NATIONAL GREENHOUSE GAS EMISSIONS AND REMOVALS INVENTORY FOR MALTA - 2017

ANNUAL REPORT FOR SUBMISSION UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE AND THE EUROPEAN UNION MONITORING MECHANISM

The Malta Resources Authority
on behalf of the
Ministry for Sustainable Development, the Environment and Climate Change

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PREFACE

This report, being Malta's submission pursuant to Article 7 of the European Union's Monitoring Mechanism[1], contains national estimates of greenhouse gas emissions from sources and removals by sinks for the period 1990-2015, and information on the methods and approaches used to produce the estimates. The report is prepared in accordance with Decision 24/CP.19[2] and follows the structure outlined in the Appendix to Annex I[3] to Decision 24/CP.19.

The Climate Change Unit of the Malta Resources Authority compiles the Greenhouse Gas Inventory. The GHG Inventory is compiled mainly according to 2006 IPCC Guidelines and the Good Practice Guidance; however, in some exceptional cases, the 1996 Revised Guidelines may have been used. Each year the inventory is updated to include the latest data available. Methodological changes are made to take account of new data sources, new guidance from IPCC or other specific issues.

[1] 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. OJ L 165, 18.6.2013.

[2] FCCC Decision 24/CP.19: Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention. FCCC/CP/2013/10/Add.3, 31 January 2014.

[3] Annex I to FCCC Decision 24/CP.19: 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. FCCC/CP/2013/10/Add.3, 31 January 2014.

EXECUTIVE SUMMARY

ES.1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES AND CLIMATE CHANGE

The recognition that "*climate change is a common concern of mankind*[4]" and the acknowledgment that "*necessary and timely action should be taken to deal with climate change within a global framework*"[5] led to the adoption of the United Nations Framework Convention on Climate Change in 1992. A few years later saw the adoption of the Kyoto Protocol to the Convention, this protocol eventually coming into force in 2005.

The Convention and the Protocol together provide a basis for action on climate change on two main fronts: mitigation of climate change through the limitation or reduction of greenhouse gas emissions from anthropogenic activities, and adaptation to the climatic changes that have and will continue to occur in view of the accumulated greenhouse gases in the atmosphere.

Malta ratified the UNFCCC on 17th March 1994, originally as a non-Annex I party, and the Kyoto Protocol, under the same status, on 11th November 2001. The non-Annex I status meant that Malta was not set a quantified emission limitation or reduction target under the Kyoto Protocol. At the Conference of the Parties to the UNFCCC, serving as the Meeting of the Parties to the Kyoto Protocol (COP15/MOP5) held in Copenhagen in 2009, Malta made a request for its inclusion in Annex I, a request which was formally approved in 2010. The accession to Annex I status however was based on the understanding that until 2012, Malta would still not take on a quantified emission limitation or reduction target under the Protocol, a situation which changed in 2013.

Among the obligations that the Convention and the Protocol set for Parties who have ratified these instruments, the reporting of emissions of greenhouse gases by sources and removals by sinks remains a fundamental element.

The obligation to present an annual report on anthropogenic greenhouse gas emissions and removals has been translated into European Union law.

Malta's greenhouse gas inventory is compiled by the national greenhouse gas inventory team within the Climate Change Unit of the Malta Resources Authority. Overall responsibility for Malta's national greenhouse gas inventory lies with the Ministry for Sustainable Development, the Environment and Climate Change in its capacity as Single National Entity, as designated by National System for the Estimation of Anthropogenic Greenhouse Gas Emissions by Sources and Removals By Sinks Regulations of 2015.

This inventory submission contains greenhouse gas emissions and removals estimates for the period 1990 to 2015, and this written report provides the methodology underpinning the estimation of emissions and removals. This report complements the detailed data and information presented in the attached Common Reporting Format.

The inventory covers the direct greenhouse gases which currently fall within the scope of the Kyoto Protocol, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3), and the indirect greenhouse gases nitrogen oxides (NOx; reported as NO_2), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs). Sulphur dioxide (SO_2) emissions are also covered by this inventory.

[4] United Nations General Assembly Resolution 43/53; 1988.

[5] Ibid.

Sectors that either serve as sources of emissions or as sinks for removals of greenhouse gases are aggregated into the following categories:

- 1. Energy;
- 2. Industrial Processes;
- 3. Solvents and Other Products Use;
- 4. Agriculture;
- 5. Land Use, Land-Use Change and Forestry (LULUCF); and,
- 6. Waste.

Emissions from international bunkers, both aviation and marine related, are also estimated; however, these are not considered as being 'national' emissions.

This report is structured as follows, in accordance with guidelines issued by the Conference of the Parties to the UNFCCC on the general structure of national inventory reports:

- Chapter 1 provides general background information on Malta and its approach to inventory preparation;
- Chapter 2 presents and discussed main emission trends for aggregated greenhouse gas emissions and removals, by sector and by gas;
- Chapters 3 to 9 discuss the separate main source categories listed above, providing detailed information on the methodologies applied to estimate emissions and removals from the various source categories under each sector (Chapter 3: Energy; Chapter 4: Industrial Processes; Chapter 5: Solvents and Other Product Use; Chapter 6: Agriculture; Chapter 7: Land Use, Land-use Change and Forestry; Chapter 8: Waste; Chapter 9: Other Sectors);
- Additional information is provided in further chapters and annexes.

ES.2 SUMMARY OF NATIONAL EMISSION AND REMOVAL TRENDS

Table ES-1 gives an overview of total gross (without LULUCF) and net (with LULUCF) national greenhouse gas emissions and emissions disaggregated by gas. The change in total emissions between base year and the latest reported year (2015) for the without-LULUCF estimates represents a decrease of 6.53%, while for the with-LULUCF estimates this represents a decrease of 6.54%. Carbon dioxide (CO_2) maintains its standing as the gas with the highest share of total national emissions, followed by hydrofluorocarbons (HFCs) and methane (CH_4). It is worth noting the increasing trend in emissions of HFCs.

ES.3 OVERVIEW OF SOURCE AND SINK CATEGORY EMISSIONS ESTIMATES AND TRENDS

Table ES-2 presents an overview of emission and removal trends by sector. Sector Energy, which includes, among others, energy industries and road transport, remains the sector with the highest contribution to national total emissions. The sector Industrial Processes and Product Use has the second highest contribution, in recent years surpassing other sectors such as Agriculture and Waste. The increase in emissions of the sector Industrial Processes and Product Use is due primarily to the increase in emissions of HFCs, as already noted above.

Table ES-1 Greenhouse gas emissions, by gas and total gross (without LULUCF) and net (with LULUCF), for the period 1990 to 2015.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
	Gg CO_2 equivalent									
CO_2 (without LULUCF)	2,170.72	2,360.48	2,417.83	2,704.54	2,638.47	2,725.75	2,819.43	2,482.00	2,481.26	1,756.91
CO_2 (with LULUCF)	2,173.68	2,363.55	2,420.97	2,706.17	2,640.42	2,727.93	2,821.85	2,484.66	2,484.15	1,760.04
CH_4	154.96	145.49	173.85	212.91	179.58	167.53	165.34	155.34	171.53	178.01
N_2O	56.34	59.37	61.26	58.02	53.97	48.10	47.30	45.58	46.12	44.74
HFCs	NO, NE, IE, NA	0.00	6.70	41.78	145.49	169.02	201.03	216.32	230.77	247.00
PFCs	NO, NA	NO, NA	NO, NA	NO, NA	0.00	0.00	0.00	0.00	0.00	0.00
SF_6	0.01	1.44	1.47	1.56	1.69	4.59	0.45	2.68	0.58	0.19
Total (without LULUCF)	2,382.04	2,566.78	2,661.11	3018.81	3019.21	3115.01	3233.55	2901.92	2930.27	2226.87
Total (with LULUCF	2,385.00	2,569.85	2,664.26	3,020.44	3021.17	3117.19	3235.97	2904.58	2933.16	2230.00

Table ES-2 Emissions of greenhouse gases by sector for the period 1990 to 2015.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
	Gg CO_2 equivalent									
Energy	2227.95	2380.68	2430.86	2715.60	2648.46	2735.23	2829.73	2490.94	2490.95	1766.43
Industrial Processes and product use	7.94	9.47	15.20	49.48	152.17	179.02	206.76	223.85	235.45	248.39
Agriculture	77.13	72.38	75.03	74.51	68.91	66.50	67.24	66.99	66.31	65.90
LULUCF	2.96	3.07	3.15	1.63	1.96	2.18	2.43	2.66	2.90	3.13
Waste	69.02	104.24	140.02	179.22	149.66	134.26	129.82	120.13	137.55	146.14
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	2385.00	2569.85	2664.26	3020.44	3021.17	3117.19	3235.97	2904.58	2933.16	2230.00

Chapter 1. INTRODUCTION

1.1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES AND CLIMATE CHANGE

1.1.1 BACKGROUND INFORMATION ON CLIMATE CHANGE

The Earth's climate, acting over long periods of time, is a principal determinant of the landscape and living organisms. It has, for much of humankind's prehistory and history, influenced to a marked extent the relationship between human beings and their surroundings.

It is well known that the Earth's climate has changed over time. For much of the planet's lifetime, such changes were due to natural causes. However, a significantly rapid change in climatic conditions has been observed over the course of the last 200 years or so. An unprecedented global warming trend has been measured. There is now widespread consensus that its main cause is anthropogenic: that is, human activities, such as the combustion of fossil fuels, releasing large quantities of greenhouse gases into the atmosphere, and deforestation, which represents the destruction of an important sink, trees having the faculty of being able to absorb carbon dioxide from the atmosphere, this chemical species being an important greenhouse gas.

The increase in atmospheric temperature brings with it important effects on weather patterns, with different regions experiencing different impacts. While in certain areas of the world, rates of precipitation may increase, possibly leading even to severe flooding, precipitation in other regions is observed to decrease, even drastically, leading to drought conditions. Both scenarios represent concerns to humans and ecosystems. Sea level rise is caused by thermal expansion of the ocean waters and the melting of glaciers and ice caps. Low lying areas are particularly susceptible to this effect of climate change. Impacts of climate change on agriculture, water resources, health and infrastructure are also cause for concern.

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 with the objective of achieving "*stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*". The Kyoto Protocol to the Convention, adopted in 1997, was intended to make the Convention more effective by setting legally binding quantified emission limitation or reduction targets for several industrialised countries (the so-called Annex I Parties to the Convention, as opposed to the non-Annex I Parties which did not have binding emission related obligations). As the Protocol's first commitment period (2008-2012) elapsed, an extension to the Protocol was adopted until 2020. A new agreement (the so-called Paris Agreement) was adopted at the 21st Conference of the Parties held in Paris in 2015, and will replace the Kyoto Protocol after 2020.

1.1.2 BACKGROUND INFORMATION ON MALTA

Malta is a group of islands situated in the central Mediterranean, some 90 kilometres to the south of Sicily and 290 kilometres north of the African mainland. The Maltese Islands include Malta, Gozo and Comino, the three inhabited islands, Malta being the largest, Comino the smallest. Smaller uninhabited islands (Cominotto, Filfla and St Paul's Islands) and few islets are situated close to the coastline. The islands together encompass an area of 316 square kilometres with a total shoreline of 271 kilometres.

The climate is typically Mediterranean, with hot, dry summers and relatively mild winters with fluctuating rain patterns. The general trend for climatic conditions normally sees the highest mean monthly air temperature in July and August (for 2013, 26.6°C and 27.5°C respectively), with the lowest monthly mean usually observed in January and February (for 2013, 13.3°C and 12.3°C respectively). Average monthly relative humidity typically varies between 60% (in summer months) and 80% (in winter months). Average annual total rainfall for the period 2009-2013 was 557 mm.

With a population standing at 427,421 in 2015, Malta is one of the most densely populated countries in the world, with a population density of 1,353 persons/km^2. Over the past 30 years or so, the islands' small and open economy has transitioned from one originally based primarily on manufacturing activity towards a greater emphasis on high value added activities such as tourism and services. The domestic market is relatively small and the insularity inherent in a small island state offers added challenges.

Malta is not immune to the impacts of climate change, and as a small island state it can be considered as being particularly vulnerable to such impacts. Indeed, events of high temperatures in summer, resulting in heat waves, are not a rare occurrence. Precipitation rates are of concern to the country. With no indigenous sources of readily available fresh water such as lakes or rivers, Malta is limited to extraction of water from the water table, replenished through rainfall, or, as has been the case in the recent few decades, desalination of sea water, a process that whilst satisfying more than half of the potable water requirements of the country at present, is also particularly energy intensive. The impact of changing climatic conditions in other areas of the world may also be felt by Malta. Its proximity to the North African coastline could make Malta a point of transit for migrants escaping the devastation that climate change can bring about in Africa. Malta's economy being highly dependent on trade with other countries, whether it is for imports and exports, or for tourism, the vulnerability of the country to the economic impacts of climate change cannot be ignored.

1.1.3 Background information on greenhouse gas inventories

Greenhouse gas (GHG) inventories of anthropogenic emissions by sources and removals by sinks are an important tool in climate policy, especially where this relates to greenhouse gas mitigation action. The UNFCCC establishes the basic principles of greenhouse gas inventories.

Article 4 of the Convention states that:

> "*1. All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:*
>
> *(a) Develop, periodically update, publish and make available to the Conference of the Parties,* [...] *national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties*".

Article 12 continues thus:

> "*1. In accordance with Article 4, paragraph 1, each Party shall communicate to the Conference of the Parties, through the secretariat, the following elements of information:*
>
> *(a) A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties*".

The Kyoto Protocol furthermore requires Annex I Parties to:

> "*have in place* [...] *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 submission of a greenhouse gas inventory by an Annex I Party incorporates a National Inventory Report (NIR) which includes, among others, a description of the methodologies used, sources of data and the national approach to inventory compilation, accompanied by detailed quantified data on emissions and removals in Common Reporting Format (CRF) tables.

1.1.3.1 Greenhouse gases reported

Two types of greenhouse gases are reported in national greenhouse gas inventories.

Direct greenhouse gases contribute directly to climate change due to their positive radiative forcing effect; that is, their presence in the atmosphere tends to lead to an increase in atmospheric temperature. Greenhouse gas inventories cover seven categories of such gases, namely:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF_6); and,
- Nitrogen trifluoride (NF_3).

The radiative forcing effect for each greenhouse gas species is usually denoted as the Global Warming Potential (GWP). Global Warming Potentials of the direct greenhouse gases discussed in this inventory report are provided in Annex III to Decision 24/CP.19 '*Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention*'[6].

As scientific knowledge on the effect of different gases has grown, the GWPs of many greenhouse gases previously established in the 2nd Assessment Report (2AR) of the Inter-Governmental Panel on Climate Change (IPCC) were updated in the 4th Assessment Report (4AR), published in 2007. Inventory submissions up to the 2014 (covering the years 1990 to 2012) used 2AR GWP values. This inventory submission uses 4AR GWP values, in accordance with the applicable decisions taken under the UNFCCC. Historic estimates of emissions and removals for the years up to 2012 have been recalculated to consider the revised GWP values.

For purposes of aggregation of estimated emissions or removals of different greenhouse gases into a single total, and to facilitate comparison between different gases, quantities of greenhouse gases emitted or removed are often also presented in terms of 'CO_2 equivalents', whereby a quantity of a particular gas is multiplied by the GWP of that gas. Thus, 1 tonne of CH_4 can also be represented as 21 tonnes of CO_2 equivalents; 1 tonne of N_2O can be represented as 310 tonnes CO_2 equivalents, and so on.

[6] Report of the Conference of the Parties on its nineteenth session, held in Warsaw from 11 to 23 November 2013, Addendum; FCCC/CP/2013/10/Add.3.

Table 1-1 Global Warming Potentials (GWP) of direct greenhouse gases covered by this inventory report pursuant to IPCC Climate Change 2007 – The Physical Science Basis – WGI Contribution to the 4th Assessment Report

Chemical species	Chemical formula	GWP (time horizon: 100 years) based on Fourth Assessment Report
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298
Nitrogen trifluoride	NF_3	17,200
Hydrofluorocarbons:		
HFC-23	CHF_3	14,800
HFC-32	CH_2F_2	675
HFC-125	CHF_2CF_3	3,500
HFC-134a	CH_2FCF_3	1,430
HFC-143a	CH_3CF3	4,470
HFC-227ea	CF_3CHFCF_3	3,220
HFC-245fa	$CHF_2CH_2CF_3$	1,030
HFC-365mfc	$CH_3CF_2CH_2CF_3$	794
Perfluorocarbons:		
Perfluoropropane (PFC-218)	C_3F_8	8,830
Sulphur hexafluoride	SF_6	22,800

Indirect greenhouse gases, also known as precursors, do not directly induce an increase in atmospheric temperature as such; however, their release into the atmosphere results in their chemical conversion into species that have an effect similar to the direct greenhouse gases mentioned above. The indirect greenhouse gases included in national greenhouse gas inventories are:

- Nitrogen oxides (NOx; reported as NO_2);
- Carbon monoxide (CO);
- Non-methane volatile organic compounds (NMVOCs);
- Sulphur dioxide (SO_2).

This latter group of gases, albeit subject to similar reporting requirements as for the direct greenhouse gases, are not however aggregated with the direct greenhouse gases and are usually discussed separately from the direct greenhouse gases.

1.1.3.2 Sectors reported

Six main sectors of sources and sinks of greenhouse gases are covered by the national GHG inventory. Each sector is further disaggregated into categories for each of which separate estimations of emissions or removals are carried out in accordance with accepted methodologies and depending on their occurrence in the country. These sectors are:

- 1. Energy;
- 2. Industrial Processes;
- 3. Solvents and Other Products Use;
- 4. Agriculture;
- 5. Land Use, Land-Use Change and Forestry (LULUCF); and,
- 6. Waste.

Also, forming part of an inventory submission are estimates of emissions from additional categories known as 'Memo Items'. Emission estimates for these categories which include, *inter alia*, emissions from international maritime and aviation bunkering activities, are however not considered as part of 'national totals' of emissions and removals.

1.2 DESCRIPTION OF THE NATIONAL INVENTORY ARRANGEMENTS

1.2.1 INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS

A first national GHG inventory was compiled as a stand-alone exercise in the context of the preparation of Malta's First National Communication to the UNFCCC, submitted and published in 2004. At the time, Malta was a non-Annex I party to the Convention and reporting obligations were those applicable to such a status. This first inventory was carried out by a team of inventory compilers coordinated by the University of Malta.

In 2004, Malta acceded to full membership of the European Union (EU). Despite retaining the non-Annex I status under the UNFCCC, reporting obligations relating to greenhouse gas emissions and removals became more stringent, and in line with the EU's Monitoring Mechanism[7], which included the requirement to report a national GHG inventory on an annual frequency with strict timeframes, namely: the submission of a 'provisional' inventory on 15th January of each year to the European Commission, covering the time series from 1990 (as base year) to the year before last (X-2); a 'final' inventory submission by the following 15th March, that may include changes to the January submission; and the submission under the UNFCCC by 15th April.

As of 2010 Malta's status under the UNFCCC changed to that of Annex I Party, which means that reporting obligations relating to such a status became fully applicable to Malta.

The inventory reporting requirements under EU legislation, and then also under Annex I status, made it necessary to establish a process whereby annual inventory reporting could be fulfilled. The Malta Environment and Planning Authority (MEPA) was initially entrusted to take on this obligation, subsequently followed by a migration of this and other climate action responsibilities to the Malta Resources Authority (MRA) as of 2010. Thus, the Climate Change Unit at MRA is currently responsible for the preparation of the national GHG inventory, including this submission.

Political ownership and overall responsibility of the national GHG inventory is vested in the Ministry responsible for climate change policy, this being the Ministry for Sustainable Development, the Environment and Climate Change (MSDEC).

Any Annex I Party to the UNFCCC has an obligation to establish a National Greenhouse Gas Inventory System, defined by decision 19/CMP.1 "Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol" as:

> "*all institutional, legal and procedural arrangements made within a Party included in Annex I 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*."

This obligation has also been transposed into EU law.

[7] Formerly Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol; replaced by Regulation (EU) No 525/2013.

A first recommendation for the setting up of a national inventory system was made in 2005, following discussions with inventory experts from the Federal Environment Agency of Austria. This led to the recruitment of staff to work on national inventories (greenhouse gases and air quality) and the first steps towards a more structured inventory compilation process. In 2007/2008 MEPA commissioned a more in-depth assessment of inventory compilation practices in place at the time to draw up recommendations for the formal establishment of a national inventory system that would be in accordance with requirements under the Kyoto Protocol; the intention was to integrate inventory reporting relating to both climate change and air quality obligations. Unfortunately, due to several reasons, this assessment and its recommendations could not be followed-up with concrete action.

Malta's accession to Annex I status, the ratification requirements of the Doha Amendments to the Kyoto Protocol and the obligations arising from EU law make it imperative that a fully functioning national inventory system that meets the requirements of decision 19/CMP.1 is established. To this effect, the Climate Change Unit at MRA had taken the initiative, in 2013 to submit a report "Establishing a National Greenhouse Gas Inventory System for Malta"[8] to the relevant local authorities to instigate and inform the decision-making process. As a result of this initiative, the "National System for the Estimation of Anthropogenic Greenhouse Gas Emissions by Sources and Removals By Sinks Regulations of 2015" establish a national system for greenhouse gas inventories[9]. The legal notice, among other aspects, formally identifies the Minister responsible for climate change as the Single National Entity in accordance with the relevant UNFCCC requirements and provides for the formal designation of an inventory agency. Under the same legal notice, the Malta Resources Authority has been designated as the Inventory Agency. The legal notice forms part of a wider legislative framework being established specifically for climate action in Malta, with the main underpinning legal instrument being the Climate Action Act, 2015 (Chap. 543)[10].

1.2.2 Overview of inventory planning, preparation and management

The Climate Change Unit at MRA is entirely responsible for the planning, preparation and management of the national GHG inventory. Staff within the Unit perform duties related to the inventory, including: the preparation of the annual greenhouse gas inventory submission of Malta, performing most of the functions involved, starting from the gathering of data from the relevant data providers, to estimating sectoral emissions or removals of greenhouse gases; drafting of this report and the inputting of data into the CRF Reporter software; and, final submission to the European Commission, the European Environment Agency and the UNFCCC Secretariat. As necessary, the Unit also engages outside contributors to assist in the preparation of submissions.

The preparation of the annual inventory submission is spread over a whole year cycle. The conclusion of an inventory cycle, once the April submission to the UNFCCC Secretariat has been completed, is marked by an internal post-submission evaluation that identifies areas where improvements need to be carried out. The results of annual inventory peer reviews also provide valuable feedback to this evaluation. Following the evaluation process work starts on the next year's submission. In summer, communication with data providers commence, with the quantification of emissions and removals done through the months leading to December, when the drafting of the inventory report and the inputting of data into the CRF Reporter software are carried out. Following the January submission, updating of the inventory to include any additional improvements that may be required is done, prior to finalizing the submissions of March and April respectively.

The national legislation establishing a formal national inventory system provides a legal framework for the management of the inventory process. However, one must acknowledge that ongoing and

[8] Establishing a National Greenhouse Gas Inventory System for Malta; Climate Change Unit-Malta Resources Authority; 30th May 2013.

[9] Legal Notice 259 of 2015, National System For The Estimation Of Anthropogenic Greenhouse Gas Emissions By Sources And Removals By Sinks Regulations, 2015.

[10] Climate Action Act, 2015, Chapter 543; 7th July 2015.

further refinement is needed for further consolidation of the processes. This is particularly evident in respect of gathering data, where efforts continue as to establish, to the extent possible, formal channels of data gathering to ensure timely provision of reliable data. The current approach to inventory compilation may be schematically represented as in Figure 1-1.

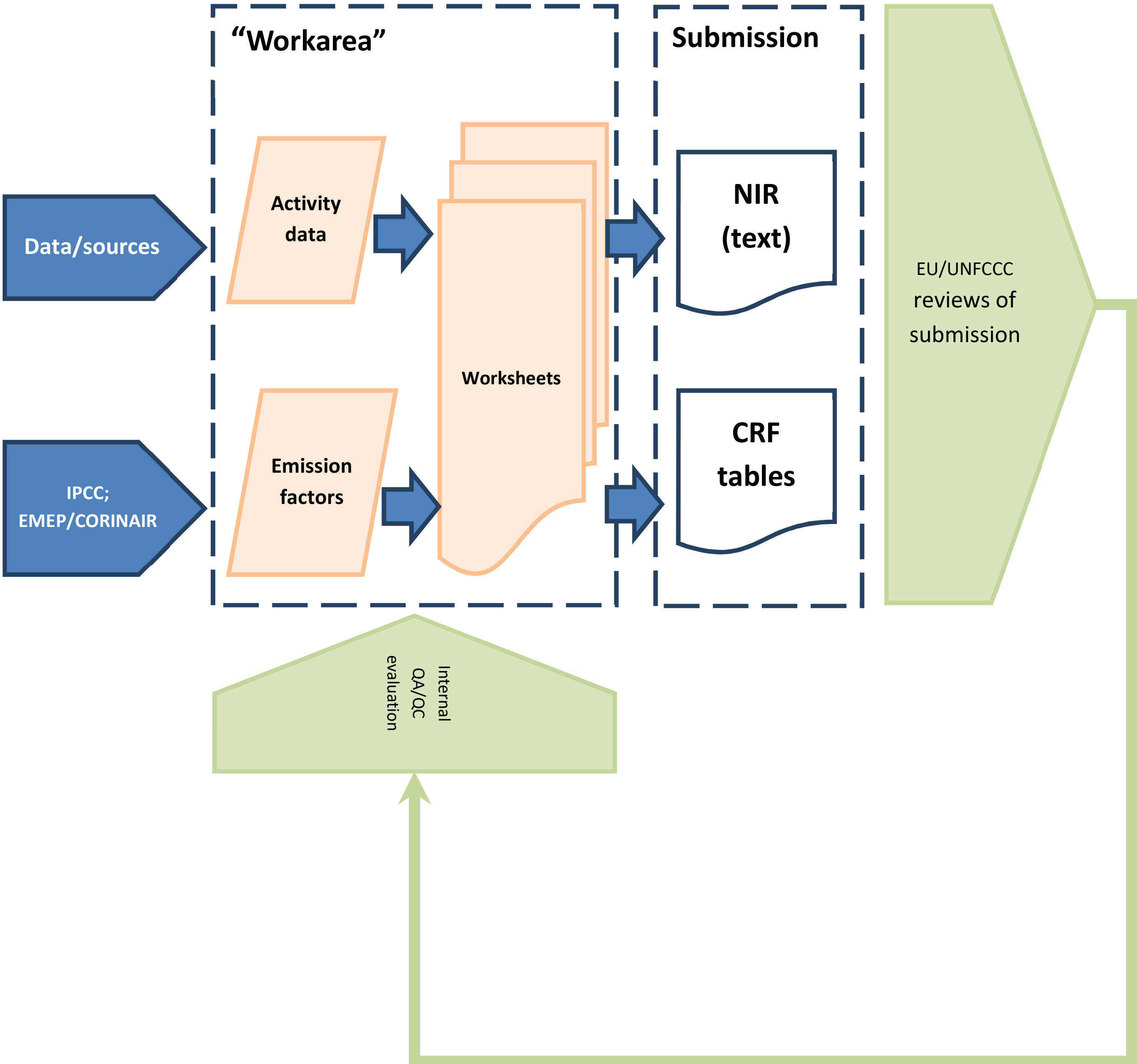

Figure 1-1 Schematic representation of the current approach to greenhouse gas inventory compilation applied by the Climate Change Unit.

1.2.3 QUALITY ASSURANCE, QUALITY CONTROL AND VERIFICATION PLAN

The inventory preparation and management process aims at ensuring the accuracy, comparability, consistency, completeness, transparency and timeliness of national inventory submissions. *"It is good practice to implement quality assurance and quality control (QA/QC) procedures in the development of national greenhouse gas inventories"*[11] to meet the listed quality criteria.

A formally documented greenhouse gas inventory QA/QC system for the inventory process is in its final stages and shall be implemented during the course of 2017. A series of operating procedures and system procedures including a Quality Manual have been set up. These procedures reflect the implementation, by the Climate Change Unit, of GHG inventory practices as established by IPCC guidelines and are also in accordance with ISO 9001:2015 and their purpose is to guide Sectoral Experts in their sectoral assessments. In addition, other quality checks are carried out yearly through two peer review processes: a peer review in-line with requirements set out in the EU's Monitoring Mechanism and a peer review under UNFCCC rules. An important deliverable from these reviews is the publication of reports highlighting those areas where the respective review teams feel that inventory compilation practices need to be further developed to ensure better-quality reporting. These review reports feed into the internal evaluations of inventory submissions performed by the inventory team itself and thus help guide the inventory team in its preparation of future submissions.

The scope of the Quality Management System (QMS) is that of applying the established requirements of the standard to operations and day-to-day processes, executed by the CCU for the overall compilation of the Greenhouse Gas Inventory. This includes all processes pertaining to the:

- Identification of Key Categories;
- Collection of Data and its Compilation;
- Mechanisms for the Estimation of Emissions and Removals;
- Completion of the National Inventory Report; and
- Approval processes applicable prior to final submission.

The QMS involves the following list of system and operating procedures (Table 1-2) which are subject to changes due to the ongoing work currently being carried out.

Table 1-2: List of System Procedures and Operational Procedures pertaining to the Quality Management System based on ISO 9001:2015.

Quality Management System	
System Procedures	**Operating Procedures**
CCU-QSP-01 Document and Data Control Procedure	CCU-QOP-01 Completion and Submission of Approximate Inventory (for submission to EC)
CCU-QSP-02 Internal Auditing Procedure	CCU-QOP-02 Identification of Key Categories
CCU-QSP-03 Treatment of Non-conformity and Risk Procedure	CCU-QOP-03 Determining Methodology Strategy for collection, processing, calculation and compilation of data
CCU-QSP-04 Training and Competency Management	CCU-QOP-04 Collection of data, estimation of emissions and removals, input to CRF and verification procedures
	CCU-QOP-05 Compilation of NIR and verification procedure
	CCU-QOP-06 Ministerial Review of NIR and CRF
	CCU-QOP-07 Submission of NIR and CRF for Review (EC & UN) and findings review

[11] Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG2000, IPCC, 2000).

The quality manual and associated procedures shall be continuously improved as part of the on-going continuous improvement process for the national GHG inventory. In view of the drive towards continuous improvement, the Quality and Procedure system shall be periodically updated to reflect changes in compiling and reporting the national GHG inventory.

The Quality and Operations Manual outlines the required checks at every stage required to finalise the National GHG Inventory. It ensures the involvement of experts on an on-going basis in an open and transparent process, using multiple reviews and open communication amongst the inventory compilers.

Several ancillary forms listed in Table 1-3 are used to document the work performed by the CCU as part of the quality operating procedures.

Table 1-3 List of QA/QC forms in use by the Climate Change Unit at MRA to document aspects of greenhouse gas inventory compilation

Name of form	Purpose
Inventory Tasks	To record the distribution of tasks related to the compilation of a year's inventory among the members of the inventory team.
Data Log	To document the collection of data used for the preparation of a year's inventory, including the source.
Emission Factors Log	To document the emission factors used in the preparation of a year's inventory, including the source.
Report Submission Log	To document the versions of reports prepared and submitted by the Climate Change Unit.
Annual Inventory Evaluation	To record findings from inventory peer reviews and/or internal evaluations and record decisions and actions taken accordingly.

1.2.4 CHANGES IN THE NATIONAL INVENTORY ARRANGEMENTS SINCE THE PREVIOUS ANNUAL GHG INVENTORY SUBMISSION

There are no changes to national inventory arrangements to report; however, it is worth to highlight ongoing efforts by the Single National Entity and the Climate Change Unit at MRA to document inventory procedures and processes.

1.3 INVENTORY PREPARATION, AND DATA COLLECTION, PROCESSING AND STORAGE

Inventory preparation starts with communication with data providers that are the source of the all-important activity data, on the basis of which sectoral emissions and removals estimates can be performed.

Receipt of activity data is logged to ensure optimal traceability. The activity data received is then assessed for its validity as an input into the emission and removals estimation process. The estimations of emissions and removals are performed using spreadsheets developed internally and specifically for the national greenhouse gas inventory process; these spreadsheets describe the calculations involved in translating activity data and calculation factors (e.g. emissions factors, oxidation factors) into reportable emission and removal values. Each inventory compiler in the national greenhouse gas inventory team is responsible for a number of sectoral categories.

Once the quantification of emissions and removals is concluded, the next phase entails the drafting of the national inventory report (this written report) and the inputting of the quantified results of the estimation of emissions and removals into the CRF Reporter software. The written report provides detailed information on the overall set-up of inventory preparation in the country, the approach used to estimate emissions and removals and other information as required by the relevant reporting rules and legislation. The CRF reporting system serves to bring together, in a sequence of detailed spreadsheets, the relevant quantitative information on emissions and removals as estimated, and activity data and calculation factors as used in the compilation of the inventory, covering the whole time series, starting from 1990 (as base year) until the last but one year from the year of submission (year X-2).

The data and spreadsheets that form the crucial basis for any inventory submission are held on secure IT systems maintained by MRA. The server handling this material is housed within the MRA offices protected with advanced antivirus and firewall systems that are updated on a regular basis. Backups are performed on a daily basis onto separate backup hard drives. Access to the folder in which the relevant inventory files are held is limited to the staff within the Climate Change Unit; access by all staff of MRA to the Authority's servers is restricted by passwords which need to be changed regularly. These features, and the fact that the server system has no direct link with the outside, not only further enhance the security of the inventory compilation process but also ensure confidentiality of inventory-related information, at least where such information is not already available in the public domain. Furthermore, all MRA staff and any contracted external experts (including any external experts contributing to the preparation of the national greenhouse gas inventory) are required to sign up to a confidentiality agreement.

Following official consideration and approval of the report and CRF tables, submissions are made to the European Commission through the EIONET web-system of the European Environment Agency and the UNFCCC Secretariat.

As already indicated above, a first submission to the European Commission is made by not later than mid-January, including both the written report and the CRF tables. It is sometimes the case that revised or previously missing data is found following this provisional submission, which justifies revisions to the estimations previously performed. There may also be instances where a change in the methodological approach is identified after the January submission which could improve the greenhouse gas inventory estimation process and which thus would also warrant an update of the inventory report and the CRF tables. Such updates[12] are often carried out during the period of weeks leading up to mid-March, when a final submission of the national inventory report and final CRF tables to the European Commission have to be submitted.

A final submission is then prepared and submitted to the UNFCCC Secretariat by mid-April. To the extent possible, this submission is maintained the same as that made in the previous March to the European Commission. There are however occasions where some amendments either to the text of the report or even changes to estimations of emissions and removals of greenhouse gases are done to ensure the continued relevance of the submission.

It is to be noted that the inventory submissions made by the European Union Member States to the European Commission serve as the basis for the latter's compilation and submission of the Union greenhouse gas inventory to the UNFCCC Secretariat, in the context of the European Union's reporting obligations as an Annex I Party in its own right to the UNFCCC and the Kyoto Protocol.

[12] The updates referred to in this instance do not relate to recalculations. Recalculations represent updates in inventory estimations taking place between one year and the other.

1.4 BRIEF GENERAL DESCRIPTION OF METHODOLOGIES (INCLUDING TIERS USED) AND DATA SOURCES USED

Detailed information on the methodological approaches applied to estimate emissions and removals for the various source and sink categories covered by this inventory can be found in the respective sector-specific chapters.

In general, methodologies were primarily derived from the '2006 IPCC Guidelines for National Greenhouse Gas Inventories' unless otherwise stated in the methodological descriptions. It is worth noting that following the first use, in the 2014 submission, of the COPERT estimation modelling system to estimate non-CO_2 emissions from the road transport sector for the year 2012, the use of this tool has now been applied to cover the years 2010 to 2014 in this submission.

Key data providers include the National Statistics Office (NSO), governed by the Malta Statistics Authority Act, 2000 (Chap. 422)[13] and serving as the main body responsible for the collection, compilation, analysis and publications of statistical information related to Malta. Ministries and Departments, regulatory authorities and agencies, public entities and private establishments and industry organizations also provide important sources of data, and in certain cases, added technical expertise in matters relating to specific sectors. Reports published by various entities are also sourced in some instances. A list of key data providers, by sector, is presented in Table 1-4.

Table 1-4 Key data providers relevant for this inventory submission

Sector	Data providers
1. **Energy (including 'Memo Items')**	Enemalta PLC Fish and Farming Regulation and Control Gozo Channel Individual private industrial establishments Malta International Airport Transport Malta (Maritime) Regulator for Energy and Water Services National Statistics Office Transport Malta Tug Malta
2. **Industrial Processes**	Enemalta PLC Foundation for Medical Services Individual private industrial establishments National Statistics Office Transport Malta
3. **Solvent and Other Product Use**	Malta Federation of Industry National Statistics Office
4. **Agriculture**	National Statistics Office
5. **Land Use, Land-use Change and Forestry**	Environment and Resources Authority Ministry for Gozo Ministry for Sustainable Development, the Environment and Climate Change
6. **Waste**	Environment & Resources Authority Regulator for Energy and Water Services Malta Shipyards Ministry for Health WasteServ Malta Ltd

[13] Malta Statistics Authority Act, 2000, Chapter 422; 1st March, 2001.

1.5 BRIEF DESCRIPTION OF KEY CATEGORIES

A 'key category' is an individual source or sink category that warrants prioritisation within the national inventory system because it has a significant influence on the national inventory concerned, in terms of the absolute level of emissions or removals, the trend in emissions or removals, or both. It was previously usually referred to as 'key source category'[14], which was limited to emission source categories. More recently, the reference to 'source' has been largely discontinued to also cover LULUCF removals by sinks.

To-date, Malta utilises a Tier 1 method for identifying key categories. This approach assesses the influence of different categories of emissions and removals on the level of the national inventory, and where possible, on the trend of the inventory. This assessment is usually presented as a listing of all those categories that cumulatively account for up to 95% of the total inventory when summed up in descending order of magnitude. The with-LULUCF key category assessment includes values relating to estimated removals in the LULUCF sector, taking into consideration the quantified values without due account to the sign (removals can be considered as being equivalent to negative emissions). The without-LULUCF assessment excludes estimates of removals from the LULUCF sector.

1.5.1 KEY CATEGORIES: LEVEL ASSESSMENT

The level assessment represents the contribution of each source or sink category to the total national inventory level. A detailed level assessment of key categories is presented in Annex 1 to this report.

1.5.2 KEY CATEGORIES: TREND ASSESSMENT

A trend assessment takes into account the trend in emissions or removals of a category over time in addition to the level of emissions or removals for that category. This assessment approach can highlight categories that may not appear to be key categories under a level assessment but whose trend is significantly divergent from that of the overall inventory, thus requiring further attention. As a trend assessment requires an analysis against a previous year's inventory (usually against the base year), a trend assessment for 1990 cannot of course be presented. A detailed trend assessment of key categories is presented in Annex 1 to this report.

1.6 GENERAL UNCERTAINTY EVALUATION, INCLUDING DATA ON THE OVERALL UNCERTAINTY FOR THE INVENTORY TOTALS

The measure of every quantity that serves as input data for the estimation of emissions and removals in greenhouse gas inventories is subject to some degree of 'uncertainty'. Uncertainty reflects the lack of absolute certainty on the true value of a variable parameter. A greenhouse gas inventory is also prone to uncertainty and it is good practice for an uncertainty analysis to be carried out.

A Tier 1 approach, in accordance with the IPCC Good Practice Guidance[15] is applied to uncertainty assessment for this submission. A detailed representation of uncertainties is included in Annex 2 to this report.

[14] Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG2000, IPCC, 2000).
[15] Ibid.

1.7 GENERAL ASSESSMENT OF COMPLETENESS

A *'complete'* inventory refers to an inventory which includes estimates for all relevant sources and sinks and gases, and that covers all the applicable geographic area of the country concerned.

Malta's inventory strives to include all emissions and removals from all known sources and sinks within the whole Maltese territory.

An assessment of completeness of reporting will be submitted as a separate file to this report.

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Chapter 2. TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR AGGREGATED GREENHOUSE GAS EMISSIONS

Annual national emissions of greenhouse gases over the period 1990 to 2015 that are covered by this inventory submission are presented in Table 2-1. Emission trends by gas and total annual “with” and “without” LULUCF estimates are also provided in this table.

It is pertinent to note that the discussion in this chapter is restricted to national emissions and thus exclude emissions from ‘memo items’, unless otherwise indicated in the text or captions.

The change in total emissions between the base year and the latest reported year (2015) for the without-LULUCF estimates show a decrease of 6.53%, while for the with-LULUCF estimates this represents a decrease of 6.54%.

The general trend for the combined emissions (in CO_2 equivalent) shows a persistent increase up until 2012 with a marked drop in 2013 and 2015 reflecting improvements in the generation efficiency within the energy sector and the use of the electricity interconnector. This trend can be more easily observed in figure 2-1 which represents the trend for each gas for the with-LULUCF estimations for the period 1990-2015.

Table 2-1 Greenhouse gas emission trends by gas for 1990-2015.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
	Gg CO_2 equivalent									
CO_2 (without LULUCF)	2,170.72	2,360.48	2,417.83	2,704.54	2,638.47	2,725.75	2,819.43	2,482.00	2,481.26	1,756.91
CO_2 (with LULUCF)	2,173.68	2,363.55	2,420.97	2,706.17	2,640.42	2,727.93	2,821.85	2,484.66	2,484.15	1,760.04
CH_4	154.96	145.49	173.85	212.91	179.58	167.53	165.34	155.34	171.53	178.01
N_2O	56.34	59.37	61.26	58.02	53.97	48.10	47.30	45.58	46.12	44.74
HFCs	NO, NE, IE, NA	0.00	6.70	41.78	145.49	169.02	201.03	216.32	230.77	247.00
PFCs	NO, NA	NO, NA	NO, NA	NO, NA	0.00	0.00	0.00	0.00	0.00	0.00
SF_6	0.01	1.44	1.47	1.56	1.69	4.59	0.45	2.68	0.58	0.19
Total (without LULUCF)	2,382.04	2,566.78	2,661.11	3018.81	3019.21	3115.01	3233.55	2901.92	2930.27	2226.87
Total (with LULUCF	2,385.00	2,569.85	2,664.26	3,020.44	3021.17	3117.19	3235.97	2904.58	2933.16	2230.00

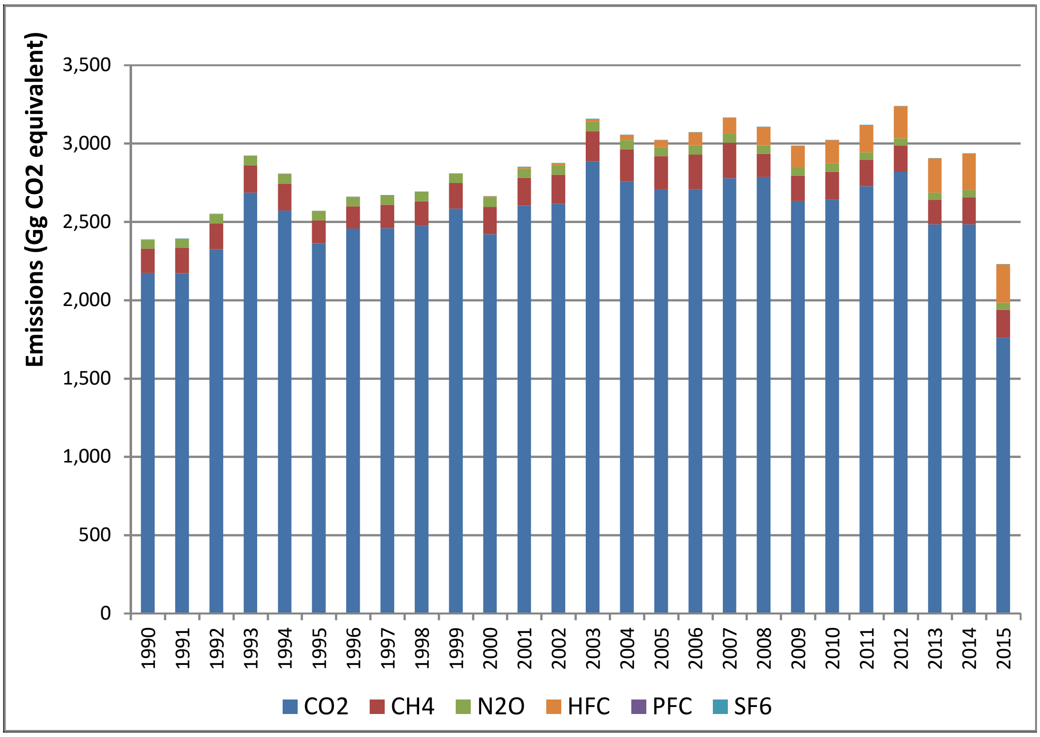

Figure 2-1 Emissions of greenhouse gases by type of gas, including LULUCF, for 1990 – 2015.

The year-on-year increases (or decreases) in the overall emissions (with-LULUCF) are illustrated in Figure 2-2. It reflects the overall trend in total emissions as shown in Figure 2-1, for the years up to and including 2015. As can be seen, most of the year-on-year changes are positive (i.e. year-on-year increases). One may note that despite the large variation in the level of individual year-on-year changes, the general trend is that the year-on-year increases observed in the later years are lower than for earlier years. Indeed, the occurrence of year-on-year decreases in emissions also tends to increase with time.

Substantial decreases in year-on-year emissions can be observed for the years 2012-2013 (-10%) and 2014-2015 (-24%) to the extent that they are also significantly larger than any year-on-year change observed in previous years.

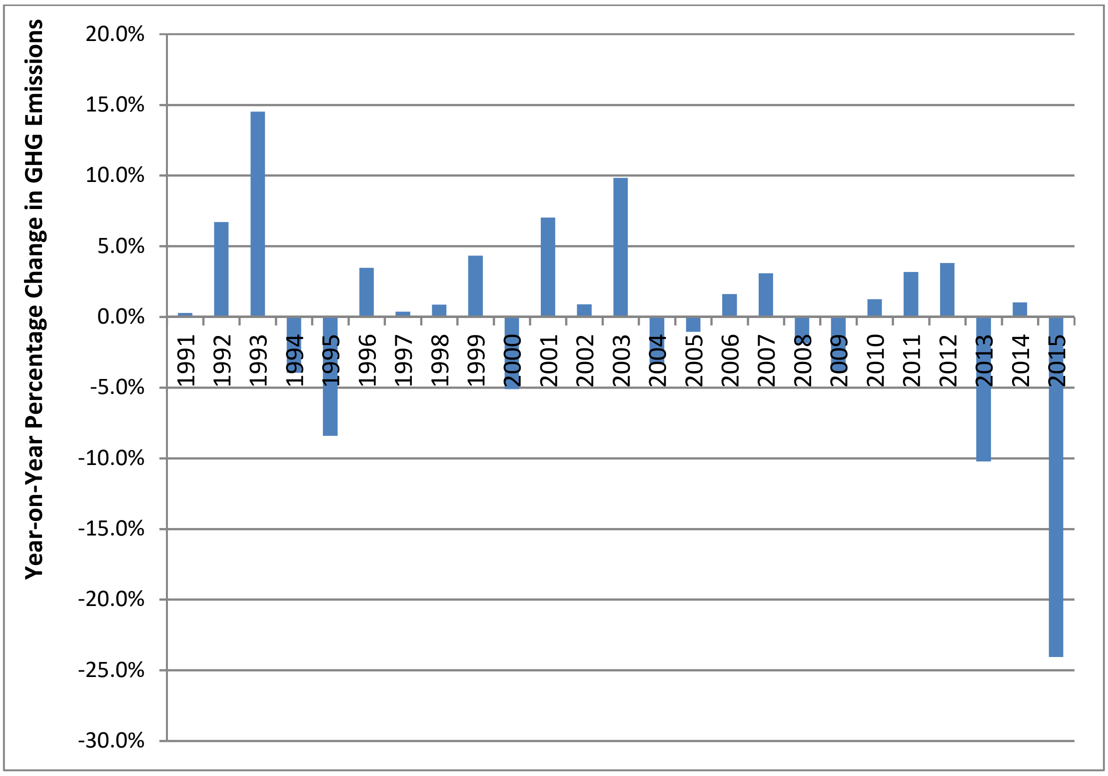

Figure 2-2 Annual percentage increase or decrease in total greenhouse gas emissions (based on total emissions including LULUCF)

2.1.1 Trends in GHG emissions per Capita

A comparison of emissions with the demographic development of a country can serve as a useful indicator of the progress in emissions control over a set period.

Malta's population has seen a sustained growth over the period covered by this inventory submission, and a concomitant increasing per capita trend in emissions was observed until 2012. However, a marked drop in this trend can be observed for the years 2013 and 2015, as shown in Figure 2-3. This reduction has been reflected in per capita emissions, whereby 2015 has seen the lowest per capita emissions since the base year (1990).

In 1990, the per capita emissions stood at 6.7 tonnes of CO_2 equivalent and this increased to 7.7 tonnes of CO_2 equivalent per capita in 2012, representing an overall increase of 15%. However, this trend was reversed for 2013 to 2015, with a substantial decrease in total national emissions translating itself into a decrease in per capita emissions; with a 33% reduction in 2015 from the value in 2012. The level of per capita emissions in 2015 is the lowest since 1990 and stood at 5.2 tonnes of CO_2 equivalents per capita.

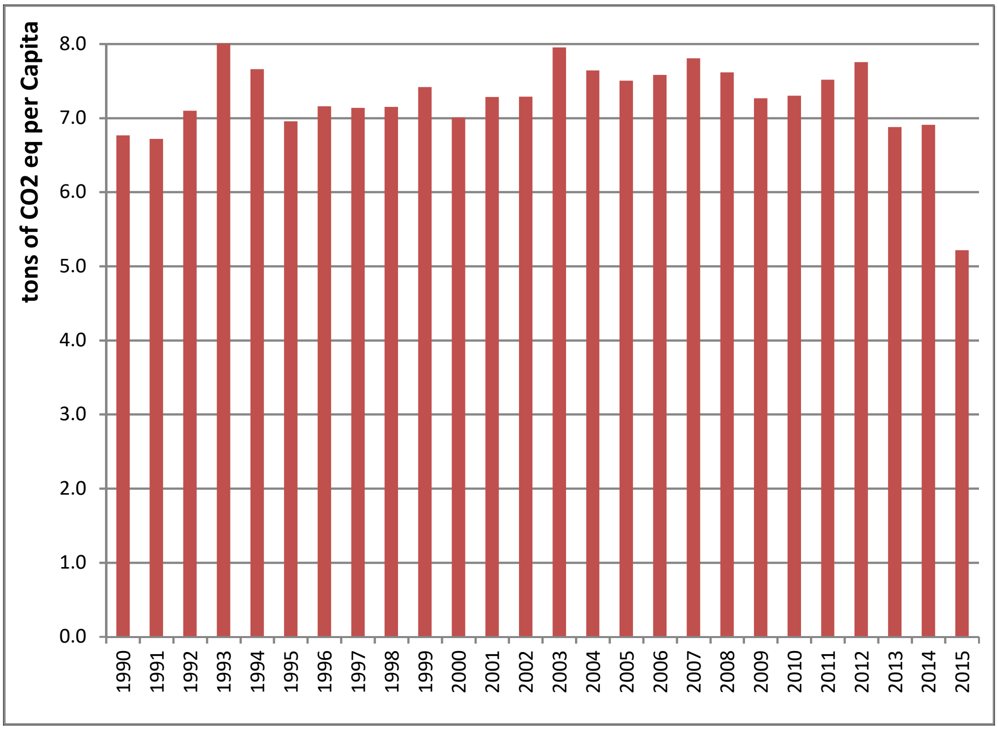

Figure 2-3 GHG emissions per capita [Source of population data for 1990 to 2015: Eurostat]

2.1.2 Trend in overall emissions compared to Gross Domestic Product

Another important indicator compares the trend in emissions of greenhouse gases and the economic activity of the country, the latter being represented in terms of Gross Domestic Product (GDP). The relationship between these two parameters, or the 'emissions intensity' of Malta's economy, indicates that, contrary to the trend observed in per capita emissions, the emissions intensity has seen a generally consistent downward trend, as seen in Figure 2-4. This can be interpreted as a decoupling of national greenhouse gas emissions from the country's economic development trends. The continued improvement in the emission intensity trend of the Maltese economy may be due to a combination of reasons, including increased efficiency, from an emissions perspective, of the activities covered by the inventory.

