default value available for biodiesel, the fuel type that has been used as a substitute." | Resolved |
| 2.A.1 Cement production – CO2 | "The Party reported its NIR that the emissions for sub-category 1.A.2.a. iron and steel are included in sub-category 1.A.2.b non-ferrous metals for the years 1990–2018 and included in 1.A.2.a. iron and steel for the years 2019 – 2021. The ERT noted that this is not in accordance with the UNFCCC reporting guidelines, which provide that recalculations should ensure the consistency of the time series and shall be carried out to improve accuracy and/or completeness. The ERT also noted that for 2019 the Party reports in the NIR (table 3.3, p. 64) the notation key “IE” which is inconsistent with what the Party reports in the CRF Table 1.A(a) (sheet 2). | Resolved |

| | | |
|---|---|---|
| 2.A.4 Other process uses of carbonates – CO2 | During the review, the Party clarified that separate data for the years 1990–2018 is not available, however further analysis could be undertaken to see the share of each sub-category compared to their total and recalculate emissions separately using the share and a trend. | Partially resolved |
| 3.A Enteric fermentation – CH4 | Review and select an appropriate approach from the 2006 IPCC guidelines to recalculate the emissions for historical years where no separate AD is available and include the related information in the next NIR." | Partially resolved |
| 3.D.a.2.c Other organic fertilizers applied to soils – N2O | "The ERT noted that that there is no clear information in the NIR regarding the recalculations that have occurred between the 2022 and 2023 submissions in the category 1.A.2 manufacturing industries and construction for the years 1990–2004. | Further improvements in future submissions. No data for now to apply a TIER 2 methodology on certain identified key categories |
| 3.A.1 Cattle – CH4 | During the review, the Party clarified that the recalculation was due to the correction of a mistake detected after the 2022 submission in the AD of the diesel consumption for the sub-category 1.A.2.g.iii mining (excluding fuels) and quarrying for the years 1990–2004. The Party informed the ERT that the impact is significant for the emissions from the diesel consumption for this sub-category only, and these recalculations will be described in the next NIR. | Resolved |
| 3.D.b.1 Atmospheric deposition – N2O | Explain the rationale and the impact of the recalculations for the sub-category 1.A.2.g.iii mining (excluding fuels) and quarrying for the years 1990–2004 in the next NIR." | Resolved |
| 5.C.1 Waste incineration – CO2, CH4 and N2O | "The ERT noted that the Party did recalculations for diesel emissions from the transport sector for the categories: 1.A.3.b.i cars, 1.A.3.b.ii light duty trucks and 1.A.3.b.iii heavy duty trucks and busses and the gases CO2, N2O and CH4 for the years 1990 –2021. The ERT also noted that to an extent in 1994, CH4 emissions in NIR 2023 were lower than the NIR 2022 by 55%. In Section 3.2 and Chapter 10 of the NIR 2023, there is no explanation of why the recalculations were done. This is not in accordance with the 2006 IPCC Guidelines (vol. 1, chap. 5, Section 5.2.1) and the UNFCCC reporting guidelines paragraph 17, according to which the Parties need to provide transparent explanations regarding the performed recalculations and their impact on the GHG | Resolved |

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| | emissions. The ERT also noted that the 1.A.3.b road transportation is a key category. | |
| 5.D Wastewater treatment and discharge – CH4 | During the review, the Party clarified that it continually does activity data refinement or error correction as it receives activity data for COPERT model from diverse sources to derive the vehicle fleets. | This will be addressed in future submissions. A note is added to NIR2024. |
| 5.D.1 Domestic wastewater – CH4 and N2O | Provide detailed explanation regarding the performed recalculations, following guidance given in 2006 IPCC Guidelines (Chapter 5, Section 5.2.1), in its next NIR." | Resolved. |
| 5.B Biological treatment of solid waste – CH4 | "1.A.3.A - Domestic (civil) aviation (for CO2 emissions) is identified as a key category by trend in the 2021 inventory and it is estimated using Tier 1 method. The ERT noted that this is not in accordance with 2006 IPCC Guidelines of using higher-tier method for key categories. In the NIR, page 81, it is stated that it is currently not possible to move to higher Tier and that it will be assessed again for future submissions. | Resolved. |
| 5.C.2 Open burning of waste – CO2 | During the review process, the Party clarified that these emissions were calculated using EUROCONTROL data and that there was no more detailed data available. | Further improvements in future submissions. No data for now to apply a TIER 2 methodology on certain identified key categories |
| 5.D Wastewater treatment and discharge – CH4 | Understanding that EUROCONTROL information should allow the use of higher-tier methods and considering that 1.A.3.A - Domestic (civil) aviation (for CO2 emissions) is a key category, make further efforts in order to apply a Tier 2 estimation." | Resolved. |
| 5.D.2 Industrial wastewater – CH4 | "The Party reported in section 3.2.3.2 of its NIR (p. 70) that oil and gas extraction have taken place since 2020, however in section 3.3 (p. 100) it states that no primary production of fuels or processing takes place in Cyprus and therefore NO is used in the CRF table 1.B.2 for categories 1.B.2.a oil and 1.B.2.b natural gas for "exploration" and "production". The ERT noted that this is not in accordance with the 2006 IPCC Guidelines (vol. 2, chap. 4), because all exploration or extraction activities are associated with fugitive emissions and the notation key NO | Resolved. |