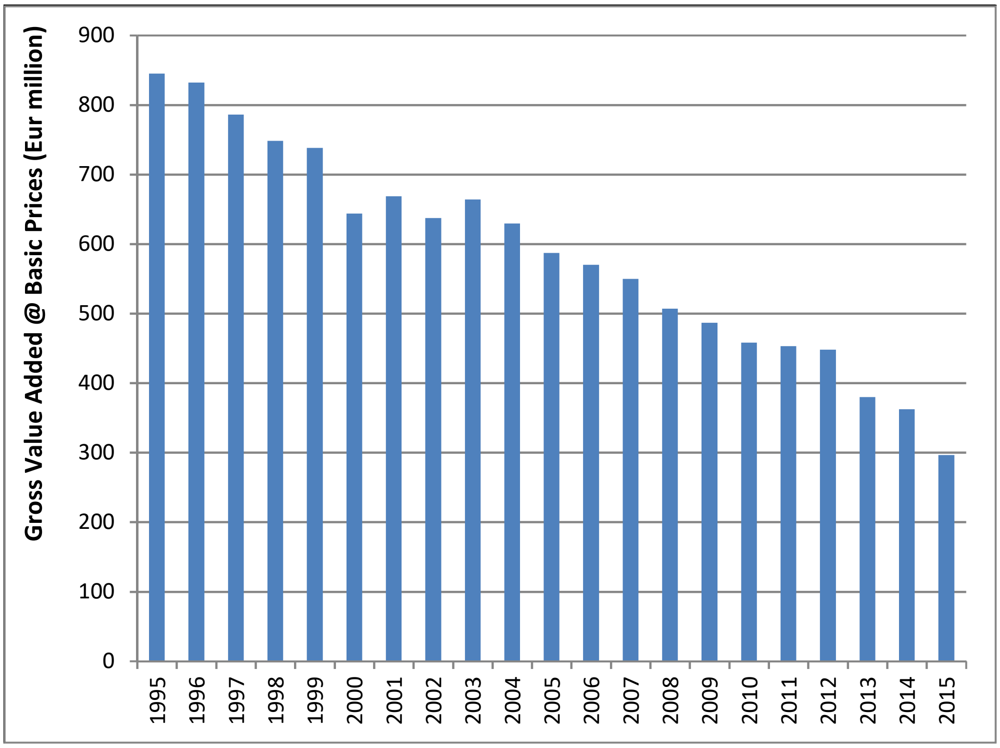

Figure 2-4 GHG emissions per unit GDP [Source of GDP data for 1990 to 2015: Eurostat]

2.2 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS BY GAS

2.2.1 GENERAL DISCUSSION OF EMISSION TRENDS BY GAS.

Emission trends for each greenhouse gas covered by this inventory are presented in Table 2-1 above. Table 2-2 provides an overview of the changes in emissions between the latest year covered by this inventory and the base year 1990.

Table 2-2 Emissions of greenhouse gases by gas for the years 1990 and 2015.

	1990	2015	% change 1990-2015
	Gg CO_2 equivalent		
CO_2 (without-LULUCF)	2,170.72	1,756.91	-19.06%
CO_2 (with- LULUCF)	2,173.69	1,760.04	-19.03%
CH_4	154.96	178.02	14.8%
N_2O	56.34	44.74	-20.59%
HFCs	NO, NA, NE, IE	247.00	---
PFCs	NA	0.00	---
SF_6	0.01	0.19	1800%
Total (without-LULUCF)	2,382.04	2,226.87	-6.51%
Total (with-LULUCF)	2,385.00	2,230.00	-6.50%

Table 2-1 and Table 2-2 highlight the major contribution that carbon dioxide has in total national emissions. The status of this greenhouse gas as the highest contributor has been maintained throughout the years. This can also be observed in Figure 2-5. The relative contribution of CO_2 emissions to total national emissions represents the strong influence that this gas has on the national emissions trends, to the extent that the trend for national emissions runs almost parallel to the trend for CO_2 emissions. One does however note that with time, the relative contribution of CO_2 has tended to decrease, in conjunction with changes in relative contributions of other emitted gases, primarily the substantial increase in the share of emissions of HFCs.

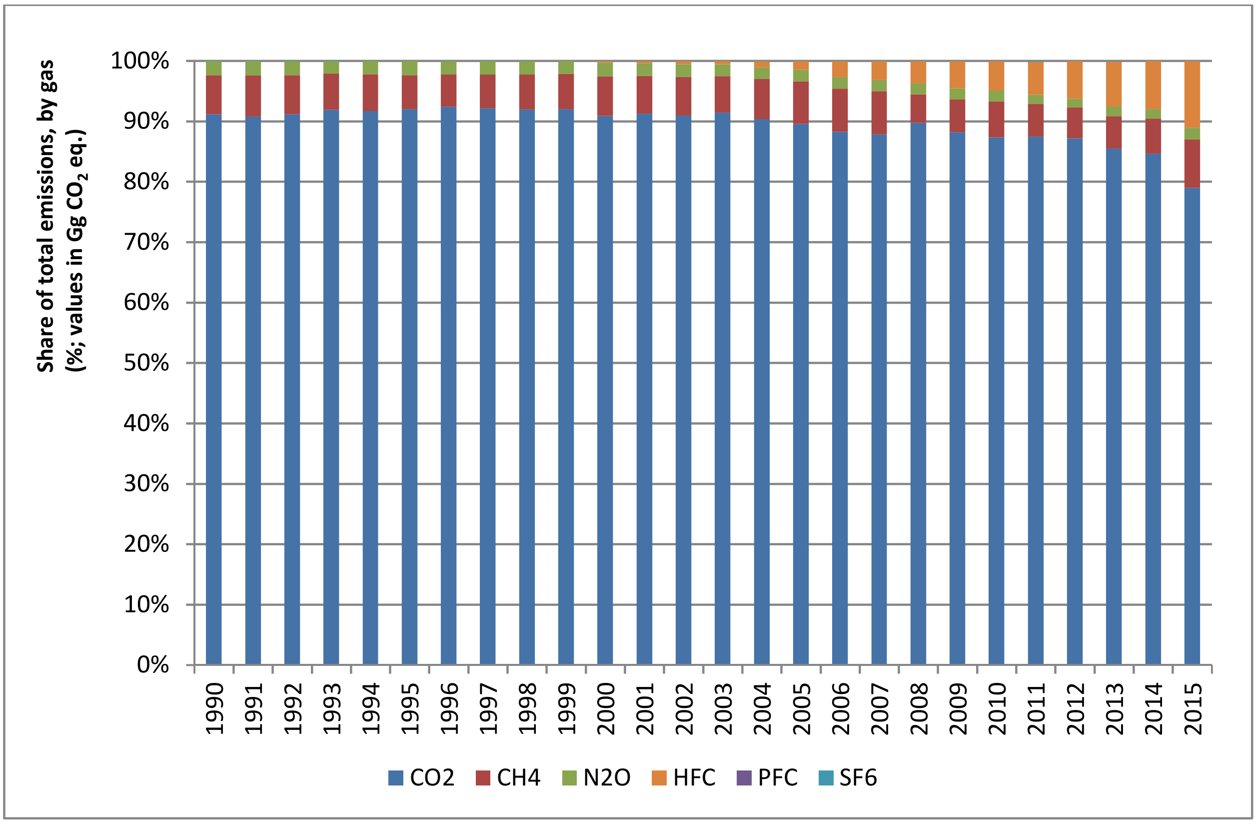

Figure 2-5 Percentage contribution of each greenhouse gas to total national greenhouse gas emissions (with-LULUCF).

2.2.2 CARBON DIOXIDE EMISSIONS AND REMOVALS.

The overall profile of carbon dioxide emissions by sources and removals by sinks is presented in Figure 2-6. It is obvious that emissions far outweigh removals – indeed, removals of carbon dioxide by the LULUCF sector only offset a very minimal amount of emissions of this gas.

Sectorally, the principal contributor to carbon dioxide emissions is the Energy sector (CRF sector 1). Carbon dioxide emissions from this sector account for 99.6% of total gross national carbon dioxide emissions. Within this sector, the source category Energy Industries (1A1) represents the highest overall contribution of carbon dioxide emissions, followed by source category Transport (1A3).

2.2.3 METHANE EMISSIONS.

For most of the period under consideration, methane had the second highest share of national total emissions (in terms of CO_2 equivalent). This situation has however changed since 2012, with HFCs now ranked as the second highest contributor to overall national emissions (see Figure 2-5).

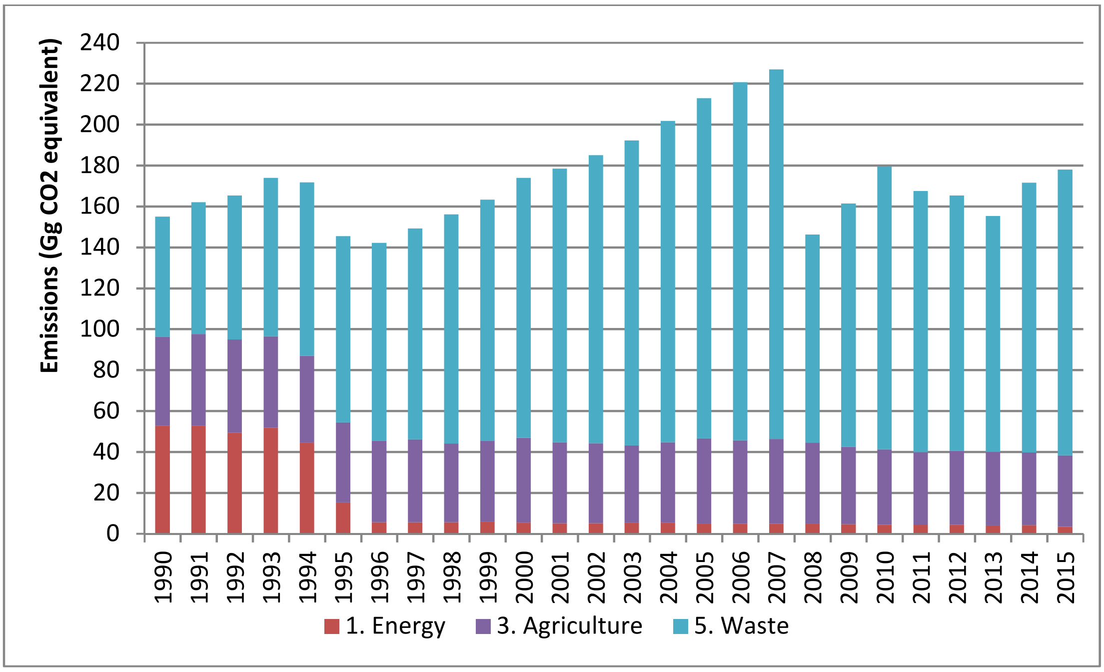

Figure **2-7** shows the general trend up to 2007 reflected an increase in emissions of methane; this however has changed in subsequent years. This change is due to the reduction in emissions of this greenhouse gas from the sector Waste (CRF sector 5), as a result of increased flaring of methane in local managed landfilling activities - category Managed Waste Disposal on Land (5A1).

Sector 4: Agriculture is another important emitter of methane through emissions from source categories Enteric Fermentation (4A) and Manure Management (4B). Estimated absolute emissions of methane from this sector peaked in 2000, with estimated emissions in 2015 being the lowest recorded since 1990.

2.2.4 Nitrous oxide emissions.

Until 2005, nitrous oxide was the gas with the third highest share of total national emissions (in terms of CO_2 equivalent), being then superseded by emissions of HFCs (Figure 2-5).

Figure 2-8 presents the general trend of nitrous oxide emissions (in Gg N_2O). Estimated emissions peaked in 1994. Sectorally, the highest contributor is sector Agriculture (CRF sector 3), with emission of this greenhouse gas mainly from source category Agricultural Soils (3D), and, to a lesser extent, source category Manure Management (3B). Further contributions to national total nitrous oxide emission are given by sectors Waste (CRF sector 5), Energy (1) and Industrial Processes and Other Product Use (2).

2.2.5 Emissions of fluorinated gases.

Whereas for a large part of the period covered by this report, fluorinated greenhouse gas emissions had a minimal share in total national emissions, their contribution increased significantly in more recent years, to the extent that the combined share of such gases (in terms of CO_2 equivalent) in total national emissions in 2011 was second highest behind carbon dioxide. The main driving force behind this change is the substantial increase observed for hydrofluorocarbons (see Figure 2-9) with their utilisation of such gases as replacements for ozone depleting substances and increased volumes in refrigeration equipment. The high global warming potentials of fluorinated gases further bolster their overall share in total emissions.

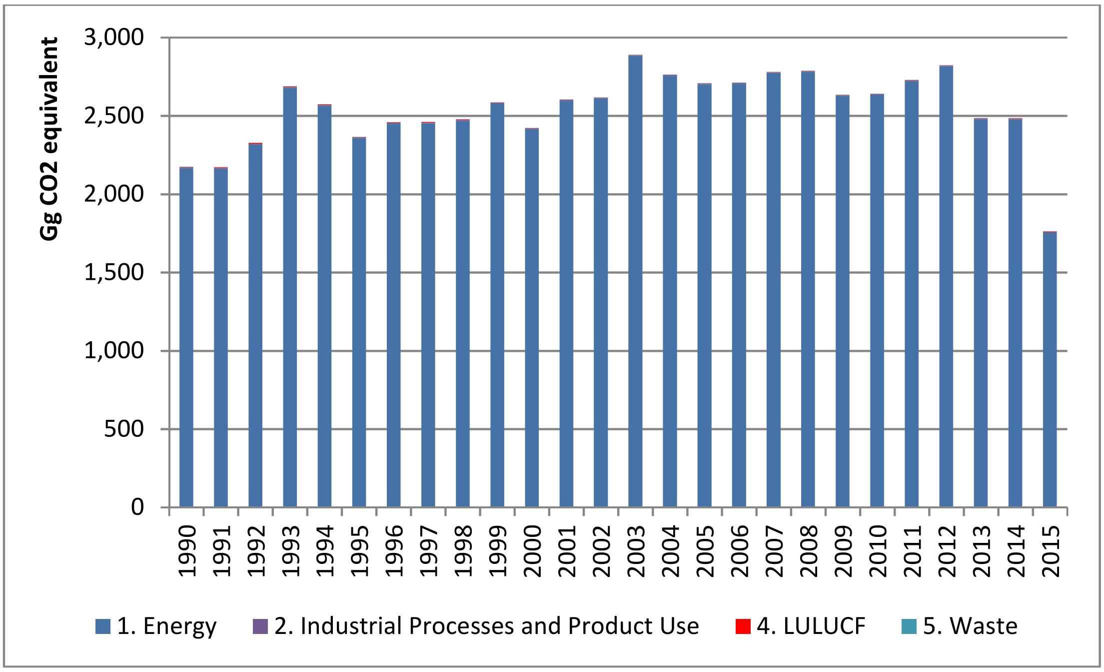

Figure 2-6 Trends in emissions by sources and removals by sinks for carbon dioxide.

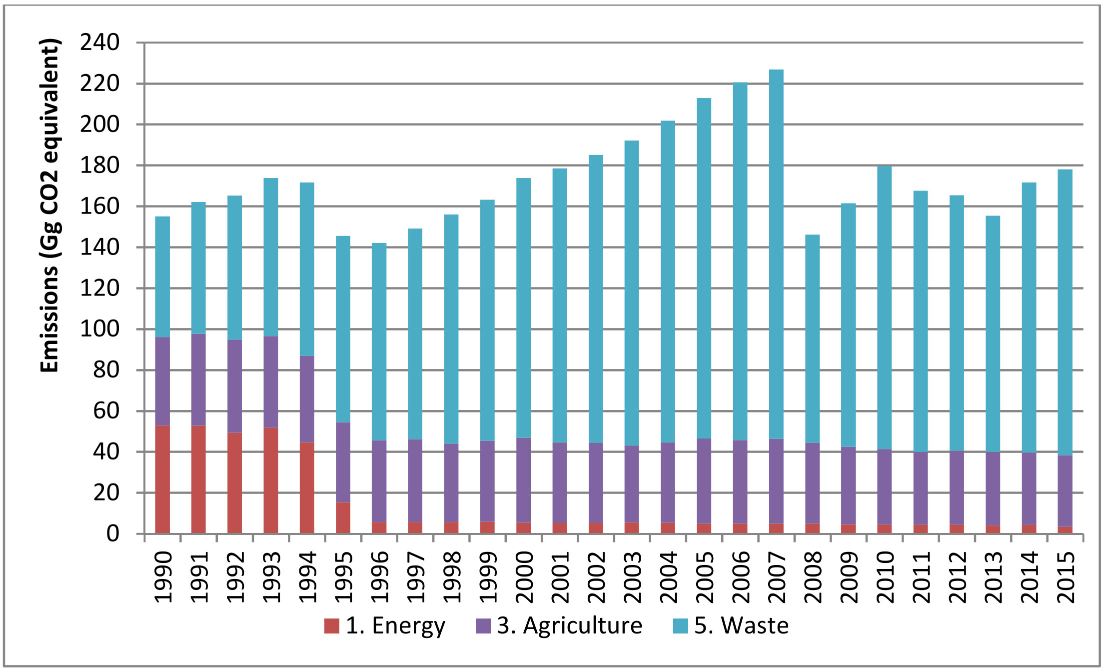

Figure 2-7 Trend in total and sectoral emissions of methane.

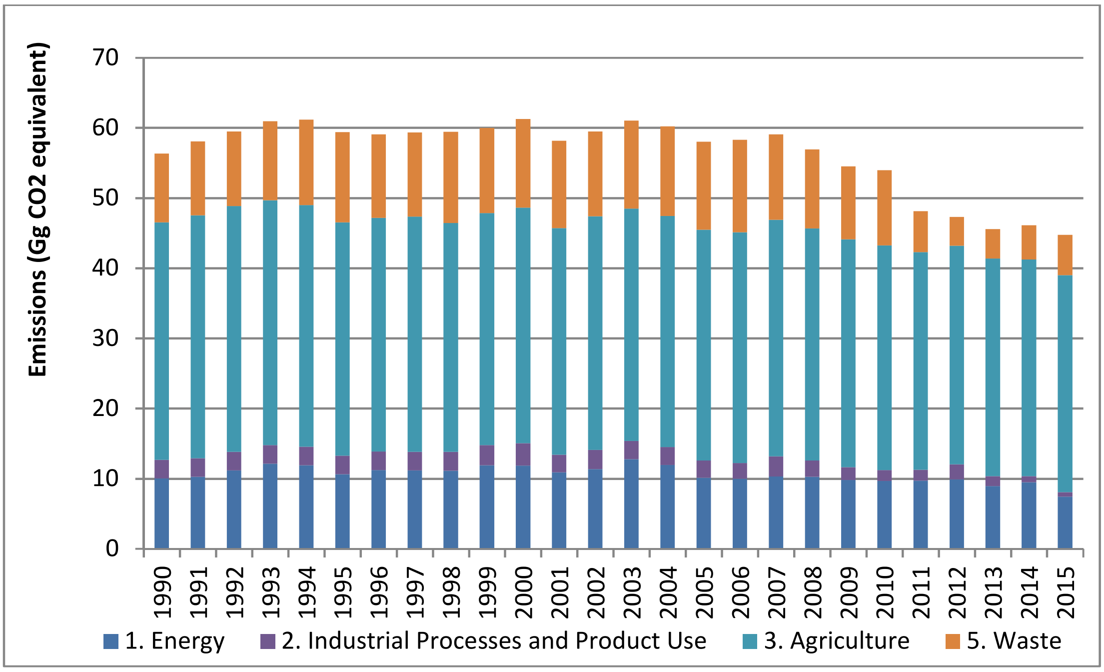

Figure 2-8 Trends in total and sectoral emissions of nitrous oxide.

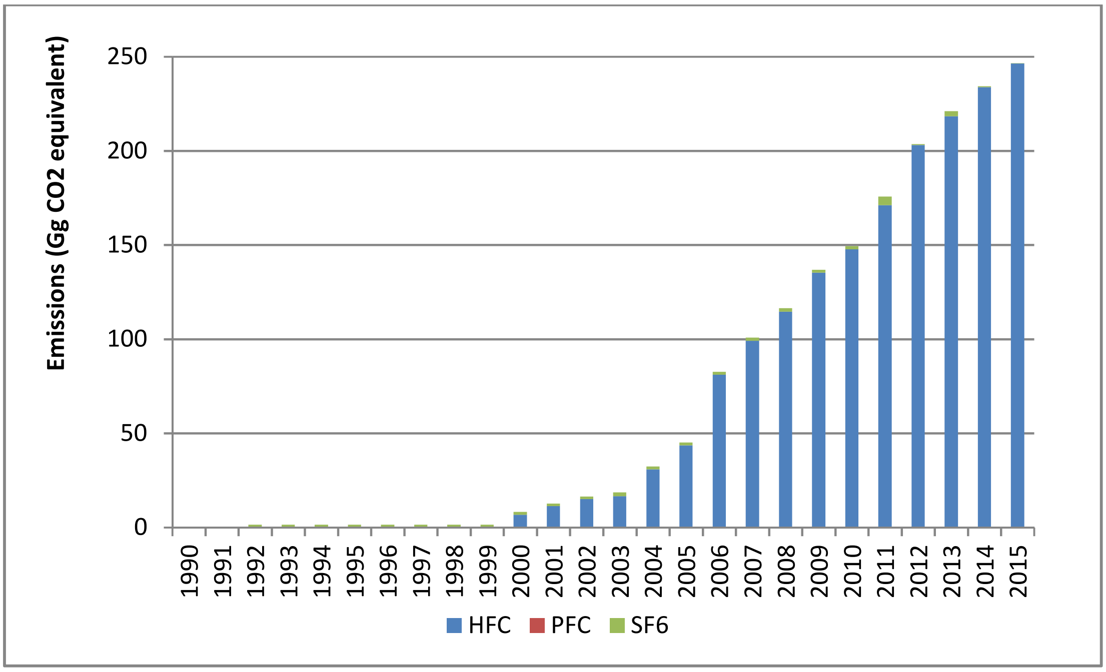

Figure 2-9 Trends in emissions of fluorinated greenhouse gases.

2.3 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS BY CATEGORY

Greenhouse emissions from all sectors covered by this inventory (except for Memo Items) over the time series concerned are presented in Table 2-3 and illustrated in Figure 2-10.

Table 2-3 Emissions of greenhouse gases by sector for the years 1990 to 2015.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
	Gg CO_2 equivalent									
Energy	2227.95	2380.68	2430.86	2715.60	2648.46	2735.23	2829.73	2490.94	2490.95	1766.43
Industrial Processes and product use	7.94	9.47	15.20	49.48	152.17	179.02	206.76	223.85	235.45	248.39
Agriculture	77.13	72.38	75.03	74.51	68.91	66.50	67.24	66.99	66.31	65.90
LULUCF	2.96	3.07	3.15	1.63	1.96	2.18	2.43	2.66	2.90	3.13
Waste	69.02	104.24	140.02	179.22	149.66	134.26	129.82	120.13	137.55	146.14
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	2385.00	2569.85	2664.26	3020.44	3021.17	3117.19	3235.97	2904.58	2933.16	2230.00

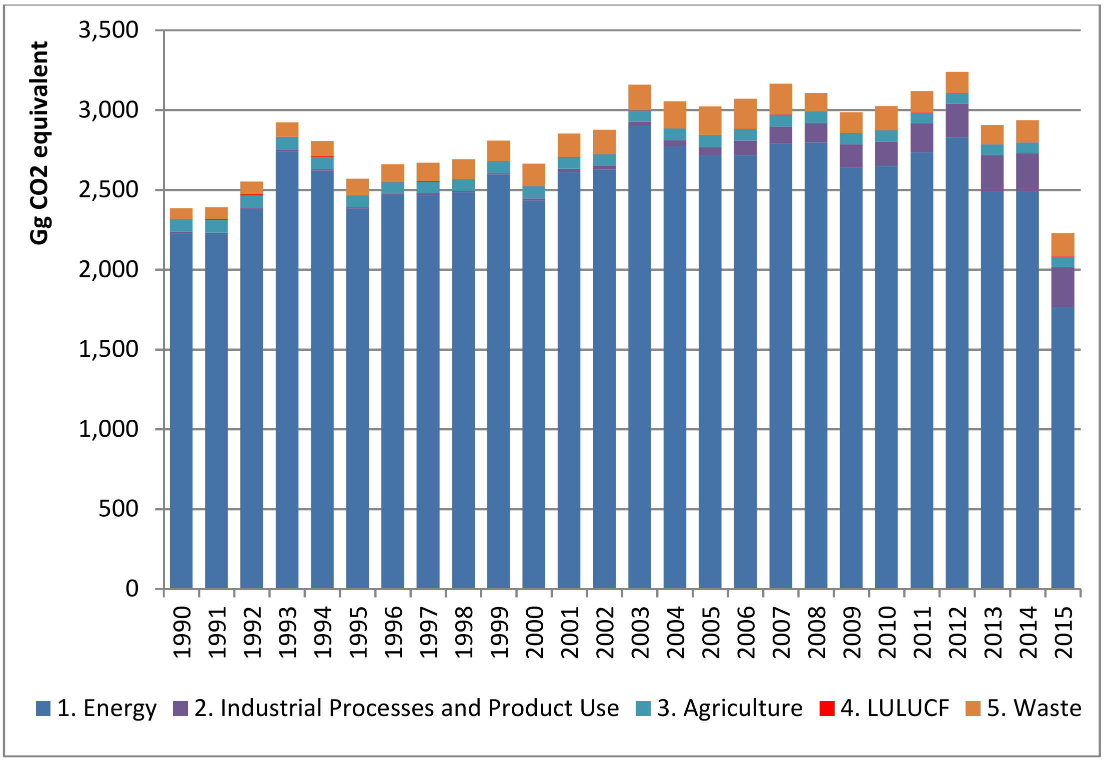

Figure 2-10 Emission trends by sector.

The most obvious feature that comes out of Table 2-3 and Figure 2-10 is the predominance of emissions from the energy sector in total national emissions. This has been the case throughout the period covered by this report. Indeed, there is a strong correlation between the profile of total national emissions and that of emissions from the energy sector, indicating that the volume of emissions attributed to this sector strongly determines the year-on-year trend in total national emissions. All other source sectors contribute substantially less to overall emissions, while LULUCF is associated with a minor removal effect.

Overall sectoral trends as a percentage change between year 1990 and year 2015 are provided in Table 2-4. After a long period (until 2012) during which the general trend was of increasing emissions, the Energy sector, in recent years, started showing a gradual decrease in overall emissions, particularly evident over the last two tears covered by this submission. This decrease is such that emissions in 2015 are even less than what they were in 1990. The trend in overall emissions for the sector Energy reflects primarily changes in the mix of sources used to meet electricity demand in the country, the impact of which even superseding emission trends for other categories included in this sector. The increase for the sector Industrial Processes and Other Product Use is explained by the substantial increase in emissions of HFCs, as already explained in an earlier section. The overall trend for the sector Agriculture represents a decrease in emissions between 1990 and 2015, though one may observe a number of fluctuations throughout the period. Sector Waste also shows an increase in emissions between the base year and 2015, though fluctuations may also be observed for this sector over the period, not least during the latter half of the time series. The level of emissions from sector LULUCF can be said to have remained relatively stable over the time series, varying between a minimum 1.23 Gg CO_2 (2002) equivalent and a maximum 4.74 Gg CO_2 equivalent (1991). More information on the reasons underpinning the observed sectoral trends can be found in the subsequent chapters dealing with the respective sectors. These chapters will also provide an insight into the sub-sectoral disaggregation of emissions and the trends in emissions for different categories under each main sector.

Table 2-4 Emissions of greenhouse gases by sector for the years 1990 and 2015 and the corresponding change between the two years.

	1990	2015	% change 1990-2015
	Gg CO_2 equivalent		
Energy	2227.95	1766.44	-20.72%
Industrial Processes and other product use	7.94	248.39	3029.70%
Agriculture	77.13	65.90	-14.57%
LULUCF	2.96	3.13	5.57%
Waste	69.02	146.14	111.74%
Other	NA	NA	NA
Total (with LULUCF)	2,385.00	2,230.00	-6.5%

2.4 EMISSION TRENDS FOR INDIRECT GREENHOUSE GASES

Emissions of indirect greenhouse gases are illustrated in Figure 2-11. It is pertinent to note that the change in methodological approach applied in 2013, namely the utilisation of the COPERT model, has been applied for the years 2010 - 2015 (for more information refer to Chapter 3).

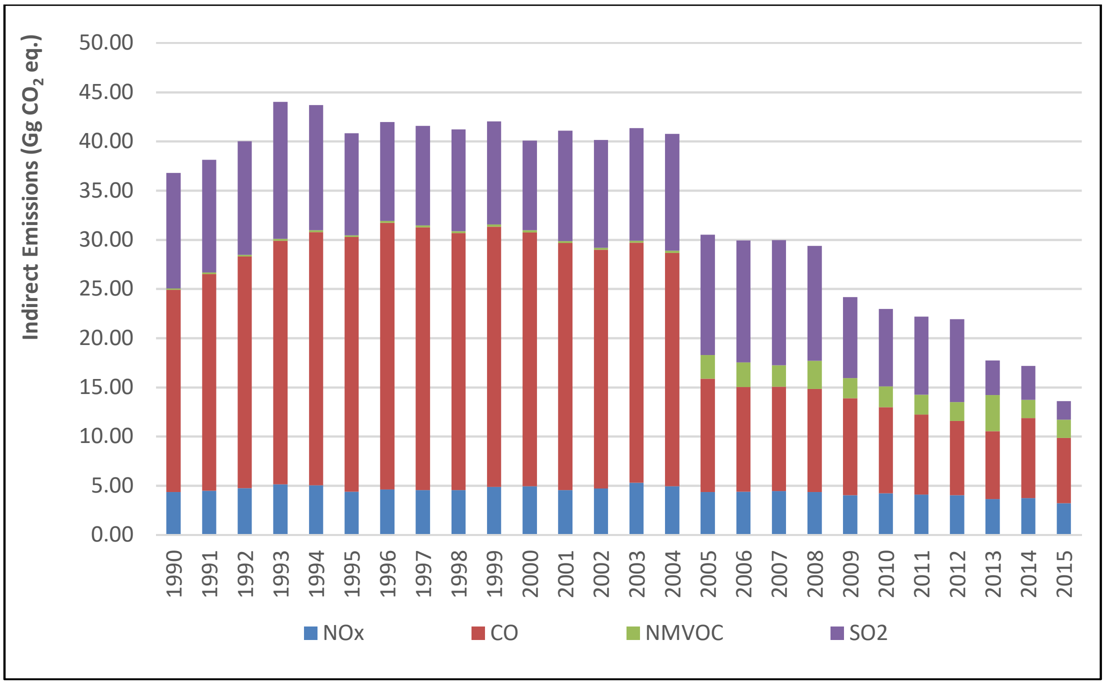

Figure 2-11 Emission trends for indirect greenhouse gases

Among these four gases, the most significant trends are those of CO and NOx. Both gases show trends that are closely correlated to the trends in activities that result in emissions of such gases, in particular energy generation (category 1A1a) and road transport (category 1A3b).

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Chapter 3. ENERGY (CRF SECTOR 1)

3.1 OVERVIEW OF SECTOR

The Energy sector is the most significant contributor of greenhouse gas emissions in Malta. Emission trends for this sector, split by sub-sector categories, are presented in Figure 3-1.

In 2015, the category Energy Industries (1A1) accounted for 50.4% of the overall greenhouse gas emissions in the Energy sector as a whole. This category has the greatest influence on the overall energy emission trends and due to the relative importance of the Energy sector, it also influences national emission trends.

The second highest contributor under this sector is Transport (1A3), incorporating Road Transport (1A3b), National Navigation (1A3dii) and Domestic Aviation (1A3aii). Cumulatively, this sector accounts for 35.8% of total national emissions. Transport is thus another major contributor to the overall national emissions.

The Manufacturing Industries category (1A2) accounts for 2.4% of the energy sector emissions, while the Commercial/Institutional (1A4a), Residential (1A4b) and Agriculture, Forestry & Fisheries (1A4c) sectors account for 7.7%, 2.5% and 0.9% of the energy sector emissions respectively. The remaining 0.2% are emissions from the 'Other' Sector (1A5) and are attributed to the combustion of fuels for Military purposes.

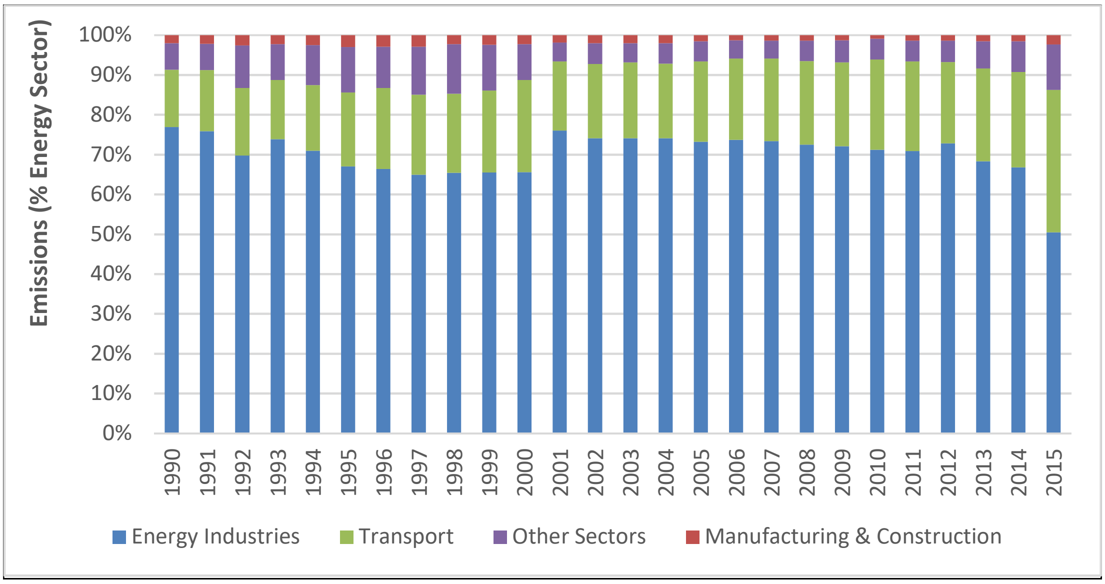

Figure 3-1 Emission trends in the sector Energy, by source category

Emissions from fossil fuel combustion account for all the fossil fuel related emissions, since no fuel oil production, oil refining or coal mining activities, are carried out on the Maltese Islands.

Unless otherwise stated, an Oxidation factor of 1.00 is used across the whole energy sector for the estimation of emissions from fuel combustion.

3.2 FUEL COMBUSTION (CRF 1.A)

3.2.1 COMPARISON OF THE SECTORAL APPROACH WITH THE REFERENCE APPROACH

The Reference Approach is a top-down methodological approach to calculate CO_2 emissions. The main data sources are the oil balance reports compiled by the Regulator for Energy and Water Services (formerly the Malta Resources Authority) and provided to the National Statistics Office for subsequent reporting to the Eurostat. The oil balance reports cover the period 2010 – 2015 while for previous years (1990-2009), the sales figures as reported by Enemalta in its annual reports were submitted. During the latter time period, Enemalta was the sole importer and wholesaler of petroleum products in the inland market.

The Reference Approach serves as a comparison with the Sectoral Approach, wherein emission estimations for individual categories are calculated using a bottom-up approach based on activity statistics pertaining to fuel consumption obtained from the various economic sectors, industrial processes and end-users included in each sub-category.

Table 3-1 compares the Reference Approach and the Sectoral Approach for the year 2015. In principle, the total figures obtained under the Reference Approach can be compared with the total of Sector 1A. The consumption of liquid fuels (excluding international bunkers) as estimated using the Reference Approach differs by -2.41% from the Sectoral Approach which leads to a discrepancy of -5.23% in the total CO_2 emissions.

Table 3-1 Comparison of Reference Approach and Sectoral Approach for 2015.

FUEL TYPES	REFERENCE APPROACH		SECTORAL APPROACH		DIFFERENCE	
	Apparent energy consumption	CO_2 emissions	Energy consumption	CO_2 emissions	Energy consumption	CO_2 emissions
	(PJ)	(Gg)	(PJ)	(Gg)	(%)	(%)
Liquid fuels (excluding international bunkers)	27.30	2,015.70	27.95	2,121.05	-2.41%	-5.23%
Solid fuels (excluding international bunkers)	NA	NA	NA	NA	NA	NA
Gaseous fuels	0.020	1.268	0.020	1.268	0.00%	0.00%
Other fossil fuels	NA	NA	NA	NA	NA	NA
Peat	NO	NO	NO	NO	NO	NO
Total	**27.32**	**2,016.96**	**27.97**	**2,122.32**	**-2.41%**	**-5.23%**

3.2.2 INTERNATIONAL BUNKER FUELS

Emissions estimated from International Bunker activities are considered as 'Memo Items' and are not taken into account in terms of national emissions of greenhouse gases. These memo items refer to fuels used for marine bunkering and for aviation purposes that are combusted outside the Maltese territorial waters or airspace, respectively.

The fuels used for international marine bunkering are fuel oil and gasoil, with the former making up the greater share of the total fuels used for this purpose (82% in 2015) within this sector. The fuel used for international aviation is jet kerosene (also known as jet A1 or aviation turbine fuel).

Activity data categorised between national navigation and international marine bunkers was provided by the Regulator for Energy and Water Services. The methodology used to identify those fuels that are used within Maltese territorial waters and those used outside Malta's territory continued to be based on the methodology adopted in the previous year following an extensive exercise that was carried out by this Authority to improve the said methodology.

Emissions from international marine bunkering have been estimated using a Tier 1 approach. IPCC 2006 default emission factors have been used for estimating CO_2, CH_4 and N_2O emissions and for calorific values. The EMEP/EEA 2013 Guidelines are used for indirect emissions. For SO_2 emissions, the sulphur content for marine fuels is obtained from the Regulation Unit within the Regulator for Energy and Water Services. This data is obtained through the sampling of fuels under reporting obligations of Directive 99/32/EC. The emission factors used are shown in Table 3-2.

Table 3-2 Emission Factors for category International Marine Bunkering.

Fuel Type	CO_2 (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)	SO_2 (%S)
Gas Oil	74,100	7.0	2.0	1,825.58	172.09	65.12	0.06
Fuel Oil	77,400	7.0	2.0	1,962.87	183.17	66.83	2.12
Petrol	69,300	7.0	2.0	212.90	12,954.85	4,097.07	0.000565

Estimated emissions for international maritime and aviation bunkers are presented in Figure 3-2. Aa comparison of memo items with 'non' memo items, i.e. those emissions that have been generated within national territory, is presented in Figure 3-3. The 'non'-memo items have been divided between those sectors falling within the scope of the EU Emissions Trading System, namely electricity generation, and those falling within the 'Effort Sharing Decision', comprising of all other sectors including transport, manufacturing industries, commercial/institutional sectors and the residential sector.

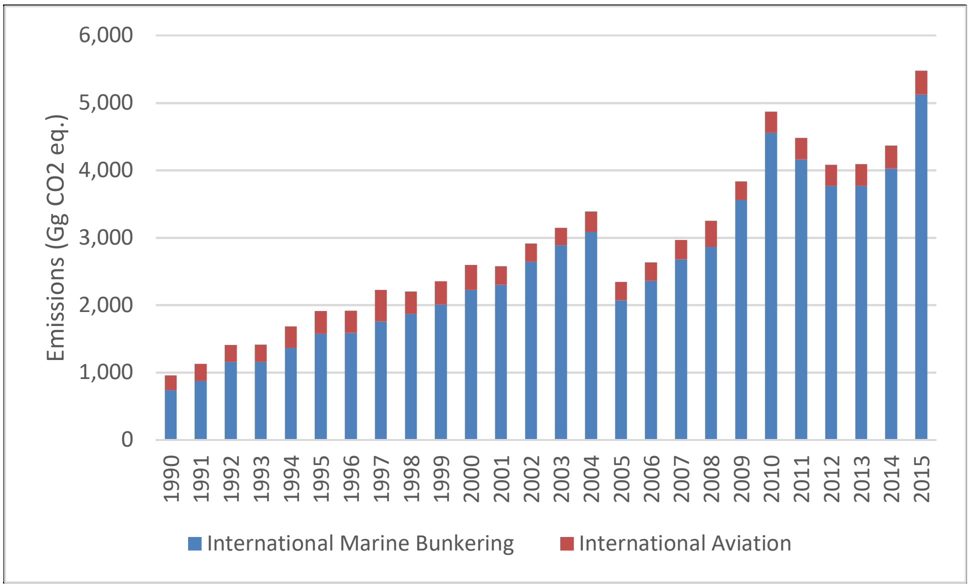

Figure 3-2 Emissions for categories International Aviation and International Marine Bunkers.

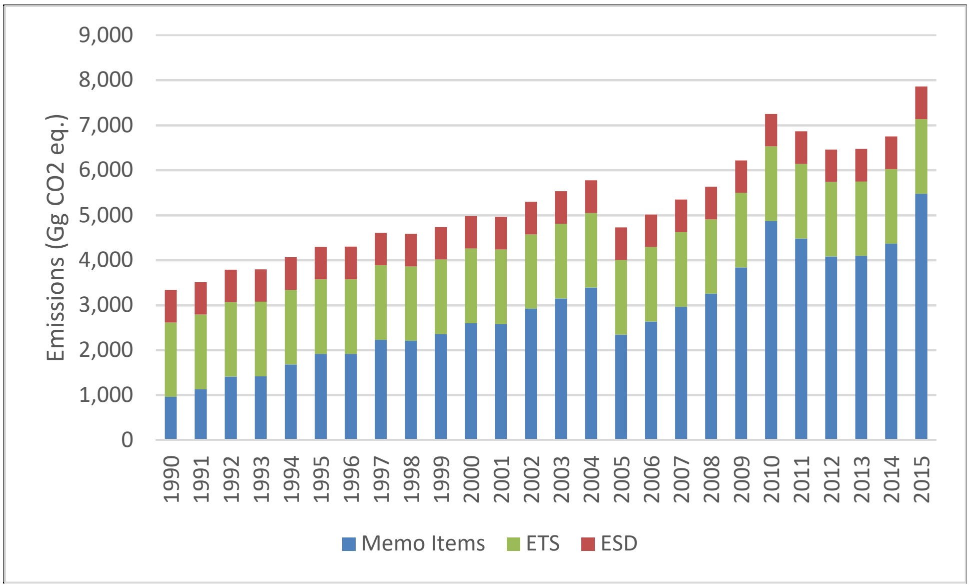

Figure 3-3 Emissions falling under Memo Items, ETS and ESD.

3.2.3 FEEDSTOCKS AND NON-ENERGY USE OF FUELS

Activity data on feedstocks and non-energy use of fuels has, to-date, not been collected. Efforts are being made to improve on this specific area in order to include it in the methodological approach described in section 3.2.5.2 and to thus be able to estimate emissions (if any) in this particular category.

3.2.4 ENERGY INDUSTRIES (CRF SUB-CATEGORY 1A1A)

3.2.4.1 Category Description

This section is limited to emission calculations for the Public Electricity Generation sub-category (1A1a), since sub-categories Petroleum Refining (1A1b) and Manufacture of Solid Fuels and Other Energy Industries (1A1c) do not occur in Malta.

Subcategory 1A1a incorporates two point sources, namely the two electricity generation plants (Marsa Power Station and Delimara Power Station) that have been operational up to 2015 and which are run on fuel oil and gasoil. It should be noted that until 1995, bituminous coal was also used for electricity generation in one of these plants. Moreover, emissions from flue gas treatment through desulphurisation and deNO$_x$ using bicarbonate and urea have been included in this submission.

A time-series of the carbon intensity in this sector indicates that emissions per unit of electricity generated have substantially declined over the past 3 years due to the installation of more efficient electricity generation turbines and the use of the electricity interconnector with mainland Europe. This trend is illustrated in Figure 3.4 below.

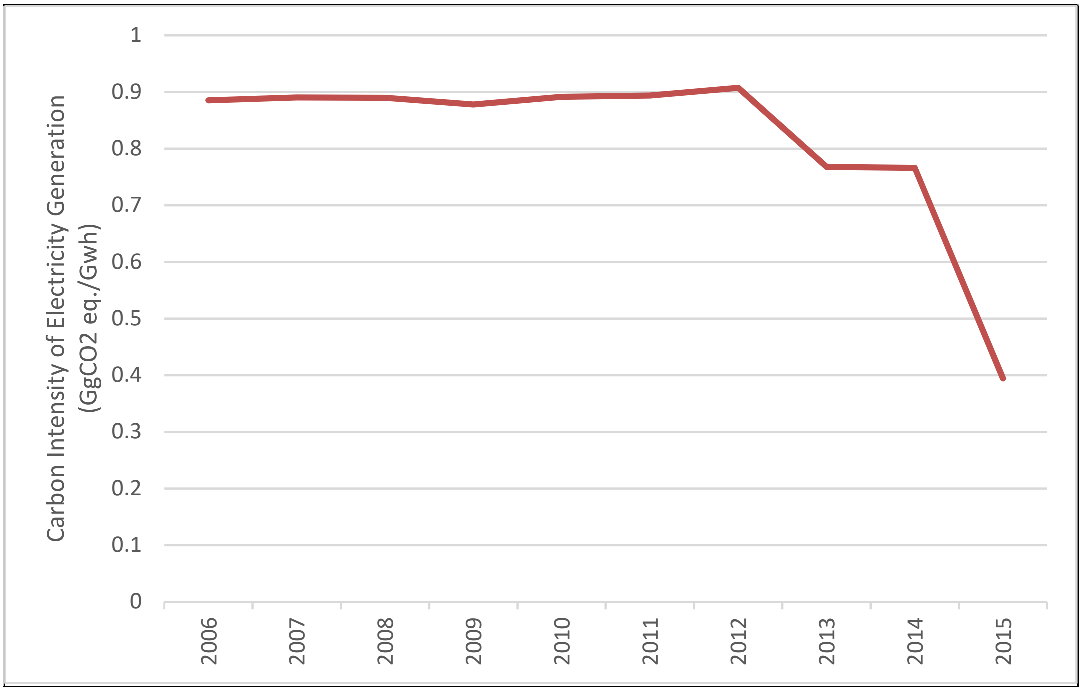

Figure 3-4 Carbon Intensity of Electricity Generation.

3.2.4.2 Methodological Issues

Emissions for the sub-category Public Electricity and Heat Production have been compiled using fuel consumption data as reported annually by Enemalta Corporation pursuant to European Union Directive 2003/87/EC[16]. The Directive requires that data reported by operators of stationary installations that fall within the scope of the Directive is duly verified by accredited and independent verification bodies. The data obtained from this report covers the period 2005-2015.

[16] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC

The calculation of emissions for the years until 2008 is carried out using a country-specific calorific value for each of the fuels used in each power station and an oxidation factor of 1 in accordance with the 2006 IPCC Guidelines. For the years 2009 onwards, the calorific values and oxidation factor identified in the verified emission reports submitted pursuant to Directive 2003/87/EC have been used for estimating greenhouse gas inventory emissions.

The default emission factors for N_2O and CH_4 stated in the IPCC 2006 Guidelines and the calorific values calculated as explained above were used for the whole time-series. IPCC 1996 emission factors were used for NO_X, CO and NMVOC. The percentage sulphur content was taken from data provided by Enemalta for 2015. The emission factors used for emission estimation under this sub-category are shown in Table 3-3

Table 3-3 Factors for category Energy Industries.

Fuel Type	C (tC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)
Gas Oil	20.2	3.0	0.6	200.0	15.0	5.0
Fuel Oil	21.1	3.0	0.6	200.0	15.0	5.0

3.2.4.3 Uncertainties and time-series consistency

As stated below, time-series consistency was improved due to the use of consistent data sources throughout the period 1990-2015, namely the National Statistics Office and Enemalta Corporation.

3.2.4.4 Category-specific QA/QC and verification

Pursuant to Directive 2003/87/EC internal data quality assurance and control procedures by the operator of the plants, and independent verification processes by accredited verifiers are applied at a plant level, complemented by review and formal acceptance of emission reports by the competent authority. It is to note that all plants falling within the scope of this inventory category fall within the scope of the said directive.

3.2.4.5 Category-specific recalculations

Activity data for the source category ‘Energy Industries’ was obtained from the NSO and Enemalta for the time periods 1990-2004 and 2005-2015, respectively. This has, however, resulted in recalculations when compared to the data submitted in previous inventories, which was sourced from the REWS, due to the differences in the activity data itself. Additionally, updates of emission factors used also affected the gross level of emissions, as shown in Table 3-4.

Table 3-4 Recalculation of direct emissions for category Energy Industries.

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
	CO_2	CO_2		CH_4	CH_4		N_2O	N_2O	
1990	1361.28	1657.87	21.79%	0.88	50.10	5567.25%	4.64	5.33	14.90%
1991	1506.93	1630.89	8.23%	1.03	49.85	4742.53%	4.97	5.27	5.90%
1992	1582.55	1605.72	1.46%	1.14	45.79	3918.94%	5.02	5.08	1.08%
1993	1637.46	1968.57	20.22%	1.16	48.13	4054.77%	5.27	5.98	13.54%
1994	1661.03	1811.00	9.03%	1.26	40.73	3129.80%	5.04	5.39	6.96%
1995	1640.15	1579.50	-3.70%	1.50	11.46	662.75%	4.10	3.96	-3.41%
1996	1618.78	1630.84	0.75%	1.57	1.59	0.78%	3.75	3.78	0.78%
1997	1610.39	1595.50	-0.92%	1.56	1.55	-0.84%	3.73	3.69	-0.84%
1998	1637.74	1619.90	-1.09%	1.59	1.57	-1.07%	3.79	3.75	-1.07%
1999	1696.66	1692.73	-0.23%	1.65	1.65	-0.33%	3.94	3.92	-0.33%
2000	1673.94	1587.62	-5.16%	1.63	1.55	-5.01%	3.89	3.69	-5.01%
2001	1792.83	1978.85	10.38%	1.74	1.93	10.72%	4.16	4.60	10.72%
2002	1745.32	1938.98	11.10%	1.70	1.89	11.35%	4.05	4.51	11.35%
2003	1904.34	2140.72	12.41%	1.85	2.09	12.93%	4.42	4.99	12.93%
2004	1841.66	2046.19	11.11%	1.79	1.99	11.32%	4.27	4.76	11.32%
2005	1971.94	1981.16	0.47%	1.92	1.93	0.51%	4.57	4.59	0.51%
2006	1996.90	1995.74	-0.06%	1.94	1.94	-0.02%	4.63	4.63	-0.02%
2007	2029.39	2037.55	0.40%	1.97	1.98	0.44%	4.70	4.72	0.44%
2008	1987.56	2018.59	1.56%	1.94	1.97	1.59%	4.62	4.69	1.59%
2009	1867.73	1897.11	1.57%	1.82	1.85	1.60%	4.34	4.41	1.60%
2010	1862.27	1878.31	0.86%	1.82	1.83	0.89%	4.33	4.37	0.89%
2011	1907.62	1931.57	1.26%	1.86	1.88	1.29%	4.43	4.49	1.29%
2012	2021.18	2051.83	1.52%	1.97	2.00	1.49%	4.69	4.76	1.49%
2013	1638.13	1694.77	3.46%	1.60	1.62	1.56%	3.80	3.86	1.56%
2014	1600.90	1657.44	3.53%	1.56	1.59	1.76%	3.72	3.78	1.76%

3.2.4.6 Category-specific planned improvements

Not applicable.

3.2.5 Manufacturing Industries and Construction (CRF sub-category 1A2)

3.2.5.1 Category Description

This category comprises emissions from fuel combustion in the manufacturing industries and construction (NACE categories B, C and F). The fuel types used in this sector are petrol, diesel, gas oil, fuel oil, liquefied petroleum gas (LPG), propane, kerosene and biodiesel. Biodiesel was first used in this sector in 2003 and is still being used to-date.

3.2.5.2 Methodological Issues

Fuel data for the source category 'Manufacturing Industries and Construction' was, up until 2009, provided by the Petroleum Division of Enemalta Corporation, which for many years was the sole importer of fuels used in industry. Following the liberalisation of the inland fuel market and the entry of new operators into the market, the Regulator for Energy and Water Services implemented a reporting system to collect, collate, audit and report fuel-related data to the National Statistics Office. This led to an overhaul of the activity data used for inventory purposes.

Furthermore, in recognition of the need to have a better picture of fuel use in Malta, the Malta Resources Authority, in conjunction with the National Statistics Office, carried out a detailed survey on the types of fuels used, and for which purpose(s), split according to the classification of the economic sectors, for the period 2010 - 2013. The results of the survey thus distinguished the fuel usage for each NACE Section. Following the completion of the survey, the Malta Resources Authority carried out a statistical normalization exercise whereby the survey results were 'back-casted' over the period 1990-2009. The questionnaire used to obtain the data from the survey is provided in Annex 3 of this report.

In the case of 2014 and 2015, the average of the survey results for the period 2010-2013 was used to estimate the fuel use for each NACE Section. This methodology will be applied to estimate 2016 data as well. However, it is expected that a second survey on the fuel used in the economic sectors will be carried out in 2017 and will cover the period 2014-2016. Thus, the data for the period 2014-2016 will be revised accordingly in 2017.

The results obtained from this methodological approach represent the main data source for the estimation of emissions for all the fuel combustion source categories (excluding for electricity generation since this category uses a Tier 3 approach) for the purposes of this Inventory.

The calorific values for all fuel types were aligned with those used by the National Statistics Office[17] (as opposed to using the default factors of the IPCC 2006 Guidelines). In the case of biodiesel, the calorific value used to convert the mass of fuel into the required energy equivalent is in accordance with Subsidiary Legislation 423.28[18] to convert weight of fuel into energy equivalent.

The default emission factors for direct emissions provided in the IPCC 2006 Guidelines have been used for the whole time-series. The emission factors for indirect emissions were based on the EMEP/EEA 2013 Guidelines. For the years 2010 to 2013, the percentage sulphur content of the fuels consumed has been obtained from the Malta Resources Authority. The emission factors used are shown in Table 3-5.

[17] NSO News Release 106/2015
[18] Subsidiary Legislation 423.28 (Legal Notice 278 of 2007) Petroleum for the Inland (Wholesale) Fuel Market, Bottling of LPG and Primary Storage Facilities Regulations.

Table 3-5 Emission factors and oxidation factor for category Manufacturing Industry and Construction.

Fuel Type	CO_2 (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)	NCV (TJ/KT)
LPG / Propane	63,100	1.0	0.1	150	29	23	46
Fuel Oil	77,400	3.0	0.6	74	66	25	40
Kerosene	71,500	3.0	0.6	513	66	25	43.8
Automotive Diesel	74,100	3.0	0.6	513	66	25	43
Gas Oil	74,100	3.0	0.6	513	66	25	43
Biodiesel	70,800	1.0	0.6	91	57	30	37

All the emissions from fuel combustion in the manufacturing and construction industries have been reported in the CRF under 1AA 2F 'all industry' since a sub-division of end-user fuel consumption according to NACE codes has not been undertaken to-date. It is envisaged that an exercise to identify the fuel used in each sub-division will be carried out following the completion of the survey that is expected to be undertakenin 2017 and reported in the 2018 Submission, accordingly.

3.2.5.3 Uncertainties and time-series consistency

Uncertainty in the activity data and time-series consistency were greatly ameliorated as a direct result of the implementation of the methodological approach described in sub-section 3.2.5.2.

3.2.5.4 Category-specific QA/QC and verification

Not applicable.

3.2.5.5 Source Specific Recalculations

Recalculations were performed for emissions of direct greenhouse gases in the category Manufacturing Industries and Construction due to a revision in the methodology used to apportion the total fuel used between the various NACE categories, while maintaining the sectoral fuel balance, in-line with the total fuel use in the inland market. These recalculations are presented in **Error! Reference source not found.**Table 3-6.

Table 3-6 Recalculations of direct emissions for category Manufacturing Industry and Construction

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
	CO_2	CO_2		CH_4	CH_4		N_2O	N_2O	
1990	22.67	46.09	103.30%	0.02	0.04	107.64%	0.05	0.10	107.67%
1991	24.45	49.33	101.78%	0.02	0.05	107.03%	0.05	0.11	107.36%
1992	29.52	63.04	113.54%	0.03	0.06	120.73%	0.06	0.14	121.74%
1993	30.78	63.38	105.91%	0.03	0.06	112.08%	0.07	0.14	112.73%
1994	31.88	66.45	108.42%	0.03	0.06	114.84%	0.07	0.15	115.56%
1995	36.27	72.47	99.83%	0.03	0.07	105.56%	0.08	0.16	106.08%

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
	CO_2	CO_2		CH_4	CH_4		N_2O	N_2O	
1996	36.51	72.01	97.23%	0.03	0.07	103.06%	0.08	0.16	103.70%
1997	37.25	72.83	95.50%	0.04	0.07	100.72%	0.08	0.17	101.29%
1998	35.87	56.27	56.89%	0.03	0.05	59.01%	0.08	0.12	58.96%
1999	36.29	63.55	75.14%	0.03	0.06	79.72%	0.08	0.14	80.24%
2000	36.29	55.57	53.11%	0.03	0.05	55.92%	0.08	0.12	56.07%
2001	36.78	48.84	32.78%	0.03	0.05	33.33%	0.08	0.11	32.87%
2002	36.97	54.52	47.49%	0.03	0.05	49.61%	0.08	0.12	49.49%
2003	40.80	59.06	44.75%	0.04	0.06	47.34%	0.09	0.13	47.34%
2004	42.18	58.02	37.55%	0.04	0.06	39.71%	0.09	0.13	39.54%
2005	35.15	41.75	18.78%	0.03	0.04	17.40%	0.08	0.09	16.71%
2006	36.41	36.63	0.61%	0.03	0.03	-1.86%	0.08	0.08	-2.94%
2007	37.22	38.91	4.53%	0.03	0.04	1.82%	0.08	0.08	0.68%
2008	38.85	38.87	0.04%	0.04	0.03	-2.71%	0.08	0.08	-3.83%
2009	33.91	36.27	6.94%	0.03	0.03	3.50%	0.07	0.07	2.13%
2010	24.14	25.72	6.54%	0.02	0.02	1.05%	0.05	0.05	-1.02%
2011	36.77	38.45	4.56%	0.03	0.03	0.74%	0.08	0.08	-0.70%
2012	38.38	40.55	5.65%	0.04	0.04	1.50%	0.08	0.08	-0.13%
2013	35.23	39.15	11.12%	0.03	0.03	5.79%	0.08	0.08	3.72%
2014	32.59	39.94	22.57%	0.03	0.04	17.81%	0.07	0.08	15.85%

3.2.6 TRANSPORT (CRF SUB-CATEGORY 1A3)

This category covers transport activities within Malta's national territory, thus including road transport, domestic aviation, national navigation and other relevant transport modes (where applicable), where direct emissions from such modes occur. International aviation and maritime emissions (so-called 'Memo Items') are not included under this category.

3.2.6.1 Transport - Civil Aviation (1A3a)

3.2.6.1.1 Category Description

This source category covers emissions in respect of flights that depart from and arrive at aerodromes within the Malta's territory. Aviation turbine fuel (Jet Kerosene) and aviation gasoline are used in domestic aviation.

3.2.6.1.2 Methodological Issues

Activity data for the civil aviation was obtained using the methodological approach described in sub-section 3.2.5.2.

Emission factors are based on the 2009 EMEP/EEA air pollutant emission inventory guidebook, Section 1.A.3.a tables 3.3 (Jet A1) and 3.4 (Aviation Gasoline). For the purposes of this report, all aviation turbine fuel emissions are calculated using emission factors of Domestic Cruise (Average fleet).

3.2.6.1.3 Uncertainties and time-series consistency

Uncertainty in the activity data and time-series consistency were greatly ameliorated as a direct result of the implementation of the methodological approach described in sub-section 3.2.5.2.

3.2.6.1.4 Category-specific QA/QC and verification

Data for emissions in this sector are also available from European sources such as Eurocontrol, which collects data from flight planning and route charging, and in agreement with the EU, provides this data for comparative purposes. For the current year, no comparative exercise has been carried out with the data obtained using the methodological approach described in sub-section 3.2.5.2.

3.2.6.1.5 Source Specific Recalculations

Not applicable.

3.2.6.1.6 Category-specific planned improvements

A comparative exercise with data provided by Eurocontrol is expected to be carried out for the next Submission.

3.2.6.2 Transport - Road Transport (1A3b)

3.2.6.2.1 Category Description

The transport sector in Malta is dominated by emissions from sub-category Road Transport (see Figure 3-4), with CO_2 being the gas that accounts for the bulk of overall GHG emissions for this sub-category. Road transport is also identified as a key source, for 1990 and 2015, in respect of CO_2 emissions.

Specific to road transport, the share of the market between petrol and diesel in 2015 was 39% and 58% respectively, 2.4% share of biodiesel (B100 & blended portion) and <1% share for LPG (autogas). Most of the biodiesel is sold 'pre-blended' with diesel following the implementation of the substitution obligation for importers/wholesalers of diesel (EN590) and petrol (EN228) in 2010. The substitution obligation for 2015 requires a minimum of 5.5% of the total energy content of the petroleum placed on the market. This figure is projected to increase by approximately 1% every year until it reaches the 10% RES target[19] in 2020. The trends in emissions follow closely the distribution of market shares for each fuel type as illustrated in Figure 3-5

[19] As required by Directive 2009/28/EC on the promotion of the use of energy from renewable sources

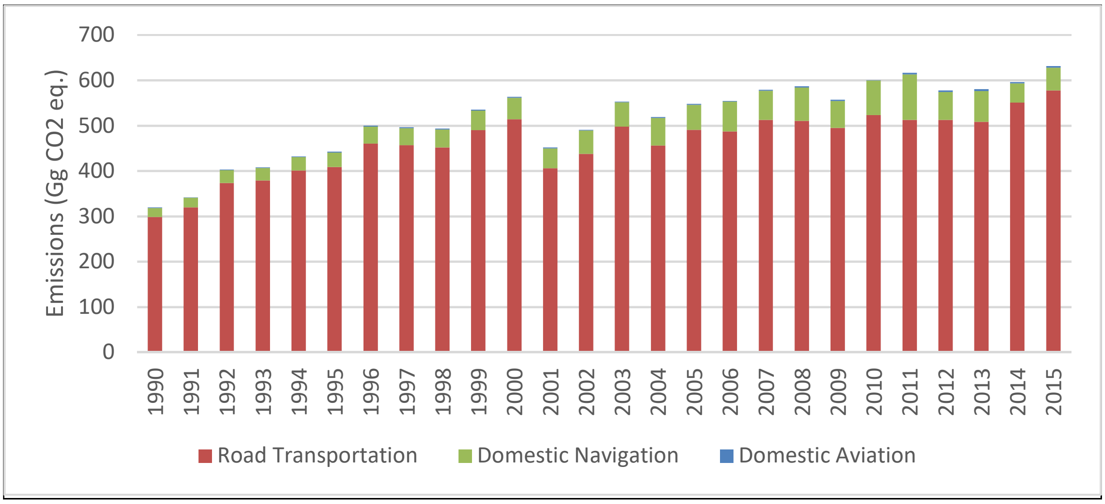

Figure 3-4 Emission trends in category Transport, by sub-category.

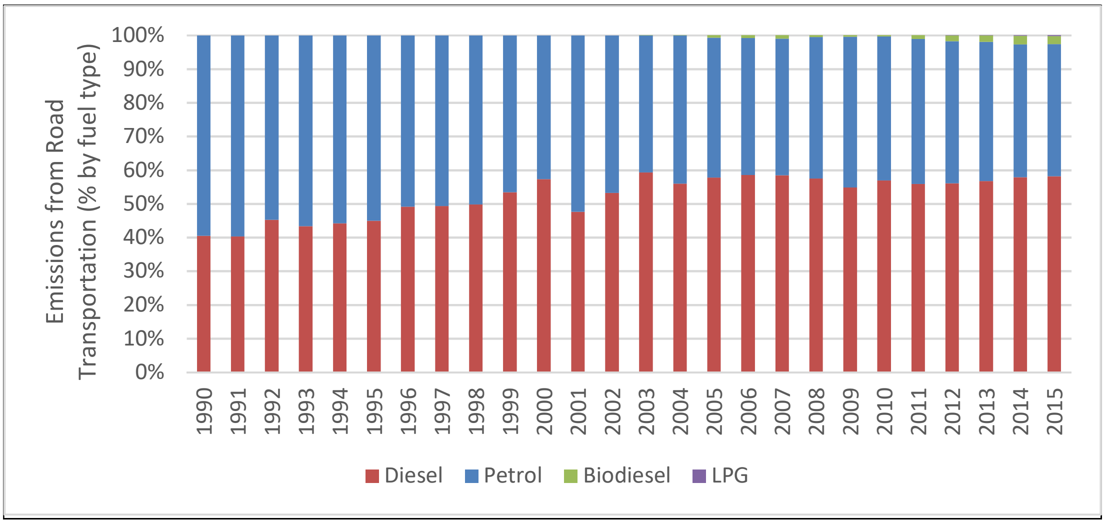

Figure 3-5 Emission trends in category Road Transport, by fuel type.

3.2.6.2.2 Methodological Issues

3.2.6.2.2.1 Methodological Issues: Activity data

Activity data for road transport was previously provided by the Petroleum Division of Enemalta Corporation, however to be consistent throughout the different source categories, the same methodological approach described in sub-section 3.2.5.2 was applied to estimate the fuels used for road transport using a 'top-down' approach.

Following recommendations made during inventory peer reviews of previous inventory submissions, it has been decided to start the implementation of a Tier 3 approach based on the 2013 EMEP/CORINAIR Guidebook and using the COPERT 5 model. The latter is a freeware developed by Emisia SA and supported by the European Environment Agency (EEA) and is used to estimate exhaust emissions for: passenger cars (1A3bi), light goods vehicles (1A3bii), heavy duty vehicles including buses and coaches (1A3biii), and motorcycles (1A3biv). A Tier 2 methodology has been used for calculating evaporative emissions (1A3bv) from petrol vehicles.

Total fuel sales for petrol, diesel, biodiesel and autogas for road transport were obtained from the Malta Resources Authority using the methodological approach described in sub-section 3.2.5.2. Other key figures, including traffic activity data, used in the estimation of emissions that are fed in the COPERT 5 were obtained from the relevant government entities or in the case were such data was not provided (or does not exist to-date), the default parameter as provided by the COPERT was used.

The disaggregation of fuel use by the specific vehicle category i.e. categories 1A3bi [Cars], 1A3bii [Light duty trucks], 1A3biii [Heavy duty trucks and buses] and 1A3iv [Motorcycles], was not possible for the time being due to issues with vehicle fleet data for the period 1990 – 2004 and their non-inclusion in the COPERT model. As a means for closing these gaps in data, it is envisaged that an exercise will be carried out in order to identify a methodological approach to estimate emissions from these sub-categories for the years prior to 2005. However, until such an exercise is completed, the annual fuel use for these categories was included under category 1A3bi [Cars].

The composition of the vehicle fleet is obtained from the National Statistics Office using the vehicle numbers of each vehicle type in each class. The other parameters that are fed into the COPERT 5 model are listed in Annex 3, and were possible, national parameters have been obtained.

The emission factors used are the default factors as per IPCC guidelines 2006 as shown in Table 3-7.

Table 3-7 Fuel based emission factors used to estimate emissions of greenhouse gases for category Road Transport.

Fuel	CO_2 kg/TJ	CH_4 kg/TJ	N_2O kg/TJ
Diesel	74,100	3.9	3.9
Petrol	69,300	33.0	3.2
Biodiesel	70,800	3.0	0.6

3.2.6.2.2.2 Methodological Issues: Emissions Data for the years 1990-2005

For the years 1990 to 2004, emissions of CO2 reported under category Road Transport are computed from the amounts of petrol, diesel, autogas and biofuel provided under road transport in the national oil balance. Emissions of NO_x, SO_2 and NMVOC have been calculated using the 2006 EMEP/CORINAIR Guidebook.

For the years 2005 to 2015, emissions from CO2, CH_4 and N_2O from road transport are estimated using the COPERT 5 model, which estimates emissions on the basis of distance travelled using a detailed bottom-up approach (Tier 3) that accounts for factors including fuel type, fuel consumption, engine capacity, driving speed and a range of applicable technological emission controls that may be applied on the basis of the age of the vehicle. The same model is also used to calculate indirect GHG emissions.

3.2.6.2.3 Uncertainties and time-series consistency

The use of the COPERT 5 to estimate emissions from 2005-2015 creates a 'break' in the timeseries, insofar as the fleet characteristics diverge from the top-down fuel consumption as reported in the oil balance report.

3.2.6.2.4 Category-specific QA/QC and verification

Quality of fleet data is ensured through the use of NSO reviewed data for fleet numbers and characteristics, which is periodically published and communicated to Eurostat.

3.2.6.2.5 Source Specific Recalculations

Recalculations for the whole timeseries was made following the provision of a revised VERA database from the National Statistics Office, changes in the estimation of fuel used for road transportation and the inclusion of [some] national parameters in the COPERT model. This necessitated a re-run of the COPERT for each year (2005-2015). These recalculations are shown in Table 3-8 below.

Table 3-8 Recalculations of direct emissions for category Road Transportation.

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
	CO_2	CO_2		CH_4	CH_4		N_2O	N_2O	
1990	334.90	312.95	-6.55%	2.30	2.29	-0.63%	4.76	4.30	-9.69%
1991	356.46	334.57	-6.14%	2.47	2.45	-0.53%	5.07	4.59	-9.29%
1992	386.94	394.71	2.01%	2.66	2.69	1.12%	5.45	5.42	-0.52%
1993	405.57	399.95	-1.39%	2.79	2.80	0.46%	5.73	5.48	-4.27%
1994	425.90	423.50	-0.56%	2.91	2.93	0.62%	6.01	5.81	-3.36%
1995	435.66	433.95	-0.39%	2.94	2.96	0.69%	6.13	5.93	-3.26%
1996	467.50	489.80	4.77%	3.08	3.14	1.80%	6.57	6.72	2.32%
1997	477.93	486.78	1.85%	3.10	3.11	0.40%	6.73	6.67	-0.88%
1998	485.97	483.52	-0.50%	3.05	3.06	0.31%	6.84	6.61	-3.36%
1999	496.74	524.87	5.66%	3.07	3.13	2.08%	6.99	7.20	3.03%
2000	509.57	552.67	8.46%	3.03	3.09	1.99%	7.16	7.61	6.17%
2001	531.71	442.98	-16.69%	2.97	2.87	-3.17%	7.52	5.94	-21.00%
2002	490.18	481.30	-1.81%	2.85	2.85	0.22%	6.84	6.47	-5.39%
2003	509.83	542.34	6.38%	2.87	2.91	1.40%	7.13	7.40	3.78%
2004	493.43	509.11	3.18%	2.82	2.87	1.63%	6.79	6.78	-0.20%
2005	547.18	539.81	-1.35%	2.89	2.58	-10.47%	7.71	5.20	-32.60%
2006	555.03	546.80	-1.48%	2.86	2.49	-13.00%	7.75	5.09	-34.34%
2007	577.29	571.25	-1.05%	3.00	2.52	-15.82%	8.09	5.28	-34.72%
2008	591.60	578.98	-2.13%	3.08	2.49	-19.12%	8.20	5.25	-35.88%
2009	564.72	549.66	-2.67%	3.11	2.32	-25.55%	7.84	5.07	-35.33%
2010	614.73	593.44	-3.46%	1.69	2.09	23.33%	6.82	5.02	-26.34%
2011	625.70	609.36	-2.61%	2.14	2.05	-4.56%	10.11	4.88	-51.73%
2012	571.00	571.01	0.00%	2.04	1.80	-11.86%	10.15	4.77	-53.05%
2013	573.46	573.93	0.08%	2.05	1.73	-15.45%	10.31	4.65	-54.90%
2014	636.60	589.14	-7.45%	2.08	1.87	-10.08%	10.76	5.25	-51.16%

3.2.6.2.6 Category-specific planned improvements

For road transport, further refinement of the COPERT input data is being sought. For next year's Submission, Malta will be considering whether to introduce year specific values for temperature and relative humidity, thus calculating the Beta values on an annual basis. Moreover, improvements in the VERA database and the specific studies to estimate key parameters, including average speed and average mileage are also expected to be carried out and which will impact the emissions of the whole time-series.

3.2.6.3 Transport - Railways (1A3c)

This source sub-category does not occur in Malta.

3.2.6.4 Transport - National (Water borne) Navigation (1A3d)

3.2.6.4.1 Category Description

Fuels used for national navigation are gasoil, fuel oil and petrol (used mainly in jet skis and small pleasure craft). Data for national navigation was obtained from Transport Malta. The latter entity collects data on bunker fuel sales directly from the operators. The types of vessels which are accounted for in the national navigation sector include pleasure cruisers, small yachts, pilot boats, tug boats, supply vessels and ferries. A detailed list is provided in Annex 3 of this report.

3.2.6.4.2 Methodological Issues

The methodological approach described in Annex 3 was applied to the activity data pertaining to national navigation in order to remain consistent throughout the different source categories.

Data on fuels used by fishing vessels was previously reported under the category 'National Navigation' but it has now been included under category 'Agriculture, Forestry & Fisheries' in accordance with Good Practice Guidelines.

Emissions from national navigation have been estimated using a Tier 1 approach. IPCC 2006 default emission factors have been used for estimating CO_2, CH_4 and N_2O emissions and for calorific values. The EMEP/EEA 2013 Guidelines are used for indirect emissions.

For SO_2 emissions, the sulphur content for marine fuels is obtained from the MRA Regulation Unit. This data is obtained through the sampling of fuels under reporting obligations of Directive 99/32/EC. The emission factors used are shown in Table 3-9.

Table 3-9 Emission Factors for category National Navigation excluding Fishing Vessels.

Fuel Type	CO_2 (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)	SO_2 (%S)
Gas Oil	74,100	7.0	2.0	1,825.58	172.09	65.12	0.06
Petrol	69,300	7.0	2.0	212.90	12,954.85	4,097.07	0.000565
Residual Oil	77,400	7.0	2.0	1,962.87	183.17	66.83	2.12

3.2.6.4.3 Uncertainties and time-series consistency

Uncertainty in the activity data and time-series consistency were greatly ameliorated as a direct result of the implementation of the methodological approach described in sub-section 3.2.5.2 and in Annex 3 and following the extensive exercise carried out in 2015 between the Malta Resources Authority and

Transport Malta to update the methodology used to identify, and subsequently classify, those vessel types that are likely to use fuels within territorial waters, and thus falling under the definition of 'national navigation'.

3.2.6.4.4 Category-specific QA/QC and verification

Not applicable.

3.2.6.4.5 Source Specific Recalculation

No recalculations were required.

3.2.6.4.6 Category-specific planned improvements

Not applicable.

3.2.6.5 Transport - Other Transportation (1A3e)

Data on specific fuel consumption by major users of diesel for airport ground support equipment and port machinery was included under the specific NACE category that this economic activity falls under i.e. under Sector 1A4 Other Sectors.

3.2.7 Other Sectors (CRF sub-category 1A4)

3.2.7.1 Category description

Source category 1A4 comprises emissions from fuel combustion in the categories Commercial/Institutional (1A4a), Residential (1A4b) and Agriculture/Forestry/Fisheries (1A4c).

The fuels used in the commercial & institutional sector (excluding fuels used for automotive purposes which are shown under Road Transport (1A3b)) are diesel, biodiesel, biogas, gasoil, fuel oil, kerosene, and propane. Up until 2004, kerosene was prominently used but this has gradually declined following a marked increase in excise duty levied on this product.

Fuels used in the residential sector are LPG, gasoil, kerosene and biomass. LPG makes up the greater bulk of fuel consumption within the residential sector (excluding fuels used for automotive purposes which are shown under Road Transport (1A3b)). This fuel type is used for heating and cooking purposes while gasoil is used for heating purposes and small generators. Fuels used in the Agriculture/Forestry/Fisheries sector are petrol, diesel, biodiesel and propane.

3.2.7.2 Methodological Issues

Activity data for this source category was previously obtained from the Petroleum Division of Enemalta Corporation. However, from 2010 onwards, the data was obtained from the National Statistics Office as reflected in the oil balance reports. The sectoral breakdown of fuel consumption follows the methodological approach described in sub-section 3.2.5.2, with the exception of the residential sector.

Activity data pertaining to the residential sector is collated from a number of sources including the Customs Department on gasoil and the Regulator for Energy and Water Services on the LPG. A number of different methodologies were also adopted depending on the fuel type or the purpose for which the particular fuel is used e.g. the volume of LPG used for cooking and heating purposes, respectively.

Activity data related to fuels used for fishing purposes under the sub-category Agriculture/Forestry/Fisheries was obtained from Transport Malta as detailed in Annex 3.

Table 3-10 Emission factors for categories Residential and Agriculture/Forestry/Fisheries.Table 3-10 illustrates the emission factors used for each fuel. The default emission factors and calorific values provided in the IPCC 2006 Guidelines have been used for the whole time-series. The other emission factors have been based on the EMEP/EEA 2013 Guidelines. The percentage sulphur content has been obtained from the Regulator for Energy and Water Services.

The emissions for solid fuels, gaseous fuels and other fuels in the CRF tables have been changed to 'NO' (Not Occurring) since the burning of solid fuels and other fuels does not occur in the Commercial/Institutional and Agriculture/Forestry/Fisheries categories.

Table 3-10 Emission factors for categories Residential and Agriculture/Forestry/Fisheries.

Fuel Type	CO_2 (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)
Agriculture Automotive Diesel	74,100	10	0.6	815.0	254.4	78.3
Fisheries Diesel Oil	74,100	10	0.6	1,825.6	172.1	65.1
Gasoil	74,100	10	0.6	513.0	66.0	25.0
Petrol	69,300	10	0.6	212.2	12,954.9	4097.1
Fuel oil	77,400	10	0.6	513	66	25
Kerosene	71,500	10	0.6	513	66	25

3.2.7.3 Uncertainties and time-series consistency

Uncertainty in the activity data and time-series consistency were greatly ameliorated as a direct result of the implementation of the methodological approach described in sub-section 3.2.5.2.

For the residential sector, it is expected that data sources or methodologies will be collated in order to have a more accurate picture on the fuels used (and for what purposes) in this sector. This approach will also streamline the time series, if a back-casting exercise is carried out.

3.2.7.4 Category-specific QA/QC and verification

Not applicable.

3.2.7.5 Source Specific Recalculations

Recalculations were performed for emissions of direct greenhouse gases in the category Other Sectors due to a revision in the methodology used to apportion the total fuel used between the various NACE categories, while maintaining the sectoral fuel balance, in-line with the total fuel use in the inland market. These recalculations are presented in Table 3-11.

Table 3-11 Recalculations for category 'Other Sectors'.

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
	CO_2	CO_2		CH_4	CH_4		N_2O	N_2O	
1990	136.16	145.65	6.97%	0.40	0.43	8.62%	0.25	0.27	6.52%
1991	147.89	143.20	-3.17%	0.43	0.42	-2.96%	0.28	0.26	-7.23%
1992	170.34	249.83	46.67%	0.50	0.78	54.05%	0.33	0.51	54.76%
1993	172.97	242.44	40.17%	0.51	0.75	46.20%	0.34	0.49	44.20%
1994	178.42	258.86	45.09%	0.53	0.81	51.65%	0.36	0.53	48.77%
1995	195.65	266.29	36.11%	0.59	0.83	41.21%	0.40	0.55	36.86%
1996	201.03	252.74	25.72%	0.61	0.79	30.16%	0.42	0.52	25.26%
1997	200.88	292.48	45.60%	0.61	0.93	52.86%	0.42	0.62	48.20%
1998	173.60	305.08	75.73%	0.51	0.96	89.82%	0.35	0.65	83.86%
1999	184.69	293.50	58.91%	0.54	0.93	70.51%	0.38	0.62	64.14%
2000	190.37	215.27	13.08%	0.56	0.66	18.10%	0.39	0.43	10.23%
2001	185.20	122.43	-33.89%	0.55	0.35	-35.93%	0.39	0.21	-45.88%
2002	187.68	132.54	-29.38%	0.55	0.38	-30.94%	0.40	0.23	-42.21%
2003	207.16	137.49	-33.63%	0.62	0.40	-35.29%	0.44	0.24	-45.52%
2004	223.80	139.36	-37.73%	0.67	0.40	-40.01%	0.50	0.25	-50.98%
2005	178.32	135.38	-24.08%	0.52	0.38	-26.22%	0.37	0.22	-40.06%
2006	183.52	121.74	-33.66%	0.52	0.33	-35.75%	0.38	0.19	-49.89%
2007	184.16	123.01	-33.20%	0.52	0.34	-35.33%	0.38	0.19	-49.75%
2008	200.50	141.32	-29.52%	0.57	0.40	-30.18%	0.43	0.23	-45.96%
2009	213.84	141.53	-33.82%	0.61	0.39	-36.31%	0.44	0.22	-50.33%
2010	185.37	134.61	-27.38%	0.52	0.47	-9.90%	0.39	0.23	-42.17%
2011	211.25	138.69	-34.35%	0.61	0.49	-19.38%	0.44	0.24	-46.03%
2012	234.11	149.30	-36.23%	0.68	0.56	-17.29%	0.50	0.27	-46.63%
2013	225.30	166.92	-25.91%	0.65	0.61	-6.82%	0.50	0.31	-37.69%
2014	209.51	187.07	-10.71%	0.60	0.70	17.23%	0.46	0.36	-19.85%

3.3 FUGITIVE EMISSIONS FROM SOLID FUELS AND OIL AND NATURAL GAS AND OTHER EMISSIONS FROM ENERGY PRODUCTION (CRF 1.B)

3.3.1 [CATEGORY] ([CRF CATEGORY NUMBER])

3.3.1.1 Category Description

Malta has no fuel refining/abstraction processes of fuels and thus limited possibilities for fugitive emissions except for those related to the retailing of gasoline, which is considered as a source of NMVOCs. The trend in this particular emission source is shown in Figure 3-6.

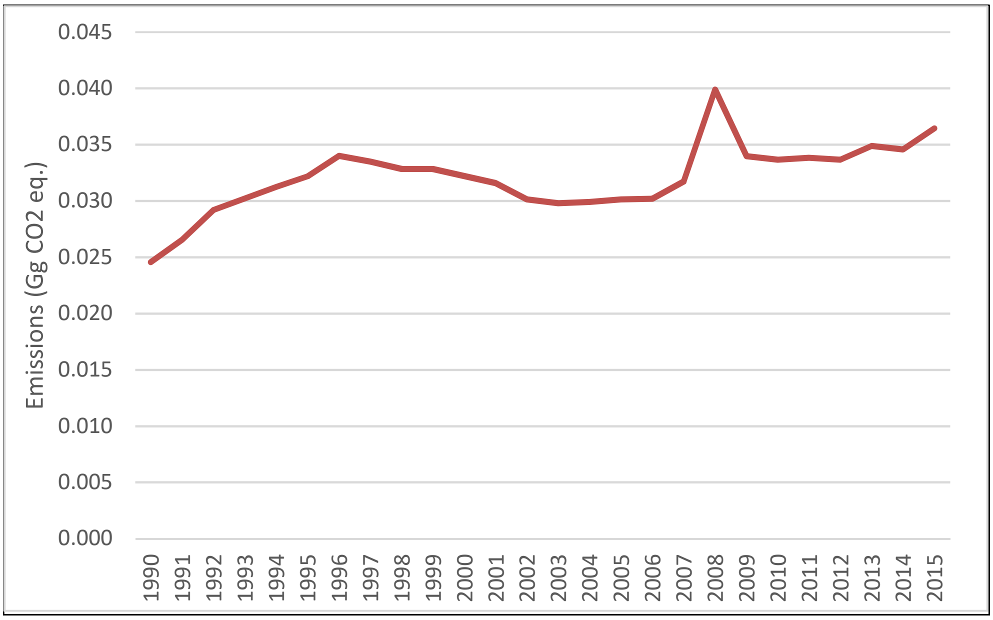

Figure 3-6 Trend in Fugitive Emission for category Transport

3.3.1.2 Methodological Issues

Activity data for this source category was related to the total volume of gasoline distributed for consumption throughout the retail network. Thus, the total amount of gasoline reported within the retail sectors has been used and an emission factor of $0.022Gg/10^3m^3$ is considered. The emission factor is sourced from table 4.2.4 of Volume 2 of the 2006 IPCC Guidelines.

3.3.1.3 Uncertainties and time-series consistency

Not applicable.

3.3.1.4 Category-specific QA/QC and verification

Not applicable.

3.3.1.5 Category-specific recalculations

No recalculations are required.

3.3.1.6 Category-specific planned improvements

Not applicable.

3.4 CO_2 TRANSPORT AND STORAGE (CRF 1.C)

3.4.1 [CATEGORY] ([CRF CATEGORY NUMBER])

3.4.1.1 Category Description

This activity does not exist in Malta.

3.4.1.2 Methodological Issues

Not applicable.

3.4.1.3 Uncertainties and time-series consistency

Not applicable.

3.4.1.4 Category-specific QA/QC and verification

Not applicable.

3.4.1.5 Category-specific recalculations

Not applicable.

3.4.1.6 Category-specific planned improvements

Not applicable.

Chapter 4. INDUSTRIAL PROCESSES AND OTHER PRODUCT USE (CRF SECTOR 2)

4.1 OVERVIEW OF SECTOR

Emissions within this sector comprise direct and indirect greenhouse gas emissions arising from various industrial activities. In Malta, the most relevant sub-sectors comprise the use of fluorinated fluids. When assessing contributions by gas within this sector, in terms of carbon dioxide equivalent, the fluorinated gases contribute to almost 100% of the direct GHG emissions in this sector, especially due to their high global warming potentials. Figure 4-1 shows direct GHG emissions in this sector increasing continuously over the whole-time series. Emissions of other GHGs in this sector are relatively marginal. A preliminary analysis of the industrial sectors in Malta shows the relative low presence of industrial production of significant GHG source. In the current situation, the vast part of emissions arises from use of products (especially refrigerants and other F-gases) rather than from production processes. In reality a good number of production sub-sectors are considered not operational.

The emissions contribution from the industrial processes sector to the total national GHG emissions in Malta amounted to 11.1% in 2015.

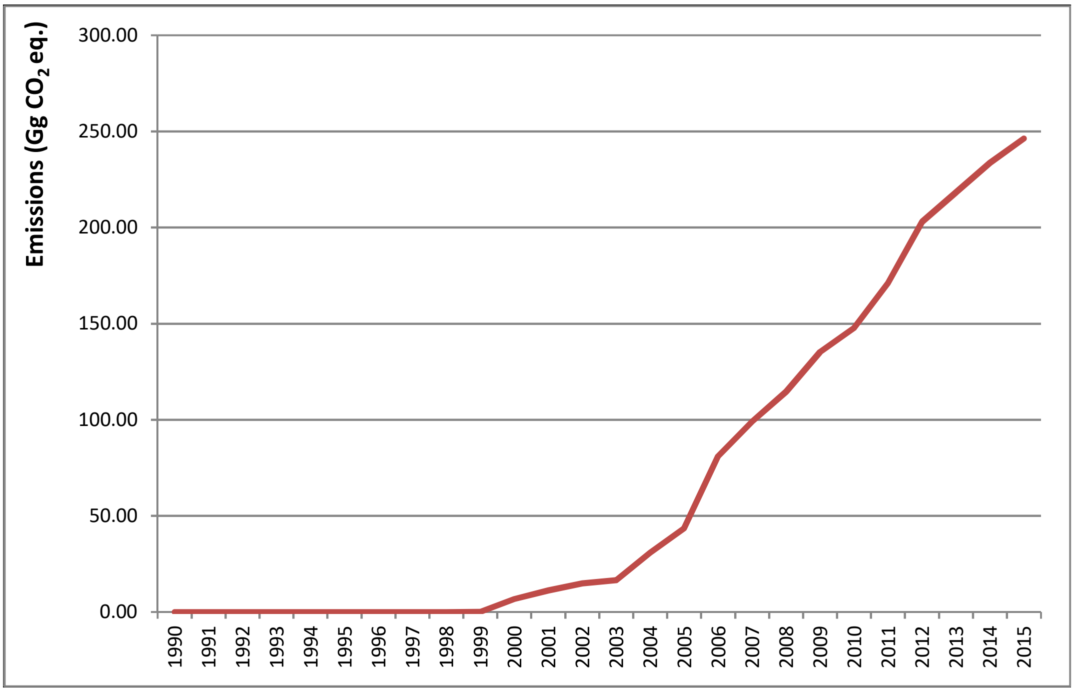

Figure 4-1 Direct GHG emissions for sector Industrial Processes and Product Use

Figure 4-2 illustrates trends in the indirect greenhouse gas emissions of NMVOC resulting from the sub-categories Road Paving with Asphalt (2A6) and Food and Drink (2D2).

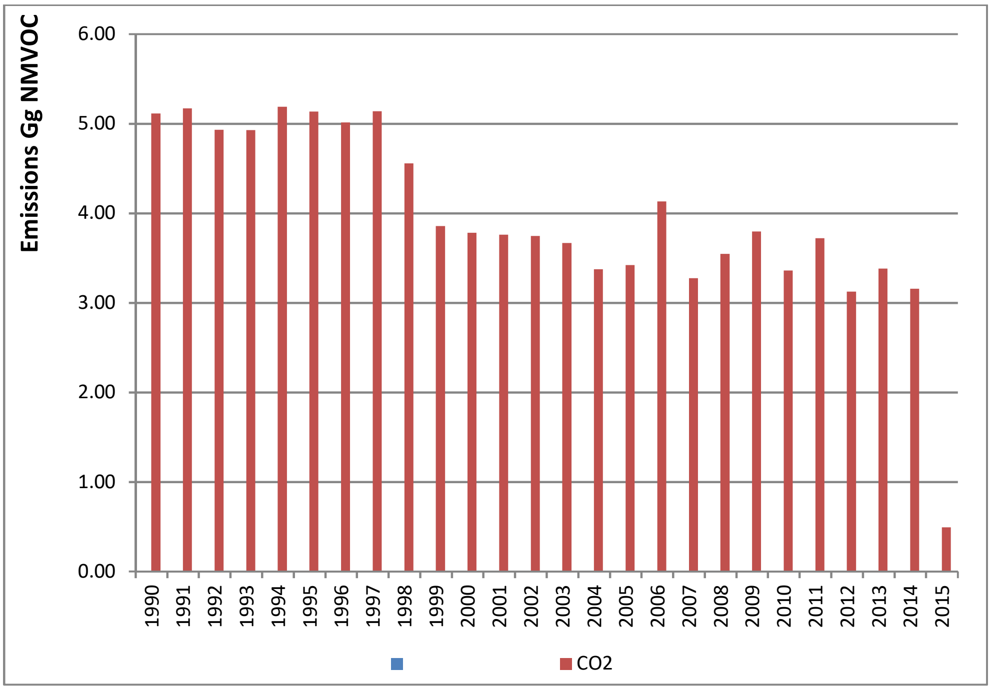

Figure 4-2 Indirect GHG emissions for sector Industrial Processes and Product Use

4.2 MINERAL PRODUCTS (CRF CATEGORY 2A)

4.2.1 MINERAL PRODUCTS - CEMENT PRODUCTION (2A1)

4.2.1.1 Category Description

This sector does not occur in Malta.

4.2.1.2 Methodological Issues

Not applicable.

4.2.1.3 Uncertainties and time-series consistency

Not applicable.

4.2.1.4 Category-specific QA/QC and verification

Not applicable.

4.2.1.5 Category-specific recalculations

Not applicable.

4.2.1.6 Category-specific planned improvements

Not applicable.

4.2.2 Mineral Products - Lime Production (2A2)

4.2.2.1 Category Description

Lime production (Quick Lime) was commonplace in Malta in the past. The lime produced was of the high calcium type. In more recent years, lime production activities no longer take place and any lime used in Malta is imported. Where applicable, activity data (quantity of lime produced) used for the estimation of emissions from this source category was compiled by Gauci (Gauci, 2000) from data provided by the then National Office of Statistics (now the National Statistics Office).

Emissions have been reported for the years 1990 till 1994, but since at the time two lime production plants were operational, the quantities of lime produced were not possible to obtain from the operators due to confidentiality rules and perceived market sensitivity data. Hence emissions for these years have been projected backwards from data available at a later stage. CO_2 emissions from this activity during the period 1995-1998 have also been reported.

4.2.2.2 Methodological Issues

The 2006 IPCC Guidelines provide two default emission factors. The Lime produced in Malta can be classified as high Calcium lime, thus an emission factor of 0.75 ton CO_2 per ton lime produced is used.

Production data for the period 1990-1994 was obtained by back extrapolation of actual production figures reported between 1995 and 1997.

4.2.2.3 Category-specific QA/QC and verification

Not applicable.

4.2.2.4 Source Specific Recalculations

No recalculations were required.

4.2.2.5 Uncertainty and time series consistency

The main issue with time series consistency in this sector has been described in the Category Description. Uncertainty is estimated at 8% for activity data and 2% for the emission factor.

4.2.2.6 Category Specific planned improvements

No planned improvements in this specific category.

4.2.3 Mineral Products - Glass production (2A3)

4.2.3.1 Category Description

This sector does not occur in Malta.

4.2.3.2 Methodological Issues

Not applicable.

4.2.3.3 Uncertainties and time-series consistency

Not applicable.

4.2.3.4 Category-specific QA/QC and verification
Not applicable.

4.2.3.5 Category-specific recalculations
Not applicable.

4.2.3.6 Category-specific planned improvements
Not applicable.

4.2.4 MINERAL PRODUCTS - OTHER USES OF CARBONATES (2A4)

4.2.4.1 Category Description
The use of Soda ash (sodium carbonate) as a raw material was identified in a large number of industries but more commonly in soap and detergent manufacture and for water treatment. Soda ash is neither mined nor produced in Malta but imported. Part of the import is used in acid neutralisation (desulphurisation) in power plants and waste incinerators. These emissions are accounted for under the specific sectors. All other uses apart from desulphurisation are included under this heading. It is being assumed that emissive uses of carbonates other than soda ash are not occurring.

4.2.4.2 Methodological Issues
Data on mass of soda ash imports by year for the whole time series were obtained from the National Statistics Office. On heating, Na_2CO_3 dissociates releasing one mole of CO_2 per mole of Na_2CO_3 heated. Via a simple stoichiometric calculation, the emission factor is determined as 415kg CO_2 emitted per tonne Na_2CO_3 used.

4.2.4.3 Category-specific QA/QC and verification
Not applicable.

4.2.4.4 Source Specific Recalculations
No recalculations were required.

4.2.4.5 Uncertainty and time series consistency
Activity data uncertainty is relatively low since imported carbonates mass is well documented in trade statistics, thus an uncertainty of 2% is assumed. On the contrary, the emission factor has a relatively high uncertainty due to the fact that the fate of carbonates not destined to desulphurisation is unknown; thus the assumption that all the carbonates imported are used in processes that release CO_2 may not be accurate. This is why a higher value of the emission factor uncertainty range (5%) is applied for this.

4.2.4.6 Category Specific planned improvements
No improvements are planned for this category.

4.3 CHEMICAL INDUSTRY (CRF CATEGORY 2B)

4.3.1 CATEGORY DESCRIPTION

The category 2B covers a wide variety of chemical production sub-categories for which, however, Malta does not have any activity. Nonetheless Malta imports Carbide for production of Acetylene, the production process used emits no Greenhouse gases, though the use of acetylene in metal welding and cutting is a source of CO_2 emissions. In cases of chemical industry subsectors, where a chemical (e.g. urea) is imported for use in other sectors, the emissions from such use are included in the respective sector's estimations.

4.3.2 METHODOLOGICAL ISSUES (2B10)

Imports of Carbide of calcium used for acetylene production as previously reported falls under CN code 28491000. Calcium carbide imports can be assumed as being 100% directed towards Acetylene production, thus imports under this CN code are included in the calculation.

The EF applied to this use is based on the stoichiometric calculation of the reactions involved in the use of acetylene based on the following assumptions:

- All carbide imported is used in Acetylene production.
- The process of acetylene production yield is 100%, thus all Carbide is transformed into Acetylene.
- All acetylene produced is combusted in the year of Production.
- Acetylene oxidation factor is set to 1.0
- Acetylene use is not considered as an energy use even though it is combusted in the process.

The chemical reactions involved are as follows:

$$2\,CaC_2 + 4\,H_2O \rightarrow 2\,C_2H_2 + 2\,Ca(OH)_2$$

$$2C_2H_2 + 3O_2 \rightarrow 4\,CO_2 + 2\,H_2O$$

This implies that 1 mole of CaC_2 would yield 2 moles of CO_2. Thus, considering the Relative molecular mass of CaC_2 as being 64 and the relative molecular mass of CO_2 as being 44, the EF can be calculated as follows:

$$64t\ of\ CaC_2 \Rightarrow 88t\ of\ CO_2\ (2x\ 44)$$

Thus, 1t of CaC_2 would yield:

$$^{88}/_{64} = 1.375\ t\ CO_2/t\ CaC_2$$

4.3.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

For activity data, noting that it is data reported to NSO in Mass, an uncertainty of ±5% is used, the EF is based on a stoichiometric reaction, for which the uncertainty is very low. Nonetheless the assumptions listed in the methodological description, invariably introduce higher uncertainty, which through Expert judgment can be assumed to be as high as ±50%

4.3.4 CATEGORY-SPECIFIC QA/QC AND VERIFICATION

Not applicable.

4.3.5 CATEGORY-SPECIFIC RECALCULATIONS

In the previous submissions, this category was excluded due to lack of guidance in the 2006 IPCC guidelines. Following UNFCCC review of the 2016 submission, the ERT recommended to re include emissions from this sector, thus triggering the below recalculation.

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Total Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
1990	NO	0.1688	NA
1991	NO	0.3376	NA
1992	NO	0.1676	NA
1993	NO	0.2082	NA
1994	NO	0.2328	NA
1995	NO	0.2480	NA
1996	NO	0.1377	NA
1997	NO	0.2212	NA
1998	NO	0.2001	NA
1999	NO	0.1392	NA
2000	NO	0.0856	NA
2001	NO	0.2041	NA
2002	NO	0.1702	NA
2003	NO	0.0949	NA
2004	NO	0.1565	NA
2005	NO	0.2568	NA
2006	NO	0.0944	NA
2007	NO	0.1010	NA
2008	NO	0.0596	NA
2009	NO	0.0956	NA
2010	NO	0.0963	NA
2011	NO	0.1288	NA
2012	NO	0.0336	NA
2013	NO	0.0336	NA
2014	NO	0.0701	NA
2015	NA	0.0701	NA

4.3.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

Not applicable.

4.4 METAL INDUSTRY (CRF CATEGORY 2C)

4.4.1 CATEGORY DESCRIPTION

The category 2C covers a wide variety of metal and alloy production activities, none of which, however, occurs in Malta. The category is thus considered as not occurring in Malta.

4.4.2 Methodological Issues

Not applicable.

4.4.3 Uncertainties and time-series consistency

Not applicable.

4.4.4 Category-specific QA/QC and verification

Not applicable.

4.4.5 Category-specific recalculations

Not applicable.

4.4.6 Category-specific planned improvements

Not applicable.

4.5 NON-ENERGY PRODUCTS FROM FUEL AND SOLVENT USE (CRF CATEGORY 2D)

4.5.1 Non-Energy Products from Fuel and Solvent Use - Lubricant Use (2D1)

4.5.1.1 Category Description

Lubricants can be generally subdivided into two major groups by their physical characteristics, liquid oils (motor and industrial oils) and more viscous greases. The main function of lubricants is to minimise friction between moving surfaces; as lubricants are exposed to relatively high temperatures, oxidisation occurs which results in certain GHG emissions. This oxidisation is not considered as an energy use and thus the emissions from these lubricants are reported in this sector. Emissions from Lube oil used in 2-stroke engines are not included in the estimate.

4.5.1.2 Methodological issues

Due to unavailability of segregated data on lubricant use, total importation data is used to calculate emissions from use. The assumption is that lubricants imported in year x are used in the same year and emissions are attributed in whole to the same year. This data could only be readily available for the years 2004 onwards, thus a gap-filling exercise was carried out to estimate activity in the sector prior to 2004. This was done by back extrapolation of net emissions from the sector. Extrapolation of emissions was preferred to extrapolation of importation data. Since default emissions factors are being used in the present calculation, back extrapolation of activity data was considered to be unnecessary.

The calculation used is based on a tier 1 approach as specified in the 2006 IPCC Guidelines. The mass of lubricant imports is converted into energy equivalent assuming 0.0402 TJ/ton of lubricant as specified in the IPCC 2006 Guidelines Volume 2 (Energy). Default values for the parameters Oxidised During Use (ODU) and carbon content are used to calculate the relative emission factor.

4.5.1.3 Category-specific QA/QC and verification

Not applicable.

4.5.1.4 Source Specific Recalculations

No recalculations were required.

4.5.1.5 Uncertainty and time series consistency

The consistency of the time series is ensured by the back-extrapolation exercise carried out, which based on expert judgement provides a conservative estimate since the growth in GDP over the years back extrapolated was far higher than the rate of increase which resulted.

To date lubricants and waxes are not included in the national energy balance calculation, thus this introduces a further factor of uncertainty in the activity data used. An uncertainty factor of 10% is used for activity data in this sub-sector. The emission factor used is based on the tier 1 approach specified in the 2006 IPCC Guidelines which also suggests that uncertainty could be as high as 50%. In view of this the emission factor uncertainty is estimated at 50%.

4.5.1.6 Category Specific planned improvements

Following the inclusion of this sector and identification of a data source, an additional data source or proxy is currently being identified to be used as a proxy. Moreover, there is currently no mention of this category in the country's energy balance, which also needs to be examined.

4.5.2 Non-Energy Products from Fuel and Solvent Use - Paraffin Wax use (2D2)

4.5.2.1 Category Description

Paraffin is a product of crude oil fractioning, and is commonly used in the production of candles, surfactants, paper coatings and polish. In Malta, since no petroleum refining occurs, all paraffin is imported, possibly transformed and largely used locally. The main source of emission from paraffin comes from its combustion in the form of candles, tapers etc. This is particularly relevant in the Maltese context due to the use of candles in religious and other popular practices. Most other uses do not emit GHGs.