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| | means that an activity or process does not exist within a country (vol. 1, chap. 8, table 8.1). | |
| 4. General (LULUCF) | Report the areas converted to a different land use under the relevant land-use conversion category for 20 consecutive years before reporting them under the corresponding land remaining category. | Resolved |
| 4. General (LULUCF) – CO2, CH4 and N2O | Report "NO" for any category, pool and/or gas for which there is information confirming that it does not occur, and provide such information in the NIR, and report "NE" for categories, pools and/or gases for which there is no information on emissions or removals or for which net emissions or removals are negligible. | Resolved |
| 4. General (LULUCF) – CO2, CH4 and N2O | Report all mandatory carbon pools | Resolved |
| 4.A Forest land – CO2 | Revise the reporting of the area of settlements converted to forest land and ensure consistency among the areas reported in the NIR, CRF table 4.1 and CRF table 4.A. | Resolved |
| 4.A Forest land – CO2, CH4 and N2O | Include in the next submission AD for forest fires and any other coefficients and parameters used in calculating forest fire emissions. | Resolved |
| 4.B.1 Cropland remaining cropland – CO2 | Assume that the growth and harvest of orchards in the country cancel each other out and therefore carbon stocks for living biomass are in equilibrium, and report "NA" in CRF table 4.B. | Resolved |
| 4.B.1 Cropland remaining cropland – CO2 | Correct the errors in NIR table 6.9 (p.193) | Resolved |
| 4.C.1 Grassland remaining grassland – CO2 | Assume that the growth and harvest of woody grassland in the country cancel each other out and therefore carbon stocks for living biomass are in equilibrium, and report "NA" in CRF table 4.C. | Resolved |
| 4.D.2.2 Land converted to flooded land – CO2 | Report only emissions for newly constructed dams and flooded mines and construction sites, attributable to instantaneous oxidation of biomass for the year of conversion | Resolved |
| 4(V) Biomass burning – CO2, CH4 and N2O | Provide the missing estimates of emissions from forest fires for land converted to forest land for 2011 | Resolved |

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| 4(V) Biomass burning – CO2, N2O and CH4 | Estimate and report wildfire emissions under the category for the land use on which they occur, noting that (1) data from the Department of Forests should be used to assign wildfires to forest land and grassland, (2) once the Party obtains data on the total area affected by wildfires, it should be able to deduce the areas affected by wildfires on land other than forest land and grassland and (3) default IPCC parameters from the 2019 Refinement to the 2006 IPCC Guidelines (vol. 4, tables 2.5–2.6) should be applied to estimate emissions from wildfires on cropland. | It will be resolved in future submissions |
| 4.B.1 Cropland remaining cropland – CO2 | Either implement its improvement plan and apply higher-tier methods using country-specific or regional-specific data for estimating emissions/removals from biomass on woody cropland remaining woody cropland or explain in its next NIR why it was unable to do so, and in that case report woody cropland as a subcategory of cropland (alongside annual cropland) | It will be resolved in future submissions |

# Annex 7: Key actions of the National Inventory Improvement Plan

Table A7.1 presents the key actions identified for the improvement of the national inventory, after the preparation of the 2024 submission.

**Table A7.1.Key actions of the National Inventory Improvement Plan**

| | **Description** | **Planned Implementation** |
|---|---|---|
| **General** | | |
| 1 | Improve QA/QC plan | Continuous |
| 2 | Improve implementation of QA/QC procedures | Continuous |
| 3 | Improve descriptive information in NID (e.g. inter-annual variations) to improve transparency | Continuous |
| 4 | Implement Tier 2 methodologies for key categories | Continuous |
| **Sector 1. Energy** | | |
| 1 | 1.A.3.b Road transportation: Development of country-specific EFs | To be assessed for 2025 submission |
| **Sector 2. IPPU** | | |
| 1 | 2.F Product uses as substitutes for ozone depleting substances: Continue efforts to collect AD and report emissions fully in accordance with the 2006 IPCC Guidelines - Emissions from blowing agents (2.F.2), fire protection (2.F.3) and aerosols (2.F.4) | Collection of the necessary data is ongoing. Further improvements in future submissions |
| 2 | 2.G. SF6 and PFCs from other product use: Explore whether SF6 is used in particle accelerators (used e.g. in hospitals for cancer treatment, research) and PFCs and SF6 are used in naval and military applications. | Further improvements in future submissions. |
| **Sector 3. Agriculture** | | |
| 1 | 3A. Improvement of DE time series for the improvement of estimation of $CH_4$ emissions from enteric fermentation dairy cattle. | In view of the difficulty to find reasonably good data on time series for feeding plans and in the absence of historical data, we in future submissions to explore some modelling approach which could be used to derive DE |

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| | | from other related variables. |
| 2 | 3A. Enhance data collection to apply Tier 2 methodology in the estimation of the identified key categories, i.e., methane emissions from enteric fermentation from non-dairy cattle. | Further improvements in future submissions. |
| 3. | 3D. Implement a tier 2 methodology to estimate emissions for categories 3.D.a.1 and 3.D.A.2 considering desk studies or expert judgment as alternatives given in the national circumstances. | In progress. |
| **Sector 5. Waste** | | |
| 1 | 5.D Wastewater treatment and discharge: Move to higher-tier methods | Further improvements in future submissions |

# References

All references used in the national inventory report are presented as footnotes to the text.