4.5.2.2 Methodological issues

Activity data for this sector is obtained from importation data collected by the National Statistics Office. Data for mass of imported material is reported under specific CN codes specific to the nature of the product being imported. For paraffin wax codes 3406 0000 and 2712 20(00-99) are included[20]. This data could only be readily available for the years 2004 onwards, thus a gap-filling exercise was carried out to estimate activity in the sector prior to 2004. This was done through the back extrapolation of net emissions from the sector. Extrapolation of emissions was preferred to extrapolation of importation data. Since default emission factors are being used in the present calculation, the back extrapolation of activity data was considered to be unnecessary.

The activity data noted above is elaborated using the Tier 1 methodology and emission factors specified in the 2006 IPCC Guidelines. Default ODU and carbon content values are used to calculate emission factors for this sector. The net emission factor used is 14.6667tCO_2/TJ paraffin imported.

[20] IntraStat Combined Nomenclature 2013

4.5.2.3 Category-specific QA/QC and verification
Not applicable.

4.5.2.4 Source Specific Recalculations
No recalculations were required.

4.5.2.5 Uncertainty and time series consistency
The consistency of the time series is ensured by the back-extrapolation exercise carried out, which on the basis of expert judgement provides a conservative estimate.

To date waxes and wanes are not included in the national energy balance calculation, thus this introduces a further factor of uncertainty in the activity data used. An uncertainty factor of 10% is used for activity data in this sub-sector. The emission factor used is based on the tier 1 approach specified in the 2006 IPCC Guidelines which also suggests that uncertainty could be as high as 50%. In view of this the emission factor uncertainty is estimated at 50%.

4.5.2.6 Category Specific planned improvements
Following the inclusion of this sector and identification of a data source, an additional data source or proxy is currently being identified to be used as a proxy. Moreover, there is currently no mention of this category in the country's energy balance, which also needs to be examined.

4.5.3 Non-Energy Products from Fuel and Solvent Use - Solvent use (2D3)

4.5.3.1 Category Description
Estimated non-methane volatile organic compound emissions from the use of organic solvents and solvent-containing products are reported under this category. Solvents and related compounds include chemical cleaning substances used in dry cleaning, printing activities, metal degreasing and a variety of other industrial applications as well as household uses. All of these activities and applications make use of chemicals that contain significant amounts of NMVOCs. Emissions are produced through evaporation of the volatile chemicals when these products are exposed to air. There is a gradual increase in NMVOCs emissions over the inventory time series.

4.5.3.2 Methodological issues
The EMEP/EEA (2013) Guidebook provides two methodologies that can be used to estimate NMVOC emissions:

- Estimating the amount of (pure) solvents consumed;
- Estimating the amount of solvent containing products consumed (taking account of their solvent content).

The first method based on a mass balance per solvent is being used in this inventory process, where the sum of all solvent mass balances equals the NMVOC emission due to solvent use. The following equation was assumed for each inventory year in Malta:

Solvent Import Quantities = Solvent Consumption Quantities = NMVOC Emissions

The list of volatile chemical compounds has been used as a reference list for volatile chemicals that may be imported annually in Malta. This list of chemicals was then double-checked with the National

Statistics Office. The yearly Solvent Import quantities were provided by the International Trade Unit within the National Statistics Office.

4.5.3.3 Category-specific QA/QC and verification

Not applicable.

4.5.3.4 Source Specific Recalculations

No recalculations were required.

4.5.3.5 Uncertainty and time series consistency

In terms of time series consistency, importation data provides time consistency but due to the variety of products falling under the different codes and the relatively different behaviour of each, the level of uncertainty is rather high.

4.5.3.6 Category Specific planned improvements

No planned improvements in this specific category.

4.5.4 Non-Energy Products from Fuel and Solvent Use - Other (2D4)

4.5.4.1 Road Paving with Asphalt

4.5.4.1.1 Category Description

Asphalt road surfacing is composed of compacted aggregate and an asphalt binder. In this inventory submission, CO_2 and NMVOC emissions from both the production phase and the application phase of asphalt to road surfaces have been reported.

Quantity of Asphalt used is obtained annually from Transport Malta. For the years prior to 2011, since no consistent data source has been identified activity was back extrapolated from the available data.

4.5.4.1.2 Methodological Issues

Emissions of NMVOC for road surface (16g NMVOC per Mg asphalt produced and applied to the road surface) is used. In this inventory submission, the emission factor for both the production phase and the application phase of the asphalt to road surfaces, were applied to the Maltese activity data. The emission factor was obtained from EMEP/CORINAIR 2013 emission inventory guidebook. Malta is additionally reporting an estimate of CO_2 emissions, using the methodology provided in the 2009 Portuguese GHG Inventory Report. The Portuguese asphalt methodology assumes that solvents in asphalt products are 100% composed of NMVOC. The emitted NMVOC from the asphalt processes have on average 85% carbon content, which is the normal carbon content for medium linear simple hydrocarbons. Through multiplication, one can therefore estimate the resulting CO_2 emissions:

$$\textit{Emissions (Gg } CO_2\textit{) = Emissions (Gg NMVOC) * 0.85 * (44/12)}$$

It is also essential to note that even though the 2006 IPCC Guidelines specify that significant emissions of CO can occur from this activity, no adequate emission factor was identified, thus no CO emissions are estimated for this activity.

4.5.4.1.3 Category-specific QA/QC and verification

Not applicable.

4.5.4.1.4 Source Specific Recalculations

Following UNFCCC review of the 2016 submission, the ERT recommended to re-estimate and ensure time series consistency in this sector. To fulfil this request Malta decided to back extrapolate all the time series prior to 2011 using trend based on data from 2011 to 2014, thus triggering the below recalculation.

Year	Emissions (Gg CO2 eq.) as reported in the 2016 inventory report	Total Emissions (Gg CO2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
	Gg CO2 eq	**Gg CO2 eq**	**Gg CO2 eq**
1990	0.005	0.023	388.30%
1991	0.005	0.022	370.07%
1992	0.005	0.021	351.84%
1993	0.005	0.020	333.61%
1994	0.005	0.020	315.38%
1995	0.000	0.019	92544.94%
1996	0.001	0.018	2357.54%
1997	0.000	0.017	4393.25%
1998	0.000	0.016	4399.32%
1999	0.000	0.015	4530.75%
2000	0.000	0.014	6654.72%
2001	0.001	0.014	1593.32%
2002	0.000	0.013	3720.83%
2003	0.000	0.012	2944.83%
2004	0.004	0.011	191.34%
2005	0.015	0.010	-32.86%
2006	0.008	0.009	22.89%
2007	0.006	0.008	48.66%
2008	0.013	0.008	-42.80%
2009	0.006	0.007	18.28%
2010	0.005	0.006	23.72%
2011	0.004	0.004	0.00%
2012	0.007	0.007	0.00%
2013	0.002	0.002	0.00%
2014	0.002	0.002	0.00%
2015	NA	0.002	NA

4.5.4.1.5 Uncertainty and time series consistency

The data collected covers all public road works carried out in the geographical scope of the inventory, though private asphalt use is not included in the estimate. It is assumed that this use is limited and accounts for a marginal part of this sub-sector. Uncertainty of activity data is considered to be of 10% in line with the 2006 IPCC Guidelines, whereas EF uncertainty is assumed at 100%. This high emission factor does not affect significantly the overall uncertainty of the inventory due to the small extent of the emissions in this sub-sector.

4.5.4.1.6 Category Specific planned improvements

Not applicable.

4.6 ELECTRONICS INDUSTRY (CRF CATEGORY 2E)

4.6.1 Category Description

Advanced electronics production technologies use fluorinated compounds due to their chemical and physical characteristics. The industry makes use of both gaseous forms and liquid forms of fluorinated compounds.

The local electronics industry is relatively limited in scope, most of the processes that have been identified as emissive are not carried out locally. Local manufacturing of electronics as defined in the 2006 IPCC Guidelines generally does not occur in Malta. There is only one production plant, which falls within the scope of this sector, in the semi-conductor manufacturing sub-sector. This plant though performs only the final stages of semiconductor manufacture. It reported the use of HFC 23 and HFE 499sl as cleaning agents.

4.6.2 Methodological issues

Due to the very limited use of gases in this sector and the fact that there is only one plant in which such activities occur, activity data was directly obtained from the plant operator. The operator in question (a multinational electronics firm) compiles a GHG inventory compliant to ISO 14064. Consumption (activity) data has been extracted from this inventory. Due to the nature of the process an EF of 1 is used, thus assuming that all fluid consumed is actually emitted.

This methodology differs from what is outlined in the IPCC 2006 Guidelines. The Guidelines' Tier 2 method requires specific plant data to calculate consumption; however, this data is not available. Since it is not obligatory to report HFE499sl, this is not included in the CRF submission.

4.6.3 Category-specific QA/QC and verification

The data provider for this sector provides ISO 14064 verified inventories for calculation of emissions in this sector. The verification process is considered sufficient QC for the data submitted.

4.6.4 Source Specific Recalculations

No recalculations were required.

4.6.5 Uncertainty and time series consistency

The availability of verified data in this sector, through ISO 14064 inventories, makes the uncertainty of activity data rather low, and assumed to be 2%. Since the data submitted is actual consumption data and considering the type of process, the emission factor uncertainty is also low.

4.6.6 Category Specific planned improvements

No planned improvements in this specific category.

4.7 PRODUCT USES AS OZONE DEPLETING SUBSTANCES (ODS) SUBSTITUTES (CRF CATEGORY 2F)

Current areas of application for the products in subject include refrigeration and air conditioning equipment, foam blowing applications, fire extinguishers and metered-dose inhalers. Figure 4-3 presents a pictorial overview of emissions of these gases from various applications over the whole time series covered by this report.

For recent inventory submissions, an effort was made to improve the reporting of emissions from the consumption of halocarbons and sulphur hexafluoride. A data gathering exercise was carried out in 2011/2012, in addition to another survey done in 2009 where importation and consumption quantities of fluorinated gases for the most recent years was collected. Information on the processes taking place locally, as well as details on the gases being used was also gathered.

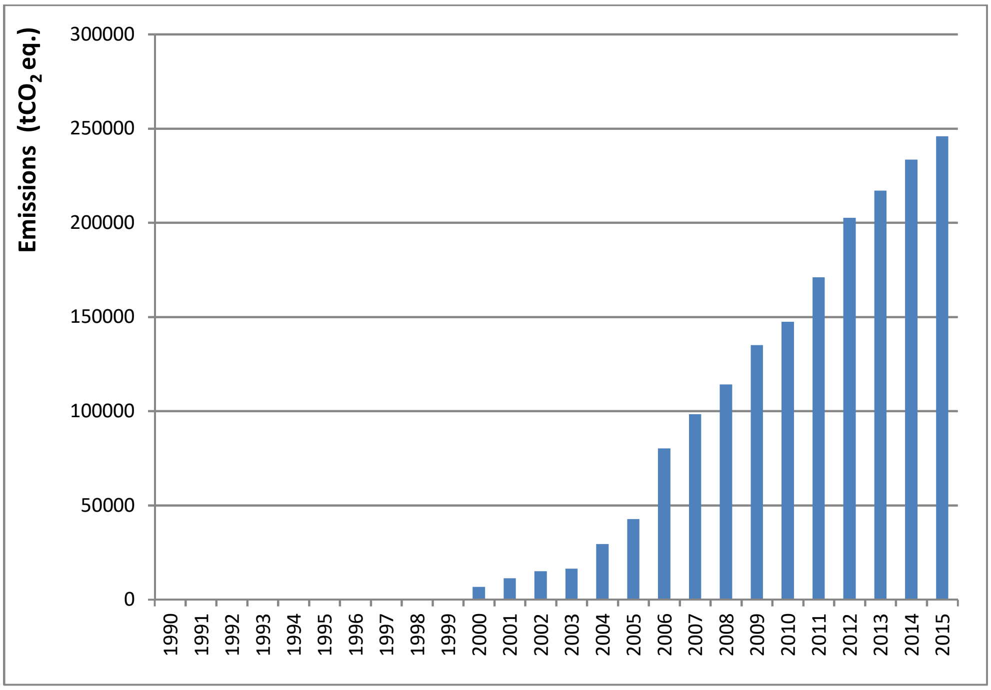

Figure 4-3 Actual emissions from category Refrigeration and Air-Conditioning

The project for the improvement of the methodology of the national inventory report in the Product uses as Ozone Depleting substances (ODS) substitutes Sector conducted between 2012 and 2014 has been concluded and first used in the NIR of 2015. Minor continuous improvements will be sustained. The current methodology is in line with the 2006 IPCC Guidelines.

More detailed information on the outcome of this improvement process is presented in the following source category discussions.

4.7.1 Product Uses as ODS Substitutes - Refrigeration and Air-conditioning (2F1)

4.7.1.1 Stationary refrigeration

4.7.1.1.1 Category Description

As in most European countries, the local market for domestic refrigeration appliances has reached saturation since many years (Abela 2012). It is estimated that about 182,000 appliances exist in ca. 139,000 households in Malta. Based on a replacement rate of 6% of the existing stock, about 11,000 domestic refrigeration and freezing equipment units are imported annually. An emission factor approach is used for emission estimates from the domestic refrigeration sub-category.

Imports of appliances containing R134a are estimated to have started in 1994 (as in most European countries) and increased gradually for some years. Previously all units were running on R12 which is an ozone depleting substance and has been subject to substitution by R134a. It is estimated that new units containing R12 were no longer imported from 2001 onwards.

Most Central European manufacturers of domestic appliances had converted their production lines to hydrocarbons (R600a) by the late 1990s, and manufacturers in Southern Europe have been following since. Therefore, it is assumed that imports containing hydrocarbons as refrigerants started in 2000 at a low rate of 10% and have increased from then onwards to a stable rate of 90% since 2008.

Commercial refrigeration today accounts for large parts of the F-gas demand, with R404A being one of the main refrigerants imported to Malta. This refrigerant blend is mainly used in supermarket installations (centralised systems) but also other types of small commercial refrigeration equipment. Commercial refrigeration systems are very diverse as they are usually customised to meet specific requirements (e.g. concerning the temperature ranges for different products) and built on site. The same applies to industrial refrigeration equipment which includes a large range of equipment types to cater for the needs of various industries. As no equipment register or statistical information on commercial and industrial refrigeration systems are available in Malta, the approach chosen for emission estimates relies on import data of HFC bulk substances which are partly used for first fill and refill of commercial and industrial refrigeration systems.

While in other European countries alternative commercial refrigeration technologies relying on natural refrigerants such as CO_2 as a refrigerant and hydrocarbons are gradually being introduced to the market, this development has not started in Malta yet.

4.7.1.1.2 Methodological issues

For domestic refrigeration the average charge size of 0.2 kg indicated by Abela (2012) is used as well as an estimated average lifetime of 15 years (CasaInginiera, 2012). No detailed information on the disposal of domestic appliances is available. CasaInginiera (2012) assumes that no recovery procedures are in place for scrapped equipment which, however, has not been confirmed by the national authorities. A disposal emission rate of 90% is assumed (recovery < 10%).

For commercial refrigeration the method chosen is a top-down approach: imported quantities of different refrigerants as reported by gas suppliers are used as the starting point for estimates. Refrigerants fully attributed to the commercial refrigeration subcategory (including transport refrigeration and industrial refrigeration) are R404A, R417A, R422A, R422D and R507A.

The situation is different for R134a, which is mainly used in mobile air conditioning devices but also to some extent in stationary (and transport) refrigeration applications. Thus, quantities used in the mobile air conditioning subcategory are calculated first (see relevant subcategory) and the remaining quantities are attributed to the commercial refrigeration subcategory.

The quantities of the refrigerants attributed to the commercial refrigeration sub-category imported annually are used both for first fill of new equipment and refill of existing equipment.

The amounts of refrigerants (mainly R134a, some R404A) needed annually for servicing of mobile air conditioning and transport refrigeration are deducted from the total imports of R134a and R404A. It is assumed that due to the relatively high temperatures in Malta mobile air conditioning and mobile refrigeration systems are being serviced regularly and that emitted refrigerants are refilled without major delay. Hence the calculated emissions for mobile AC and mobile refrigeration equal the quantities refilled in the same year.

The remaining refrigerant quantities of R134a, R404A, R417A, R422A, R422D and R507A, are attributed to the commercial refrigeration sub-category (including industrial refrigeration).

The chosen methodology for estimation of emissions in this sub-sector is similar to the one used for domestic refrigeration with a sub-sector specific emission factor of 10% from current year and banked gases used. The 20% includes both operation and disposal emissions in the sector, in view of the fact that disposal emissions for such larger systems are usually small due to recollection of gas.

4.7.1.1.3 Category-specific QA/QC and verification

Not applicable.

4.7.1.1.4 Source Specific Recalculations

Recalculations under this subsector will be described at the end of Section 4.7.1.6.

4.7.1.2 Stationary Air-conditioning

4.7.1.2.1 Category Description

The Maltese stationary air conditioning market cannot yet be considered a mature market (CasaInginiera, 2012) but it is growing steadily.

The equipment types used include room air conditioners mainly imported from Asia, and chillers, mainly imported from Southern and Western Europe. Manufacturing emissions hardly occur but emissions during topping-up (mostly of pre-charged equipment) on installation do occur. These emissions are accounted for within lifetime emissions.

According to Maltese industry experts, the refrigerants R407C and R410A are the only HFC-refrigerants used in stationary air conditioning systems apart from R22 in older systems. The latter however is an Ozone Depleting Substance (ODS) and thus not subject to emission reporting. Hence the quantities of R407C and R410A imported for servicing are fully attributed to the stationary air conditioning category. These refrigerants entered the Maltese market only after its accession to the EU in 2005, given that R22 was used previously. Thus, HFC emissions from this sub-category started occurring only from 2005 onwards.

4.7.1.2.2 Methodological issues

For stationary air-conditioning systems a Tier 2 methodology has been preferred mainly due to the general dissemination of equipment across all sectors including domestic and commercial, mainly composed of smaller equipment.

The method chosen is a top-down approach: Imported quantities of different refrigerants as reported by gas suppliers are used as the starting point for estimates. Refrigerants fully attributed to the stationary air conditioning subcategory are R407C, R410A, R427A and R428A.

The quantities of the refrigerants attributed to the stationary air conditioning sub-category imported annually are used both for first fill of new equipment and refill of existing equipment.

Just as for commercial refrigeration, a bank of gases is built up through yearly imports of gases assigned to this sub-sector. An EF of 7% annual loss from the bank has been assigned to this sector which includes installation operation and disposal emissions.

4.7.1.2.3 Category-specific QA/QC and verification

Not applicable.

4.7.1.2.4 Source Specific Recalculations

Recalculations under this subsector will be described at the end of Section 4.7.1.6.

4.7.1.3 Transport Refrigeration

4.7.1.3.1 Category Description

Transport refrigeration comprises vehicle and self-powered refrigeration units used in commercial vehicles. The biggest source within transport refrigeration is the local movement of perishable (frozen or refrigerated) goods in Malta. This includes transport from port or producer to distributor and from distributor to commercial premises. The sector also includes emissions from the use of refrigerated trailers. Contrary to air-conditioning systems, it is estimated that the dominant refrigerant used in the transport refrigeration sector is R-404A and not R-134a.

4.7.1.3.2 Methodological issues

Emission estimates for transport refrigeration are also based on an emission factor approach. Data on the number of refrigerated trucks and vans was obtained through the VERA system managed by Transport Malta and the National Statistics Office, the total is used to estimate emissions. Since most vehicles are imported from the UK, the same average charge of 3.9 kg for mobile refrigeration is used as reported in the UK NIR (2013).

Both R404A and R134a are used in transport refrigeration today and the split of the two refrigerants can be assumed to be 90% of R404A and 10% of R134a (expert estimate[21]). However, it is also assumed that R134a was the only refrigerant used in transport refrigeration in the period 2000-2004. R404A units were introduced in 2004 and emissions in that year only arose from the newly imported units. Refill of these units is assumed to have taken place in 2005 when imports of bulk quantities of R404A were first reported. The current number of refrigerated vans, trucks and trailers is not available from vehicle registration data or model reported.

[21] Stakeholder consultation: Sébastien Lemoine, company "Carrier", 5 November 2013.

Manufacturing emissions do not occur in Malta since no vehicle production takes place. A rate of 15% for operation emissions is used based on the fact that mainly short-distance transportation is carried out and the assumption that servicing and repair take place regularly. However, a European study (Schwarz et al. 2011) suggests higher emission rates of up to 25%.

Disposal emissions will only take place from 2016 onwards due to the introduction of HFC-refrigerants in 2001 and their estimated lifetime of 16 years.

4.7.1.3.3 Category-specific QA/QC and verification

Not applicable.

4.7.1.3.4 Source Specific Recalculations

Recalculations under this subsector will be described at the end of Section 4.7.1.6.

4.7.1.4 Mobile Air Conditioning

4.7.1.4.1 Category Description

Emissions from mobile air conditioning today account for large shares of F-gas emissions in all European countries. Most vehicles imported in recent years are equipped with air-conditioning. In view of the local weather patterns it is also expected that air-conditioning in vehicles is regularly maintained in running order.

4.7.1.4.2 Methodological issues

As the refrigerant R134a is the main refrigerant used in mobile air conditioning of road vehicles and vehicle registration data for passenger cars, minibuses, buses, trucks are available, it was decided that emission estimates will follow an emission-factor approach.

For emission estimates from mobile air conditioning in ships, the approach chosen relies on data of bulk imports by a ship repair company.

4.7.1.4.2.1 Road vehicles

The method used for emission estimates is based on vehicle registration data for passenger cars, minibuses, buses, coaches and trucks.

Relative to the country's size, the size of the car fleet of Malta is significant, at around 346,918 licensed passenger cars in 2015, an increase of 3.5% over the last quarter of 2014 (>799 cars per 1,000 inhabitants; EU average ca. 498 in 2014). However, it is assumed that a proportion of these cars are not used on a daily basis. Both new and second-hand vehicles are being imported, mainly from the UK and Japan (due to left hand driving systems as in Malta). Export of end-of-life vehicles or second hand cars is negligible.

The lifetimes of all types of vehicles in Malta are comparably high since it is a country heavily depending on imports. Local experts in the business of mobile AC servicing[22] estimated that the

[22] References: Companies "V.Spiteri", "Tecnoplus".

currently used refrigerant R134a, introduced in new cars in 2000[23], has been the only refrigerant for car air conditioning since 2005 both in new and in second hand cars.

Due to the phase-out of the ozone depleting refrigerant R12 and the accession of Malta to the EU in 2004, R12 was no longer available from then onwards.

Concerning new refrigerants, local gas suppliers contacted during the stakeholder consultation[24] confirmed that no imports of HFC-1234yf have taken place so far since no vehicles with AC systems running on this new refrigerant have been imported.

A time series of the vehicle fleet in Malta (passenger cars, vans, trucks, buses) and an estimated number of air-conditioned vehicles has been used for emission estimates.

The percentage of air-conditioned vehicles of 54% in 2012 is the same as in a model by Emisia[25] on the vehicle fleet used also for other categories of the Maltese greenhouse gas inventory. The current AC quota of new cars is assumed to be about 90%. There is no data on the number of new cars available therefore it is calculated as the stock divided by the average lifetime plus the increase in stock compared to the year before. It is calculated that the AC quota of new cars in the year 2000 was about 50%, which is rather low compared to other European markets (e.g. Germany: 90% in 2000).

Lifetime: 16 years for all types of road vehicles (cars, trucks and buses) which range at the upper end of the span of 9 to 16 years provided in the 2006 IPCC Guidelines (table 7.9, p. 7.52).

As for passenger cars, the average charge is estimated to be 0.8 kg, which is also the default value given in the IPCC Good Practice Guidelines and well within the range of 0.5 to 1.5 kg provided by the 2006 IPCC Guidelines. The value is somewhat higher than in other European countries but takes into account the relatively long average lifetime of vehicles in Malta. As for buses and coaches, the average charge is 12 kg and for mobile air conditioning in trucks, a charge of 0.9 kg is assumed.

4.7.1.4.2.2 Ships

Two ship repair facilities exist in Malta: Palumbo Ship Repair (since 2010; formerly Malta Shipyards/ Dry-docks) and Cassar Ship Repair. In addition, Palumbo Malta Superyachts Ltd is a major local provider of general servicing and refitting services for yachts.

During the stakeholder consultation, it was found that additional quantities of refrigerants had been imported by one of the ship repair companies (Palumbo Ship Repair). These quantities are used for the refill of refrigeration and air conditioning systems of yachts and small Maltese ships and not sold on the Maltese market.

The other ship repair company (Cassar Ship Repair) usually sub-contracts repair work of air conditioning and refrigeration systems of ships to Maltese service companies. Refrigerant quantities used are hence accounted for within the commercial refrigeration or stationary air conditioning sub-category of 2F1 and cannot be separated.

Large sea-going ships that are registered under Malta's flag, but are operated by foreign owners, and coming to Maltese ports, usually bring along their own refrigerant supplies which is mostly not purchased in Malta due to comparably high prices. Thus, the ship's own refrigerant supply is used for servicing and repair needs. Emissions from ships which occur in areas beyond national jurisdiction are not accounted for in the national inventory.

[23] This finding is somewhat contradictory to the situation in most other European countries as the European carmakers were not producing cars with air conditioning systems containing R12 from 1995 onwards. However, second hand cars running on R-12 might have been imported well beyond 2000.
[24] Reference: John Catania, Multigas.
[25] EMISIA SA. Antoni Tritsi 21, GR 57 001, Thessaloniki, Greece.

Imports of bulk HFC quantities by one ship repair company amount to 120 kg of R410A (50% HFC-32; 50% HFC-125) and 80 kg of R134a annually since 2010. These quantities account for emissions from certain air conditioning systems on small national ships operating in Maltese waters and thus equal operation emissions from these ships in the respective years.

Before 2010, the ship repair facility was state-owned (Malta Shipyards/Drydocks) and substantially larger. No information on the historic time series before 2010 is available. However, based on the information for bulk imports reported by companies and expert input, it is estimated that the same level of F-gas emissions occurred since 2005 (first year of import of R410A). Prior to 2005, only R22 was used in refrigeration and air conditioning systems on ships.

4.7.1.4.3 Category-specific QA/QC and verification

Not applicable.

4.7.1.4.4 Source Specific Recalculations

Recalculations under this sub-sector will be described at the end of Section 4.7.1.6.

4.7.1.5 Category-specific QA/QC and verification

Not applicable.

4.7.1.6 Source Specific Recalculations

Following review of the methodology used, it was identified that the calculation used to estimate the number of vehicles with A/C installed in the previous submission was incorrect, giving incongruent numbers of vehicles with A/C in cases actually larger than the total number of vehicles, thus it was corrected. The new approach takes the actual number of vehicles and multiplies this by a number (<1) to obtain the number of air-conditioned vehicles in the fleet. The factor used was obtained by expert judgment (10% of vehicles in 2000 with a linear increase of 2.9% per year). Secondly, following the outcomes of the UNFCCC review of the 2016 submission, an investigation into the number of refrigerated vans and trucks reported in the inventory was carried out and this number was updated. These changes affected the emissions from the transport sector and, since the distribution of HFC 134a between categories is dependent on usage, the amount of HFC 134A assigned to other categories was also affected.

Table 4-1 Recalculations for category Refrigeration and Air-Conditioning.

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Total Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
1990	NO	NO	NA
1991	NO	NO	NA
1992	NO	NO	NA
1993	NO	NO	NA
1994	0.001	0.001	0.00%
1995	0.002	0.002	0.00%
1996	0.003	0.003	0.00%
1997	0.005	0.005	0.00%

Year	Emissions (Gg CO_2 eq.) as reported in the 2016 inventory report	Total Emissions (Gg CO_2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
1998	0.008	0.008	0.00%
1999	0.011	0.011	0.00%
2000	2.065	6.701	224.45%
2001	8.011	11.258	40.54%
2002	12.953	14.985	15.68%
2003	15.621	16.455	5.34%
2004	20.548	29.475	43.44%
2005	35.228	42.772	21.41%
2006	72.703	80.225	10.35%
2007	85.243	98.367	15.40%
2008	100.996	114.172	13.05%
2009	121.890	135.062	10.81%
2010	137.996	147.498	6.89%
2011	157.155	171.049	8.84%
2012	192.685	202.535	5.11%
2013	210.389	216.998	3.14%
2014	227.293	233.402	2.69%
2015	NA	240.896	NA

4.7.1.7 Uncertainty and time series consistency

It is implied that due to the nature of this sector, it is expected that efforts are made to reduce uncertainty of estimation to a minimum. The current methodology provides better certainty than the previously used Tier 1 methodology since it disaggregates uses of the diverse gases and provides for sub-sector specific emission factors. The relative completeness of the data collected (for bulk imports) and the characterisation of the Market through studies further reduces the uncertainty in this sector. A key source of uncertainty is still the distribution of the different gases across the sectors, since it is mostly based on a one-time study and not an annual recurrent exercise.

EF uncertainty originates mainly from the use of emission factors that are either default emission factors or based on general Europe-wide data, which may not completely represent the Maltese situation. However, it is still considered as good practice to use such emission factors in the absence of Country specific emission factors.

4.7.1.8 Category Specific planned improvements

No planned improvements in this specific category.

4.7.2 Product Uses as ODS Substitutes - Foam Blowing Agents (2F2)

4.7.2.1 Category Description

HFCs are commonly being used in the foam blowing industry, mainly as replacements for CFCs and HCFCs. The distinction in types of foam between open-cell and closed-cell relates to the way in which the blowing agent is lost from the product. For open-cell foam, emissions of fluorinated gases used as blowing agents are likely to occur during the manufacturing process and shortly thereafter. Open-celled foams are used for applications such as household furniture cushioning, mattresses and moulded products.

In closed-cell foam, only minimum emissions occur during the manufacturing phase. Emissions therefore extend into the in-use phase, with often the majority of emissions not occurring until end-of-life. Closed-cell foams are primarily used for insulating applications where the gaseous thermal conductivity of the chosen blowing agent is used to contribute to the insulating performance of the product throughout its lifetime.

In the present inventory compilation, local businesses involved in foam preparation and use were identified. The types of fluorinated gases used and the applications carried out were noted. Emissions for HFC-227ea and HFC 365mfc, which is typically used as a flame retardant in the foam applications, have been reported. In 2010 no emissions were reported thus this sector is reported as NO.

4.7.2.2 Methodological issues

Estimating emissions for the two different types of foam requires a different methodological approach. Activity data for this category was collected by contacting all foam sector businesses registered with the Regulator for Energy and Water Services, a list is of which is available at http://www.rews.org.mt, as part of a government-run rebate scheme for the promotion of insulation in households. The rate of response was rather limited; however, it is assumed that the vast majority of the local foam blowing market is covered by the data actually gathered.

Closed-cell foams, due to their characteristics, cannot be accounted for using a simple methodology similar to the one used for open-cell foams. Thus, a Gamlen-based model for estimating emissions started being used in recent years for inventory purposes for the activities: blown foam and imported foam. The method is based on the mass of foam blown in a year and assumes that 1% of the mass of the foam is in fact blowing agent. The model also assumes that the lifetime of the product is 15yrs and that a constant 4.5% emission of blowing agent occurs in each year of its lifetime and that the remaining 32.5% of blowing agent is emitted in the year of destruction.

Imported closed-cell foams are also accounted for in this submission. The method of calculation is identical to the one used for locally blown closed-cell foams but omitting first year emissions as it is assumed that this emission will mainly take place at the point of production or during transit, nevertheless before entering the geographical scope of this inventory.

4.7.2.3 Category-specific QA/QC and verification

Not applicable.

4.7.2.4 Source Specific Recalculations

No recalculations were required.

4.7.2.5 Uncertainty and time series consistency

The inclusion of imported foams in addition to locally blown foams improved the completeness of the current inventory compilation. As specified in the 2006 IPCC Guidelines, there is significant uncertainty in the estimations of activity and emissions in this sector. This is especially relevant to such source categories in countries where consumption is very limited.

4.7.2.6 Category Specific planned improvements

No planned improvements in this specific category.

4.7.3 Product Uses as ODS Substitutes - Fire Protection (2F3)

4.7.3.1 Category Description

Nowadays fire protection (fire suppression) equipment using HFCs and/or PFCs is being used as partial replacement for halons. While actual emissions from the fire protection sub-sector are expected to be quite small, the use of such gases is growing, resulting in an accumulating bank of future potential emissions.

4.7.3.2 Methodological issues

The use of HFC-227ea has been identified in such applications. Local enterprises providing fire protection services were asked to indicate the use (if any) of fluorinated gases in fire protection systems.

It has been difficult to identify all the establishments that have fire protection systems containing HFC-227ea installed on their premises. In the past, where this was possible, the annual releases of HFC-227ea during fire incidents or accidental leakages were reported by the establishments, with annual activity data since the year 2004 being provided. For the present inventory submission, the data collection focus was on firms offering fire extinguishing equipment servicing in an effort to enhance coverage of HFC-227ea use.

4.7.3.3 Category-specific QA/QC and verification

Not applicable.

4.7.3.4 Source Specific Recalculations

No recalculations were required.

4.7.3.5 Uncertainty and time series consistency

Activity data uncertainty in this sector is relatively low due to the possibility of extensive coverage of the small sector given that only two service providers carrying out such services were identified. Thus, coverage was guaranteed through information gathered from both service providers.

4.7.3.6 Category Specific planned improvements

No planned improvements in this specific category.

4.7.4 Product Uses as ODS Substitutes - Aerosols and Metered Dose Inhalers (2F4)

4.7.4.1 Category Description

Most aerosol packages contain hydrocarbons as propellants albeit in a small fraction of the total content. HFCs and PFCs may be used as propellants or solvents. Through the use of aerosol products, 100% of the propellant or solvent chemicals in such products are emitted.

Local potential importers were identified through communication with the Medicines Authority, It was established that Metered-Dose Inhalers (MDIs) containing the medical fluorinated propellant Norfluorane (HFC-134a) have been imported since the year 2004. In general, today only a few technical aerosol products contain HFCs and relate mainly to technical sprays used for the manufacture and/ or the repair of electrical and electronic equipment where only non-flammable substances (such as HFCs) may be used. No other uses of aerosols have been identified.

4.7.4.2 Methodological issues

The local importers have provided activity data on the annual quantities of imported inhalers containing Norfluorane. The charge of propellant per inhaler type was also provided. In some instances, where the actual charge of propellant was not identified, the default value of 10g Norfluorane per inhaler was applied. Emissions from the use of MDIs were assumed to take place during the actual importation year. The emissions of HFCs from use are proportional to the amount of HFC containing MDIs imported and their relative charge. A significant increase in importation numbers was observed. It is also noted that the average charge per unit imported increased from 10.8g/unit to 12.4g/unit between 2009 and 2011.

4.7.4.3 Category-specific QA/QC and verification

Not applicable.

4.7.4.4 Source Specific Recalculations

No recalculations were required.

4.7.4.5 Uncertainty and time series consistency

Production and imports of medicinal products is controlled through the Medicines Authority, though data on propellants used may not be always readily available. The main uncertainty in this field is the uncertainty with respect to propellant charge per unit and the fate of residual charge after use of the product or its expiry.

4.7.4.6 Category Specific planned improvements

Currently efforts are being focused on creating an alternative approach, which could be based on the prevalence of asthma amongst the Maltese population and the methods of treatment (i.e. type of inhalative therapy) (Schwarz, et al., 2011). This methodology could serve as a quality assurance mechanism. Only two types of HFCs are used in MDIs: HFC-134a and HFC-227ea (only one manufacturer worldwide). The typical charge contained in each product (10 ml) ranges at 12 grams of HFC-134a and at 14 grams of HFC-227ea (reference for example: 2012 NIR Germany, p. 351: "0.15 g per 10 ml inhaler").

4.8 OTHER PRODUCT MANUFACTURE AND USE (CRF CATEGORY 2G)

4.8.1 OTHER PRODUCT MANUFACTURE AND USE - ELECTRICAL EQUIPMENT (2G1)

4.8.1.1 Category Description

SF_6 has unique properties that allow the optimised operation of electrical switchgear and electricity networks. Electrical equipment based on SF_6 technology is used in the generation, transmission and distribution of electricity. SF_6 is also used in medical radiotherapy linear accelerators. While SF_6 possesses a unique combination of properties ideal for its uses, it has a potent greenhouse effect and despite great research efforts, to date no equivalent alternative gas has been identified.

Enemalta plc is identified as the main local user and emitter of SF_6 gas from switchgear equipment (emitting around 99% of the total estimated in 2014). Such switchgear equipment is found in the two local power generation plants operated by this organisation (Delimara and Marsa Power Stations, the latter currently on cold standby) and in the Electricity Distribution Network (substations and distribution centres).

Other users of SF_6-containing equipment include two hospitals (Sir Paul Boffa Hospital and Mater Dei Hospital) as well as a number of private establishments.

4.8.1.2 Methodological issues

In the year 2008, as part of this inventory process, industrial establishments and institutions that have SF_6-containing equipment in operation were identified. Through contacts with these organisations, data on the quantities of SF_6 gas contained in equipment by type (closed or sealed switchgear, linear accelerator), as well as information on installation dates, maintenance procedures and leakage rates per equipment type, were made available. The leakage rates as provided by the manufacturers of the respective equipment have been used to estimate emissions. It has been noted that during maintenance work, contaminated SF_6 is evacuated, collected in cylinders and shipped abroad for purification.

Where entities operating equipment containing SF_6 have not reported changes to equipment, that equipment is considered as still being in operation under constant operating conditions, with the level of emissions being assumed to be at a constant rate. In the case of any equipment that has been identified as being in operation but for which the respective operator has not provided estimates of emissions, IPCC 2006 Guidelines default emission factors have been used.

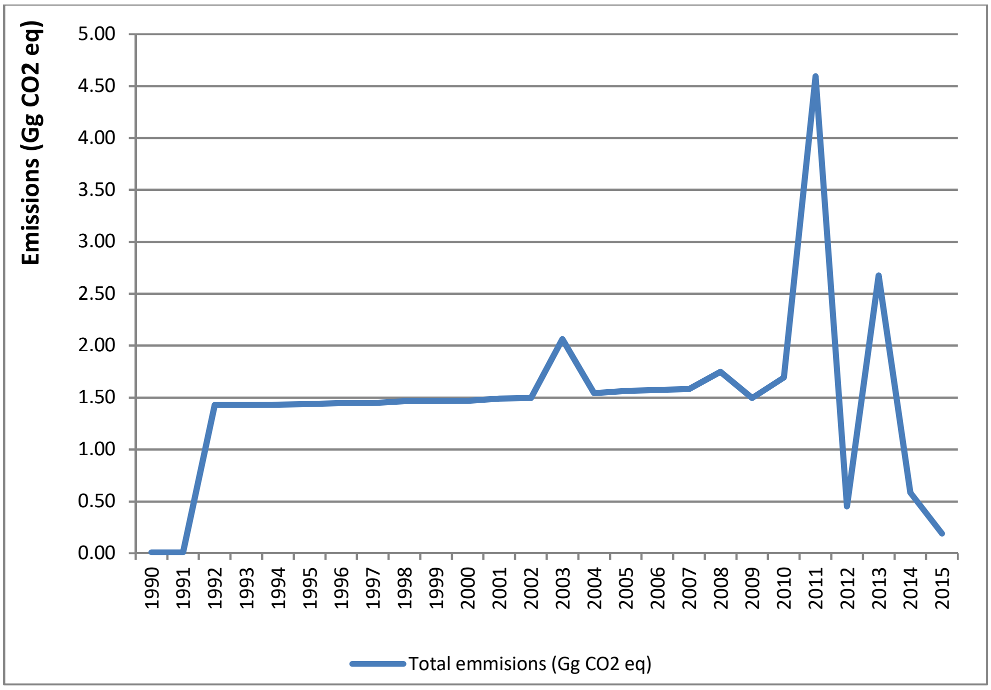

Figure 4-4 SF_6 Emissions from category Electrical Equipment

Figure 4-4 presents the sulphur hexafluoride emissions in carbon dioxide equivalents over the inventory time series. The emissions in the years 1990 and 1991 are minimal due to the very limited extent to which equipment containing SF_6 was used at the time (mainly in the electricity distribution network). The commissioning of new equipment, by current and new (including private industry as from around the year 2000) operators as well as extensions to existing systems explains the subsequent significant increase, compared to 1990 and 1991.

The spike in emissions reported for the year 2003 resulted from an incident at one of the establishments operating such equipment during which SF_6 was released from switchgear equipment in a substation badly damaged by a storm. The much more significant spike in emissions reported for 2011 is the consequence of a leak detected in a local power plant which could not be immediately repaired, with the operator having to continuously maintain the charging of gas into the leaking system until the leak was eventually closed. A specific cause for the 2013 peak has not yet been identified.

4.8.1.3 Category-specific QA/QC and verification

Not Applicable.

4.8.1.4 Source Specific Recalculations

No recalculations were required.

4.8.1.5 Uncertainty and time series consistency

The data collection for the major emitter in this sector (electricity generation and distribution) is collected by the operator of the grid and due to this it has very low uncertainty. It is assumed that 5% activity data uncertainty and 2% EF uncertainty is sufficient.

4.8.1.6 Category Specific planned improvements

No planned improvements in this specific category.

4.8.2 Other Product Manufacture and Use - SF_6 and PFC from other Product Uses (Medical) (2G2)

4.8.2.1 Category Description

HFCs, PFCs and SF_6 represent a large choice of gases whose properties make them attractive for a variety of niche applications which for inventory purposes are aggregated. Recently, as part of the data gathering exercise on the use of fluorinated gases in Malta, it has been determined that very small quantities of SF_6 and PFC-218 (perfluoropropane) are used during hospital operations.

4.8.2.2 Methodological issues

Activity data for this sector was collected via communication with all other known local users of these gases; all the users reported use of small amounts in the medical sector.

4.8.2.3 Category-specific QA/QC and verification

Not applicable.

4.8.2.4 Source Specific Recalculations

No recalculations were required.

4.8.2.5 Uncertainty and time series consistency

Uncertainty in this sector is mainly attributable to the small quantities and very specific applications in which such fluids are used. The possibility of incomplete coverage is present though the scale of this incompleteness is presumably small enough not to affect significantly the end result. Activity data uncertainty is assumed at 100%, whereas emission factor uncertainty is assumed at 5%.

4.8.2.6 Category Specific planned improvements

No planned improvements in this specific category.

4.8.3 Other Product Manufacture and Use - N_2O from Product Use (2G3)

4.8.3.1 Category Description

In Malta, medical grade nitrous oxide is used for anaesthetic, analgesic use and veterinary use. Other uses of N2O is as propellant in whipped cream preparations (in aerosol cans).

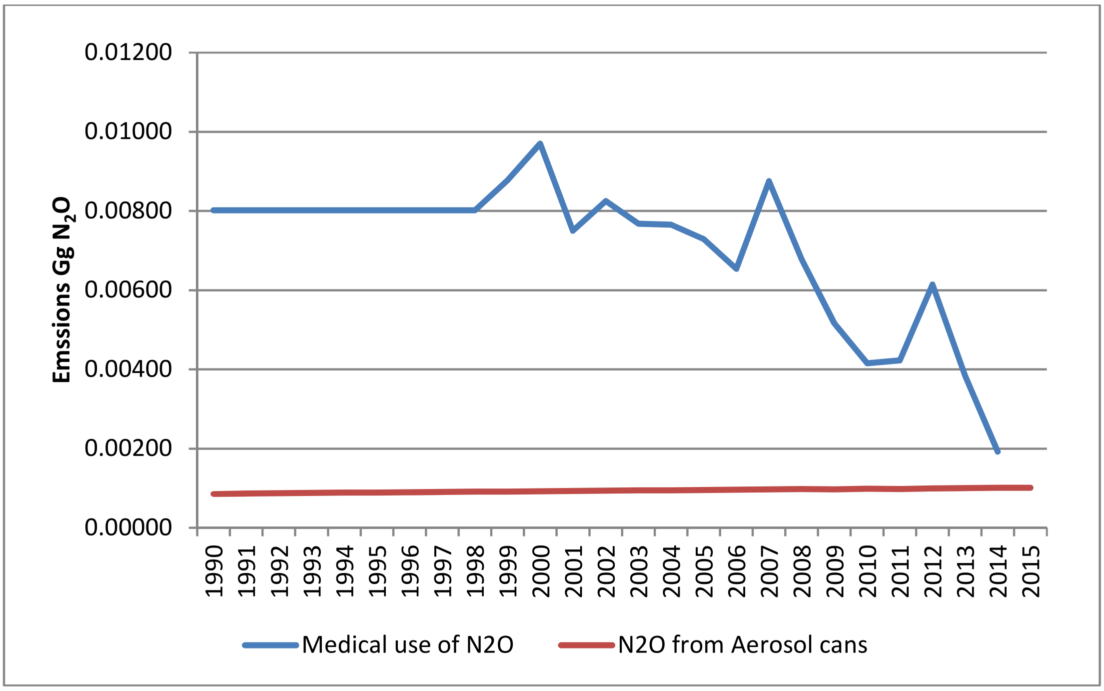

Figure 4-5 Nitrous Oxide emissions from anaesthetic use and Aerosol cans

Figure 4-5 shows the variations in N_2O emissions that result from the consumption of medical grade N_2O during medical applications in Malta. The emissions figure being reported for the years 1990 to 1998 (0.008 Gg N_2O per year) is the calculated average of the actual consumption of N_2O during the years 1999 till 2007. A downward trend in the consumption of N_2O for this scope is observed from 2008 onwards, linked to a decrease in the use of Antenox in dental and other surgical applications. Figure 4-5 also shows emissions of N2O from aerosol cans which remains quite constant across the time series.

4.8.3.2 Methodological Issues

4.8.3.2.1 Medical use of N2O

The use of medical grade nitrous oxide in public and private hospitals and other small clinics operating in Malta has been investigated through communication with these institutions in 2008. A comparative analysis of the information provided by these institutions and the available imports data of medical grade nitrous oxide in Malta shows that the institutions were only able to provide reliable and complete information for the most recent years, whereas the complete imports statistics are available as from 1999 onwards. This inventory process therefore uses the imports data of medical grade nitrous oxide rather than relying solely on the information provided by the institutions.

The methodology as available in the IPCC 2006 Guidelines has been followed, with an emission factor of 1.0 made applicable to the activity data, since it can be assumed that all of the administered nitrous oxide is returned to the atmosphere. It is also assumed that the quantity of medical grade nitrous oxide imported is all consumed during the same importation year. Since actual imports data for the years 1990 to 1998 are unavailable, the average import figure for the years 1999 to 2007 has been applied to the years 1990 till 1998.

4.8.3.2.2 Aerosol cans

Most commonly Whipped cream preparation is the main type of aerosol can in which N2O is used as a propellant. Data on local use of such cans is very limited and thus a proxy needed to be developed. Influence of British cuisine on Maltese cuisine and the fact that the UK inventory has a well-developed methodology to estimate emissions from this sector, triggered the decision to use the UK data as a proxy for Malta's activity. The per capita emission factor based on the 2016 submission of the UK under the convention, which amounts to 2.3548×10^{-9} GgN_2O/capita was multiplied by the Maltese population over the time series.

4.8.3.3 Category-specific QA/QC and verification

Not applicable.

4.8.3.4 Source Specific Recalculations

First time estimation of emissions from aerosol cans was carried out in this submission, thus a recalculation has been done across the time series.

Table 4-3 Recalculation for N2O emissions from aerosol cans.

	Emissions (Gg CO2 eq.) as reported in the 2016 inventory report	Total Emissions (Gg CO2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
Year	Gg CO_2 eq	Gg CO_2 eq	Gg CO_2 eq
1990	NO	0.254	NA
1991	NO	0.257	NA
1992	NO	0.259	NA
1993	NO	0.262	NA
1994	NO	0.264	NA
1995	NO	0.266	NA

	Emissions (Gg CO2 eq.) as reported in the 2016 inventory report	Total Emissions (Gg CO2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
1996	NO	0.268	NA
1997	NO	0.270	NA
1998	NO	0.271	NA
1999	NO	0.273	NA
2000	NO	0.275	NA
2001	NO	0.277	NA
2002	NO	0.279	NA
2003	NO	0.281	NA
2004	NO	0.283	NA
2005	NO	0.284	NA
2006	NO	0.286	NA
2007	NO	0.288	NA
2008	NO	0.290	NA
2009	NO	0.290	NA
2010	NO	0.293	NA
2011	NO	0.292	NA
2012	NO	0.296	NA
2013	NO	0.299	NA
2014	NO	0.301	NA
2015	NA	0.301	NA

4.8.3.5 Uncertainty and time series consistency

Data collection coverage in this sector is complete, since only one manufacturer of medical grade N_2O exists in Malta. Thus, it is assumed that activity data uncertainty in this sector only pertains to the instrumental uncertainty of the bottling plant, which is assumed at 3%. The emission factor uncertainty is presumably very low, as described in the IPCC 2006 Guidelines, it can be assumed that all gas inhaled is eventually exhaled, thus an arbitrary 1% EF uncertainty is used.

4.8.3.6 Category Specific planned improvements

No planned improvements in this specific category.

4.8.4 Other Product Manufacture and Use - Other (2G4)

Not applicable.

4.9 OTHER (CRF CATEGORY 2H)

Not applicable

Chapter 5. AGRICULTURE (CRF SECTOR 3)

5.1 OVERVIEW OF SECTOR

This chapter contains information on the estimation of greenhouse gas (GHG) emissions from the Agricultural sector. Emissions are estimated for the following source categories: Enteric Fermentation (3A), Manure Management (3B) and Agriculture Soils (3D). The source categories Rice Cultivation (3C), Prescribed Burning of Savannas (3E), Field Burning of Agricultural Residues (3F), Liming (3G), Other Carbon-containing Fertilisers (3I) do not occur in Malta. Source category Urea Application (3H) has not been estimated. No emissions have been included under the source category Other Sources (3J). Gases estimated and reported are methane (CH_4) and nitrous oxide (N_2O).

Accounting for about 2.8 percent of GDP, Malta's agricultural sector is small yet diverse. Most farm structures are small and privately owned. Most of the crops and foods produced are for domestic consumption. The main crops are potatoes, cauliflower, grapes, wheat, barley, tomatoes, citrus, and green peppers. The total utilized agricultural area (UAA) in 2013 amounted to 11,689 hectares. Agricultural holdings in Malta and Gozo are small with 75.6% having a UAA of less than 1 hectare. Medium-sized agricultural holdings make up 22% of the total (1-5 ha in size) while a mere 2.4% are considered large each having a minimum of 5 ha of UAA.

Consequently, research activities that aspire to characterise and valorise the sector in detail or to make the sector more efficient are few and far between. This is also observed within government entities, whereby data and information maintained regarding the sector are restricted to that necessary to comply with reporting obligations. Therefore, it is very difficult to obtain data that would enable robust country-specific characterisation of livestock and horticulture. A substantial amount of information that is used in this characterisation is based on expert judgments from experts in the field, and this information cannot be corroborated by official or unofficial documents and statements.

Figure 5-1 shows the emissions in carbon dioxide equivalents from the Agriculture sector for the years 1990 till 2015. In 2015, the Agriculture sector in Malta contributed around 3% of the total national GHG emissions, compared to % in 1990. Agriculture is responsible for CH_4 and N_2O emissions resulting from Enteric Fermentation (46.9%), Manure Management (22.3%) and Agricultural Soils (30.8%). Total emissions decreased by 0.42 Gg CO_2 eq. from 2014 to 2015. In 2015, agriculture contributed 20% of the total CH_4 emissions and 69% of total N_2O emissions.

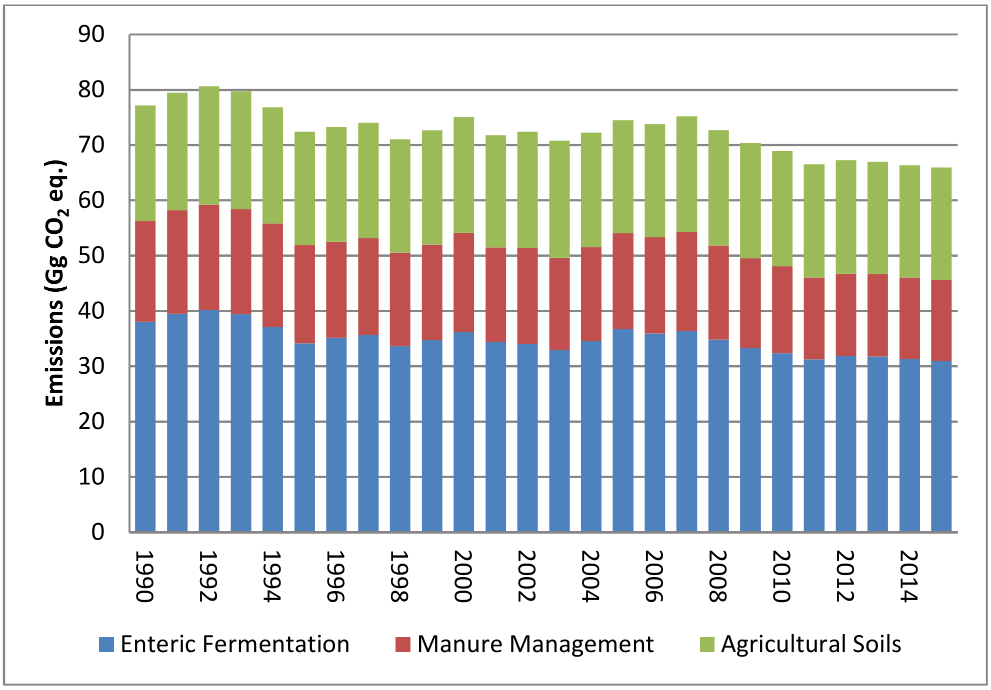

Figure 5-1 Emissions from Agriculture.

The calculation of GHG emissions from Agriculture is based on the methodologies and emission factors suggested by the IPCC 2006 Guidelines, with some country specific emission factors. Tier 1 methods with default IPCC 2006 emission factors are used for all calculations except enteric fermentation emissions from rabbits, which are estimated using country specific emission factors, and enteric fermentation from cattle and sheep and manure management from cattle, swine, poultry, which are estimated using a Tier 2 method. The methodologies and emission factors are summarized in Table 5-1 below.

Table 5-1. A summary of methodologies and emission factors used.

Source category	CH_4		N_2O	
	Method	EF	Method	EF
3.1.A1. Livestock – Enteric Fermentation – Cattle and Sheep	T2	CS		
3.1.A1. Livestock – Enteric Fermentation – Swine, goats, horses	T1	D		
3.1.A1. Livestock – Enteric Fermentation – rabbits	T1	CS		
3.1.B1. Livestock – Manure Management – sheep, goats, horses, rabbits	T1	D		
3.1.B1. Livestock – Manure Management – cattle, swine, poultry	T2	CS		
3.1.B1. Livestock – Manure Management – dairy cattle, poultry			T2	CS
3.1.B1. Livestock – Manure Management – cattle, swine, sheep, goats, horses, rabbits			T1	D
3.1.D. Agricultural Soils			T1	D

T1, T2: IPCC Guidelines Tier 1 and 2 respectively; D: IPCC default methodology and emission Factor; CS: Country specific.

Statistics on animal numbers prior to 2000 or 2001 are not available in local documentation or publications. Previous attempts at creating a time series between 1990 and 1999/2000 from a number of sources led to discontinuities in the trend. In order to streamline the data and reduce uncertainty, animal heads for most of the species for the years 1990 to 1999/2000 were taken from FAOstat Statistics. Data for animal species are available, and, in order to provide continuity with current methodology, numbers in animal sub-categories were estimated by applying the shares of subcategories in later statistics.

5.2 ENTERIC FERMENTATION (3A)

5.2.1 CATEGORY DESCRIPTION

Domestic livestock rearing leads to CH_4 emissions from enteric fermentation, the gas being a by-product of the digestive process in herbivores by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the blood stream. Both ruminant animals (e.g. cattle, sheep) and some non-ruminant animals (e.g. pigs, horses) produce CH_4, although ruminants are the largest contributor. The amount of CH_4 that is released depends mainly upon the type, age and weight of the animal and the quantity and quality of the feed consumed. Emissions from wild animals and pets do not fall within the scope of national GHG inventories.

In Malta the two most important livestock types reared for meat production are swine and poultry (broilers), while cattle is generally reared for dairy production, with beef being a by-product of this activity. In 2015, total CH4 emissions from Enteric Fermentation amounted to 34.98 Gg CO2 eq.

Tier 1 methodology provided by the IPCC 2006 guidelines is applied for methane emissions from enteric fermentation from swine, goats, poultry, horses and rabbits, while a Tier 2 methodology is used for enteric fermentation emissions from cattle and sheep. Methane emissions from enteric fermentation in 2015 accounted for 46.9% of the total GHG emissions from agriculture.

5.2.2 METHODOLOGICAL ISSUES

5.2.2.1 Livestock characterisation

5.2.2.1.1 Cattle

Methane emissions from enteric fermentation from cattle are estimated using a Tier 2 approach based on a livestock characterisation. Characterisation of the cattle population is very poorly documented and heavy reliance is made on expert judgments made by experts in the sector. The cattle population is split into dairy cows, mature cattle (bulls and non-lactating cows) and growing cattle (calves less than 1 year and cattle between 1 and 2 years of age).

Data used in the estimation is tabulated below.

Table 5-2 Livestock characteristics for cattle based on expert judgement.

Livestock category	Weight (kg)	Feed (kg)		Average daily weight gain (kg/day)	Feeding situation
		Concentrates	Forage		
Dairy cows	550	12 > 13	3 > 11		Stall
Non-lactating cows	640	12 > 13	3 > 11		Stall
Bulls	700	12 > 13	3 > 11		Stall
Calves (less than 1 year)	200			0.5	Stall
Growing Cattle (between 1 and 2 years)	400			0.4	Stall

Cattle is characterised using the values above and default values for coefficients and feed digestibility from Tables 10.2 – 10.8 of the 2006 IPCC Guidelines.

Table 5-3 IPCC 2006 equations and default factors used for estimation of emissions from cows.

Parameter	Value					Source
	DC	NLC	B	C	GC	
C_{fi}	0.386	0.322	0.37	0.322	0.322	Table 10.4
Ca	0.00	0.00	0.00	0	0	Table 10.5
C	0.8	0.8	1.2	1	1	p. 10.17 (NRC 1996)
$C_{pregnany}$	0.1	n.a.	n.a.	n.a.	n.a.	Table 10.7
DE%	66.25	66	66			Table 10.2
DE% (feed digestibility) (>90% conc. Diet)	80	80	80	80	80	Table 10.2
DE% (feed digestibility) (forage)	50	50	50			Table 10.2
GE	279.39	119.48	147.05	47.52	73.94	Equation 10.16

DC: Dairy Cows, NLC: Mature Cattle (Non-Lactating cows), B: Mature Cattle (Bulls), C: Calves, GC: Growing cattle.

5.2.2.1.2 Sheep

Methane emissions from enteric fermentation from sheep are estimated using a Tier 2 approach based on a livestock characterisation. The sheep population is split into lambs, ewes (ewes and ewe lambs) and male sheep.

Data used in the estimation are tabulated below.

Table 5-4 Livestock characteristics for sheep based on expert judgement.

Animal category	Weight (kg)	Feed (kg)		Feeding situation
		Concentrates	Forage	
Lambs	20	0.8	0.7	Housed fattening lambs
Ewes	50	1	2.8	Housed ewes
Male sheep	60	1	1.5	Housed ewes

Sheep is characterised using the values above and default values for coefficients and feed digestibility from Tables 10.2 – 10.8 of the 2006 IPCC Guidelines.

Table 5-5 IPCC 2006 equations and default factors used for estimation of emissions from sheep.

Parameter	Value			Source
	Mature Ewes	Other mature sheep >1 year	Growing Lambs	
C_{fi}	0.217	0.217	0.236	Table 10.4
Ca	0.009	0.009	0.0067	Table 10.5
$C_{pregnany}$	0.113	n.a.	n.a.	Table 10.7

DE% (digestible energy)	58	62	66	Table 10.2
DE% (feed digestibility) >90% conc. diet)	80	80	80	Table 10.2
DE% (feed digestibility) (forage)	50	50	50	Table 10.2
GE	39.36	15.64	10.11	Equation 10.16
a	2.1	2.1	0.4	Table 10.6
b	0.45	0.45	0.658	Table 10.6

5.2.2.2 Methane emissions

For livestock category of cattle, default methane conversion factors from Table 10.12 of the 2006 IPCC Guidelines in conjunction with the animal characterisation described above, are applied following using Equation 10.21 of the 2006 IPCC Guidelines to develop a methane emission factor for each animal category as shown in Table 5-6.

Table 5-6 Methane Conversion factors and emission factors for cattle.

Animal category	Digestible Energy (%)	Methane Conversion Factor (Y_m)	Methane Emission Factor (kg CH_4 head^{-1} yr^{-1}) [for 2015]
Dairy cows	73	6.5	119.11
Non-lactating cows	73	6.5	119.48
Bulls	64	6.5	147.05
Calves (less than 1 year)	80	6.5	47.52
Growing Cattle (between 1 and 2 years)	80	6.5	73.94

For the livestock category sheep, default methane conversion factors from Table 10.13 of the 2006 IPCC Guidelines are applied to Gross Energy values determined as described above using Equation 10.21 of the 2006 IPCC Guidelines to develop a methane emission factor for each animal category as shown in Table 5-7.

Table 5-7 Methane Conversion factors and emission factors for sheep.

Animal category	Digestible Energy (%)	Methane Conversion Factor (Y_m)	Methane Emission Factor (kg CH_4 head^{-1} yr^{-1}) [for 2015]
Lambs	66	4.5	2.98
Ewes	58	6.5	10.65
Male sheep	62	6.5	7.13

Emissions from enteric fermentation by other species are determined using a Tier 1 method and default emission factors, applying Equation 10.19 and Table 10.10 of the 2006 IPCC Guidelines, with the exception of poultry and rabbits, where country-specific factors are used since no default values are available.

Table 5-8 Enteric fermentation emission factors used.

Animal category	Methane emission factor (kg CH_4 head^{-1} yr^{-1})
Swine	1.5
Goats	5
Horses	18
Poultry	0.01
Rabbits	0.08

The emission factor for rabbits is taken from a report drawn up by the Italian Agency for the Protection of the Environment and for technical Services[26]. The emission factor for poultry matches that used by most countries which estimate enteric fermentation from poultry.

5.2.3 Uncertainties and time-series consistency

Time-series consistency has been improved by using only two sources for animal numbers, i.e. FAOstat statistics and NSO statistics.

Milk production data for cattle and sheep is only available as far back as 1995. The preceding five years are gap-filled. Changes in feed conditions for cattle have been taken into consideration as far as possible, based on expert judgement.

FAOstat statistics for poultry have not been used, since the values are too low and correspond more closely to number of holdings reported by NSO.

For some livestock, numerical FAOstat data available matches data held by NSO, but are reported for an adjacent year. In the cases where NSO data is available, this has been used in preference to FAOstat data.

Statistics on rabbit numbers are collected for breeding females on agricultural holdings having at least 50 does. There could be other holdings breeding rabbits with less than 50 does, which are therefore not captured in the statistics. Preliminary estimates based on rabbit feed sold indicate that the statistical numbers are not representative of the total population, and are in fact only a small proportion.

5.2.4 Category-specific QA/QC and verification

Data on animal numbers and milk production is collected annually from NSO. Data on cattle milk fat content is collected annually from Malta Dairy Products, who have also provided a time series as far back as 1992. Malta Dairy Products also collects data on milk products, but this is restricted to farmers in the Milk producers' cooperative. Therefore, data from NSO is used for this activity data. All data collected is stored and logged. In cases where a break in trend is observed, for example in milk productivity, the correctness of the data is checked. It must be noted, that with the small animal

[26] Methodologies used in Italy for the estimation of air emission inventory in the agriculture sector. Agenzia per la protezione dell'ambiente e per I servizi tecnici (APAT). 2005.

populations, annual variations in the livestock numbers can cause significant changes in the time series.

Emission factors developed using Tier 2 methods are cross-checked against IPCC defaults. In most cases, the emission factors are comparable. In instances where this is not the case, one must revert back to the fact that a number of the parameters feeding into the construction of the emission factor are based on expert judgment, and cannot be verified.

5.2.5 CATEGORY-SPECIFIC RECALCULATIONS

The most significant revision has been the revision of animal numbers for the years 1990 – 1999/2000 using data from FAOstat. This approach evens out inconsistencies in the trend.

Average daily weight gains for calves and growing cattle was revised downwards (0.5 kg day^{-1} and 0.4 kg day^{-1} respectively) based on expert judgment. The methane conversion factor for dairy cows and mature cattle was kept constant at 6.5%.

Ewe numbers were revised across the whole time series based on a revision exercise carried out by NSO. Milk yield was improved across the whole time series since annual data (from 1995) was applied from NSO statistics. For the estimation of milk yield, ewe lambs are considered in the same category as ewes.

A methane emission factor of 0.1 kg $head^{-1}$ yr^{-1} for poultry could not be evidenced by documentation, and this was therefore revised to 0.01 kg $head^{-1}$ yr^{-1} based on common practice among countries that report emissions from poultry.

Table 5-9 Recalculations for the category Enteric Fermentation.

Year	Enteric Fermentation (Gg CO2 eq.) as reported in the previous inventory report	Enteric Fermentation (Gg CO2 eq.) as reported in this inventory report	Percentage change in reported emissions (%)
1990	25.73	38.05	47.89
1991	29.28	39.50	34.89
1992	33.42	40.12	20.05
1993	37.17	39.37	5.90
1994	40.60	37.10	-8.61
1995	42.20	34.09	-19.21
1996	41.72	35.13	-15.78
1997	44.89	35.60	-20.69
1998	35.76	33.61	-6.02
1999	37.91	34.73	-8.39
2000	42.02	36.15	-13.97
2001	41.30	34.33	-16.89
2002	40.61	34.03	-16.20
2003	39.31	32.90	-16.30
2004	40.67	34.57	-15.00
2005	40.29	36.70	-8.90
2006	40.35	35.92	-10.98
2007	41.53	36.33	-12.52
2008	39.50	34.80	-11.90

Year	Enteric Fermentation (Gg CO2 eq.) as reported in the previous inventory report	Enteric Fermentation (Gg CO2 eq.) as reported in this inventory report	Percentage change in reported emissions (%)
2009	38.00	33.27	-12.47
2010	36.62	32.35	-11.65
2011	36.18	31.26	-13.60
2012	36.13	31.87	-11.81
2013	36.23	31.72	-12.43
2014	35.70	31.27	-12.40

5.2.6 Category-specific planned improvements

Statistics for animal numbers is not always consistent with that available at FAOstat for some of the years where both sets of data are available. Improvements are planned to ascertain the correctness of both sets of data. Similarly, with the issue of poultry numbers, which seem to be number of holdings in FAOstat statistics, efforts must be made to determine the source of this data and how it needs to be updated.

5.3 MANURE MANAGEMENT (3B)

5.3.1 Category Description

This category reports emissions of methane from animal manures as well as emissions from their manure arising during its storage. Domestic livestock rearing leads to both CH_4 and N_2O emissions from manure management. CH_4 from the management of animal manure occurs as the result of its decomposition under anaerobic conditions. N_2O emissions from manure management vary significantly between the types of manure management systems used (e.g. solid or liquid). When manure is stored or treated as liquid in a pond or tank it tends to decompose anaerobically and produce a significant quantity of methane. When manure is handled as a solid or when it is deposited on pastures, it tends to decompose aerobically and little or no methane is produced. Hence the system of manure management used affects emission rates. Emissions form manure management account for 22.3% of Agriculture emissions. Methane contributes 27% and nitrous oxide 72% of manure management emissions. Table 5-10 shows the methane and nitrous oxide emissions from manure management in CO_2 equivalents.

Table 5-10 Methane and Nitrous oxide emissions from Manure management.

3B. Manure Management	1990	1995	2000	2005	2010	2014	2015
CH_4	5.20	5.03	5.32	4.92	4.52	4.19	4.06
N_2O	12.99	2.82	12.67	12.42	11.19	10.56	10.62

5.3.2 Methodological Issues

5.3.2.1 Methane Emissions

Methane emissions from cattle, swine and poultry have been estimated using Tier 2 methodology with country specific inputs. A Tier 1 methodology and default emission factors for other livestock are applied.

5.3.2.1.1 Cattle

Estimation of emissions from cattle builds on the livestock characterisation developed for estimation of enteric fermentation emissions. Gross Energy and Digestible Energy are used as inputs to derive a methane emission factor. Equation 10.24 is applied to estimate the volatile solid excretion rate (VS). Maximum methane producing capacity (B_0) and methane conversion factor (MCF) are default values taken from Tables 10A-4 and 10A-5, using values for solid storage in temperate regions (19°C) and Eastern Europe. Equation 10.23 is applied to develop a methane emission factor. The values used are shown in Table 5-11.

Table 5-11 Parameters and emission factors for estimation of methane emissions from manure management for cattle.

Animal category	VS (kg VS day^{-1})	B_0 (m^3 CH_4 kg^{-1} VS)	MCF (%)	EF (kg CH_4 animal^{-1} yr^{-1}) [2015]
Dairy cows	3.25	0.24	4.00	12.35
Non-lactating cows	2.25	0.17	4.00	3.74
Bulls	2.78	0.17	4.00	4.61
Calves	0.57	0.17	4.00	0.95
Growing cattle	0.88	0.17	4.00	1.47

5.3.2.1.2 Swine

Although a livestock characterisation is not carried out for swine, some information is available to enable a Tier 2 estimation of methane emissions from manure management. Some values are presented in draft and final reports drawn up to inform the Agricultural Waste Management Plan.

Table 5-12 Parameters for estimation of methane emissions from manure management for swine

Wet slurry	10.1 – 22.0 l animal^{-1} day^{-1} (ρ 1000 kg m^{-3})	Table 4, Sustech 2008[27]
Dry matter	1.55%	Table 4, Sustech 2008
Volatile solids	61.1% of dry solids	Table 7, Sustech 2005[28]
B_0	0.45 m^3 CH_4 kg^{-1} VS	Table 10A-7, IPCC 2006

[27] Agricultural Waste Management Plan for the Maltese Islands. Final Report. June 2008. Sustech Consulting.
[28] Agricultural Waste management plan for the Maltese Islands. Draft Final Report. May 2005. Sustech Consulting.

In order to estimate the amount of dry matter excreted, the average excretion of wet slurry (16.05 kg animal^{-1} day^{-1}) is multiplied by the dry solid content, which results in a value of 0.25 kg dry matter animal^{-1} day^{-1}. Multiplying this value by the percentage content of volatile solids results in 0.15 kg VS day^{-1}.

There is no solid waste generated on pig farms. Faeces and urine from the pigs, and unconsumed water from drinking nipples, fall through the slats in the pen floor and is flushed with additional washing water to cesspits. In some cases, the farm is directly linked to the sewer system, but in general the liquid slurry is transported to a sewage manhole by means of a bowser. The cesspit capacity must be sufficient to collect all urine and washing for at least 15 days. Cesspits in pig production should be emptied every week but extra space for at least another week should be available. It is prohibited to direct pig slurry to the sewer system, however the practice remains. It is also not allowed to apply pig slurry to soils, but based on expert judgement about 10% of slurry is applied to soils. This is revised downwards to 5% after the adoption of the Nitrates Action Plan.

In order to reflect this manure management system, two default methane conversion factors are applied from Table 10.17, taking into consideration the fraction of slurry that is applied to soils and the fraction that is directed to the sewer system. This results in separate emission factors for each fraction of the slurry as shown in Table 5-13 applying equation 10.23.

Table 5-13 Methane conversion factors and emission factors for estimation of methane emissions from manure management for swine.

	MCF (%)	EF (kg CH_4 animal^{-1} yr^{-1}) [2015]
Pit storage below animal confinements <1 month	3	0.48
Pit storage below animal confinements >1 month at 19°C	39	0.33

5.3.2.1.3 Poultry

As for swine, some information is available in order to enable a Tier 2 estimation of methane emissions from manure management of poultry.

Table 5-14 Parameters for estimation of methane emissions from manure management for poultry.

	Layers	Broilers	Source
Wet slurry	0.167 l animal^{-1} day^{-1} (ρ 944 kg m^{-3})	0.09 - 0.208 l animal^{-1} day^{-1} (ρ 503 kg m^{-3})	Table 4, Sustech 2008
Dry matter	29.44%	46.15%	Table 4, Sustech 2008
Volatile solids	74.06% of dry solids	85.97% of dry solids	Table 7, Sustech 2005
B_0	0.39 m^3 CH_4 kg^{-1} VS	0.36 m^3 CH_4 kg^{-1} VS	Table 10A-9, IPCC 2006

In order to estimate the amount of dry matter excreted, the average excretion of wet slurry (0.149 kg animal^{-1} day^{-1} for broilers) is multiplied by the dry solid content, which results in a value of 0.05 kg dry matter animal^{-1} day^{-1} in the case of layers and 0.03 kg dry matter animal^{-1} day^{-1} in the case of broilers. Multiplying this value by the percentage content of volatile solids, results in 0.05 kg VS day^{-1} for layers and 0.03 kg VS day^{-1} for broilers.

A default methane conversion factor is applied for each livestock category from Table 10A-9 representing solid storage in temperate regions, resulting in separate emission factors for each category as shown in Table 5-13 using Equation 10.23.

Table 5-15 Methane conversion factors and emission factors for estimation of methane emissions from manure management for swine.

	MCF (%)	EF (kg CH_4 animal^{-1} yr^{-1}) [2015]
Layers	1.5	0.05
Broilers	1.5	0.04

5.3.2.1.4 Other livestock

Methane emissions from sheep, goats, horses and rabbits are estimated using Tier 1 methodology. Emission factors for sheep, goats and horses are default factors from Table 10.15. These are tabulated in Table 5-16.

Table 5-16 Methane emission factors from manure management by animal type.

Animal category	Emission Factor (kg CH_4^{-1} head^{-1} year^{-1})
Sheep	0.28
Goats	0.20
Horses	2.34
Rabbits	0.08

5.3.2.1 Nitrous oxide Emissions

Nitrous oxide emissions are dependent on the storage and treatment of manure before it is applied to agricultural land. Direct N_2O emissions occur via combined nitrification and denitrification of nitrogen contained in the manure.

Emissions from dairy cattle and poultry have been estimated using Tier 2 methodology with country specific nitrogen excretion rates. Tier 1 methodology with default emission factors for other livestock is applied.

Some parameters used in the livestock characterisation have been used to develop a nitrogen excretion rate and emission factor for dairy cattle. Equations 10.32 and 10.33 have been applied to estimate nitrogen intake and nitrogen retained, for use in Equation 10.31 to derive nitrogen excretion rate. The values shown in Table 5-17 are applicable for reporting year 2015.

Table 5-17 Parameters and emission factors for estimation of nitrous oxide emissions from manure management for dairy cattle.

Fat content (%)	3.36
Protein, feed (% in dry matter)	15.5
GE intake (kg N head^{-1} yr^{-1})	279.39

N intake (kg N head^{-1} yr^{-1})	137.08
Milk yield (kg head^{-1} yr^{-1})	17.90
N milk (kg N head^{-1} yr^{-1})	33.22
Annual N excretion rate (kg N head^{-1} yr^{-1})	103.86

The nitrogen excretion is then multiplied by the default emission factor From Table 10.21 for solid storage, i.e. 0.005 kg N_2O-N (kg nitrogen excreted)$^{-1}$. The country-specific nitrogen excretion rates used for poultry are presented in

Table 5-18 below. For broilers, the mid-point of the quoted range was used for emission estimation. These values are taken from the Sustech Reports on Agricultural Waste Management Plan for the Maltese Islands.

Table 5-18 Nitrogen excretion rates for poultry.

Animal Category	Nitrogen Excretion Rates
Poultry – Broilers	0.35 – 0.82 kg N / place
Poultry – Layers	0.87 kg N / place

The nitrogen excretion is then multiplied by the default emission factor From Table 10.21 for poultry manure, i.e. 0.001 kg N_2O-N (kg nitrogen excreted)$^{-1}$.Default nitrogen excretion rates from Table 10.19 (values for Eastern Europe) and emission factors for direct N_2O emissions from manure management from Table 10.21 were used for the determination of direct nitrous oxide emissions for the other animal categories. The excretion rates, emission factors and management systems used are presented in

Table **5-19** below.

Table 5-19 Default emission factors for direct N_2O emissions from manure management.

Animal Category	Nitrogen Excretion Rate (kg N (1000kg animal mass)$^{-1}$ day^{-1})	Default Emission Factor (kg N_2O-N (kg N excreted)$^{-1}$)	Management System
Other Cattle	0.35	0.005	Solid storage
Swine - market	0.55	0.002	Pit storage
Swine - breeding	0.46	0.002	Pit storage
Sheep	0.90	0.01	Deep bedding
Goats	1.28	0.01	Deep bedding
Horses	0.30	0.005	Solid storage
Rabbits	8.10	0.001	Poultry manure without litter

5.3.2.1.1 Indirect Nitrous Oxide Emissions from Manure Management

A significant proportion of the total nitrogen excreted by the animals in managed systems is lost prior to final application of the manure to the soils. In order to estimate the amount of animal manure nitrogen that is directly applied to the soils, it is necessary to reduce the total amount of nitrogen excreted by the animals that is lost as volatilisation.

Default values for nitrogen loss due to volatilisation of NH_3 and NO_x from manure management, from Table 10.22 are applied to the quantities of kg N excreted annually by livestock categories. These are presented in Table 5-20 below.

Table 5-20 Default values for nitrogen loss due to volatilisation from manure management.

Animal Category	Default Value	Management System
Dairy Cattle	30%	Solid storage
Other Cattle	45%	Solid storage
Swine	25%	Pit storage
Poultry - layers	55%	Poultry without litter
Poultry - broilers	40%	Poultry with litter
Sheep	25%	Deep bedding
Goats	25%	Deep bedding
Horses	12%	Solid storage
Rabbits	55%	Poultry without litter

The fraction of nitrogen thus volatilised is multiplied with the default emission factor to estimate indirect N_2O-N emissions from manure management (0.01 kg N_2O-N kg N^{-1}), as available in Table 11.3.

5.3.3 Uncertainties and Time-Series Consistency

The characterisation of the animal waste management systems and the treatment of manure is not sufficiently documented. Assessment of animal waste management systems are based on discussions with experts. Changes to these management systems throughout the time series can therefore not be accounted for. However, emissions are estimated for all livestock categories and all systems of manure management as far as possible.

5.3.4 Category-Specific QA/QC and Verification

Emissions are estimated for all livestock categories. Issues affecting animal numbers are the same as those related to emissions from enteric fermentation.

5.3.5 Category-Specific Recalculations

The revision of animal numbers using data from FAOstat also affects emission from manure management. Methodology for estimation of methane emissions from cattle was revised to a Tier 2 methodology using parameters determined for the livestock characterisation.

The estimation for emissions from the manure management of swine is revised to take into consideration the differentiated treatment of part of the slurry by applying it to soil, whereas the most part of the slurry is disposed of in the sewer.

Table 5-21 Recalculations for the category Manure Management.

Year	Manure Management (Gg CO2 eq.) as reported in the previous inventory report	Manure Management (Gg CO2 eq.) as reported in this inventory report	Percentage change in reported emissions (%)
1990	26.12	18.20	-30.34
1991	26.04	18.69	-28.21
1992	27.89	19.07	-31.62
1993	30.07	19.07	-36.59
1994	31.32	18.72	-40.24
1995	32.50	17.85	-45.08
1996	32.93	17.35	-47.30
1997	35.38	17.52	-50.49
1998	28.89	16.95	-41.32
1999	30.38	17.25	-43.21
2000	36.51	17.99	-50.71
2001	36.00	17.13	-52.42
2002	35.30	17.39	-50.75
2003	33.41	16.71	-49.99
2004	34.49	16.95	-50.86
2005	33.61	17.34	-48.41
2006	33.77	17.39	-48.51
2007	35.26	17.95	-49.08
2008	31.93	16.99	-46.81
2009	30.85	16.26	-47.29
2010	30.30	15.71	-48.17
2011	25.52	14.78	-42.10
2012	25.29	14.88	-41.15
2013	26.42	14.92	-43.54
2014	25.82	14.75	-42.86

5.3.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

No further improvements are planned for this category.

5.4 RICE CULTIVATION (3C)

5.4.1 Category Description

This category does not occur.

5.4.2 Methodological Issues

Not applicable.

5.4.3 Uncertainties and time-series consistency

Not applicable.

5.4.4 Category-specific QA/QC and verification

Not applicable.

5.4.5 Category-specific recalculations

Not applicable.

5.4.6 Category-specific planned improvements

Not applicable.

5.5 AGRICULTURAL SOILS (3D)

5.5.1 Category Description

Nitrous oxide is produced as an intermediate in the denitrification reaction and as a by-product of nitrification. The availability of inorganic nitrogen in the soil is a controlling factor in the process and therefore, N_2O emissions are estimated through human-induced N additions into the soil or N mineralisation. Emissions of N_2O occur through direct and indirect pathways. Direct emissions result from the addition or release of N directly from the soil, while indirect emissions occur through volatilisation of NH_3 and NO_x from managed soils or after leaching and runoff of N mainly as NO_3^-.

In 2015, nitrous oxide emissions from agricultural soils account 30.8% of the total agricultural emissions.

Table 5-22. N_2O emissions from agricultural soils.

CO_2 eq.	1990	1995	2000	2005	2010	2014	2015
Direct N_2O emissions	14.1848	16.1814	16.837	16.688	16.7774	16.0622	16.0026
Indirect N_2O emissions due to volatilisation	1.7582	2.1456	2.2946	2.235	2.1754	1.9966	1.9966
Indirect N_2O emissions due to leaching/run-off	3.1886	3.6356	3.7846	3.7548	3.7846	3.6058	3.6058
Total N_2O emissions	19.1316	21.9924	22.9162	22.7076	22.7076	21.6944	21.605

Nitrogen inputs that are considered for direct and indirect nitrous oxide emissions from soils are:

- Application of synthetic nitrogen fertilisers (F_{SN});
- Application of organic nitrogen as fertiliser (animal manure) (F_{ON});
- Nitrogen input from crop residues (F_{CR});
- Nitrogen mineralisation associated with loss of soil organic carbon (F_{SOM}).

Organic soils and grazing do not occur in Malta, and therefore there is no contribution of nitrogen inputs to be considered.

5.5.2 Methodological Issues

Tier 1 methodologies were applied for the calculation of both direct and indirect soil emissions.

5.5.2.1 Activity Data

5.5.2.1.1 Synthetic Fertiliser Nitrogen Applied to Soils

There are two possible sources to establish the input of nitrogen from synthetic fertilisers on managed soils for the estimation of both direct and indirect N_2O emissions. One is using data on the consumption of fertilisers on a national level, derived from importation/trade data, and the other is using nitrogen application rates on the basis of fertiliser use data for different crops, aggregated on a national level. In fact, the source for the latter rates is the NSO study on the gross nitrogen balance for Malta conducted in 2007 and published in 2008[29]. The average nitrogen rate per hectare derived from the import data is approximately 50.7 kg N/ha; while the same rate on the basis of application data is approximately 60.3 kg N/ha. Taking into consideration the values obtained from the two data sources, it was recommended to use an average rate of 55.5 kg N/ha throughout the time series[30]. Total utilised agricultural land area is obtained for years 2001 every two or three years from NSO through the Farm Structure Survey. Years for which no statistics are available are interpolated. The years 1991 to 2000 are interpolated between values available for 1990 and 2001.

[29] Gross Nitrogen Balance for Malta, 2007. NSO. 2008.
[30] Estimation of greenhouse gas emissions from agricultural activities for Malta's inventory. Final Report. October 2015. Sammut and Associates.

5.5.2.1.2 Animal Manure Nitrogen Applied to Soils

The amount of nitrogen remaining in manure after direct and indirect emissions are accounted for, is the amount of nitrogen used for estimation of emission from agricultural soils.

For the estimation of emissions due to pig slurry, the assumption is made that only a small fraction of pig slurry is applied to soils. Since it is customary for almost all pig slurry to be flushed into the sewerage system, in effect any emissions from the slurry are taken into account at the sewage treatment plant. Therefore, in order to avoid double counting of emissions – as applied on land and as treated in the sewage treatment plant – the same assumptions made for calculating methane emissions from manure management of pig slurry are made when transferring nitrogen from pig slurry to agricultural soils. The amount of nitrogen transferred to the sewage system is passed on to the Waste sector for accounting under that sector.

5.5.2.1.3 Nitrogen in Crop Residues returned to soils

Calculations of the amount of nitrogen available from crop residues were based on the information in Table 11.2 of the IPCC 2006 guidelines for the main crops under the categories listed: 1. Non-N fixing grain crops, 2. N-fixing grains and pulses, 3. Root and tuber crops, 4. N-fixing forage crops and 5. Other forages/perennial grasses. In practice this includes wheat, barley, beans, chickpeas, Sulla, peas, potato, carrots and other vetch. These crops constitute a significant share of the total utilised agricultural area, standing at 55% in 2013.

The approximate yield (in terms of weight of dry matter per hectare) for each of the main crops considered was obtained from different sources, using national data wherever possible. Country-specific data on crop yields was in fact obtained for wheat, barley and Sulla (commonly known locally as 'silla') [Vella, S., 1997] and for potato [Vella, S., 2003].

5.5.2.1.4 Amount of Nitrogen mineralisation associated with loss of soil organic matter

The amount of nitrogen mineralised due to changes in land-use areas are obtained from the LULUCF sector. Refer to Section 6.5.2.1 for method description.

5.5.2.2 Nitrous oxide emissions

Default emission factors are used for the estimation of direct and indirect nitrous oxide emissions, applying Equations 11.1, 11.9 and 11.10 of the IPCC guidelines 2006. These are tabulated in Table 5-23.

Table 5-23 Default factors for Direct and Indirect Soil N_2O emissions.

Emissions factor	Default Value	Source (IPCC guidelines 2006)
EF_1 for N additions (kg N_2O–N (kg N)$^{-1}$)	0.01	Table 11.1
EF_4 [N volatilisation and re-deposition] (kg N_2O–N (kg NH_3–N + NO_X–N volatilised)$^{-1}$)	0.01	Table 11.3
EF_5 [leaching/runoff], kg N_2O–N (kg N leaching/runoff) $^{-1}$	0.075	Table 11.3

$Frac_{GASF}$ [Volatilisation from synthetic fertiliser] (kg NH_3–N + NO_x–N) (kg N applied) $^{-1}$	0.10	Table 11.3
$Frac_{GASM}$ [Volatilisation from all organic N fertilisers applied] (kg NH_3–N + NO_x–N) (kg N applied) $^{-1}$	0.20	Table 11.3
$Frac_{LEACH-(H)}$ [N losses by leaching/runoff], kg N (kg N additions)$^{-1}$	0.30	Table 11.3

For the estimation of direct emissions, the total nitrogen applied to soils is multiplied by the respective emission factor (EF_1).

Indirect emissions due to volatilisation are estimated by first determining the amount of nitrogen that is volatilised from synthetic fertilisers and animal manure ($Frac_{GASF}$ and $Frac_{GASM}$ respectively). The resulting nitrogen amount is the multiplied by the relevant emission factor (EF_4).

Leaching and run-off accounts for another source of indirect nitrous oxide emissions, emissions are estimated by applying a fraction to all nitrogen applied or returned to the soils ($Frac_{Leach-(H)}$) and multiplying by the relevant emissions factor (EF_5).

5.5.3 Uncertainties and time-series consistency

There is uncertainty regarding the use of fertilisers and the input from inorganic nitrogen to soils. This has been partially addressed through the estimation of nitrogen applied through the utilised agricultural area and rate of application. In relation to emissions from leaching, efforts have been made to determine whether precipitation is lower than evapotranspiration throughout most of the year and leaching is therefore unlikely to occur, the information available is inconclusive. Therefore, a conservative approach is taken, and emissions from leaching are estimated.

5.5.4 Category-specific QA/QC and verification

Data for agricultural land and areas under crops are obtained from periodical publications from NSO. The rate of application of fertilisers cannot be verified. Discussions are held with the Department of Agriculture in this regard. It is planned to maintain a database of nitrogen inputs to soil, which could then be used to feed into this part of emission estimation.

5.5.5 Category-specific recalculations

Changes made to animal numbers, and to nitrous oxide emission estimates from manure management will have a direct effect on nitrous oxide emissions from agricultural soils. Additionally, changes have been made to the estimation of agricultural land areas and crop areas for the years where statistics are not produced.

The methodology for determining the amount of nitrogen from animal manure applied to soils has been amended since it was incorrect. The amount of N mineralisation associated with loss of soil organic matter is now also included in the total nitrogen additions. The sum effects of these revisions are tabulated in Table 5-24.

Table 5-24 Recalculations for the category Agricultural Soils.

Year	Agricultural Soils (Gg CO2 eq.) as reported in the previous inventory report	Agricultural Soils (Gg CO2 eq.) as reported in this inventory report	Percentage change in reported emissions (%)
1990	30.15	20.88	-30.74
1991	30.71	21.25	-30.79
1992	31.33	21.39	-31.72
1993	31.96	21.25	-33.51
1994	32.56	20.98	-35.57
1995	33.29	20.44	-38.62
1996	33.23	20.77	-37.49
1997	33.95	20.88	-38.49
1998	32.11	20.46	-36.30
1999	32.62	20.67	-36.64
2000	33.73	20.89	-38.07
2001	33.45	20.31	-39.29
2002	33.19	20.98	-36.80
2003	31.72	21.16	-33.28
2004	30.42	20.73	-31.86
2005	29.00	20.46	-29.43
2006	29.96	20.49	-31.61
2007	31.43	20.88	-33.57
2008	30.39	20.89	-31.26
2009	29.36	20.86	-28.96
2010	27.97	20.85	-25.44
2011	26.95	20.47	-24.07
2012	26.13	20.49	-21.58
2013	27.47	20.35	-25.92
2014	27.34	20.29	-25.81

5.5.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

The information on evapotranspiration and precipitation should be further reviewed in order to assess the relevance of applying the relevant fraction and emission factor. Efforts are maintained to improve data on inorganic fertilisers.

5.6 PRESCRIBED BURNING OF SAVANNAS (3E)

5.6.1 CATEGORY DESCRIPTION

This category does not occur.

5.6.2 METHODOLOGICAL ISSUES

Not applicable.

5.6.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Not applicable.

5.6.4 CATEGORY-SPECIFIC QA/QC AND VERIFICATION

Not applicable.

5.6.5 CATEGORY-SPECIFIC RECALCULATIONS

Not applicable.

5.6.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

Not applicable.

5.7 FIELD BURNING OF AGRICULTURAL RESIDUES (3F)

5.7.1 CATEGORY DESCRIPTION

In accordance to Standard B2 of the first set of national Good Agricultural and Environmental Conditions (GAEC) adopted for Malta (Rural Development Programme for Malta 2007 – 2013, Rural Development Department Ministry for Sustainable Development, the Environment and Climate Change, April 2013), stubble and vegetable residue should not be burnt in the field, except by order of the local Plant Health authorities in case of the presence of harmful pests and diseases. In view of this condition, there is no need to consider emissions arising from the burning of crop residues on the fields.[31]

5.7.2 METHODOLOGICAL ISSUES

Not applicable.

[31] Estimation of greenhouse gas emissions from agricultural activities for Malta's inventory. Final Report. October 2015. Sammut and Associates.

5.7.3 Uncertainties and time-series consistency

Not applicable.

5.7.4 Category-specific QA/QC and verification

Not applicable.

5.7.5 Category-specific recalculations

Not applicable.

5.7.6 Category-specific planned improvements

Not applicable.

5.8 LIMING (3G)

5.8.1 Category Description

Lime-rich calcisols occupy 27% of the Maltese land area [2004][32]. In accordance with the findings of MALSIS, due to the high alkalinity of soils, lime application in Malta does not occur.

5.8.2 Methodological Issues

Not applicable.

5.8.3 Uncertainties and time-series consistency

Not applicable.

5.8.4 Category-specific QA/QC and verification

Not applicable.

[32] MALSIS. Maltese Soil Information System. 2004. Soil geographic database of the Maltese Islands. National Soil Unit, Ministry for Rural Affairs and the Environment, Malta.

5.8.5 CATEGORY-SPECIFIC RECALCULATIONS

Not applicable.

5.8.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

Not applicable.

5.9 UREA APPLICATION (3H)

5.9.1 CATEGORY DESCRIPTION

Data on urea imports through customs is not disaggregated by end use. It is known that the bulk of urea imports go towards utilisation in deNOx abatement processes particularly in one of the local power generation plants. From a survey carried out in 2014 it results that urea utilised for agricultural purposes amounted to 60kg in 2010, 360kg in 2011, and 750kg in 2012. Resulting emissions are therefore 0.044t CO_2 in 2010, 0.264t in 2011, and 0.55t in 2012. These estimates represent a minute share of national totals. The survey has not been repeated after 2014, and there are no plans for another survey to be carried out. Therefore, reporting these 3 years would create an issue with the values for other years where no data is available. Therefore, this category is reported as not estimated.

5.9.2 METHODOLOGICAL ISSUES

Not applicable.

5.9.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Not applicable.

5.9.4 CATEGORY-SPECIFIC QA/QC AND VERIFICATION

Not applicable.

5.9.5 CATEGORY-SPECIFIC RECALCULATIONS

Not applicable.

5.9.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

Not applicable.

5.10 OTHER CARBON-CONTAINING FERTILIZERS (3I)

5.10.1 CATEGORY DESCRIPTION

This category does not occur.

5.10.2 METHODOLOGICAL ISSUES

Not applicable.

5.10.3 Uncertainties and time-series consistency

Not applicable.

5.10.4 Category-specific QA/QC and verification

Not applicable.

5.10.5 Category-specific recalculations

Not applicable.

5.10.6 Category-specific planned improvements

Not applicable

5.11 OTHER (3J)

5.11.1 Category Description

This category does not occur.

5.11.2 Methodological Issues

Not applicable.

5.11.3 Uncertainties and time-series consistency

Not applicable.

5.11.4 Category-specific QA/QC and verification

Not applicable.

5.11.5 Category-specific recalculations

Not applicable.

5.11.6 Category-specific planned improvements

Not applicable.

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Chapter 6. LAND USE, LAND-USE CHANGE AND FORESTRY (CRF SECTOR 4)

6.1 OVERVIEW OF SECTOR

The Land Use, Land-Use Change and Forestry (LULUCF) sector can contribute to both emissions (from sources) and removals of CO_2 (through sinks). Overall, the sector accounted for 3.13 Gg of CO_2 emissions in 2015. The calculations for this sector were formulated using the '2006 IPCC Guidelines for National Greenhouse Gas Inventories' following 'Volume 4: Agriculture, Forestry and Other Land Use', which were applied for all the categories of this sector. Moreover, the '2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry' was also referred to in few instances. The data used for the LULUCF sector was derived from national statistics and the Corine Land Cover 1990, 2000, 2006 and 2012 land use maps.

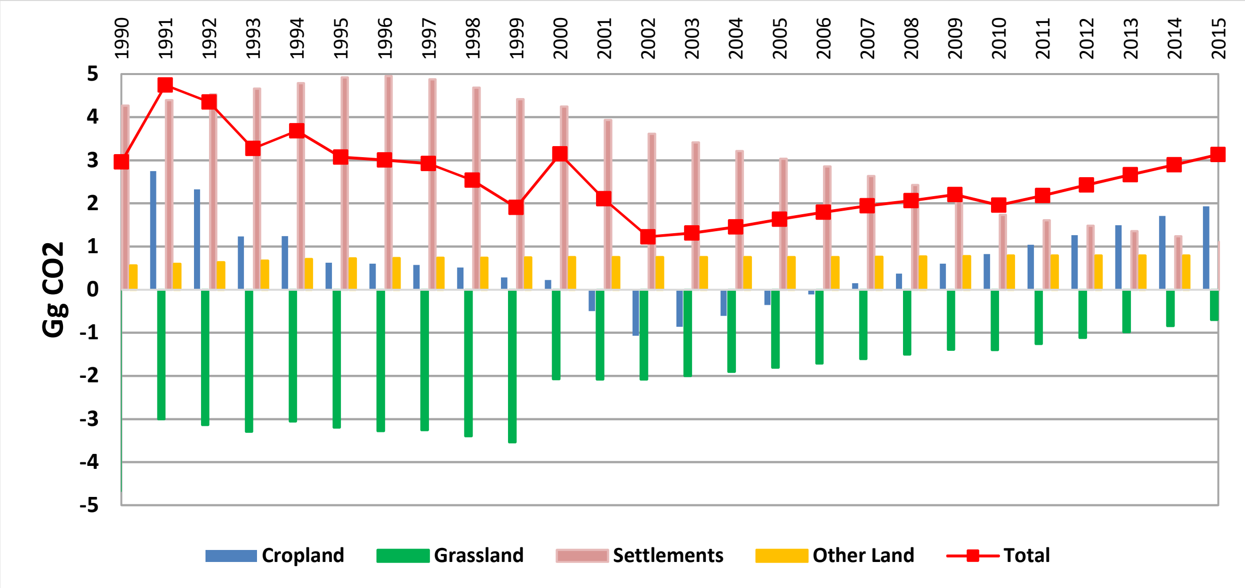

Figure 6-1 – Total CO2 removals and emissions for the LULUCF sector (Forest Land and Wetland categories not shown).

Figure 6-1 portrays the trend for carbon dioxide removals and emissions in the LULUCF sector for Malta. A mean figure of 2.562 Gg CO_2 has been estimated to be emitted by Maltese land use during the time series 1990 to 2015. In this inventory, calculations from the categories Cropland (CRF 4.B), Grassland (CRF 4.C), Settlements (CRF 4.D) and Other Land (4.E) were estimated. No estimations were calculated from the categories of Forest Land (CRF 4.A) and Wetlands (CRF 4.D), thus not indicated in the Figure above (more details are given later on in the chapter).This year, the Malta national LULUCF sector has undergone through changes following the UNFCCC in-country review which was conducted in October 2016. The review lead for a more accurate presentation of the Maltese LULUCF sector. The information pertaining to these changes, was based on the recommendations by the LULUCF Expert Review Team (ERT) during the in-country review, and are thus provided and presented in the subsequent chapters for this submission.

Improvement is to continue in the LULUCF sector, working with the project carried out with University of Malta (please refer to the 2015 national inventory submission for more information). Through this project, it was indicated the importance of proper characterization, quantification and monitoring of land cover, land use and their changes. It is evident, from interviews with various stakeholders, that the information currently available on land use at a national scale is incomplete, and access to this data is difficult due to fragmented data sources, potentially leading to inaccuracies. This study has confirmed the need for more effort to be put into consolidating and combining data sets and enhancing quality. The need for a working group specifically for the sector where experts can meet, discuss issues and decide on the way forward to a more accurate and reliable inventory for LULUCF, was been identified. In fact, an AFOLU Working Group, with clearly defined terms of reference, which include coordination of data gathering efforts, was set up by MRA, meeting around twice a year.

As for the previous submission, for this year's submission the emissions and removals were calculated utilising spreadsheets specifically made to manually insert the values for the time series from 1990 to 2015.

6.2 LAND-USE DEFINITIONS AND THE CLASSIFICATION SYSTEMS USED AND THEIR CORRESPONDENCE TO THE LAND USE, LAND-USE CHANGE AND FORESTRY CATEGORIES

The definitions established and used for this reporting are thus:

- **Forest Land** is defined as an area with minimum area of land of 1 hectare, tree crown cover more than 30% and trees minimum height more than 5 meters.
- **Cropland** includes arable and tillage land, and agro-forestry systems where vegetation falls below the thresholds used for forestry land categories. Cropland includes all annual and perennial crops as well as temporary fallow land (i.e., land set at rest for one or several years before being cultivated again). Annual crops may include cereals, oils seeds, vegetables, root crops and forages. Perennial crops can include trees and shrubs, in combination with herbaceous crops (e.g. agroforestry) or as orchards, vineyards and plantations, except where these lands meet the criteria for categorisation as forest land. Arable land which is normally used for cultivation of annual crops but which is temporarily used for forage crops or grazing as part of an annual crop-pasture rotation is included under cropland.
- **Grassland** is defined as areas with highly biodiverse grassland:
    - habitats as listed in Annex I of Council Directive 92/43/EEC;
    - habitats of significant importance for animal and plant species of Union interest listed in Annex II and IV of Directive 92/43/EEC;
    - habitats of significant importance for wild bird species listed in Annex I of Directive 2009/147/EC. Highly biodiverse grassland in the European Union is not limited to the geographic ranges referred to under Article 3 of Directive 92/43/EEC. Other grassland might fulfill the criteria for highly biodiverse grassland set out in Article 1 of the same Directive. "
- **Wetland** is defined the same as for the RAMSAR Convention, Article 1.1 and Article 2.1:
    - Article 1.1 states:

    "For the purpose of this Convention wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."
    - Article 2.1 provides that wetlands:

"[…] *may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands".*

- **Settlement** includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.
- **Other Land** includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories.

6.3 INFORMATION ON APPROACHES USED FOR REPRESENTING LAND AREAS AND ON LAND-USE DATABASES USED FOR THE INVENTORY PREPARATION

For the identification of the land use areas, Approach 2 as described in 'Volume 4 Agriculture, Forestry, and Other Land Use (Part 1)' of the 2006 IPCC Guidelines was utilised, where it essentially provides an assessment of the total areas of specific land-use categories including also the changes between categories, i.e. the conversions between the land use categories occurring within the time series. Data for the elaboration of land-use transition matrices was obtained from Corine Land Cover (1990, 2000, 2006 and 2012), with additional data relating to Cropland from the National Statistics Office such as the Agriculture Censuses and Farm Structure surveys, the latter providing more recent data for the Cropland category. Corine Land Cover data was obtained from the local competent authority (former 'Malta Environment & Planning Authority (MEPA) now Planning Authority (PA)) responsible for the Corine Land Cover, rather than the EEA directly. The latest Corine Land Cover report available for the purpose of this submission was the 2012 Corine Land Cover.

6.3.1 THE LAND USE TRANSITION MATRIX

In accordance with feedback from past inventory reviews, a land use matrix was created to represent, in a consistent quantified manner, land-use conversions. The matrices allow the determination of areas under land-use transition-for different initial and final land use combinations. Annual values for areas in transition from one type of land use to another have been derived by a hierarchy of basic assumptions with expert judgement of land-use changes in Malta, with support from the LULUCF Expert Review Team (ERT) during reviews. Land-use change matrices for each year of the period 1970-2015 have been drawn up, based on national land use statistics for categories Forest land, Cropland (which is divided into sub-categories: Annual Cropland, and Perennial Cropland), Grassland (divided into sub-categories: maquis Grassland, and other Grassland), Wetland, Settlement and Other Land.

Areas of land use and land-use change are compiled from a number of sources. Areas of Forest Land, Grassland, Wetland, Settlement and Other Land are derived from the Corine Land Cover 1990, 2000, 2006 and 2012. Land areas related to Cropland were sourced from the National Statistics Office. The values for the land use transition matrix being presented in the present submission were adjusted by the LULUCF ERT during the in-country review to create a more robust time series of area data for each of the land use change category reported, as well as addressing the issues pertaining to inconsistencies in areas. Moreover, this was done to reflect the reliability and accuracy of the matrix, as well as changes in the cumulated 20 year areas. Where historic data was not available from the Corine Land Cover and national statistics, a gapfilling exercise using linear extrapolation was carried out, to be consistent with the trendline of the whole time-series.

For the land use changes, it was assumed that conversion to category Other land comes from the categories Other Grassland, maquis Grassland and Settlements. For land use transitions to category Settlements, changes are assumed to come from categories annual Cropland, other Grassland, maquis

Grassland and Perennial Cropland. For land converted to other Grassland, changes are assumed from categories annual Cropland and maquis Grassland. For land converted to maquis Grassland, changes are assumed from categories Other Grassland, perennial Cropland and Settlements (conversions from category Settlements are assumed to refer to abandoned gardens). For land use converted to annual Cropland, changes are assumed from categories Other Grassland, perennial Cropland and maquis Grassland. Lastly, land use converted to perennial Cropland is assumed to be from categories annual Cropland, Other Grassland and maquis Grassland.

It is to note that three types of conversions, namely those from Other Grassland to Perennial Cropland, Perennial Cropland to Settlements, and, Other Grassland to Other Land, were not considered since no such conversions have occurred, thus no carbon stock changes will have accumulated within these changes.

The land-use matrix for the period 1970 to 1990 is presented in Table 6-1 below. The remaining land use conversions for 1990-2015 are not portrayed here since these are included in the CRF tables and may therefore be accessed there. It is to note that for the categories Forest Land and Wetland no occurrences of land-use transition to, or from, both categories have been identified.

Table 6-1 Land-use change matrices for the years 1970-1990 (areas in kilohectares)

	Year 1970-1971									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1970**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.516							0.516
	Annual Cropland		0.012	10.289		1.156				11.457
	Maquis Grassland				9.710					9.710
	Other Grassland				0.979	0.720				1.699
	Wetland						0.025			0.025
	Settlement				0.053			7.802	0.005	7.860
	Other Land								0.196	0.196
	Total end 1971	0.072	0.528	10.289	10.742	1.876	0.025	7..802	0.201	31.535

	Year 1971-1972									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1971**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.528							0.528
	Annual Cropland			10.289						10.289
	Maquis Grassland		0.059	0.194	10.489					10.742
	Other Grassland			0.038		1.838				1.876
	Wetland						0.025			0.025
	Settlement				0.050			7.747	0.005	7.802
	Other Land								0.201	0.201
	Total end 1972	0.072	0.587	10.521	10.539	1.838	0.025	7.747	0.206	31.535

	Year 1972-1973									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1972**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.587							0.587
	Annual Cropland			10.521						10.521
	Maquis Grassland		0.021	0.609	9.890	0.019				10.539
	Other Grassland			0.128		1.710				1.838
	Wetland						0.025			0.025
	Settlement				0.040			7.701	0.005	7.746
	Other Land								0.207	0.207
	Total end 1973	0.072	0.608	11.258	9.930	1.729	0.025	7.701	0.212	31.535

	Year 1973-1974									
	TO	Forest Land	Perennial Cropland	Annual Cropland	Maquis Grassland	Other Grassland	Wetland	Settlement	Other Land	Total end 1973
FROM	Forest Land	0.072								0.072
	Perennial Cropland		0.608							0.608
	Annual Cropland		0.017	11.000		0.241				11.258
	Maquis Grassland				9.930	0.000				9.930
	Other Grassland				0.205	1.524				1.729
	Wetland						0.025			0.025
	Settlement				0.021			7.675	0.005	7.701
	Other Land								0.212	0.212
	Total end 1974	0.072	0.625	11.000	10.156	1.765	0.025	7.675	0.217	31.535

	Year 1974-1975									
	TO	Forest Land	Perennial Cropland	Annual Cropland	Maquis Grassland	Other Grassland	Wetland	Settlement	Other Land	Total end 1974
FROM	Forest Land	0.072								0.072
	Perennial Cropland		0.625							0.625
	Annual Cropland			11.000						11.000
	Maquis Grassland		0.011	0.314	9.827				0.003	10.155
	Other Grassland			0.060		1.705				1.765
	Wetland						0.025			0.025
	Settlement							7.673	0.002	7.675
	Other Land								0.217	0.217
	Total end 1975	0.072	0.636	11.374	9.827	1.705	0.025	7.673	0.222	31.535

	Year 1975-1976									
	TO	Forest Land	Perennial Cropland	Annual Cropland	Maquis Grassland	Other Grassland	Wetland	Settlement	Other Land	Total end 1975
FROM	Forest Land	0.072								0.072
	Perennial Cropland		0.636							0.636
	Annual Cropland		0.017	11.298		0.035		0.024		11.374
	Maquis Grassland				9.822				0.005	9.827
	Other Grassland				0.033	1.672				1.705
	Wetland						0.025			0.025
	Settlement							7.673		7.673
	Other Land								0.223	0.223
	Total end 1976	0.072	0.653	11.298	9.855	1.707	0.025	7.697	0.228	31.535

	Year 1976-1977									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1976**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.653							0.653
	Annual Cropland			11.150		0.101		0.048		11.299
	Maquis Grassland				9.849				0.005	9.854
	Other Grassland				0.089	1.618				1.707
	Wetland						0.025			0.025
	Settlement							7.697		7.697
	Other Land								0.228	0.228
	Total end 1977	0.072	0.653	11.150	9.938	1.719	0.025	7.745	0.233	31.535

	Year 1977-1978									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1977**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.653							0.653
	Annual Cropland		0.011	11.121				0.018		11.150
	Maquis Grassland				9.897			0.036	0.005	9.938
	Other Grassland					1.709		0.010		1.719
	Wetland						0.025			0.025
	Settlement							7.745		7.745
	Other Land								0.233	0.233
	Total end 1978	0.072	0.664	11.121	9.897	1.709	0.025	7.809	0.238	31.535

	Year 1978-1979									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1978**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.631	0.033						0.664
	Annual Cropland			11.121						11.121
	Maquis Grassland			0.055	9.766			0.071	0.005	9.897
	Other Grassland			0.025		1.684				1.709
	Wetland						0.025			0.025
	Settlement							7.808		7.808
	Other Land								0.239	0.239
	Total end 1979	0.072	0.631	11.234	9.766	1.684	0.025	7.879	0.244	31.535

	Year 1979-1980									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1979**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.613		0.018					0.631
	Annual Cropland			10.151		1.012		0.071		11.234
	Maquis Grassland				9.760				0.005	9.765
	Other Grassland				0.864	0.820				1.684
	Wetland						0.025			0.025
	Settlement							7.880		7.880
	Other Land								0.244	0.244
	Total end 1980	0.072	0.613	10.151	10.642	1.832	0.025	7.951	0.249	31.535

	Year 1980-1981									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1980**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.575	0.038						0.613
	Annual Cropland			10.151						10.151
	Maquis Grassland			0.384	10.184			0.069	0.005	10.642
	Other Grassland			0.082		1.750				1.832
	Wetland						0.025			0.025
	Settlement							7.951		7.951
	Other Land								0.249	0.249
	Total end 1981	0.072	0.575	10.655	10.184	1.750	0.025	8.020	0.254	31.535

	Year 1981-1982									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1981**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.571	0.004						0.575
	Annual Cropland			10.655						10.655
	Maquis Grassland			0.325	9.785			0.068	0.005	10.183
	Other Grassland			0.071		1.679				1.750
	Wetland						0.025			0.025
	Settlement							8.020		8.020
	Other Land								0.255	0.255
	Total end 1982	0.072	0.571	11.055	9.785	1.679	0.025	8.088	0.260	31.535

	Year 1982-1983									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1982**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.571							0.571
	Annual Cropland		0.019	10.918		0.052		0.065		11.054
	Maquis Grassland				9.780				0.005	9.785
	Other Grassland				0.048	1.631				1.679
	Wetland						0.025			0.025
	Settlement							8.088		8.088
	Other Land								0.260	0.260
	Total end 1983	0.072	0.590	10.918	9.828	1.683	0.025	8.153	0.265	31.535

	Year 1983-1984									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1983**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.590							0.590
	Annual Cropland		0.019	10.782		0.056		0.062		10.919
	Maquis Grassland				9.822				0.005	9.827
	Other Grassland				0.051	1.632				1.683
	Wetland						0.025			0.025
	Settlement							8.153		8.153
	Other Land								0.265	0.265
	Total end 1984	0.072	0.609	10.782	9.873	1.688	0.025	8.215	0.270	31.535

	Year 1984-1985									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1984**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.610							0.610
	Annual Cropland		0.019	10.645		0.061		0.057		10.782
	Maquis Grassland				9.867				0.005	9.872
	Other Grassland				0.055	1.633				1.688
	Wetland						0.025			0.025
	Settlement							8.216		8.216
	Other Land								0.271	0.271
	Total end 1985	0.072	0.629	10.645	9.922	1.694	0.025	8.273	0.276	31.535

	Year 1985-1986									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1985**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.629							0.629
	Annual Cropland		0.019	10.508		0.060		0.058		10.645
	Maquis Grassland				9.917				0.005	9.922
	Other Grassland				0.054	1.640				1.694
	Wetland						0.025			0.025
	Settlement							8.272		8.272
	Other Land								0.276	0.276
	Total end 1986	0.072	0.648	10.508	9.971	1.700	0.025	8.330	0.281	31.535

	Year 1986-1987									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1986**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.648							0.648
	Annual Cropland		0.019	10.371		0.063		0.055		10.508
	Maquis Grassland				9.965				0.005	9.970
	Other Grassland				0.057	1.642				1.699
	Wetland						0.025			0.025
	Settlement							8.330		8.330
	Other Land								0.281	0.281
	Total end 1987	0.072	0.667	10.371	10.022	1.705	0.025	8.385	0.286	31.535

	Year 1987-1988									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1987**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.667							0.667
	Annual Cropland		0.019	10.235		0.067		0.051		10.372
	Maquis Grassland				10.017				0.005	10.022
	Other Grassland				0.060	1.645				1.705
	Wetland						0.025			0.025
	Settlement							8.385		8.385
	Other Land								0.287	0.287
	Total end 1988	0.072	0.686	10.235	10.077	1.712	0.025	8.436	0.292	31.535

	Year 1988-1989									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1988**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.687							0.687
	Annual Cropland		0.019	10.098		0.068		0.050		10.235
	Maquis Grassland				10.071				0.005	10.076
	Other Grassland				0.061	1.651				1.712
	Wetland						0.025			0.025
	Settlement							8.437		8.437
	Other Land								0.292	0.292
	Total end 1989	0.072	0.706	10.098	10.132	1.719	0.025	8.487	0.297	31.535

	Year 1989-1990									
	TO	**Forest Land**	**Perennial Cropland**	**Annual Cropland**	**Maquis Grassland**	**Other Grassland**	**Wetland**	**Settlement**	**Other Land**	**Total end 1989**
FROM	**Forest Land**	0.072								0.072
	Perennial Cropland		0.706							0.706
	Annual Cropland		0.019	9.961		0.002		0.115		10.097
	Maquis Grassland				10.124	0.005			0.004	10.133
	Other Grassland					1.718				1.718
	Wetland						0.025			0.025
	Settlement							8.487		8.487
	Other Land								0.297	0.297
	Total end 1990	0.072	0.725	9.961	10.124	1.725	0.025	8.602	0.301	31.535

6.4 FOREST LAND (CRF CATEGORY 4A)

6.4.1 FOREST LAND - FOREST LAND REMAINING FOREST LAND (4.A.1)

6.4.1.1 Category Description

Within the Mediterranean region, Malta has one of the lowest levels of forest coverage (FAO, 2014), presumably a combined result of the country's small size, extraordinary high population density, and long history of human habitation, leading to a large human footprint and extensive anthropicization of the land. The only remaining forest remnants occur in localized pockets (with four particular copses of significant age) (Cassar & Conrad, 2014). The largest areas of these remnants are the Mizieb and Buskett areas. None of these woodland areas are utilized for logging or harvesting (MRRA, 2009). Both areas are under a management plan under the responsibility of the Planning Authority (former Malta Environment Planning Authority) (MRRA, 2009).

Buskett Woodland is the only occurring significant extent of mature woodland in the Maltese Islands, which is a result of afforestation that started during the Knights of St. John's period (Cassar & Conrad, 2014). Today a large part of Buskett Woodland is semi-natural woodland. There are still some areas that are managed particularly the citrus groves from the alcove to the picnic area. The land management at Il-Buskett is particularly unique for a Special Area of Conservation in Malta. It is one of a handful of sites that are actively managed by the Government. Certain parts of the woodland are under direct management of the ELC consortium through a Private-Public Partnership agreement with the Government of Malta while the Directorate for Parks, Afforestation and Countryside Restoration (PARKS) within the Ministry for Sustainable Development, the Environment and Climate Change is responsible for the woodland. There are a number of plans to rehabilitate the area. Specific interest is ensuring that forested areas are safeguarded, enhanced and positively promoted (MRRA, 2009).

Miżieb area is also part of the Natura 2000 network but is largely privately owned. The site is mainly managed by the area's landowners who use the area for its agricultural value. A number of landowners have received funding in order to conserve the area. Some invasive alien species have been removed and replaced by the Sandarac Gum tree (MEPA, 2015). The Miżieb Special Area of Conservation incorporates a plateau that has been weathered to give a karstic landscape, bounded by a steep scarp that indents to form the headwaters of two small valleys which flow into Wied il-Miżieb. The southern half of the site is located below the coralline plateau, and consists of a mixture of used and abandoned agricultural land.

Woodland is protected under Maltese legislation, namely Legal Notice 12 of 2001[33] 'Trees and Woodland (Protection) Regulations'. The evergreen woodland is dominated by evergreen tree species such as Oak (*Quercus ilex*) and Aleppo pine (*Pinus halepensis*); however very few old oak trees still exist. The land area for sub-category Forest Land remaining Forest Land is taken from the 2012 Corine Land Cover data. In the previous submissions, estimates of emissions and removal from Forest Land category were calculated following the IPCC Guidelines using the Tier 1 method. Under Forest land, for this year's submission reported removals and emissions were not calculated from this category as was recommended by expert judgement from the LULUCF Expert Review Team during the in-country review. This is explained in the subsequent section.

The area under the category Forest Land equivalent to the two locations of Buskett and Mizieb forests is 0.072 Kha.

6.4.1.2 Methodological Issues

The estimates of emissions and removals were not calculated from this category. The reason being, as recommended by the LULUCF Expert Review Team, the IPCC Guidelines are not appropriate for the calculation of estimates for Malta's forests in the category Forest Land. It is noted that the use of the IPCC default aboveground net increment factors is not appropriate for forest land that is neither subject to harvesting nor to disturbances, which in this case are Malta's forests. Indeed, the ERT notes that in such a case the use of IPCC factors results in the absurd estimate of an indefinite net carbon accumulation across time, while carbon pools have physical limits to the amount of carbon stock they may store.

Furthermore, since Malta is limited to two forest reserves, where the forest cover is almost at maturity and where therefore carbon stock losses are offset by carbon stock gains, so that, without considering the indirect impacts of the fertilization effect due to nitrogen deposition and the increasing CO_2 concentration in the atmosphere, their long-term carbon stock balance can be assumed at equilibrium. Thus, since this is in equilibrium, the emissions and removals from the category Forest Land are determined to be equal to zero.

6.4.1.3 Uncertainties and time-series consistency

Not applicable.

[33] Legal Notice 12 of 2001 Environment Protection Act (CAP. 348) Trees and Woodland (Protection) Regulations, 2001

6.4.1.4 Category-specific QA/QC and verification
Not applicable.

6.4.1.5 Category-specific recalculations
As abovementioned, no emissions and removals were reported from the category Forest Land. The following Table 6-2 indicates the recalculations from the previous submission (2016) to this year's submission (2017).

Table 6-2 Recalculations in Forest Land category from 2016 submission to 2017 submission

Year	Forest Land (Gg CO_2 eq) as reported in the 2016 inventory report	Forest Land (Gg CO_2 eq) as reported in the 2017 inventory report
1990	-1.804	0
1991	-1.804	0
1992	-1.804	0
1993	-1.804	0
1994	-1.804	0
1995	-1.804	0
1996	-1.804	0
1997	-1.804	0
1998	-1.804	0
1999	-1.804	0
2000	-1.804	0
2001	-1.804	0
2002	-1.804	0
2003	-1.804	0
2004	-1.804	0
2005	-1.804	0
2006	-1.804	0
2007	-1.804	0
2008	-1.804	0
2009	-1.804	0
2010	-1.804	0
2011	-1.804	0
2012	-1.804	0
2013	-1.804	0
2014	-1.804	0

6.4.1.6 Category-specific planned improvements
Improvements are required in data which is still missing on the afforestation areas and addressing the difficulty of collection data relating to trees planted in parts of forested areas. This is an issue which has also been raised in the project with the University of Malta.

6.4.2 FOREST LAND - LAND CONVERTED TO FOREST LAND (4.A.2)

6.4.2.1 *Category Description*

No land converted to Forest Land occurred.

6.4.2.2 *Methodological Issues*

Not applicable.

6.4.2.3 *Uncertainties and time-series consistency*

Not applicable.

6.4.2.4 *Category-specific QA/QC and verification*

Not applicable.

6.4.2.5 *Category-specific recalculations*

Not applicable.

6.4.2.6 *Category-specific planned improvements*

Not applicable.

6.5 CROPLAND (CRF CATEGORY 4B)

6.5.1 CATEGORY DESCRIPTION

In Malta, the category of Cropland can be split into three types:

i) Arable area which is cultivated under a system of crop rotation;

ii) Kitchen gardens that include small plots of cultivated land, in which most of the products are intended for consumption by the farmer;

iii) Land under permanent crops where the crop occupies the same land for a period of time, normally 5 years or more.

The level of soil organic matter level in Maltese soils is 2%, and it is considered to be significantly low. The soils' suitability for agronomic purposes is limited by a number of factors, predominantly the unfavourable soil chemical status as a result of alkalinity and the calcareous nature of the soils, shallow depth to bedrock, low soil organic matter, high soil stoniness, and unfavourable water regime as a result of an impermeable surface crust. Soils with a carbonate and bicarbonate content greater than 25% occupy approximately 91% of the total country area. Very shallow soils (<25cm) and shallow soils (> 25cm and < 50cm) occupy 58% of the country's area. 40% of soils are estimated to contain more than 15% coarse fragments[34].

[34] MALSIS. Maltese Soil Information System. 2004. Soil geographic database of the Maltese Islands. National Soil Unit, Ministry for Rural Affairs and the Environment, Malta.

Data is taken from the Agriculture and Fisheries 2013 statistics from the National Statistics Office. The total Utilised Agricultural Area (UAA) amounted to 11,689 hectares. Agricultural holdings in Malta and Gozo are small, where 9,427 each had a UAA of less than 1 hectare. Medium-sized agricultural holdings occupy 22% of the total; such holdings comprise between one and five hectares, while 2.4% are considered large holdings, each having a minimum of five hectares of UAA. Arable land accounted for 76.7% of the total UAA, while permanent crops and kitchen gardens account to the remaining 10.8% and 12.5%, respectively.

Liming of agricultural soils is not applicable to Malta as soils have large calcium carbonate content (MRAE, 2004). Maltese soil types are classified as Leptosols, Vertisols, Calcisols, Luvisols, Cambisols, Regosols or Arensols (data from the MALSIS database sourced through (MEPA, 2006)). Of these, Calcisols occupy approximately 27% of total country area, Luvizols and Leptosols are the most common groups. Calcisols are calcareous (lime-rich) soils with significant accumulation of secondary calcium carbonates, generally developed in dry areas. The Maltese soils are now relict soils since it has developed under different climatic conditions from the more recent one.

According to the 'Rural Development Plan for Malta 2007-2013' (MRRA, 2009), the most cultivated crop is vines and therefore, for inventory purposes, the main perennial crops considered are vines/vineyards. Furthermore, limited availability of data and information on crop land areas did not allow for additional splits into other crops to be carried out.

For inventory purposes, local cropland was split into two types:

- Annual crops which are harvested each year, so there is no long-term storage of carbon in biomass; and,
- Perennial woody crops which constitute vegetation in orchards, vineyards and agroforestry systems capable of storing significant carbon in long-lived biomass.

Under this category, CO_2 removals from living biomass and soil carbon from sub-category Cropland remaining Cropland and sub-category Land converted to Cropland have been reported. Field Burning of agriculture residues estimates are not reported as the data available is not sufficient enough; this is therefore considered as Not Estimated (NE) in the CRF software.

The estimations were calculated only for perennial woody crops. Annual crops are harvested each year, thus increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in the same year – this implies that there is no net accumulation of biomass carbon stocks (IPCC, 2003). Perennial woody vegetation (e.g. in orchards and vineyards) can store significant carbon in long-lived biomass.

6.5.2 Cropland - Cropland remaining Cropland (4.B.1)

6.5.2.1 Methodological Issues

Activity data on perennial crops coverage as available from the 1991 Agriculture Census (NSO, 1993) has been used for the years 1990 to 1998, whereas for the years 1999 onwards activity data on Perennial crops as published by the National Statistics Office has been used (NSO, 2015).

In this category only changes in biomass from perennial woody crops are calculated. The methodology applied to assess the changes in carbon in cropland biomass was a Tier 1 method based on the aggregation of area estimates for perennial woody crops. As vines are the most abundant crop in Malta, only values relating to vineyards have been considered for the purposes of this submission. In the absence of country-specific values, it was suggested that Malta may consider using the values estimated by other countries. The Joint Research Centre (JRC) provided data for various tree species, which relates to countries with conditions similar to Malta's.

From expert judgement by the ERT during the LULUCF in-country review, it was recommended to continue using the values used by Greece in their national inventory[35], as has been the case in previous years. This methodology was previously established with the help of the Joint Research Centre (JRC). As abovementioned, for this inventory purposes only data attributed to vineyards will be taken into consideration, as this is the most abundant crop in Malta. In this case, the default factors adopted by Greece were taken into consideration for Malta, and will thus be utilised. It was strongly encouraged not to use the IPCC default value of 63 t C/ha^{-1}, because it is not appropriate for most Maltese conditions. Malta thus considers the value of 12 tonnes d.m. ha^{-1} for vine crops. The areas for the years utilised for these calculations were taken from the land use matrix. Table 6-3 shows the biomass calculations for Cropland remaining Cropland.

Table 6-3 Change in carbon stock in living biomass in Cropland remaining Cropland

Year	Area	Gains (Area <20 years)		Losses		Net change in C stock
	Kha	*Kha*	*Ggc*	*Kha*	*Ggc*	*GgC*
1990	0.725	0.272	0.163	0	0	-0.598
1991	0.744	0.291	0.175	0	0	-0.640
1992	0.764	0.298	0.179	0	0	-0.656
1993	0.783	0.259	0.155	0	0	-0.570
1994	0.802	0.257	0.154	0	0	-0.565
1995	0.821	0.259	0.155	0	0	-0.570
1996	0.840	0.267	0.160	0	0	-0.587
1997	0.860	0.269	0.161	0	0	-0.592
1998	0.879	0.289	0.173	0	0	-0.636
1999	0.898	0.308	0.185	0	0	-0.678
2000	0.917	0.327	0.196	0	0	-0.719
2001	0.934	0.346	0.208	0	0	-0.761
2002	0.951	0.380	0.228	0	0	-0.836
2003	0.984	0.413	0.248	0	0	-0.909
2004	1.018	0.428	0.257	0	0	-0.942
2005	1.051	0.441	0.265	0	0	-0.970
2006	1.085	0.456	0.274	0	0	-1.003
2007	1.118	0.470	0.282	0	0	-1.034
2008	1.138	0.471	0.283	0	0	-1.036
2009	1.159	0.472	0.283	0	0	-1.038
2010	1.180	0.474	0.284	0	0	-1.043
2011	1.201	0.476	0.286	0	0	-1.047
2012	1.222	0.478	0.287	0	0	-1.052
2013	1.243	0.479	0.287	0	0	-1.054
2014	1.264	0.481	0.289	0	0	-1.058
2015	1.285	0.483	0.290	0	0	-1.063

For the calculation of biomass changes in the land use conversion, different biomass stock factor values were taken into consideration to acquire the value for the C stock in biomass (*ΔC*). The main values required were for annual and perennial Cropland, as well as for maquis and other Grassland. For annual Cropland and other Grassland the default values were taken into consideration since the

[35] Annual Inventory Submission of Greece under the Convention and Kyoto Protocol for Greenhouse and Other Gases for the years 1990-2014, Ministry of Environment and Energy, 2016.

carbon stock in biomass is after one year. On the other hand, for perennial Cropland and maquis Grassland the Greek values were considered since conditions are similar to those in Malta and the values are thus deemed to be appropriate for the Maltese case. Table 6-4 below indicates the values for the abovementioned sub-sectors.

Table 6-4 Average biomass stock values and Carbon stock values for biomass estimations

Sub-sector	*Parameters*		*Reference*
	Average biomass stock (t dm ha^{-1})	**Carbon stock in biomass (t C ha^{-1})**	
Annual Cropland	5	5	Table 5.9 – 2006 IPCC guidelines
Perennial Cropland	35	1.75	Greek value[36]
Maquis Grassland	4	0.2	Greek value[32]
Other Grassland	3.05	3.05	Table 6.4 – 2006 IPCC guidelines

Conversion within the category Cropland are described here. Annual Cropland is converted to Perennial Cropland in the whole time-series, however there were no conversions from Perennial to Annual Cropland. For these conversions, the net biomass stock was calculated using Equations 2.15 and 2.16 in Chapter 2 of the '2006 IPCC Guidelines for National GHG Inventories'. For the conversion from Perennial Cropland to Annual Cropland there were no biomass stocks since no area was reported; while biomass stocks were estimated for the conversions from Annual CL to Perennial CL considering the default values of 5 t C ha^{-1} for annual Cropland taken from Table 5.9 in Chapter 5 of the '2006 IPCC Guidelines for National GHG Inventories', and using the Greek value of 1.75 t C ha^{-1} for perennial Cropland taken from Table 6-4 above (acquired from the Greek value of C stock for perennial Cropland which is 35 t dm ha-1 and dividing it by the 20 years cumulated changes). Table 6-5 below indicates the areas and the changes in carbon stocks for these conversions.

Table 6-5 Changes in carbon stock in living biomass within Cropland conversions

Year	Perennial Cropland to Annual Cropland			Annual Cropland to Perennial Cropland		
	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)
1990	0	0.075	0	0.019	0.209	0.000271
1991	0	0.075	0	0.019	0.216	0.000283
1992	0	0.075	0	0.019	0.235	0.000316
1993	0	0.075	0	0.019	0.254	0.000350
1994	0	0.075	0	0.019	0.256	0.000353
1995	0	0.075	0	0.019	0.275	0.000386
1996	0	0.075	0	0.019	0.277	0.000390
1997	0	0.075	0	0.019	0.296	0.000423
1998	0	0.075	0	0.019	0.304	0.000437
1999	0	0.042	0	0.019	0.323	0.000470

[36] Annual Inventory Submission of Greece under the Convention and Kyoto Protocol for Greenhouse and Other Gases for the years 1990-2014, Ministry of Environment and Energy, 2016

Year	Perennial Cropland to Annual Cropland				Annual Cropland to Perennial Cropland	
2000	0	0.042	0	0.019	0.342	0.000504
2001	0	0.004	0	0	0.342	0.000599
2002	0	0.000	0	0	0.342	0.000599
2003	0	0.000	0	0	0.323	0.000565
2004	0	0.000	0	0	0.304	0.000532
2005	0	0.000	0	0	0.285	0.000499
2006	0	0.000	0	0	0.266	0.000466
2007	0	0.000	0	0	0.247	0.000432
2008	0	0.000	0	0	0.228	0.000399
2009	0	0.000	0	0	0.209	0.000366
2010	0	0.000	0	0	0.190	0.000333
2011	0	0.000	0	0	0.171	0.000299
2012	0	0.000	0	0	0.152	0.000266
2013	0	0.000	0	0	0.133	0.000233
2014	0	0.000	0	0	0.114	0.000200
2015	0	0.000	0	0	0.095	0.000166

For the soil organic content changes in land conversions to Cropland, Equation 2.25 of the ‘2006 IPCC Guidelines for National GHG Inventories’ was used. Default parameters were used which were taken from the 2006 IPCC Guidelines, since country specific values are not present. The soil organic carbon stock (SOC) for each sub category, i.e. annual Cropland, perennial Cropland, other Grassland and maquis Grassland were computed by multiplying the land use (F_{LU}), tillage (F_{MG}) and input (F_I) factor values by the default reference soil organic C stock (SOC_{REF}) which is that of the high activity clay soils (HAC soils) and choosing the appropriate climatic region for Malta which is the warm temperate, dry. The 20-year transition cumulative areas were utilised in the estimation. Table 6-6 below indicates the default parameters used to calculate the SOC changes in the conversions.

Table 6-6 Cropland and Grassland emission factors for SOC changes calculation.

Parameters	*Values*	*Reference*
Climate region	Warm temperate dry	Figure 3A.5.1 – 2006 IPCC Guidelines
Soil type	High activity clay soils - HAC soils	Table 2.3 – 2006 Guidelines
Default Soil Organic C stock (SOCref)	**38** t C ha^{-1}	Table 2.3 – 2006 Guidelines
		Reference
Annual Cropland stock change factors		Table 5.5 – 2006 IPCC guidelines
F_{LU}	0.8	
F_{MG}	1	
F_I	0.95	
Annual Cropland SOC (t C / ha)	**28.88**	
Perennial Cropland stock change factors		Table 5.5 – 2006 IPCC guidelines
F_{LU}	1	
F_{MG}	1	
F_I	0.95	
Perennial Cropland SOC (t C / ha)	**36.10**	
Other Grassland stock change factors		Table 6.2 – 2006 IPCC guidelines

F_{LU}	0.95	
F_{MG}	1	
F_{I}	0.95	
Other Grassland SOC (t C / ha)	**34.295**	
Maquis Grassland stock change factors		Table 6.2 – 2006 IPCC guidelines
F_{LU}	1	
F_{MG}	1	
F_{I}	1	
Maquis Grassland SOC (t C / ha)	**38**	

Table 6-7 below indicates the SOC changes within the Cropland conversions. The SOC changes were estimated with Equation 2.25 as abovementioned by using the respective factors from Table 6-6.

Table 6-7 SOC stock changes in Cropland conversions.

Year	Perennial Cropland to Annual Cropland (GgC)	Annual Cropland to Perennial Cropland (GgC)
1990	-0.027	0.075
1991	-0.027	0.078
1992	-0.027	0.085
1993	-0.027	0.092
1994	-0.027	0.092
1995	-0.027	0.099
1996	-0.027	0.100
1997	-0.027	0.107
1998	-0.027	0.110
1999	-0.015	0.117
2000	-0.015	0.123
2001	-0.001	0.123
2002	0	0.123
2003	0	0.117
2004	0	0.110
2005	0	0.103
2006	0	0.096
2007	0	0.089
2008	0	0.082
2009	0	0.075
2010	0	0.069
2011	0	0.062
2012	0	0.055
2013	0	0.048
2014	0	0.041
2015	0	0.034

For the calculation of the Mineralised N resulting from loss of soil organic C stocks in mineral soils through land-use change or management practices to acquire the F_{SOM} value, equation 11.8 was used from the 2006 IPCC Guidelines. The cumulated 20-year transition areas in the conversions were used for these estimations. For the *R* in the equation 11.8, the default values for C:N ratio of the soil organic matter, which are indicated in the equation, were utilised for the calculation of F_{SOM} values from the conversions to Cropland. For the C:N ratio, the default value of 15 was used for the land-use change from Grassland to Cropland, while the default value of 10 was used for the management changes on Cropland Remaining Cropland. The values of the SOC stock changes in each conversion shown in Table 6-7 above were used to compute the calculations in equation 11.8. The F_{SOM} input will be calculated further to estimate the direct and indirect N_2O emissions from soil, and finally converted to Gg N_2O equivalent. The vales in Table 6-8 below were calculated using the values of the SOC stock changes from Table 6-6. It is to note that the estimates in the Cropland conversions are included in the Agriculture sector in section '3.D.1.5. Mineralisation/Immobilisation associated with Loss/Gain of Soil Organic Carbon', thus in the LULUCF CRF these are indicated as IE in section '4.B.2.2 4(III) Direct N2O emissions from N Mineralisation/Immobilisation'.

Table 6-8 Nitrogen emissions from managed soils in conversions to Cropland

Year	Perennial Cropland to Annual Cropland (kg N)	Annual Cropland to Perennial Cropland (kg N)
1990	2,708	0
1991	2,708	0
1992	2,708	0
1993	2,708	0
1994	2,708	0
1995	2,708	0
1996	2,708	0
1997	2,708	0
1998	2,708	0
1999	1,516	0
2000	1,516	0
2001	144	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0
2009	0	0
2010	0	0
2011	0	0
2012	0	0
2013	0	0
2014	0	0
2015	0	0

6.5.2.2 Uncertainties and time-series consistency

Uncertainties in data, especially in areas of cropland, may arise due to the limited data availability. Information on Maltese farming surveys and censuses is not released yearly, thus can contribute to inaccuracies in data.

6.5.2.3 Category-specific QA/QC and verification

Not applicable

6.5.2.4 Category-specific recalculations

Recalculation has been carried out due to revision in the data of Perennial crops. The revision of data occurred from the 2016 GHG Inventory report to this GHG Inventory report as indicated in Table 6-9.

Table 6-9 Recalculations for the Cropland remaining Cropland

Year	Perennial Crops (Gg CO_2 eq) as reported in the 2016 inventory report	Perennial Crops (Gg CO_2 eq) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
1990	-0.76	-0.60	21.26
1991	-0.83	-0.64	22.87
1992	-0.83	-0.66	21.01
1993	-0.83	-0.57	31.35
1994	-0.83	-0.57	31.88
1995	-0.83	-0.57	31.35
1996	-0.83	-0.59	29.23
1997	-0.83	-0.59	28.70
1998	-0.83	-0.64	23.40
1999	-0.83	-0.68	18.36
2000	-0.83	-0.72	13.33
2001	-0.83	-0.76	8.29
2002	-0.87	-0.84	3.91
2003	-0.82	-0.91	-10.80
2004	-0.84	-0.94	-12.10
2005	-0.87	-0.97	-11.52
2006	-0.91	-1.00	-10.24
2007	-0.94	-1.03	-10.00
2008	-0.97	-1.04	-6.82
2009	-0.99	-1.04	-4.89
2010	-1.02	-1.04	-2.24
2011	-1.06	-1.05	1.21
2012	-1.1	-1.05	4.40
2013	-1.06	-1.05	0.58
2014	-1.03	-1.06	-2.74

6.5.2.5 Category-specific planned improvements

Further data relating to Cropland is required to split the perennial crops into various crops, and using the Joint Research Centre (JRC) method data on emissions and removals to achieve more accurate results, however this ultimately depends on the availability of data since currently there is a significant lack of information in this category.

6.5.3 CROPLAND - LAND CONVERTED TO CROPLAND (4.B.2)

6.5.3.1 Category Description

Land converted to Cropland is assumed to come from Grassland; specifically, land converted to annual Cropland coming from other Grassland and maquis, whilst Perennial Cropland is converted from maquis Grassland.

6.5.3.2 Methodological Issues

The land conversion areas were used to calculate the biomass stocks occurring in the land use conversions in Cropland for the whole time-series through the annual changes in areas. Equations 2.15 and 2.16 of the '2006 IPCC Guidelines for National GHG Inventories' were used to calculate the biomass stocks. The emission factors used to compute the estimates were taken from Table 6-4, were the different emission factors were utilised according to and corresponding to each of the conversions. Table 6-10 indicates the areas which were used to calculate the biomass stocks in the Cropland conversions.

Table 6-10 Changes in carbon stock in living biomass in Cropland conversions

Year	Other Grassland to Annual Cropland			Maquis Grassland to Annual Cropland			Maquis Grassland to Perennial Cropland		
	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)
1990	0	0.404	0	0	1.881	0	0	0.091	0.000159
1991	0	0.404	0	0	1.881	0	0	0.091	0.000159
1992	0	0.366	0	0	1.687	0	0	0.032	0.000056
1993	0	0.238	0	0	1.078	0	0	0.011	0.000019
1994	0	0.238	0	0	1.078	0	0	0.011	0.000019
1995	0	0.178	0	0	0.764	0	0	0.000	0
1996	0	0.178	0	0	0.764	0	0	0.000	0
1997	0	0.178	0	0	0.764	0	0	0.000	0
1998	0	0.178	0	0	0.764	0	0	0.000	0
1999	0	0.153	0	0	0.709	0	0	0.000	0
2000	0	0.153	0	0	0.709	0	0	0.000	0
2001	0.021	0.092	0.004680	0.060	0.385	0.004940	0.017	0.017	-0.000038
2002	0.021	0.042	0.004680	0.060	0.120	0.004940	0.017	0.034	-0.000009
2003	0.034	0.076	0.004482	0.127	0.247	0.004873	0.033	0.067	-0.000015
2004	0.034	0.110	0.004482	0.127	0.374	0.004873	0.033	0.100	0.000043
2005	0.034	0.144	0.004482	0.127	0.501	0.004873	0.033	0.133	0.000101
2006	0.034	0.178	0.004482	0.127	0.628	0.004873	0.033	0.166	0.000159
2007	0.027	0.205	0.004588	0.134	0.762	0.004866	0.033	0.199	0.000216
2008	0.020	0.225	0.004695	0.104	0.866	0.004896	0.021	0.220	0.000301
2009	0.020	0.245	0.004695	0.104	0.970	0.004896	0.021	0.241	0.000338
2010	0.020	0.265	0.004695	0.104	1.074	0.004896	0.021	0.262	0.000375
2011	0.020	0.285	0.004695	0.104	1.178	0.004896	0.021	0.283	0.000411
2012	0.020	0.305	0.004695	0.104	1.282	0.004896	0.021	0.304	0.000448
2013	0.020	0.325	0.004695	0.104	1.386	0.004896	0.021	0.325	0.000485
2014	0.020	0.345	0.004695	0.103	1.489	0.004897	0.021	0.346	0.000522
2015	0.020	0.365	0.004695	0.103	1.592	0.004897	0.021	0.367	0.000558

For the soil organic content changes in land conversions to Cropland, Equation 2.25 of the '2006 IPCC Guidelines for National GHG Inventories' was used. Default parameters were used which were taken from the 2006 IPCC Guidelines. The same method used in Section 6.5.2.1 was applied here for land converted to Cropland to calculate the SOC changes. The 20 year transition cumulative areas was utilised in the estimation. Moreover, factors were also used from Table 6-6 (Section 6.5.2.1) for the calculations of estimations. Table 6-11 below shows the calculations of the SOC stock changes.

Table 6-11 SOC stock changes in Cropland conversions

Year	Other Grassland to Annual Cropland (GgC)	Maquis Grassland to Annual Cropland (GgC)	Maquis Grassland to Perennial Cropland (GgC)
1990	-0.109	-0.858	-0.009
1991	-0.109	-0.858	-0.009
1992	-0.099	-0.769	-0.003
1993	-0.064	-0.492	-0.001
1994	-0.064	-0.492	-0.001
1995	-0.048	-0.348	0.000
1996	-0.048	-0.348	0.000
1997	-0.048	-0.348	0.000
1998	-0.048	-0.348	0.000
1999	-0.041	-0.323	0.000
2000	-0.041	-0.323	0.000
2001	-0.025	-0.176	-0.002
2002	-0.011	-0.055	-0.003
2003	-0.021	-0.113	-0.006
2004	-0.030	-0.171	-0.009
2005	-0.039	-0.228	-0.013
2006	-0.048	-0.286	-0.016
2007	-0.056	-0.347	-0.019
2008	-0.061	-0.395	-0.021
2009	-0.066	-0.442	-0.023
2010	-0.072	-0.490	-0.025
2011	-0.077	-0.537	-0.027
2012	-0.083	-0.585	-0.029
2013	-0.088	-0.632	-0.031
2014	-0.093	-0.679	-0.033
2015	-0.099	-0.726	-0.035

For the N emission in the conversions to Cropland, the same method as in Section 6.5.2.1 was used here. Table 6-12 below shows the N estimations using the SOC stock change values in Table 6-11 above. As already stated, the estimates of N emissions in the Cropland conversions are included in the Agriculture sector in section '3.D.1.5. Mineralisation/Immobilisation associated with Loss/Gain of Soil Organic Carbon', thus in the LULUCF CRF these are indicated as IE in section '4.B.2.2 4(III) Direct N2O emissions from N Mineralisation/Immobilisation'.

Table 6-12 N emission from managed soils in conversions to Cropland.

Year	Other Grassland to Annual Cropland (kg N)	Maquis Grassland to Annual Cropland (kg N)	Maquis Grassland to Perennial Cropland (kg N)
1990	7,292	57,182	576
1991	7,292	57,182	576
1992	6,606	51,285	203
1993	4,296	32,771	70
1994	4,296	32,771	70
1995	3,213	23,226	0
1996	3,213	23,226	0
1997	3,213	23,226	0
1998	3,213	23,226	0
1999	2,762	21,554	0
2000	2,762	21,554	0
2001	1,661	11,704	108
2002	758	3,648	215
2003	1,372	7,509	424
2004	1,986	11,370	633
2005	2,599	15,230	842
2006	3,213	19,091	1,051
2007	3,700	23,165	1,260
2008	4,061	26,326	1,393
2009	4,422	29,488	1,526
2010	4,783	32,650	1,659
2011	5,144	35,811	1,792
2012	5,505	38,973	1,925
2013	5,866	42,134	2,058
2014	6,227	45,266	2,191
2015	6,588	48,397	2,324

6.5.3.3 Uncertainties and time-series consistency

National or country-specific data parameters are not available for the calculations of estimations. In view of this, there is a certain degree of uncertainty since the IPCC default values are used.

6.5.3.4 Category-specific QA/QC and verification

The calculations of estimations are double-checked with the values in the CRF software to ensure an accurate representation of the values.

6.5.3.5 Category-specific recalculations

Recalculations are not applicable since the calculations were done for the first time in this submission, following the recommendations of the LULUCF Expert Review team during the in-country review of Malta's inventory.

6.5.3.6 Category-specific planned improvements

Not applicable.

6.6 GRASSLAND (CRF CATEGORY 4C)

6.6.1 CATEGORY DESCRIPTION

Grassland in Malta is an area of high biodiversity importance protected under the Habitats Directive (Directive 92/43/ECC)[37]. As reported in the National Rural Development Strategy 2007-2013 (MRRA, 2012) the extensive permanent grass areas or pastures that are typical of most European countries are non-existent in Malta. This is mainly due to the prevailing semi-arid climate, geology of the island, relatively shallow depth of soil and small agricultural land parcels. The closest to such land is the *'xaghri',* characterised by a variety of low aromatic shrubs. Effectively, in the past grazing was practiced on such land, as well as on steppe, and this resulted in further degradation of *'xaghri'* or maquis areas as well as abandoned fields. With the transition from extensive goat and sheep herds to cattle in the 1950s, following outbreaks of Maltese fever, grazing eventually diminished and is now rarely practised, whilst the dairy industry has become mostly reliant on forage harvested as the main cereal crop (MRRA, 2009).

On the basis of Legal Notice 321 of 2011[38] (Nitrates Action Programme Regulations, as amended) which requires that animals are housed under roofed structures at all times, grazing in Malta is considered as not taking place. Furthermore, the Trees and Woodland Protection Regulations (Legal Notice 12 of 2001[39]) states that no person shall allow or attempt to allow animals to graze in any tree protection area or other protected area.

The Grassland category is split into other Grassland and maquis Grassland. On the basis of expert judgement, it was decided that maquis will be included in this category, following the inventory submission of 2014. The data of this category was derived from the Corine Land Cover 1996, 2000, 2006 and 2012 under the sclerophyllous vegetation and sparsely vegetated areas.

6.6.2 GRASSLAND - GRASSLAND REMAINING GRASSLAND (4.C.1)

6.6.2.1 Methodological Issues

Tier 1 approach was used for the calculation for sub-category Grassland remaining Grassland due to limitations in the availability of data. It is assumed that the increase in biomass stocks in a single year is equal to biomass losses from mortality in that same year. There are no changes in management practices taking place. No application of mineral and organic fertiliser, organic residues or biological nitrogen occurred on Grassland.

Conversion within the category Grassland are described here. Other Grassland is converted to maquis Grassland for a considerable amount of years in the whole time series; only one year of conversion occurred in the conversion from maquis Grassland to other Grassland. For these conversions, the net biomass stock was calculated using Equations 2.15 of the '2006 IPCC Guidelines for National GHG Inventories'. For both conversions, the biomass stocks were estimated considering the values taken from Table 6.4 above for maquis Grassland and other Grassland. Table 6-13 below indicates the areas and the changes in carbon stocks for these conversions.

[37] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
[38] Legal Notice 321 of 2011 Environment and Development Planning Act (Cap. 504) - Nitrates Action Programme Regulations, 2011
[39] Legal Notice 12 of 2001 Environment Protection Act (CAP. 348) Trees and Woodland (Protection) Regulations, 2001

Table 6-13 Changes in carbon stock in living biomass within Grassland conversions

Year	Other Grassland to Maquis Grassland			Maquis Grassland to Other Grassland		
	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)
1990	0	2.556	0.000511	0.005	0.024	0.000014
1991	0.078	1.655	0.000093	0	0.024	0
1992	0.078	1.733	0.000109	0	0.024	0
1993	0.079	1.812	0.000121	0	0.005	0
1994	0.079	1.686	0.000096	0	0.005	0
1995	0.079	1.765	0.000112	0	0.005	0
1996	0.079	1.811	0.000121	0	0.005	0
1997	0.079	1.801	0.000119	0	0.005	0
1998	0.079	1.880	0.000135	0	0.005	0
1999	0.079	1.959	0.000151	0	0.005	0
2000	0.079	1.174	-0.000006-	0	0.005	0
2001	0	1.174	0.000235	0	0.005	0
2002	0	1.174	0.000235	0	0.005	0
2003	0	1.126	0.000225	0	0.005	0
2004	0	1.075	0.000215	0	0.005	0
2005	0	1.020	0.000204	0	0.005	0
2006	0	0.966	0.000193	0	0.005	0
2007	0	0.909	0.000182	0	0.005	0
2008	0	0.849	0.000170	0	0.005	0
2009	0	0.788	0.000158	0	0.005	0
2010	0	0.788	0.000158	0	0.000	0
2011	0	0.710	0.000142	0	0.000	0
2012	0	0.632	0.000126	0	0.000	0
2013	0	0.553	0.000111	0	0.000	0
2014	0	0.474	0.000095	0	0.000	0
2015	0	0.395	0.000079	0	0.000	0

For the soil organic content changes in land conversions within Grassland, Equation 2.25 of the '2006 IPCC Guidelines for National GHG Inventories' was used. Default parameters were used which were taken from the 2006 IPCC Guidelines. The same method used in Section 6.5.2.1 was used here to calculate the SOC changes. Moreover, similar parameters were also used from Table 6-6 (Section 6.5.2.1) of the IPCC guidelines for the calculations of estimations. The 20-year transition cumulative areas were utilised in the estimation. Table 6-14 below shows the calculations of the SOC stock changes.

Table 6-14 SOC stock changes in Grassland conversions.

Year	Other Grassland to Maquis Grassland (GgC)	Maquis Grassland to Other Grassland (GgC)
1990	0.473	-0.006
1991	0.307	-0.006
1992	0.321	-0.006
1993	0.336	-0.001
1994	0.312	-0.001
1995	0.327	-0.001
1996	0.335	-0.001
1997	0.334	-0.001
1998	0.348	-0.001
1999	0.363	-0.001
2000	0.217	-0.001
2001	0.217	-0.001
2002	0.217	-0.001
2003	0.209	-0.001
2004	0.199	-0.001
2005	0.189	-0.001
2006	0.179	-0.001
2007	0.168	-0.001
2008	0.157	-0.001
2009	0.146	-0.001
2010	0.146	0.000
2011	0.132	0.000
2012	0.117	0.000
2013	0.102	0.000
2014	0.088	0.000
2015	0.073	0.000

6.6.2.2 Uncertainties and time-series consistency

National or country-specific data parameters are not available for the calculations of estimations. In view of this, there is a certain degree of uncertainty since only the IPCC default values are used.

6.6.2.3 Category-specific QA/QC and verification

The calculations of estimations are double-checked with the values in the CRF software to ensure an accurate representation of the values.

6.6.2.4 Category-specific recalculations

Recalculations are not applicable since the calculations were done for the first time in this submission, following the recommendations of the LULUCF Expert Review team during the in-country review of Malta’s inventory.

6.6.2.5 Category-specific planned improvements

Not applicable.

6.6.3 GRASSLAND - LAND CONVERTED TO GRASSLAND (4.C.2)

6.6.3.1 Category Description

Land converted to Grassland is assumed to come from Cropland and Settlements; specifically, land converted to other Grassland is coming from annual Cropland, whereas land converted to maquis Grassland is coming from perennial Cropland and Settlements. It is noted that conversions from the category Settlements are assumed to be gardens, thus there is no storage of C stock changes.

6.6.3.2 Methodological Issues

The biomass stock changes were estimated using Equation 2.16 of the '2006 IPCC Guidelines for National GHG Inventories' in the Cropland conversions. The appropriate emission factor taken from Table 6-4 above were used for each conversion. Table 6-15 indicates the areas which were used to calculate the biomass stock changes.

Table 6-15 Changes in carbon stock in living biomass in Grassland conversions

Year	Perennial Cropland to Maquis Grassland			Settlements to Maquis Grassland			Annual Cropland to Other Grassland		
	Area (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)
1990	0	0.018	0.000004	0	0.164	0.000033	0.002	2.974	-0.000004
1991	0	0.018	0.000004	0	0.111	0.000022	0.086	1.904	-0.000168
1992	0	0.018	0.000004	0	0.061	0.000012	0.086	1.990	-0.000168
1993	0	0.018	0.000004	0	0.021	0.000004	0.087	2.077	-0.000170
1994	0	0.018	0.000004	0	0.000	0	0.087	1.923	-0.000170
1995	0	0.018	0.000004	0	0.000	0	0.087	2.010	-0.000170
1996	0	0.018	0.000004	0	0.000	0	0.087	2.062	-0.000170
1997	0	0.018	0.000004	0	0.000	0	0.087	2.048	-0.000170
1998	0	0.018	0.000004	0	0.000	0	0.087	2.135	-0.000170
1999	0	0.018	0.000004	0	0.000	0	0.087	2.222	-0.000170
2000	0	0.000	0	0	0.000	0	0.086	1.296	-0.000168
2001	0	0.000	0	0	0.000	0	0	1.296	0
2002	0	0.000	0	0	0.000	0	0	1.296	0
2003	0	0.000	0	0	0.000	0	0	1.244	0
2004	0	0.000	0	0	0.000	0	0	1.188	0
2005	0	0.000	0	0	0.000	0	0	1.127	0
2006	0	0.000	0	0	0.000	0	0	1.067	0
2007	0	0.000	0	0	0.000	0	0	1.004	0
2008	0	0.000	0	0	0.000	0	0	0.937	0
2009	0	0.000	0	0	0.000	0	0	0.869	0
2010	0	0.000	0	0	0.000	0	0	0.867	0
2011	0	0.000	0	0	0.000	0	0	0.781	0
2012	0	0.000	0	0	0.000	0	0	0.695	0
2013	0	0.000	0	0	0.000	0	0	0.608	0
2014	0	0.000	0	0	0.000	0	0	0.521	0
2015	0	0.000	0	0	0.000	0	0	0.434	0

For the soil organic content changes in land conversions to Grassland, Equation 2.25 of the '2006 IPCC Guidelines for National GHG Inventories' was used. Default parameters were used which were taken from the 2006 IPCC Guidelines. The same method used in Section 6.5.2.1 was followed here for land converted to Grassland to calculate the SOC changes. Moreover, factors from Table 6-6 were used (Section 6.5.2.1) for the estimations. Table 6-16 below shows the calculations of the SOC stock changes. The conversion from Settlements to maquis Grassland is equivalent to zero for the whole time-series since these are assumed to be gardens, thus there is no C stock changes.

Table 6-16 SOC stock changes in Grassland conversions

Year	Perennial Cropland to Maquis Grassland (GgC)	Settlements to Maquis Grassland (GgC)	Annual Cropland to Other Grassland (GgC)
1990	0.002	0	0.805
1991	0.002	0	0.516
1992	0.002	0	0.539
1993	0.002	0	0.562
1994	0.002	0	0.521
1995	0.002	0	0.544
1996	0.002	0	0.558
1997	0.002	0	0.554
1998	0.002	0	0.578
1999	0.002	0	0.602
2000	0	0	0.351
2001	0	0	0.351
2002	0	0	0.351
2003	0	0	0.337
2004	0	0	0.322
2005	0	0	0.305
2006	0	0	0.289
2007	0	0	0.272
2008	0	0	0.254
2009	0	0	0.235
2010	0	0	0.235
2011	0	0	0.211
2012	0	0	0.188
2013	0	0	0.165
2014	0	0	0.141
2015	0	0	0.118

6.6.3.3 Uncertainties and time-series consistency

National or country-specific data parameters are not available for the calculations of estimations. In view of this, there is a certain degree of uncertainty since only the IPCC default values are used.

6.6.3.4 Category-specific QA/QC and verification

The calculations of estimations are double-checked with the values in the CRF software to ensure an accurate representation of the values.

6.6.3.5 Category-specific recalculations

Recalculations are not applicable since the calculations were done for the first time in this submission, following the recommendations of the LULUCF Expert Review team during the in-country review of Malta's inventory.

6.6.3.6 Category-specific planned improvements

Not applicable.

6.7 WETLANDS (CRF CATEGORY 4D)

6.7.1 WETLANDS - WETLANDS REMAINING WETLANDS (4.D.1)

6.7.1.1 Category Description

In Malta wetlands are mostly saline and therefore contain no or minimal carbon pools. For the purpose of defining Wetlands, the Ramsar Convention was taken into consideration, with two sites, l-Għadira and is-Simar (Convention, 2014), being designated as such. The Environment Resource Authority (ERA) (former MEPA)) is the lead nation agency responsible for designation, regulation and management of these protected areas. As from last year ERA issued two management plans on these sites to conserve and improve the area. Both sites do not have any aquaculture, salt production, peat extraction, drainage or rewetting.

A number of activities exert pressure on the ecology of the site. The Għadira area is popular with tourists and experiences pressures from recreational activities as well as pressure from development including impacts from noise, trampling, habitat disturbance and habitat loss. Overuse of fertilizers and pesticides from surrounding agricultural practices exerts pressure on the wetland from eutrophication and water pollution (MEPA, 2015).

The other wetland Is-Simar, is one of the few remaining habitats of its type in the Maltese Islands. It is a coastal wetland. Such habitats are therefore the only refuge left for a number of endangered or rare species such as the killifish (Aphanius fasciatus) and various species of flora. Before the conversion into a nature reserve in 1992, is-Simar was an abandoned area primarily due to human disturbance. The original marshland vegetation was completely degraded where only a small remnant remained. MEPA scheduled Is-Simar as an Area of Ecological Importance and Site of Scientific Importance as per Government Notice No. 1070/06 in the Government Gazette dated 19 December 2006, followed by a minor revision in 2008 (G.N. No. 371/08) (https://www.mepa.org.mt/simar).

The area under the category Wetland covers the two locations of Għadira and Simar which is equivalent to 0.025 Kha.

6.7.1.2 Methodological Issues

Tier 1 was used due to data-availability limitations. The calculation for this category gives a value of zero, which was reported as Not Occurring (NO) in the CRF.

6.7.1.3 Uncertainties and time-series consistency

Not applicable.

6.7.1.4 Category-specific QA/QC and verification

Not applicable.

6.7.1.5 Category-specific recalculations

Not applicable.

6.7.1.6 Category-specific planned improvements

The aim is to take into consideration data that is available in the management plan for this category.

6.7.2 Wetlands - Land converted to wetlands (4.D.2)

6.7.2.1 Category Description

No land converted to Wetland occurred.

6.7.2.2 Methodological Issues

Not applicable.

6.7.2.3 Uncertainties and time-series consistency

Not applicable.

6.7.2.4 Category-specific QA/QC and verification

Not applicable.

6.7.2.5 Category-specific recalculations

Not applicable.

6.7.2.6 Category-specific planned improvements

Not applicable

6.8 SETTLEMENTS (CRF CATEGORY 4E)

6.8.1 Settlements - Settlements remaining settlements (4.E.1)

6.8.1.1 Category Description

Settlements are defined as all developed land, including transportation infrastructure and human settlements of any size. The land-use category Settlements includes all classes of urban tree formations, namely trees grown along roads and streets, in public and private gardens, and in cemeteries, airports, construction sites, dumpsites, industrial or commercial units, port areas and sport and leisure facilities.

6.8.1.2 Methodological Issues

A Tier 1 methodology has been used, which assumes that carbon stock in living biomass, dead organic matter and soil organic carbon is in equilibrium. This is based on advice given during reviews.

6.8.1.3 Uncertainties and time-series consistency

Not applicable.

6.8.1.4 Category-specific QA/QC and verification

Not applicable.

6.8.1.5 Category-specific recalculations

Not applicable.

6.8.1.6 Category-specific planned improvements

Not applicable.

6.8.2 Settlements - Land converted to Settlements (4.E.2)

6.8.2.1 Category Description

Land converted to Settlement is assumed to come from Cropland and Grassland; specifically, converted from annual Cropland, from other Grassland and from maquis Grassland.

6.8.2.2 Methodological Issues

The biomass stock changes from land conversions to Settlement were calculated using Equations 2.15 and 2.16 of the '2006 IPCC Guidelines for National GHG Inventories'. The appropriate emission factors from Table 6-4 were considered for the conversions to Settlements. Table 6-17 below indicates the estimations which were used to calculate the biomass stock changes in conversions to Settlements

Table 6-17 Changes in carbon stock in living biomass in Settlements conversions

Year	Annual Cropland to Settlements			Other Grassland to Settlements			Maquis Grassland to Settlements		
	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)
1990	0.115	0.674	-0.000575	0	0.010	0	0.000	0.244	0
1991	0.031	0.705	-0.000155	0	0.010	0	0.000	0.244	0
1992	0.031	0.736	-0.000155	0	0.010	0	0.000	0.244	0
1993	0.031	0.767	-0.000155	0	0.010	0	0.000	0.244	0
1994	0.031	0.798	-0.000155	0	0.010	0	0.000	0.244	0
1995	0.031	0.829	-0.000155	0	0.010	0	0.000	0.244	0
1996	0.031	0.836	-0.000155	0	0.010	0	0.000	0.244	0
1997	0.031	0.819	-0.000155	0	0.010	0	0.000	0.244	0
1998	0.031	0.832	-0.000155	0	0.000	0	0.000	0.208	0
1999	0.031	0.863	-0.000155	0	0.000	0	0.000	0.137	0
2000	0.031	0.823	-0.000155	0	0.000	0	0.000	0.137	0
2001	0.000	0.823	0	0	0.000	0	0.012	0.080	-0.000048
2002	0.000	0.823	0	0	0.000	0	0.012	0.024	-0.000048
2003	0.000	0.758	0	0	0.000	0	0.012	0.036	-0.000048
2004	0.000	0.696	0	0	0.000	0	0.012	0.048	-0.000048
2005	0.000	0.639	0	0	0.000	0	0.012	0.060	-0.000048
2006	0.000	0.581	0	0	0.000	0	0.012	0.072	-0.000048
2007	0.000	0.526	0	0	0.000	0	0.001	0.073	-0.000004
2008	0.000	0.475	0	0	0.000	0	0.001	0.074	-0.000004
2009	0.000	0.425	0	0	0.000	0	0.001	0.075	-0.000004
2010	0.000	0.310	0	0	0.000	0	0.001	0.076	-0.000004
2011	0.000	0.279	0	0	0.000	0	0.001	0.077	-0.000004
2012	0.000	0.248	0	0	0.000	0	0.001	0.078	-0.000004
2013	0.000	0.217	0	0	0.000	0	0.001	0.079	-0.000004
2014	0.000	0.186	0	0	0.000	0	0.001	0.080	-0.000004
2015	0.000	0.155	0	0	0.000	0	0.001	0.081	-0.000004

For the soil organic content changes in land conversions to Settlements, Equation 2.25 of the '2006 IPCC Guidelines for National GHG Inventories' was used. Default parameters were used which were taken from the 2006 IPCC Guidelines. The same method used in Section 6.5.2.1 was used here for land converted to Settlement to calculate the SOC changes. Moreover, factors from Table 6-6 (Section 6.5.2.1) were considered for the calculations of estimations. The 20-year transition cumulative areas were utilised in the estimation. For conversions to Settlement it is assumed that settlements contain 20% of the soil organic content of the previous use (based on the percentage of the soil that is not disturbed in the conversion to settlements), thus in the equation the SOC factor was multiplied by 0.2. Table 6-18 below indicates the calculations of the SOC stock changes.

Table 6-18 SOC stock changes in Settlements conversions

Year	Annual Cropland to Settlements (GgC)	Other Grassland to Settlements (GgC)	Maquis Grassland to Settlements (GgC)
1990	-0.779	-0.014	-0.371
1991	-0.814	-0.014	-0.371
1992	-0.850	-0.014	-0.371
1993	-0.886	-0.014	-0.371
1994	-0.922	-0.014	-0.371
1995	-0.958	-0.014	-0.371
1996	-0.966	-0.014	-0.371
1997	-0.946	-0.014	-0.371
1998	-0.961	0	-0.316
1999	-0.997	0	-0.208
2000	-0.951	0	-0.208
2001	-0.951	0	-0.122
2002	-0.951	0	-0.036
2003	-0.876	0	-0.055
2004	-0.804	0	-0.073
2005	-0.738	0	-0.091
2006	-0.671	0	-0.109
2007	-0.608	0	-0.111
2008	-0.549	0	-0.112
2009	-0.491	0	-0.114
2010	-0.358	0	-0.116
2011	-0.322	0	-0.117
2012	-0.286	0	-0.119
2013	-0.251	0	-0.120
2014	-0.215	0	-0.122
2015	-0.179	0	-0.123

6.8.2.3 Uncertainties and time-series consistency

National or country-specific data parameters are not available for the calculations of estimations. In view of this, there is a certain degree of uncertainty since only the IPCC default values are used.

6.8.2.4 Category-specific QA/QC and verification

The calculations of estimations are double-checked with the values in the CRF software to ensure an accurate representation of the values.

6.8.2.5 Category-specific recalculations

Recalculations are not applicable since the calculations were done for the first time in this submission, following the recommendations of the LULUCF Expert Review team during the in-country review of Malta’s inventory.

6.8.2.6 Category-specific planned improvements

Not applicable.

6.9 OTHER LAND (CRF CATEGORY 4F)

6.9.1 OTHER LAND - OTHER LAND REMAINING OTHER LAND (4.F.1)

6.9.1.1 Category Description

This section includes bare soil, rock, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total sum of identified land areas to match the total national area. Change in carbon stocks and non-CO_2 emissions and removals are not considered, assuming that it is typically unmanaged. Mineral extraction sites in Malta are included under this land-use category. Only land area is reported in the CRF tables.

6.9.1.2 Methodological Issues

The default assumption for the Tier 1 calculation is that all carbon in biomass is released to the atmosphere immediately (i.e., in the first year after conversion) through decay processes either on- or off-site, thus it is assumed that the entire biomass is removed in the year of conversion.

6.9.1.3 Uncertainties and time-series consistency

Not applicable.

6.9.1.4 Category-specific QA/QC and verification

Not applicable.

6.9.1.5 Category-specific recalculations

Not applicable.

6.9.1.6 Category-specific planned improvements

Not applicable.

6.9.2 OTHER LAND - LAND CONVERTED TO OTHER LAND (4.F.2)

6.9.2.1 Category Description

Land converted to Other Land is assumed to come from maquis Grassland and Settlements.

6.9.2.2 Methodological Issues

The biomass stock changes from land conversions to Other Land were calculated using Equations 2.15 and 2.16 of the ‘2006 IPCC Guidelines for National GHG Inventories’. The appropriate emission factors from Table 6-4 were considered for the conversions to Other Land. Table 6-19 below indicates the estimations which were used to calculate the biomass stock changes in the conversions. For the conversion from Settlements to Other Land it is assumed that o carbon stock changes currently occur here, thus the biomass stocks are considered to be zero.

Table 6-19 Changes in carbon stock in living biomass in Other Land conversions

Year	Maquis Grassland to Other Land			Settlements to Other Land		
	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)	Areas (Kha)	20 year cumulated areas (Kha)	C stock change in biomass (GgC)
1990	0.005	0.077	-0.000016	0	0.022	0
1991	0.005	0.083	-0.000024	0	0.017	0
1992	0.005	0.089	-0.000024	0	0.012	0
1993	0.004	0.095	-0.000024	0	0.007	0
1994	0.006	0.101	-0.000024	0	0.002	0
1995	0.006	0.104	-0.000024	0	0	0
1996	0.006	0.105	-0.000024	0	0	0
1997	0.006	0.106	-0.000024	0	0	0
1998	0.006	0.107	-0.000024	0	0	0
1999	0.006	0.108	-0.000024	0	0	0
2000	0.006	0.109	-0.000024	0	0	0
2001	0.006	0.109	-0.000020	0	0	0
2002	0.006	0.109	-0.000020	0	0	0
2003	0.006	0.109	-0.000020	0	0	0
2004	0.005	0.109	-0.000020	0	0	0
2005	0.005	0.109	-0.000020	0	0	0
2006	0.005	0.109	-0.000020	0	0	0
2007	0.005	0.110	-0.000024	0	0	0
2008	0.005	0.111	-0.000024	0	0	0
2009	0.005	0.112	-0.000024	0	0	0
2010	0.006	0.114	-0.000024	0	0	0
2011	0.006	0.114	-0.000024	0	0	0
2012	0.006	0.114	-0.000024	0	0	0
2013	0.006	0.114	-0.000024	0	0	0
2014	0.006	0.114	-0.000024	0	0	0
2015	0.006	0.114	-0.000024	0	0	0

For the soil organic content changes in land conversions to Other Land, Equation 2.25 of the '2006 IPCC Guidelines for National GHG Inventories' was used. Default parameters were used which were taken from the 2006 IPCC Guidelines. The same method used in Section 6.5.2.1 was used here for land converted to Other Land to calculate the SOC changes. Moreover, similar parameters were also used from Table 6.6 (Section 6.5.2.1) for the calculations of estimations. The 20-year transition cumulative areas were utilised in the estimation. The assumption that Settlements contains 20% of the SOC of the previous use was considered for Settlements converted to Other Land. Table 6-20 below shows the calculations of the SOC stock changes.

Table 6-20 SOC stock changes in Other Land conversions

Year	Settlements to Other Land (GgC)	Maquis Grassland to Other Land (GgC)
1990	-0.008	-0.146
1991	-0.006	-0.158
1992	-0.005	-0.169
1993	-0.003	-0.181
1994	-0.001	-0.192
1995	0.000	-0.198
1996	0.000	-0.200
1997	0.000	-0.201

Year	Settlements to Other Land (GgC)	Maquis Grassland to Other Land (GgC)
1998	0.000	-0.203
1999	0.000	-0.205
2000	0.000	-0.207
2001	0.000	-0.207
2002	0.000	-0.207
2003	0.000	-0.207
2004	0.000	-0.207
2005	0.000	-0.207
2006	0.000	-0.207
2007	0.000	-0.209
2008	0.000	-0.211
2009	0.000	-0.213
2010	0.000	-0.217
2011	0.000	-0.217
2012	0.000	-0.217
2013	0.000	-0.217
2014	0.000	-0.217
2015	0.000	-0.217

6.9.2.3 Uncertainties and time-series consistency

National or country-specific data parameters are not available for the calculations of estimations. In view of this, there is a certain degree of uncertainty since only the IPCC default values are used.

6.9.2.4 Category-specific QA/QC and verification

The calculations of estimations are double-checked with the values in the CRF software to ensure an accurate representation of the values.

6.9.2.5 Category-specific recalculations

Recalculations for this category are not applicable since the calculations were done for the first time in this submission, following the recommendations of the LULUCF Expert Review team during the in-country review of Malta's inventory.

6.9.2.6 Category-specific planned improvements

Not applicable

6.10 HARVESTED WOOD PRODUCTS (CRF CATEGORY 4G)

6.10.1 Category Description

This category does not occur in Malta. For CRF purposes this is reported as Not Occurring.

6.10.2 Methodological Issues

Not applicable.

6.10.3 Uncertainties and time-series consistency

Not applicable.

6.10.4 Category-specific QA/QC and verification

Not applicable.

6.10.5 Category-specific recalculations

Not applicable.

6.10.6 Category-specific planned improvements

Not applicable.

6.11 OTHER (CRF CATEGORY 4H)

6.11.1 Category Description

Not applicable.

6.11.2 Methodological Issues

Not applicable.

6.11.3 Uncertainties and time-series consistency

Not applicable.

6.11.4 Category-specific QA/QC and verification

Not applicable.

6.11.5 Category-specific recalculations

Not applicable.

6.11.6 Category-specific planned improvements

Not applicable

Chapter 7. WASTE (CRF SECTOR 5)

7.1 OVERVIEW OF SECTOR

In the waste sector, emissions generated from waste management practices over the period 1990 to 2015 are presented. Emission source categories include Solid Waste Disposal (5A), Biological treatment of Solid Waste (5B), Incineration and Open Burning of Waste (5C), and Wastewater Treatment and Discharge (5D).

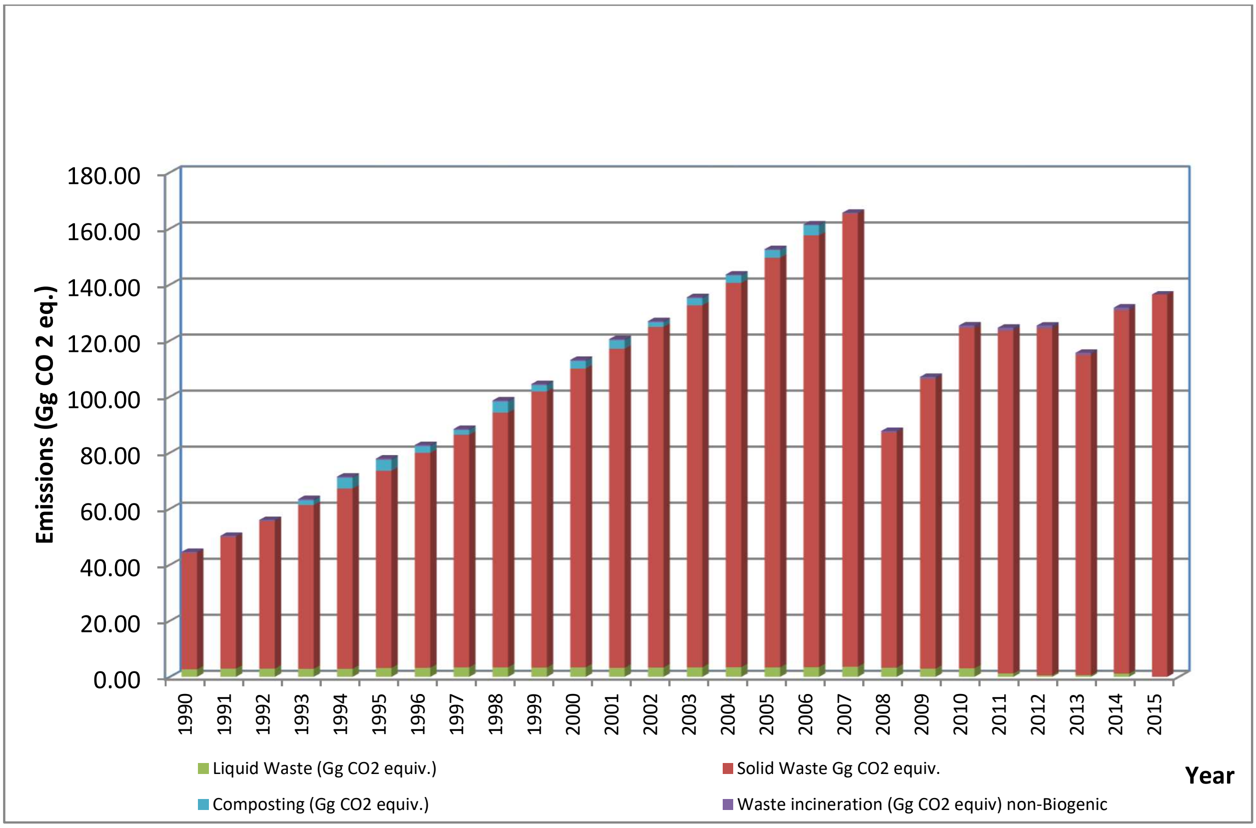

Figure 7-1 Total GHG Emissions from Waste Management Overview by Activity for sector Waste.

The waste sector contributes 6.6% to the total GHG emissions within this inventory, as estimated for 2015. Within the sector, emissions are mainly attributable to Solid Waste Disposal (SWD), specifically disposal on land. A relatively large proportion of emissions reported pertain to methane (CH_4) emitted from landfill operations.

The trend in this sector as presented in Figure 7-1 shows a growth of emissions from this sector throughout the period up to 2007. However, a drastic decrease in emissions is manifest in the years 2008, mainly in sectors 5A (Solid Waste Disposal on Land). The reasons behind this abrupt change of trends are further explained in detail in the sections discussing respective categories and can be summarised as the effect of the entry into operation of specific installations aimed at reducing emissions from these sectors. Nonetheless, and despite showing a number of year-to-year fluctuations, emissions from this sector continue to show a general increase over the years following 2009, mainly due to the continuation of landfilling practices.

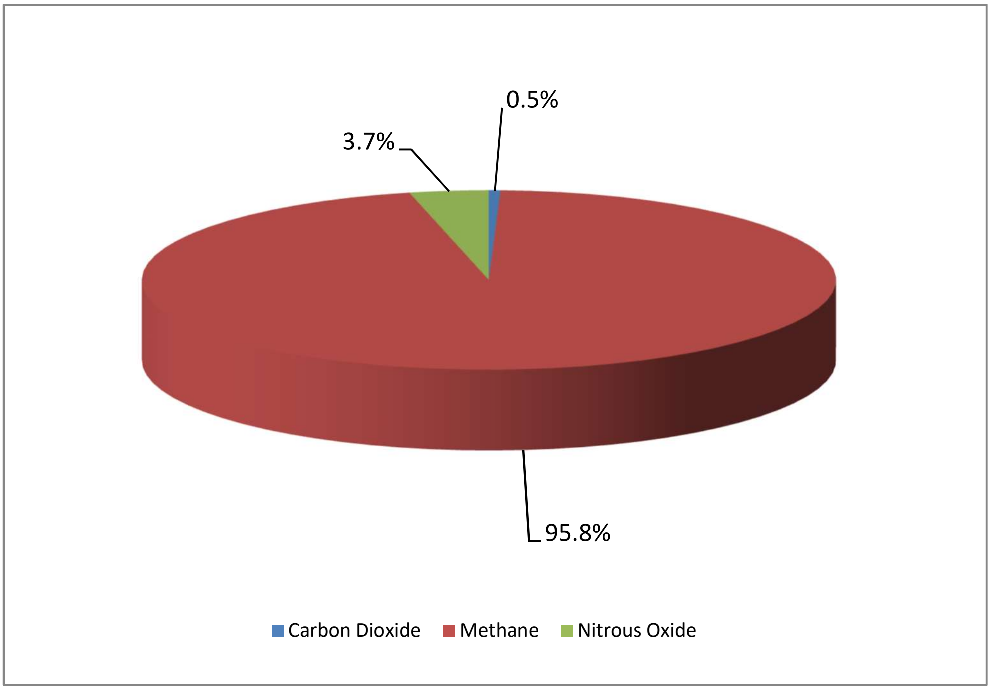

Figure 7-2 Share of emissions, by gas, for sector Waste (% share by gas, based on CO_2 equivalents).

Figure 7-2 shows the contribution in carbon dioxide equivalents of carbon dioxide, methane and nitrous oxide emissions in the latest inventory year. A large proportion is methane emissions resulting from SWD on land. Waste management practices are continuously being improved with newer technologies being planned and implemented mainly in the solid waste treatment sector, with an increased amount of organic fraction being directed to alternative processes (such as Bio-digestion), increased recycling and material recovery and aerobic treatment of liquid waste. The need to divert organics in general from solid waste disposal is the main reason behind such trends.

7.1.1 WASTE GENERATION TRENDS

A general look at the local waste generation trends shows relative stability in the totals of waste disposed (excluding recycled waste). The amount of waste being deposited in landfills has stabilised following a sharp decrease in previous years. Wastewater generation volumes also show a very similar trend. Figure 7-3 below illustrates this scenario. Correlations between the activity and resulting emissions, also through a description of the measures implemented that affect this correlation are described in the specific sector's overview.

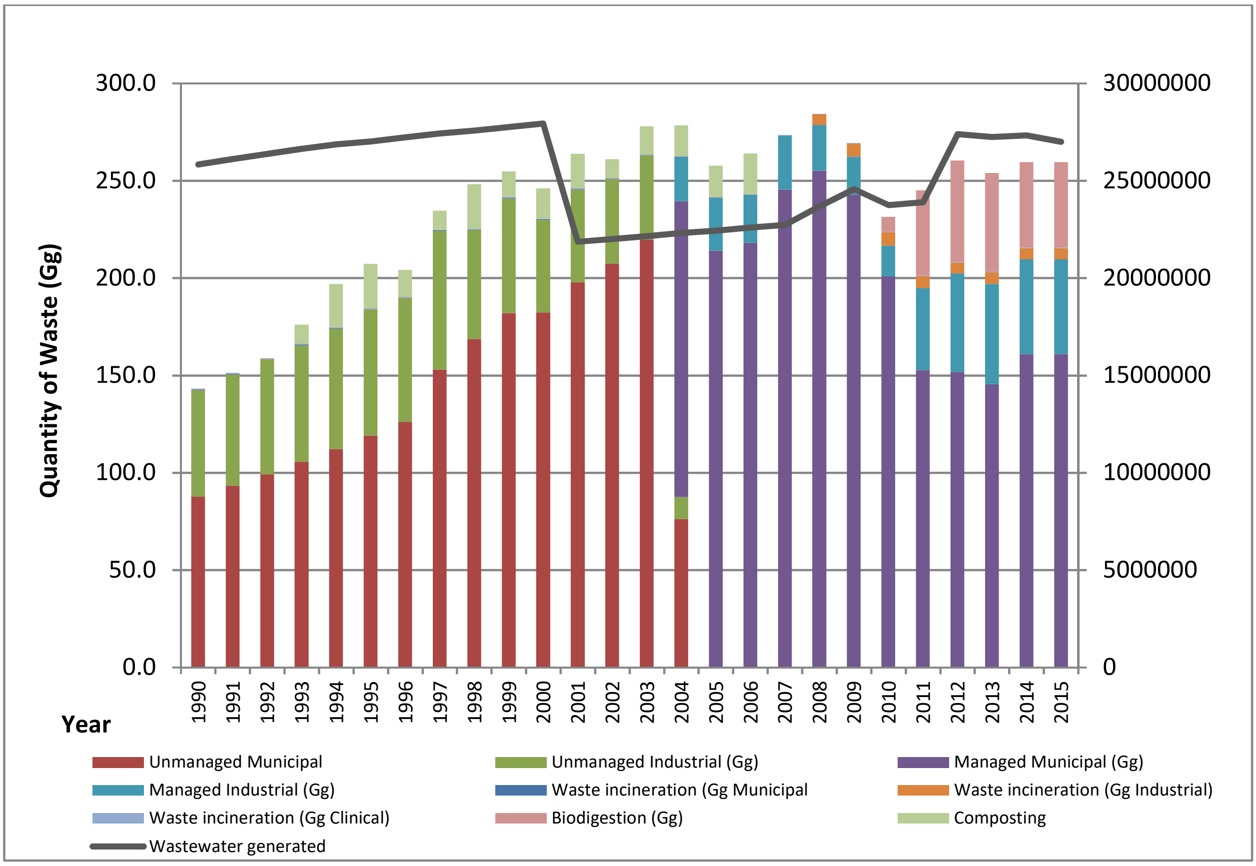

Figure 7-3 Waste disposal trends; amount of MSW generated by year.

7.2 SOLID WASTE DISPOSAL (CRF CATEGORY 5A)

7.2.1 CATEGORY DESCRIPTION

The disposal of solid waste in land-based Solid Waste Disposal sites leads to CH_4 emissions through anaerobic decomposition of organic matter into waste. From 1990 to 1996, solid waste (both municipal and industrial) was deposited into one of three unmanaged landfills: 'Magħtab' and 'Wied Fulija' in Malta and 'Qortin' in Gozo. In 1997 waste stopped being deposited at Wied Fulija, leaving all the waste generated between the years 1997 to 2004 to be deposited at Magħtab and Qortin with the vastest majority of waste entering Maghtab. Eventually, from 2004, waste deposition in unmanaged landfills was stopped, due to requirements under European Union law and all solid waste started to be deposited in the newly opened Ta' Żwejra managed landfill. The Għallis non-hazardous managed landfill also became operational in 2007. The Magħtab, Żwejra and Għallis landfills form part of the Magħtab complex and are geographically adjacent to each other and also share facilities including a Regenerative Treatment Oxidiser (RTO) and Combined Heat and Power (CHP) generation facilities. The Magħtab, Wied Fulija, Qortin, Żwejra and Għallis Landfills are under the responsibility of one operator, namely Wasteserv Malta Ltd. The Operator is a state-owned company responsible for permitting, reporting on the closed sites and operation of the active sites. Sites operating post 2004 like Għallis and Ta' Żwejra have operated under an Integrated Pollution Prevention and Control (IPPC) permit.

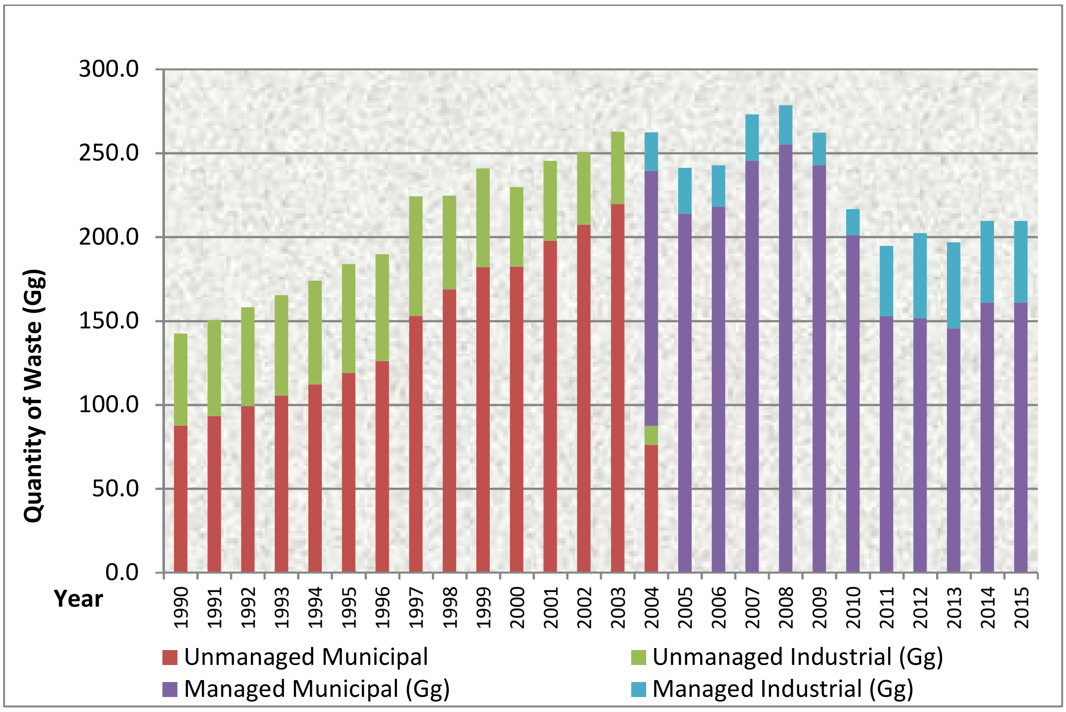

Figure 7-4 Amounts of waste deposited in SWD sites by SWD type.

The RTO gas compound at the Magħtab environmental complex became operational in 2008, following this a CHP generation facility was also installed in the same area to generate energy from the landfill oxidised gases. Methane generated in the Magħtab landfill is directed to the RTO. Characteristically, gas from this landfill is too 'poor' in methane to be burned for energy purposes and actually requires the input of energy (through the RTO's electric heaters or gas boosting from the nearby managed landfills) for successful combustion. The RTO facility has affected the overall composition of landfill gas by negative pressure exerted on the landfill mass increasing oxidation. This effect has created the need to correct MCF annually since it alters radically the characteristics of the landfill mass.

Gases from other landfills in the complex are directed to the CHP for energy production purposes. The quantities of methane oxidised to carbon dioxide during operation at the RTO and CHP have been provided for each year of operation. In addition, a smaller amount of CH_4 was oxidised to CO_2 via flaring at the Qortin Landfill.

In 2012 Wasteserv Malta Ltd scaled up the collection of gas from the Għallis landfill, through the closure of the first landfill cell, which increased drastically the amount of gas being oxidised on site. This was the main reason behind the greatly reduced emissions from the sector as from 2012. The savings from the reported annual methane emissions from the same landfills has thus been calculated. No significant gas extraction volumes have been reported for the other local landfills.

Prior to 1997 no weighing bridges were available at the Maltese landfills. Hence, the available solid waste statistics prior to 1997 may at best be considered as indicative. The quantities of industrial waste deposited in landfills decreased gradually over the years because of improved recycling practices. As shown in Figure 7-4 above a significant decrease in the amounts of municipal and industrial waste being landfilled is visible from 2009 onwards.

To fill in the gap in activity data between 1990 and 1997 a conservative back extrapolation exercise has been undertaken, using available data on GDP, population, waste/capita and waste/GDP. The data was back extrapolated to 1950 as indicated in the IPCC 2006 guidelines (IPCC, 2006) for the implementation of the Tier 2 First Order Decay Model. An explanation of the back extrapolation of activity data is presented in Annex 3.

7.2.2 Methodological Issues

A First Order Decay (FOD) spreadsheet model has been used to work out methane emissions from the solid waste category. This model method uses (IPCC, 2006) default parameters as well as country specific activity data. This method assumes that the degradable organic component in the waste decays slowly over the course of a few decades. The emissions are highest in the first few years after waste deposition, and then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

In this waste model, 1950 was chosen as the starting year for waste deposition into landfills.

The following parameters have been selected to represent Malta in the model:

- Region: Southern Europe;
- Climate: Dry Temperate;
- Starting Year for Waste Deposition: 1950;
- Delay Time for methane emissions to start being generated: 6 months;
- % waste going to SWDS = 100%;
- Methane Correction Factor (MCF):
  - unmanaged shallow landfill (1977 – 1987) = 0.4
  - unmanaged deep landfill (1988 – 2004) = 0.8 (rectified[40])
  - managed deep landfill (2004 onwards) = 1.0
- Methane Generation Rate Constant (k):
  - for municipal waste = 0.09
  - for industrial waste = 0.08
  - for sewage sludge = 0.06
- Fraction of Degradable Organic Component (DOC) in waste:
  - for municipal waste = 0.18
  - for industrial waste = 0.15
  - for sewage sludge = 0.05
- Fraction of Carbon released as CH_4 = 0.5
- Oxidation Factor (OX) (unmanaged) = 0
- Oxidation Factor (OX) (managed)= 0
- % content of paper in industrial waste = 14%
- % content of wood in industrial waste = 5%.

It is notable that the MCF for unmanaged waste deposition sites is variable for years in which RTO is in operation. This modification is based on the findings of a study carried out on behalf of the operator following the installation of the RTO plant at Magħtab, which claimed that more than 50% of the landfill gas produced is actually treated by the RTO and 90% of the methane treated is actually destroyed (Scott Wilson, 2004) (Scott Wilson, 2010). Additionally, the findings in the abovementioned study are in line with the findings in (Oonk, 2012), where the RTO collection efficiency varies between 45-75%.

[40] refer to 7.2.2.1

Municipal waste composition data used in the FOD model was obtained from waste composition surveys carried out by the National Statistics Office (NSO, 2012). The results of the surveys are described in Annex 3.

The parameters described above were only used in managed waste data, since no indications of the municipal waste composition for unmanaged practices prior 2002 can be verified and also noting that unmanaged practices were discontinued from 2004 onwards.

In the current FOD model the landfilling of industrial waste and waste water sludge from aerobic treatment of waste is also included.

7.2.2.1 Unmanaged Landfill MCF rectifications

In the landfill of Magħtab a mixture of municipal solid waste and demolition waste was deposited, resulting in a relative porous waste material. In 2008 landfill gas collection was extracted, to minimise diffuse emissions. Gas was extracted using relative high suction pressures on the gas wells, resulting in a system that resembles active aeration, using over extraction (e.g. see http://www.duurzaamstorten.nl/webfiles/DuurzaamStortenNL/files/Braambergen_project_plan_2011.pdf).

The composition of gas extracted is closely monitored. Concentrations of methane are very low (< 2 vol%), the ratio of CO2/CH4 is significantly increased compared to the normal composition of greenhouse gases and this is consistent with composition of extracted gas at another aeration project (e.g. Kuhstedt: http://www.ifas-hamburg.com/pdf/aeration03.pdf). As discussed during the in-country review, the effect on methane emissions, is best described as a decreased actual MCF upon start of gas-collection/over-extraction.

The high ratio of CO2/CH4 is a clear indication that large part of biodegradation proceeds in aerobic decomposition. In this respect it is not important whether solid organic material (DOC) is directly aerobically degraded, or whether solid organic material first degrades anaerobically and produces methane, which is subsequently oxidised. The ratio of anaerobic and aerobic processes can be estimated from the ratio of methane and carbon dioxide in the extracted gas. Assuming degradable organic material on average having the molecular composition of cellulose (CH2O)n

(note: this is an often used assumption, e.g. in the determination of DOC in waste).

Anaerobic degradation goes as:

$$(CH_2O)_n \rightarrow {}^1/_2\, n\, CH_4 + {}^1/_2\, n\, CO_2$$

Aerobic degradation goes as:

$$(CH_2O)_n + n\, O_2 \rightarrow n\, CO_2 + n\, H_2O$$

In case landfill gas contains x% of CH4 and y% of CO2, the actual MCF (the fraction of DOC removed through anaerobic processes) can be estimated as follows:

$$2 * {}^x/_{x+y}$$

For the Magħtab landfill a substantially reliable time series is available of composition of collected gas (CH4, CO2, O2-content), and this time series is used to estimate the actual MCF upon over extraction. The standard estimate of MCF for this landfill is 0.8 (default value for deep, unmanaged landfills). In the calculation, the estimate of methane generation is corrected for the actual MCF, taking into account the application of the default MCF of 0.8.

7.2.3 Uncertainty and time series consistency

Uncertainty is estimated using IPCC good practice guideline (IPCC, 2006). The main component of uncertainty is related to the emission factor and specifically to the use of default methane generation rate constant (k) as per IPCC 2006. It is understood that all activity (waste entering sites) is weighed at the gate. Uncertainty levels are presented in Table 7-1 Uncertainty levels for category Solid Waste Disposal.

Table 7-1 Uncertainty levels for category Solid Waste Disposal.

Uncertainty issues for SWD	Managed	Unmanaged
% MSW sent to SWDS	5.00%	10.00%
Total uncertainty in waste composition	60.00%	200.00%
DOC Value	20.00%	20.00%
Percentage of DOC decomposed	20.00%	20.00%
MCF	10.00%	50.00%
Fraction of CH_4 generated at Landfill	5.00%	5.00%
OX factor	NA	NA
Half life	20.00%	20.00%
Totals	24.87%	76.10%

For Activity data an uncertainty of ±10% has been used.

Data collected spans back to 1997, prior to which, as previously explained, no weighbridges were used, thus no activity data was collected. International data on such a small economy scale, is in this case considered inadequate. This is why back extrapolation based on common drivers was the preferred option.

7.2.4 Category-specific QA/QC and verification

Category specific studies have been carried out by the Malta Resources Authority to ensure accuracy and consistency in this chapter. Data provided through the operator, Wasteserv Malta Ltd, is also provided under IPPC permitting and reporting and reviewed accordingly.

7.2.5 Category Specific Recalculations

Following updates in methodology, the inclusion of an adjusted MCF for unmanaged landfills and the change in OX factor for unmanaged landfills from 0.6 to 0 a recalculation of emissions was required in this sector. Table 7-2 Recalculation of CH4 emissions from Managed Solid Waste Disposal on Land. illustrates this recalculation.

Table 7-2 Recalculation of CH_4 emissions from Managed Solid Waste Disposal on Land.

Year	Total Emissions (Gg CO2 eq.) as reported in the 2016 inventory report CH4	Total Emissions (Gg CO2 eq.) as reported in the 2017 inventory report CH4	Percentage change in reported emissions (%) CH4
1990	16.59845	41.49612	150.00%
1991	18.79557	46.98893	150.00%
1992	21.05694	52.64234	150.00%
1993	23.37213	58.43031	150.00%
1994	25.73366	64.33415	150.00%
1995	28.16398	70.40995	150.00%
1996	30.68437	76.71092	150.00%
1997	33.21589	83.03972	150.00%
1998	36.36777	90.91942	150.00%
1999	39.41355	98.53386	150.00%
2000	42.66325	106.65813	150.00%
2001	45.53976	113.84941	150.00%
2002	48.62171	121.55427	150.00%
2003	51.68107	129.20268	150.00%
2004	54.85787	137.14468	150.00%
2005	54.08576	135.21440	150.00%
2006	51.44796	128.61991	150.00%
2007	48.93882	122.34704	150.00%
2008	24.88704	14.06583	-43.48%
2009	34.14217	27.10333	-20.62%
2010	37.18703	36.15667	-2.77%
2011	35.06272	30.28326	-13.63%
2012	32.51359	24.12023	-25.81%
2013	36.25477	16.84132	-53.55%
2014	34.48660	22.75254	-34.03%
2015	N/A	8.18	NA

From the above table it clearly transpires that the recalculations have positively affected total emissions monitored between 1990 and 2007 while on the other hand, estimations for 2008 and 2014 have seen a decline in their emission output.

7.2.6 CATEGORY SPECIFIC PLANNED IMPROVEMENTS

No current planned improvements.

7.3 BIOLOGICAL TREATMENT OF SOLID WASTE (CRF CATEGORY 5B)

7.3.1 Biological Treatment of Solid Waste - Composting

7.3.1.1 Category Description

The St. Antnin Solid Waste Treatment Plant started operating in 1993. Waste arriving at the plant was either mixed waste or waste separated at source. Mixed wastes were separated mechanically and the biodegradable fraction was composted. Some non-biodegradable materials such as metals and plastics were channelled into recycling, whilst the rejects from mechanical separation were landfilled.

The organic fraction was composted using the open window system with the product raw compost being refined and left in the open to mature. No abatement measures were ever installed at the St. Antnin Solid Waste Treatment Plant (personal communication, WasteServ Malta Ltd, October 2007). The composting plant stopped operating in early 2007 and it was replaced by a Mechanical biological anaerobic treatment plant, the activity of which is accounted for. Between the decommissioning of this plant in 2007 and the commissioning of the new plant in 2010, no plant scale biological treatment of solid waste operated in Malta, as confirmed in Figure 7-5

7.3.1.2 Methodological Issues

Data on biological solid waste treated at the St. Antnin Solid Waste Treatment Plant has been provided by WasteServ Malta Ltd for the operating years 1993 to 2006. Default IPCC 2006 Tier 1 emission factors are used for CH_4 (wet weight basis- 4g CH_4/kg waste composted) and N_2O (wet weight basis- 0.3g N_2O/kg waste composted) respectively.

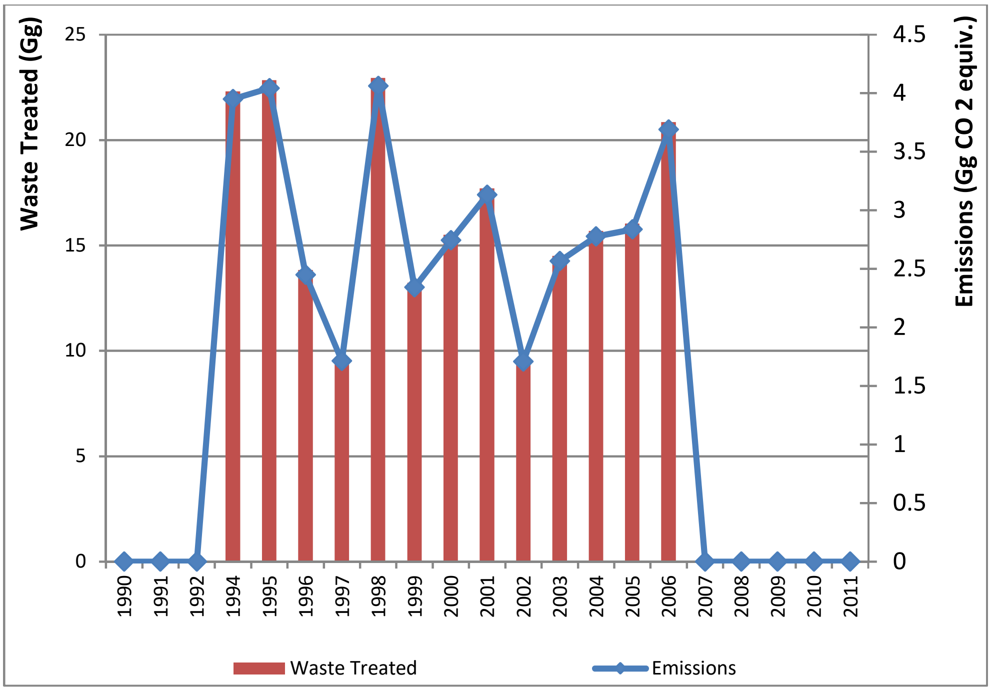

Figure 7-5 Waste treated and emissions from composting.

Figure 7-5 shows the different quantities of waste composted during the period 1990 to 2011. The quantities of waste accepted at the St. Antnin plant decreased progressively during the mid-1990s and in 2002 once again in attempts to keep odour emissions within control. The resultant emissions from composting reflect the quantities of degradable municipal waste received at the compost plant.

7.3.1.3 Uncertainty and time series consistency

Not applicable.

7.3.1.4 Category-specific QA/QC and verification

Not applicable.

7.3.1.5 Category Specific Recalculations

No recalculations were required.

7.3.1.6 Category Specific planned improvements

No current planned improvements in this specific category.

7.3.2 Biological Treatment of Solid Waste - Anaerobic Biodigestion of Waste

7.3.2.1 Category Description

The process of Biodigestion expedites the process of decomposition of organic waste through controlled conditions (e.g. temperature moisture and pH) within a reaction vessel. In the conditions set methane is generated and contrary to landfilling it can easily be directed into a combustion system to be used for energy or else flared.

Since 2010 Malta has one plant operating this process (St. Antnin Waste treatment plant following upgrading). The operator of the plant (WasteServ Malta Ltd) is the same operator of the landfills. The plant consists of an MBT plant, which separates the biological fraction of waste from the remainder and this part is sent for anaerobic treatment. The remaining fractions are either recovered or treated elsewhere.

7.3.2.2 Methodological Issues

The calculation used is based on plant specific data supplied by the operator, the operator submits the amount of waste and amount of gas generated and flared (or used for energy) on a yearly basis. The net biogenic CO_2 emissions from flaring are calculated by multiplying the amount of CH_4 flared by 2.75. The proportion which is used for energy is transferred to the specific sub sector in the energy sector.

7.3.2.3 Uncertainty and time series consistency

The time series of this sector contains a number of gaps mainly due to inconsistent operation of biological plants in the country. Two main periods of no operation are identified: 1990-1993 and 2007-2010. No operation periods can be easily explained with the inexistence or unavailability of infrastructure due to the decommissioning and subsequent upgrades of the St Antnin plant.

In terms of uncertainty, specifically in recent inventory years for anaerobic biodigestion, the use of gas monitoring data decreases the uncertainty of emission (Activity Data (AD) x Emission Factor (EF)) to ±10%. This uncertainty can be fully attributed to AD, since the EF in direct measurement is equal to 1 with no uncertainty.

7.3.2.4 Category-specific QA/QC and verification
Not applicable.

7.3.2.5 Category Specific Recalculations
No recalculations were required

7.3.2.6 Category Specific planned improvements
No current planned improvements in this specific category.

7.4 INCINERATION AND OPEN BURNING OF WASTE (CRF CATEGORY 5C)

7.4.1 CATEGORY DESCRIPTION
Waste incineration is defined as the combustion of solid and liquid waste in controlled facilities. In Malta, to date the emissions from Waste incineration are minimal (<5% of the total emissions in the Waste sector). This category includes emissions from municipal, clinical and industrial waste incineration, leading to carbon dioxide, methane and nitrous oxide emissions; as well as emissions of the indirect greenhouse gases: nitrogen oxides (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2).

Between 1990 and 2007 no regulated/licensed facility existed for Waste incineration in Malta. The facilities in operation at the time were basic and without combustion control. As a precautionary measure their emissions are considered with open burning of Waste rather than as waste incineration. A major improvement took place in early 2008 with the commissioning of a Thermal Treatment Facility in line with the European Union incineration Directive[41]. This incinerator allowed for the decommissioning of old non-compliant local incinerators.

Figure 7-6 shows the emissions in CO_2 equivalents from the combustion of municipal, clinical and industrial waste. The major source of emissions until 2007 was combustion of clinical waste, whereas from 2008, industrial waste incineration has the highest share of emissions in this category. Municipal waste combustion is being reported for the years 1990 to 2003 and intermittently from 2008 onwards. The gap between the latter sets is due to the unavailability of such waste treatment facilities, thus this type of incineration was not-operational.

Figure 7-7 includes the indirect emissions from the combustion of municipal, clinical and industrial waste.

[41] Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste.

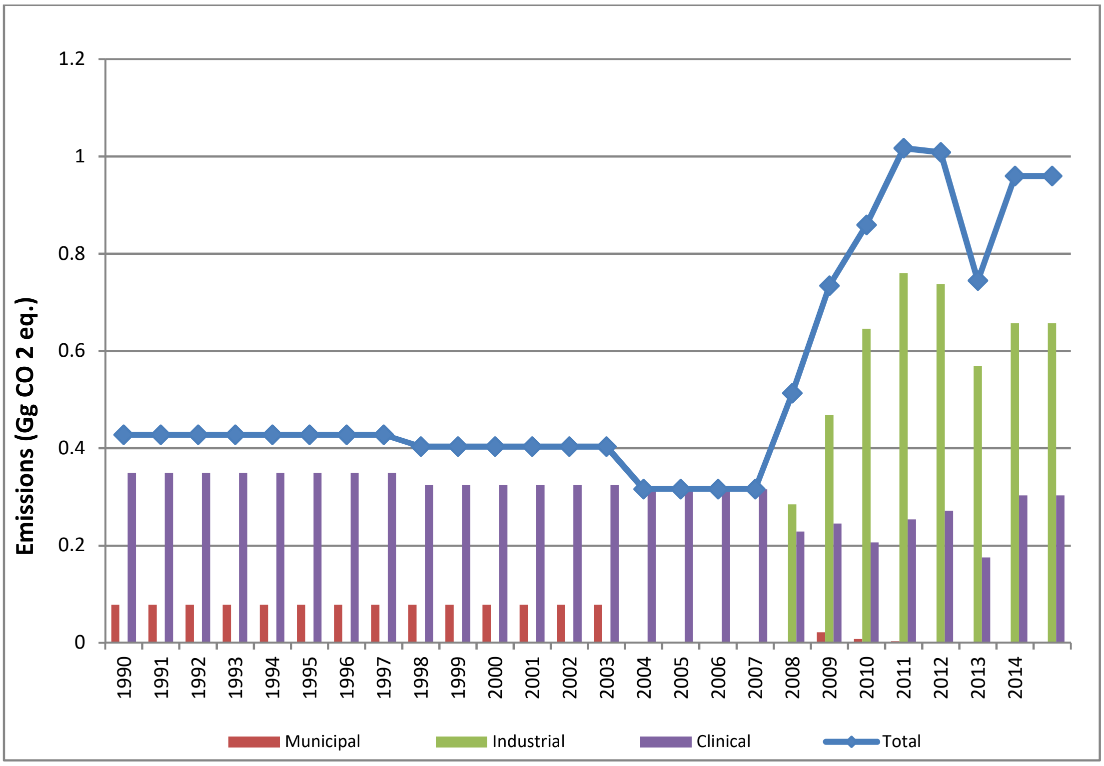

Figure 7-6 Direct GHG emissions from category Incineration.

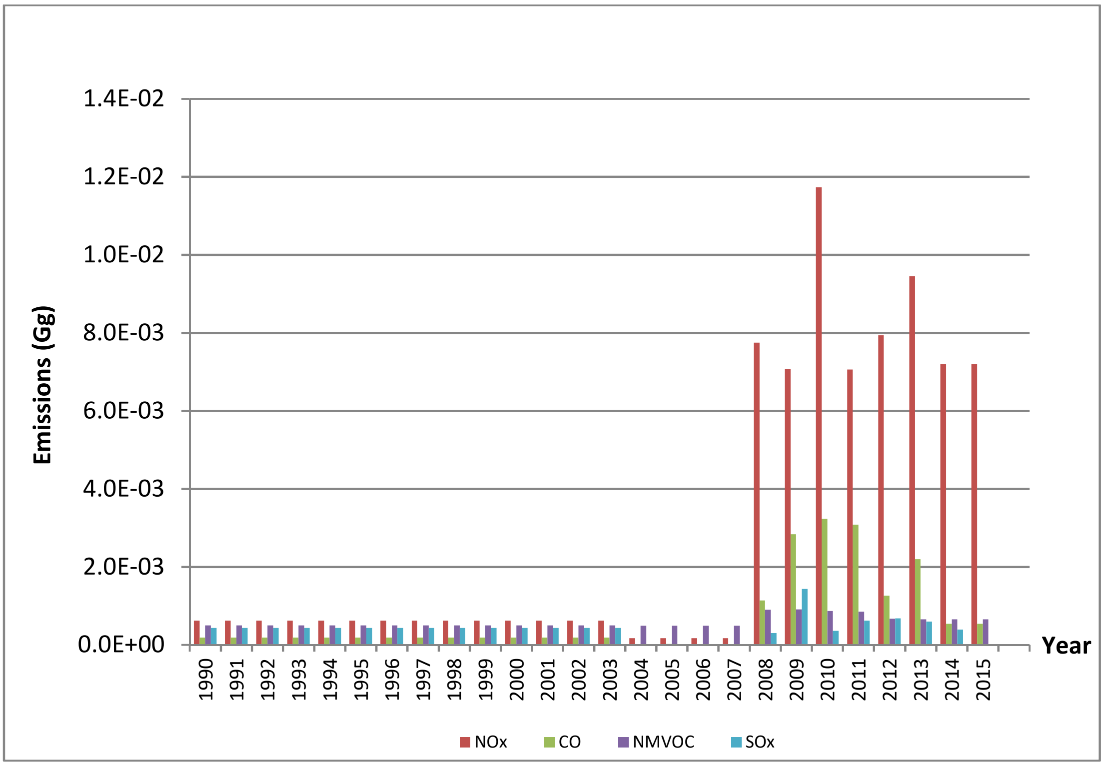

Figure 7-7 Indirect GHG emissions from category Incineration.

7.4.2 Methodological Issues

7.4.2.1 Municipal Waste Incineration

Under this section the following points are to be considered:

- Shipboard kitchen waste reported under Municipal Waste Incineration was previously incinerated at the Malta Shipyards. Shipyard wastes (sediments or paints) were never incinerated.
- Municipal waste incineration is being reported for the years 1990 to 2003, when the incinerator at the Malta Shipyards was operational.
- On average 0.25Gg of waste, 85% of which is considered to be of biogenic origin, used to be incinerated at the shipyards. It is to be noted that the incinerator coped easily with one tonne of waste daily and had no abatement measures fitted.
- For the year 2008, emissions from the incineration of about 0.1tonnes (0.0001Gg) of paper and cardboard, at the Thermal Treatment Facility have been included.
- During 2004-2007, no plants incinerating MSW were operational.

CO_2 emissions from municipal waste incineration have been calculated using the default IPCC 2006 method, as presented in Table 17-11 for the year 1990. EFs for CH_4 and N_2O used in this section prior to 2007 were equivalent to EFs specified for open burning of Waste. This has been done in order to take due account of the lacking and unregulated infrastructure which was in place at the time. Details of EFs used can be found in Annex 3.

For practicality the plant specific deNO_x and desulphurisation emissions are calculated and included in municipal waste.

DeNO_x

In 2011 the Marsa Thermal treatment plant was upgraded with the installation of a deNO_x facility which utilises Urea in liquid form (AdBlue or ISO 22241 compliant fluid) is used to reduce NO_x emissions. During this process of de-noxification, CO_2 is released as a by-product. This emission is calculated by multiplying the amount of AdBlue use reported by an EF of 0.733 tCO_2/m^3 AdBlue.

Desulphurisation

Imported Sodium Bicarbonate is currently being used for desulphurisation. This process is only possible in modern plants, thus no desulphurisation occurred prior to 2008. The amount of bicarbonate consumed by year was obtained from the operator. An emission factor of 0.525t CO_2/t Na_2HCO_3 is used.

7.4.2.2 Clinical Waste Incineration

Two clinical waste incineration facilities existed in the Maltese Islands between 1990 and 2007. During this period, the St Luke's Hospital incinerator provided services for all public and private healthcare institutions on the island of Malta. From a clinical waste survey carried out in 2001 (personal communication, Ministry of Health, 2007) it was found that approximately 1 tonne of clinical waste was produced daily in Malta. In 2006, the St Luke's Hospital incinerator was processing, on average, approximately 910kg of clinical waste per day. No abatement measures were present at the St Luke's Hospital incinerator. The total clinical waste processed by the St Luke's Hospital incinerator in 2006 was estimated at approximately 330 tonnes per year (excluding Gozo).

A second clinical waste incinerator was also operating at the Gozo General Hospital. During the early 1990s, approximately 180kg of contaminated waste per day was incinerated at the Gozo Hospital. This quantity of waste amounts to an estimated 65.7 tonnes of waste incinerated annually. This figure of waste incineration at the Gozo General Hospital is being used for the inventory years 1990 to 1997. For the years 1998 till 2003 a figure of 37.6 tonnes waste incinerated per year as reported in the 1998 MEPA report is being used. For the years 2004 till 2007, a figure of 27.5 tonnes of waste incinerated as reported from waste audits (personal communication, Ministry of Health, 2007), carried out in 2004 is being used. For the year 2008, emissions from the incineration of about 0.26Gg clinical waste at the Thermal Treatment Facility have been reported.

CO_2 emissions from clinical waste incineration are calculated using the default IPCC 2006 method, as presented in Table 17-13 in Annex 3 for the year 1990.

7.4.2.3 Industrial Waste Incineration

Under this category, incineration of paper waste at a local industrial establishment is reported for the inventory years 1990 to 2007, 99% of which is considered as waste of biogenic origin. As indicated by the operator of this facility, the incinerator was more than three decades old and was of a self-burning configuration, that is, no other fuel was used during the burning process. During the years 1990 to 2007, about 0.066Gg of paper waste was incinerated annually (personal communication, private industry representatives, October 2007). Details of this private facility are not listed for reasons of data protection.

CO_2 incineration emissions are calculated using the default IPCC 2006 method, as presented in Table 17-14 in Annex 3 for the year 1990.

7.4.3 Uncertainty and time series consistency

Activity data uncertainty in the latest years is rather low due to the introduction of IPPC permitting and obligatory weighbridges at the entry of incineration plants. The same is not true for the earliest years of the time series. Due to the lack of available data conservative assumptions on activity are included in the calculation of emissions for the period 1990-2007.

In earlier years the EFs calculations for incineration include EFs from open burning due to the lacking infrastructure. However, following the introduction of IPPC regulated plants, much more reliable data on emissions has been provided from facilities which fit the definition of 'controlled facility' in the IPCC 2006 guidelines. **Table 7-3** illustrates the quantified uncertainty for this sector.

Table 7-3 Uncertainties for category Waste Incineration.

Parameter	CO_2	CH_4	N_2O
Emission factor uncertainty (%)	60.00	100.00	100.00
Activity data uncertainty (%)		10.00	

7.4.4 Category-specific QA/QC and verification

Not Applicable.

7.4.5 Category Specific Recalculations

No recalculations were required. Incomplete data was identified in previous CRF submissions and corrected in this submission.

7.4.6 Category Specific planned improvements

No current planned improvements in this specific category.

7.5 WASTEWATER TREATMENT AND DISCHARGE (CRF CATEGORY 5D)

7.5.1 Wastewater Treatment and Discharge - Domestic and Industrial (5D1, 5D2)

7.5.1.1 Category Description

Malta's sewerage infrastructure consists of two main geographically separate networks that collect both domestic and industrial wastewaters, as well as a portion of storm-water runoff. In addition during the whole time series, slurry and liquid waste from animal husbandry is known to have been introduced in the wastewater system and thus it had to be accounted for. During the inventory years 1990 up to 2007, a single sewage treatment plant was in operation and catered for only a fraction of the total wastewater generated on the Maltese Islands. The collection treatment and discharge system has recently undergone major upgrades with the building of three new sewage treatment plants. Two of the plants came into operation in 2008, and this is reflected in an increase in the percentage of treated sewage in the years after 2008. The third and largest plant came in operation in late 2010 and was fully operational in 2011. This is reflected in the reduction of methane emissions in 2011 compared to other years. These infrastructural developments represent a near to 100% treatment of all wastewater generated, not considering exceptional events (accidental releases, overload due to storm runoff or plant breakdown), resulting in no emissions of methane and minimal emissions of nitrous oxide from this source category.

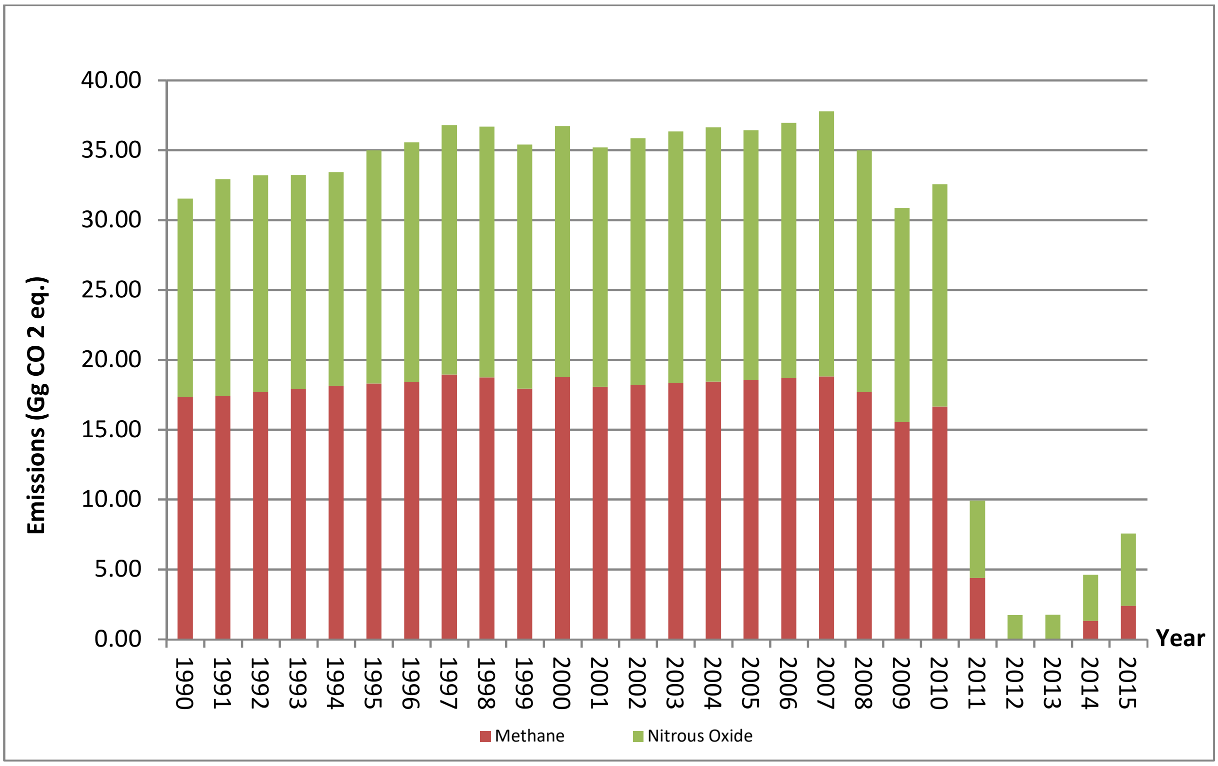

Figure 7-8 GHG emissions for category Wastewater Treatment.

7.5.1.2 Methodological Issues

For the period 1990 to 2000, the sewage generation rate for the year 1992 in m^3/capita/year has been used to calculate the total volume of sewage generated annually. For the years 2001 to 2006, the average rate of sewage generation for 2005/2006 has been used to calculate the total volume of sewage generated annually. This is because no data specific to this period is available. For the years 2007 onwards, annual wastewater generation and treatment data has been provided by the Water Services Corporation.

7.5.1.2.1 Methane emissions

Methane is released where anaerobic conditions prevail. An important factor is the amount of degradable organic component (DOC) in the wastewater, of which a quantitative measure can be taken through the Biological and Chemical oxygen demand of the wastewater (BOD, COD). This DOC in anaerobic conditions will generate methane emissions and the existence of these conditions is subject to the treatment methodology used. Estimates of the total BOD entering the system have been provided by the Wastewater system operator. This includes all BOD (domestic and Industrial) entering the Wastewater handling system. This data is available for 2012 and 2013. It is important to note that the average BOD/capita /year calculated from BOD data submitted is higher than the range of the default factor provided in Table 6.4 of the IPCC 2006 guidelines Volume 5. The average BOD/capita/year of the period 1990-2010 is back extrapolated as the average of the same between 2012 and 2013. An explanation for this could be that animal liquid waste has allegedly been introduced in the wastewater handling system.

In Malta’s case only two treatment methods are relevant: aerobic treatment in wastewater treatment plants and direct disposal at sea. Through the data collected it is possible to elucidate the amount of wastewater which was directed to both processes and thus the proportion of DOC going into the relevant process. Default emission factors as described in Table 6.3 of Volume 5 of the 2006 IPCC guidelines are used to calculate the emission from each process at this stage.

7.5.1.2.2 Nitrous Oxide emissions

N_2O emissions also occur due to anaerobic conditions during handling or disposal of Wastewater, where the nitrogenous molecules, mostly protein is broken down by specific microorganisms. Aerobic Treatment of wastewater reduces the amount of nitrogen available for formation of N_2O.

- **Direct N_2O emissions from WWT**

Wastewater treatment plants are a small but distinct source of N_2O, emanating from the nutrient removal mechanisms. Even though mainly aerobic, some anaerobic pockets do occur, creating N_2O emissions. Emissions are calculated using equation 6.9 found in Volume 5 of the 2006 IPCC guidelines, assuming, an EF_{PLANT} of 3.2g N_2O/person/year, and also including the default factor for Industrial and domestic co-disposal of wastewater (1.25):

$$N_2OEmissions_{Plant} = P * F_{IND-COM} * T_{Plant} * EF_{Plant}$$

$$N_{WWT} = N_2OEmissions_{Plant} * {}^{28}/_{44}$$

- **Indirect N_2O emissions from Effluent**

Effluent disposed in waterways, in this case the sea, is a source of N_2O. The calculation of this emission is based on the nitrogen content of Wastewater, which in this case is inferred from protein consumption/capita. This data was obtained through the FAOstat database; which provides an annual figure for the years 1990-2011. For the remaining years the 2011 estimate is used until updated data is available from FAOstat. Using the protein consumption data, assuming 16% of that mass is nitrogen and assuming an additional 40% for non-consumed protein and 25% for industrial domestic co-disposal, with no Nitrogen being retained as sludge, the Nitrogen Content of Effluent ($N_{EFFLUENT}$) is estimated. Included in this total there also is N_{Agri}, which is the total nitrogen originating from slurry and liquid waste from animal husbandry being introduced in the wastewater system. From this, N_{PLANT} (the amount of nitrogen resulting in direct emissions from WWT) is subtracted to obtain the net $N_{EFFLUENT}$. A default EF is used as highlighted in Table 6.11 of the 2006 IPCC guidelines is used and equation 6.7 of the same guidelines is used to calculate the N_2O emission.

$$N_{EFFLUENT} = \left(\left((P * Protein * F_{NPR} * F_{NON-CON} * F_{IND-COM}) - N_{Sludge} - N_{WWT}\right) + N_{Agri}\right)$$

$$N_2O\ Emissions_{Effluent} = N_{EFFLUENT} * EF_{EFFLUENT} * {}^{44}/_{28} * (1 - Efficiency_{plant})$$

$$N2O\ Emissions\ _{Total} = N2OEmissions_{Plant} + N2O\ Emissions_{Effluent}$$

7.5.1.3 Uncertainty and time series consistency

Uncertainty in both methane and nitrous oxide emissions are summarised in Table 7-4 Uncertainty estimates for category Wastewater Treatment. It is clear that the biggest uncertainty is at EF level especially for N_2O emissions.

Table 7-4 Uncertainty estimates for category Wastewater Treatment.

Uncertainty Source	Value (%)
Population	5.0
EF_j	10.0
BOD total	10.0
$T_{i,j}$	10.0
I	20.0
F_{NPR}	10.0
$EF_{Effluent}$	100.0
EF_{PLANTS}	200.0
Annual Protein Consumption	10.0
$F_{IND-COM}$	25.0
$F_{NON-CON}$	10.0
Total Uncertainties	
N_2O_{PLANT} uncertainty	100.9
$N_2O_{EFFLUENT}$ uncertainty	42.7
CH_4 uncertainty	17.5

7.5.1.4 Category-specific QA/QC and verification

Not available.

7.5.1.5 Category Specific Recalculations

Following reviews of Malta's inventory submission of 2015, two methodological changes were introduced in the calculation:

- The ERT recommended Malta to include under this sector emissions originating from slurry and liquid waste from animal husbandry being introduced in the wastewater system. This was completed by including N_{Agri} in the calculation of $N_{EFFLUENT}$.
- The UWWT were previously considered as not removing any N from the input effluent, whereas it was identified that in general such plants have a 70% N removal capacity. This factor was also included in the amended calculation:

Table 7-5 Recalculation of total emissions from wastewater treatment – domestic and industrial

Year	Total Emissions (Gg CO2 eq.) as reported in the 2016 inventory report	Total Emissions (Gg CO2 eq.) as reported in the 2017 inventory report	Percentage change in reported emissions (%)
	N_2O	N_2O	N_2O
1990	8.10602	9.79036	20.78%
1991	8.89482	10.52122	18.28%
1992	8.86720	10.62739	19.85%
1993	8.73200	10.55116	20.83%
1994	8.64407	10.54482	21.99%
1995	9.43054	11.19208	18.68%
1996	9.72552	10.87994	11.87%
1997	9.92455	11.26340	13.49%
1998	10.11854	11.32418	11.92%
1999	10.33194	11.13909	7.81%
2000	10.25509	11.53717	12.50%
2001	10.19859	11.20710	9.89%
2002	10.51439	11.39260	8.35%
2003	10.73553	11.50052	7.13%
2004	10.83963	11.66084	7.58%
2005	10.65059	11.41186	7.15%
2006	10.89023	11.67883	7.24%
2007	11.31972	12.15095	7.34%
2008	10.99534	11.10822	1.03%
2009	10.94827	10.19422	-6.89%
2010	10.80008	10.50945	-2.69%
2011	11.27311	5.61894	-50.16%
2012	11.52046	3.95638	-65.66%
2013	11.63037	4.01568	-65.47%
2014	11.69765	4.72885	-59.57%
2015	N/A	5.59870	N/A

It could be observed that this re-calculation influenced positively N_20 emissions throughout the earlier period of the time horizon i.e. 1990 to 2008 values while an opposing behaviour was manifested in more recent data.

7.5.1.6 Category Specific planned improvements
No current planned improvements in this specific category.

7.6 BIOGENIC EMISSIONS FROM WASTE

7.6.1 CATEGORY DESCRIPTION
A number of waste management practices currently implemented give rise to CO_2 that can be classified as biogenic, thus not being accounted as emissions in the totals estimated for the country. This is mainly because of the changes in waste management practices and implementation of flaring in closed landfills.

7.6.2 METHODOLOGICAL ISSUES
The major contributors of biogenic CO_2 in the waste sector are the incineration of non-fossil fractions of waste and flaring of methane from landfill gas and, or, biological processes. Only the CO_2 portion of emissions from these processes can be considered biogenic, other gases (CH_4 and N_2O) are accounted for in the previous sections of the specific sectors. Figure 7-9 summarises the emissions of biogenic CO_2 from 1990.

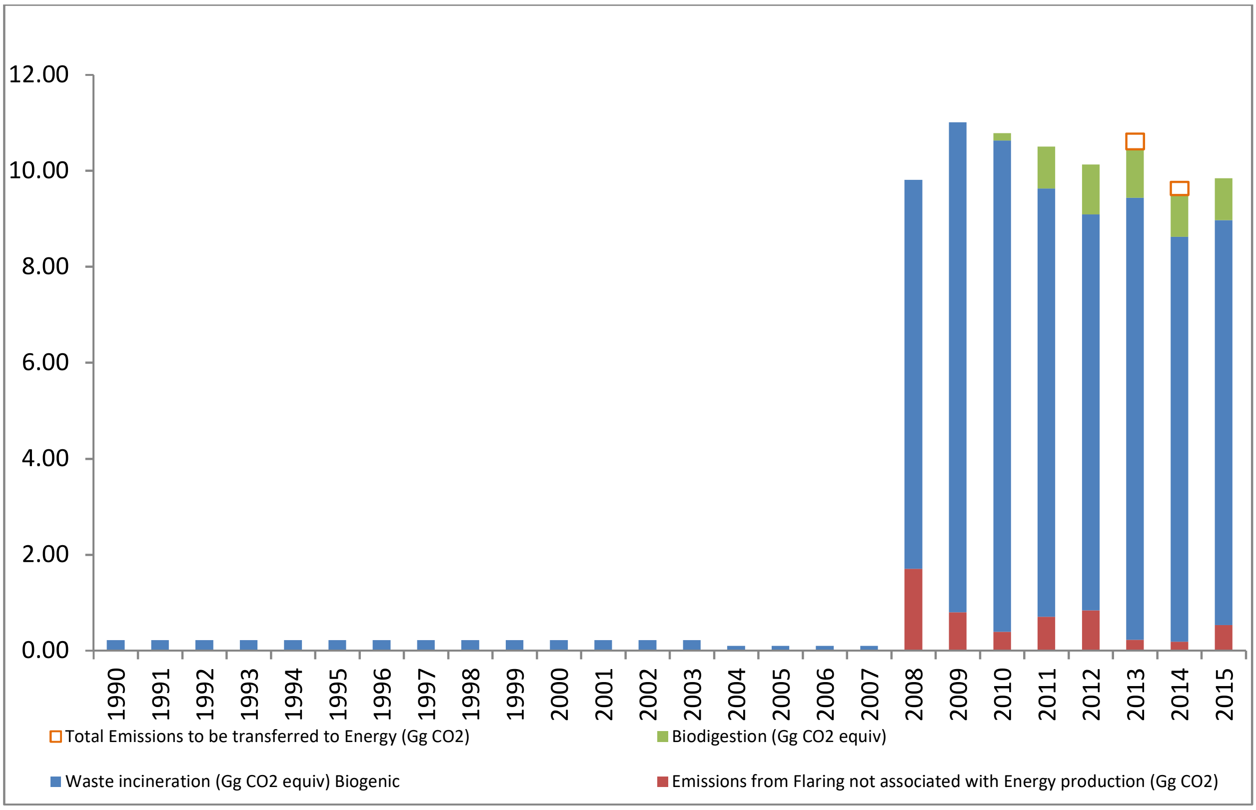

Figure 7-9 CO_2 emissions of biogenic origin from a number of waste processes.

Between 1990 and 2006 the non-fossil fraction was assumed using the type of waste and obtained from tables 2.4 and table 2.5 of section 2.3 of the 2006 IPCC guidelines. From 2007 onwards the estimation was done using the distribution and types of waste actually incinerated.

7.6.3 Uncertainty and time series consistency

Uncertainty in this category was not estimated.

7.6.4 Category-specific QA/QC and verification

Not Applicable.

7.6.5 Category Specific Recalculations

No recalculations were required.

7.6.6 Category Specific planned improvements

No current planned improvements in this specific category.

Chapter 8. OTHER (CRF SECTOR 6)

No sources of emissions or sinks have been identified that do not fall under any of the sectors discussed in Chapters 3 to 7 above. To this effect, there is no further information to report under this chapter.

Chapter 9. INDIRECT CO_2 AND N_2O EMISSIONS

Information on indirect CO_2 and N_2O emissions may be found in the sectoral chapters where such emissions occur, namely the chapter relating to source sector Agriculture.

Chapter 10. RECALCULATIONS AND IMPROVEMENTS

Information on recalculations and improvements relating to specific categories is provided in the respective sections in chapters 3 to 9.

Chapter 11. KP-LULUCF Reporting

11.1 GENERAL INFORMATION

This chapter refers to information related to KP-LULUCF reporting. This reporting was introduced for the 2nd Commitment period (2013-2020) for Malta.

11.1.1 Definition of forest and any other criteria

Malta has identified the minimum values for the three relevant parameters. Thus, 'Forest' is defined as '*an area with minimum area of land of 1 hectare, tree crown cover more than 30% and trees minimum height more than 5 meters.'*

The definition of Planted Forest and Natural forest are defined here aiding to distinguish better between the two types of forest. The definition of Planted Forest as set by the FAO is thus: *'Forest predominantly composed of trees established through planting and/or deliberate seeding.'*

Additionally, Natural forests are all forests that do not conform to the definition of 'Planted Forests'.

The two dominant forests which are present in the Maltese landscape are the Buskett and Mizieb woodland areas, which are highly considered as woodlands rather than forests. None of these woodland areas are utilized for logging or harvesting, thus harvested wood production does not occur (MRRA, 2009). Both areas are under a management plan under the responsibility of the Environment and Resource Authority (former Malta Environment Planning Authority) (MEPA, 2015).

Buskett Woodland is the only occurring significant extent of mature woodland in the Maltese Islands, which is a result of afforestation that started during the Knights of St. John's period (Cassar & Conrad, 2014). Today a large part of Buskett Woodland is semi-natural woodland. There are still some areas that are managed particularly the citrus groves from the alcove to the picnic area. The land management at Il-Buskett is particularly unique for a Special Area of Conservation in Malta. It is one of a handful of sites that are actively managed by the Government. Certain parts of the woodland are under direct management of the ELC consortium through a Private-Public Partnership agreement with the Government of Malta while the Directorate for Parks, Afforestation and Countryside Restoration (PARKS) within the Ministry for Sustainable Development, the Environment and Climate Change is responsible for the woodland. There are a number of plans to rehabilitate the area. Specific interest is ensuring that forested areas are safeguarded, enhanced and positively promoted (MRRA, 2009).

Mizieb area is also part of the Natura 2000 network but is largely privately owned. The site is mainly managed by the area's landowners who use the area for its agricultural value. A number of landowners have received funding in order to conserve the area. Some invasive alien species have been removed and replaced by the Sandarac Gum tree (MEPA 2015). The Miżieb Special Area of Conservation incorporates a plateau that has been weathered to give a karstic landscape bounded by a steep scarp that indents to form the headwaters of two small valleys which flow into Wied il-Miżieb. The southern half of the site is located below the coralline plateau and consists of a mixture of used and abandoned agricultural land.

Woodland is protected under Maltese legislation, namely Legal Notice 12 of 2001[42] 'Trees and Woodland (Protection) Regulations'. The evergreen woodland is dominated by evergreen tree species

[42] Legal Notice 12 of 2001 Environment Protection Act (CAP. 348) Trees and Woodland (Protection) Regulations, 2001

such as oak (*Quercus ilex*) and Aleppo pine (*Pinus halepensis*); however very few old oak trees still exist.

The area contributing to the Buskett and Mizieb woodland locations is equivalent to 0.072 Kha. The areas reported for Forest Management are equivalent to the areas reported under category 4A Forest Land.

11.1.2 Elected activities under Article 3, paragraph 4 of the Kyoto Protocol

Malta confirms 'Forest Management' as the only activity elected under Article 3(4) of the Kyoto Protocol for inclusion in the accounting for the 2nd Commitment Period of the Kyoto Protocol (period 2013-2020).

11.2 LAND-RELATED INFORMATION

11.2.1 Spatial assessment used for determining the area of the units of land under Article 3, paragraph 3 of the Kyoto Protocol

The assessment made is the same one that is mentioned in the LULUCF sector chapter (refer to Chapter 6), where datasets are mainly acquired from the Corine Land Cover 2012.

No emissions and removals were calculated from this sector since the management rules which apply to the two forests occur in Malta are not subject to change the profile of the forested lands. Furthermore, as aforementioned, these woodlands are protected under legislation. In view of this, no activity from Afforestation and Deforestation is occurring in these areas.

11.3 ACTIVITY-SPECIFIC INFORMATION

No emissions and removals estimations occurred from management of forests.

11.4 ARTICLE 3.3

11.4.1 Information relating to Afforestation and Deforestation

No activity is occurring in Afforestation and Deforestation.

11.4.2 Information on harvested wood products under Article 3.3

Malta does not produce any harvested wood products; therefore this category does not occur in Malta.

11.5 ARTICLE 3.4

11.5.1 Information relating to Forest Management

For activities under Article 3 (4), for this year's submission reported removals and emissions were not calculated from this category as was recommended by expert judgement from the LULUCF Expert Review Team during the in-country review. In view of this, since Malta is limited to two forest reserves, where the forest cover is almost at maturity and where therefore carbon stock losses are offset by carbon stock gains, so that, without considering the indirect impacts as the fertilization effect due to nitrogen deposition and the increasing CO_2 concentration in the atmosphere, their long-term carbon stock balance can be assumed at equilibrium. Thus, since this is in equilibrium the estimates of emissions and removals from this category is considered to be zero.

11.5.2 THE FOREST MANAGEMENT REFERENCE LEVEL

The European Union report '*Submission of information on forest management reference level by the European Union as requested by Decision 2/CMP6: The Cancun Agreements: Land use, Land Use Change and Forestry'* published in 2011 defined (paragraph 4) the FMRL value for Malta at -0.049 Mt CO_2 equivalent/year, indicating that this was derived through extrapolation of historic data on greenhouse removals related to forest management.

11.5.3 Technical correction of FMRL

Since the national greenhouse gas inventory submission of 2011, Malta has changed the methodology for estimating emissions and removals for the sector LULUCF. During those previous submissions the category 'Forestland remaining forestland' was taken to include coniferous forest, mixed forest and shrubland (maquis).

Malta has now a national definition which states that a forest is defined as an area of minimum 1 hectare with a tree crown cover of more than 30% and minimum tree height of 5 meters. This has resulted in shrubland no longer being considered as part of the category 'Forestland', now being classified as part of the category 'Grassland'.

In view of this, Malta is seeking a correction of the Forest Management Reference Level (FMRL) currently inscribed under the Kyoto Protocol. This methodological change leads to the sink value of -49Gg CO_2 equivalent as reported when using the previous methodology being reduced to a net removal for the category '*Forestland remaining forestland*' of 0Gg CO_2 equivalent. This means that for Malta, if a FMRL value of -49 Gg CO_2 equivalent had to continue being applied, it would always start which a deficit of -49 Gg CO_2 equivalent when accounting for national emissions under the Kyoto Protocol. Under such a situation Malta would have to surrender an additional amount of Assigned Amount Units equivalent to the deficit. The inconsistency created by the change in methodology used in the determination of the FMRL therefore needs to be addressed through a technical correction.

During the UNFCCC in-country review of the GHG emissions and removals Inventory for Malta of October 2016, the Forest Reference Level was reviewed based on changes in the forest land category of the LULUCF. Thus, through the help of the LULUCF Expert Review Team, the FMRL was recalculated and set to zero. The reasoning behind this is that forests in Malta are almost at maturity and where therefore C stock losses are offset by C stock gains, the long-term C stock balance in Maltese forests is assumed to be in equilibrium. The table below indicates the method used to calculate the technical correction for Malta. The technical correction to the original FMRL is set at 49 Gg CO_2 equivalent.

Table 11-1 – Technical Correction for the Forest Management Reference Level.

	Emissions and removals
FMRL (Forest Management Reference Level inscribed in the appendix to Decision 2/CMP.7))	-49 [Gg yr^{-1}]
$FMRL_{corr}$ (recalculated FMRL)	0 [Gg yr^{-1}]
Difference in per cent = 100 * [($FMRL_{corr}$ – FMRL)/FMRL] %	100%
Technical correction = $FMRL_{corr}$ – FMRL (where 'technical correction' refers to the net value of emissions and removals to be added, at the time of accounting, to the original FMRL so as to reflect the impact of methodological inconsistencies)	49 [Gg yr^{-1}]

11.5.4 Information related to natural disturbances

Malta will not be applying the provisions related to Natural Disturbances.

11.5.5 Information on harvested wood products under Article 3.4

Malta does not produce any harvested wood products; therefore, this category does not occur in Malta.

11.6 OTHER INFORMATION

No key categories were identified within this category.

11.7 INFORMATION RELATING TO ARTICLE 6

Not applicable for Malta

Chapter 12. Information on Accounting of Kyoto Units

Information relevant to this chapter will be presented in subsequent versions of the report, as may be applicable.

Chapter 13. Information on Changes in National System

An overview of the current system for the compilation of national GHG inventories and recent developments is provided in Chapter 1.

Chapter 14. INFORMATION ON CHANGES IN NATIONAL REGISTRY

In the context of the fact that Malta was connected to the International Transaction Log (ITL) for the first time in 2016, the following information on the national registry is provided:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	New tables were added to the CSEUR database for the implementation of the CP2 SEF functionality. Versions of the CSEUR released after 6.7.3 (the production version at the time of the last Chapter 14 submission) introduced other minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model, including the new tables, is provided in Annex A. No change to the capacity of the national registry occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.7.3 of the national registry are listed in Annex B. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was completed in January 2017 and the test report will be provided at a later date. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.7.3 of the national registry are listed in Annex B. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in January 2017 and the test report will be provided at a later date.

Chapter 15. Information on Minimisation of Adverse Impacts in Accordance with Article 3, Paragraph 14

Malta has no information to report on minimisation of adverse impacts.

Chapter 16. OTHER INFORMATION

No other information is being reported.

Chapter 17. ANNEXES

ANNEX 1. KEY CATEGORIES - DETAILED ASSESSMENT

Table 17-1 Key Category Level assessment (Base Year With LULUCF)

Category	Classification	Gas	Unit	Level w/o LULUCF	
Energy Industries	Liquid Fuels	CO2	kt	0.4340	0.4340
Energy Industries	Solid Fuels	CO2	kt	0.2580	0.6920
Road Transportation	Fossil fuels	CO2	kt	0.1220	0.8140
Other Sectors	Liquid Fuels	CO2	kt	0.0610	0.8750
Energy Industries	Solid Fuels	CH4	kt	0.0200	0.8950
Manufacturing Industries and Construction	Liquid Fuels	CO2	kt	0.0190	0.9140
Solid Waste Disposal	Waste	CH4	kt	0.0170	0.9310
Enteric Fermentation	Farming	CH4	kt	0.0160	0.9470
Domestic Navigation	Liquid Fuels	CO2	kt	0.0080	0.9550

Table 17-2 Key Category Level assessment (Base Year Without LULUCF)

Category	Classification	Gas	Unit	Level w/o LULUCF	
Energy Industries	Liquid Fuels	CO2	kt	0.4360	0.4360
Energy Industries	Solid Fuels	CO2	kt	0.2600	0.6960
Road Transportation	Fossil fuels	CO2	kt	0.1230	0.8190
Other Sectors	Liquid Fuels	CO2	kt	0.0610	0.8800
Energy Industries	Solid Fuels	CH4	kt	0.0210	0.9010
Manufacturing Industries and Construction	Liquid Fuels	CO2	kt	0.0190	0.9200
Solid Waste Disposal	Waste	CH4	kt	0.0170	0.9370
Enteric Fermentation	Farming	CH4	kt	0.0160	0.9530

Table 17-3 Key Category Level assessment (Latest Year With LULUCF)

Category	Classification	Gas	Unit	Level w/ LULUCF	
Energy Industries	Liquid Fuels	CO2	kt	0.3970	0.3970
Road Transportation	Fossil fuels	CO2	kt	0.2560	0.6530
Refrigeration and Air conditioning	no classification	Aggregate F-gases	t CO2 equivalent	0.1080	0.7610
Other Sectors	Liquid Fuels	CO2	kt	0.0880	0.8490
Solid Waste Disposal	Waste	CH4	kt	0.0610	0.9100
Domestic Navigation	Liquid Fuels	CO2	kt	0.0220	0.9320
Manufacturing Industries and Construction	Liquid Fuels	CO2	kt	0.0190	0.9510

Table 17-4 Key Category Level assessment (Latest Year Without LULUCF)

Category	Classification	Gas	Unit	Level w/o LULUCF	
Energy Industries	Liquid Fuels	CO2	kt	0.3990	0.3990
Road Transportation	Fossil fuels	CO2	kt	0.2570	0.6560
Refrigeration and Air conditioning	no classification	Aggregate F-gases	t CO2 equivalent	0.1080	0.7640
Other Sectors	Liquid Fuels	CO2	kt	0.0880	0.8520
Solid Waste Disposal	Waste	CH4	kt	0.0610	0.9130
Domestic Navigation	Liquid Fuels	CO2	kt	0.0220	0.9350
Manufacturing Industries and Construction	Liquid Fuels	CO2	kt	0.0190	0.9540

Table 17-5 Key Category Trend assessment With LULUCF

Category	Classification	Gas	Unit	Trend w/ LULUCF	contribution to trend	
Energy Industries	Solid Fuels	CO2	kt	0.2420	0.3897	0.3897
Road Transportation	Fossil fuels	CO2	kt	0.1250	0.2013	0.5910
Refrigeration and Air conditioning	no classification	Aggregate F-gases	t CO2 equivalent	0.1010	0.1626	0.7536
Solid Waste Disposal	Waste	CH4	kt	0.0410	0.0660	0.8196
Energy Industries	Liquid Fuels	CO2	kt	0.0350	0.0564	0.8760
Other Sectors	Liquid Fuels	CO2	kt	0.0250	0.0403	0.9163
Energy Industries	Solid Fuels	CH4	kt	0.0190	0.0306	0.9469
Domestic Navigation	Liquid Fuels	CO2	kt	0.0130	0.0209	0.9678

Table 17-6 Key Category Trend assessment Without LULUCF

Category	Classification	Gas	Unit	Trend w/o LULUCF	Contribution to trend	
Energy Industries	Solid Fuels	CO2	kt	0.2430	0.3926	0.3926
Road Transportation	Fossil fuels	CO2	kt	0.1250	0.2019	0.5945
Refrigeration and Air conditioning	no classification	Aggregate F-gases	t CO2 equivalent	0.1010	0.1632	0.7577
Solid Waste Disposal	Waste	CH4	kt	0.0410	0.0662	0.8239
Energy Industries	Liquid Fuels	CO2	kt	0.0350	0.0565	0.8805
Other Sectors	Liquid Fuels	CO2	kt	0.0250	0.0404	0.9208
Energy Industries	Solid Fuels	CH4	kt	0.0190	0.0307	0.9515

ANNEX 2. ASSESSMENT OF UNCERTAINTY

Table 17-7 Uncertainty assessment with LULUCF

IPCC Source Category		Gas	Base Year emissions 1990	Year t emissions 2015	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Contribution to Variance by Category in year T	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
			CO2 eq. (Gg)	CO2 eq. (Gg)	%	%	%		%	%	%	%	%
1A1ai	Energy Industries - Gas/Diesel Oil	CO2	79.40	63.90	1.00%	3.00%	3.16%	0.008	0.00%	0.03%	-0.01%	0.04%	0.00%
1A1ai	Energy Industries - Residual Fuel Oil	CO2	959.35	823.81	1.00%	3.00%	3.16%	1.365	-0.03%	0.35%	-0.09%	0.49%	0.00%
1A1ai	Energy Industries - bituminous coal	CO2	619.12	0.00	1.00%	3.00%	3.16%	0.000	-0.24%	0.00%	-0.73%	0.00%	0.01%

1A2	Manufacturing Industries and Construction	CO2	46.09	42.48	5.00%	12.00%	13.00%	0.061	0.00%	0.02%	0.00%	0.13%	0.00%
1A3a i	Domestic Aviation	CO2	1.20	3.79	5.00%	10.00%	11.18%	0.000	0.00%	0.00%	0.01%	0.01%	0.00%
1A3b	Road Transportation	CO2	292.06	571.48	0.00%	4.00%	4.00%	1.051	0.12%	0.24%	0.50%	0.00%	0.00%
1A3d	Navigation	CO2	19.69	49.60	5.00%	30.00%	30.41%	0.458	0.01%	0.02%	0.39%	0.15%	0.00%
1A4a	Commercial Institutional	CO2	107.55	135.47	5.00%	12.00%	13.00%	0.624	0.01%	0.06%	0.18%	0.40%	0.00%
1A4b	Residential	CO2	34.01	44.38	5.00%	12.00%	13.00%	0.067	0.01%	0.02%	0.06%	0.13%	0.00%
1A4c	Agriculture/Forestry/Fisheries/ Fish Farms	CO2	4.09	16.59	5.00%	12.00%	13.00%	0.009	0.01%	0.01%	0.06%	0.05%	0.00%
1A5	Non Specified Fuel Combustion	CO2	2.51	4.18	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2A2	Lime Production	CO2	1.25	0.00	8.00%	0.00%	8.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2A4	Other processes/uses of Carbonates	CO2	0.18	0.02	2.00%	0.00%	2.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2D1	Lubricant use	CO2	3.15	0.22	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2D2	Paraffin Wax use	CO2	0.51	0.25	10.00%	50.00%	50.99%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

3B1	Forest Land	CO2	0.00	0.00	18.00%	0.00%	18.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3B2	Cropland	CO2	2.80	1.93	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
4C	Waste Incineration	CO2	0.37	0.68	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - Gas/Diesel Oil	CH4	0.08	0.07	1.00%	60.00%	60.01%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - Residual Fuel Oil	CH4	0.93	0.78	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - bituminous coal	CH4	49.08	0.00	1.00%	0.00%	1.00%	0.000	-0.02%	0.00%	0.00%	0.00%	0.00%
1A2	Manufacturing Industries and Construction	CH4	0.04	0.04	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3a i	Domestic Aviation	CH4	0.00	0.01	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3b	Road Transportation	CH4	2.22	1.57	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3d	Navigation	CH4	0.06	0.16	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4a	Commercial Institutional	CH4	0.34	0.43	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

1A4b	Residential	CH4	0.07	0.21	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4c	Agriculture/Forestry/Fisheries/ Fish Farms	CH4	0.01	0.06	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A5	Non Specified Fuel Combustion	CH4	0.01	0.01	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1a	Cattle (Enteric Fermentation)	CH4	28.66	25.08	5.00%	0.00%	5.00%	0.003	0.00%	0.01%	0.00%	0.07%	0.00%
3A1c	Sheep (Enteric Fermentation)	CH4	3.96	2.53	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
3A1d	Goats (Enteric Fermentation)	CH4	0.78	0.62	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1f	Horses (Enteric Fermentation)	CH4	0.43	0.66	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1h	Swine (Enteric Fermentation)	CH4	3.80	1.64	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1i	Poultry (Enteric Fermentation)	CH4	0.38	0.21	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

3A1j	Others (Rabbits) (Enteric Fermentation)	CH4	0.05	0.18	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2a	Cattle (Manure Management)	CH4	2.14	2.28	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
3A2c	Sheep (Manure Management)	CH4	0.11	0.07	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2d	Goats (Manure Management)	CH4	0.03	0.02	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2f	Horses (Manure Management)	CH4	0.06	0.09	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2h	Swine (Manure Management)	CH4	1.19	0.51	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2i	Poultry (Manure Management)	CH4	1.62	0.90	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2j	Others (Rabbits) (Manure Management)	CH4	0.05	0.18	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

4A1	Managed Waste Disposal on Land	CH4	0.00	123.44	10.00%	0.00%	10.00%	0.306	0.05%	0.05%	0.00%	0.73%	0.01%
4A2	Unmanaged Waste Disposal on Land	CH4	41.50	13.03	10.00%	0.00%	10.00%	0.003	-0.01%	0.01%	0.00%	0.08%	0.00%
4B	Biological Treatment of Solid Waste	CH4	0.00	0.83	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
4D	Domestic and Commercial Wastewater	CH4	17.30	2.40	10.00%	0.00%	10.00%	0.000	-0.01%	0.00%	0.00%	0.01%	0.00%
1A1ai	Energy Industries - Gas/Diesel Oil	N2O	0.19	0.16	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - Residual Fuel Oil	N2O	2.22	1.85	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - bituminous coal	N2O	2.93	0.00	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

1A2	Manufacturing Industries and Construction	N2O	0.10	0.09	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3a i	Domestic Aviation	N2O	0.00	0.01	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3b	Road Transportation	N2O	4.25	4.82	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3d	Navigation	N2O	0.05	0.12	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4a	Commercial Institutional	N2O	0.23	0.28	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4b	Residential	N2O	0.02	0.05	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4c	Agriculture/Forestry/Fisheries/ Fish Farms	N2O	0.00	0.04	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A5	Non Specified Fuel Combustion	N2O	0.01	0.02	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2G3	Use of N2O for Product uses	N2O	2.39	0.64	3.00%	0.00%	3.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2	Direct emissions (Manure (management)	N2O	6.28	4.82	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
3C4	Direct N2O from Managed Soils	N2O	15.46	15.11	5.00%	0.00%	5.00%	0.001	0.00%	0.01%	0.00%	0.04%	0.00%

3C5	Indirect N2O from Managed Soils	N2O	5.43	5.18	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.02%	0.00%
3C6	Indirect N2O from Manure Management	N2O	6.71	5.79	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.02%	0.00%
4C	Waste Incineration	N2O	0.02	0.16	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
4D	Domestic and Commercial Wastewater	N2O	8.11	5.60	10.00%	0.00%	10.00%	0.001	0.00%	0.00%	0.00%	0.03%	0.00%
2E	Electronics Industry	HFCs	0.00	0.40	2.00%	0.00%	2.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2F1	Refrigeration and Air Conditioning	HFCs	0.00	241.07	10.00%	0.00%	10.00%	1.169	0.10%	0.10%	0.00%	1.43%	0.02%
2F2	Foam Blowing Agents	HFCs	0.00	1.03	50.00%	0.00%	50.00%	0.001	0.00%	0.00%	0.00%	0.03%	0.00%
2F3	Fire Protection	HFCs	0.00	2.72	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
2F4	Aerosols and Solvents (MDIs)	HFCs	0.00	1.78	30.00%	0.00%	30.00%	0.001	0.00%	0.00%	0.00%	0.03%	0.00%
2G1	Electrical Equipment	SF6	0.00	0.00	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

Total emission	All GHGs		2381.89	2229.81				5.130				0.04%	0.04%
						Percentage uncertainty in Total inventory		2.265			Trend Uncertainty		2.01%

NOTE: a small discrepancy may be observed between the total GHG emissions values reported in this table and the total GHG emissions reported in the CRF. This discrepancy arises due to rounding issues in the method utilised to assess uncertainty.

Table 17-8 Uncertainty assessment without LULUCF

IPCC Source Category		Gas	Base Year emissions 1990	Year t emissions 2015	Activity Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Contribution to Variance by Category in year T	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
			CO2 eq. (Gg)	CO2 eq. (Gg)	%	%	%		%	%	%	%	%
1A1ai	Energy Industries - Gas/Diesel Oil	CO2	79.40	63.90	1.00%	3.00%	3.16%	0.008	0.00%	0.03%	-0.01%	0.04%	0.00%
1A1ai	Energy Industries - Residual Fuel Oil	CO2	959.35	823.81	1.00%	3.00%	3.16%	1.369	-0.03%	0.35%	-0.09%	0.49%	0.00%
1A1ai	Energy Industries - bituminous coal	CO2	619.12	0.00	1.00%	3.00%	3.16%	0.000	-0.24%	0.00%	-0.73%	0.00%	0.01%
1A2	Manufacturing Industries and Construction	CO2	46.09	42.48	5.00%	12.00%	13.00%	0.062	0.00%	0.02%	0.00%	0.13%	0.00%
1A3a i	Domestic Aviation	CO2	1.20	3.79	5.00%	10.00%	11.18%	0.000	0.00%	0.00%	0.01%	0.01%	0.00%

1A3b	Road Transportation	CO2	292.06	571.48	0.00%	4.00%	4.00%	1.054	0.13%	0.24%	0.50%	0.00%	0.00%
1A3d	Navigation	CO2	19.69	49.60	5.00%	30.00%	30.41%	0.459	0.01%	0.02%	0.39%	0.15%	0.00%
1A4a	Commercial Institutional	CO2	107.55	135.47	5.00%	12.00%	13.00%	0.626	0.01%	0.06%	0.18%	0.40%	0.00%
1A4b	Residential	CO2	34.01	44.38	5.00%	12.00%	13.00%	0.067	0.01%	0.02%	0.06%	0.13%	0.00%
1A4c	Agriculture/Forestry/Fisheries/ Fish Farms	CO2	4.09	16.59	5.00%	12.00%	13.00%	0.009	0.01%	0.01%	0.06%	0.05%	0.00%
1A5	Non Specified Fuel Combustion	CO2	2.51	4.18	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2A2	Lime Production	CO2	1.25	0.00	8.00%	0.00%	8.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2A4	Other processes/uses of Carbonates	CO2	0.18	0.02	2.00%	0.00%	2.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2B	Chemical Industry	CO2	0.17	0.07	0.00%	5.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2D1	Lubricant use	CO2	3.15	0.22	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
2D2	Paraffin Wax use	CO2	0.51	0.25	10.00%	50.00%	50.99%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
4C	Waste Incineration	CO2	0.37	0.68	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

1A1ai	Energy Industries - Gas/Diesel Oil	CH4	0.08	0.07	1.00%	60.00%	60.01%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - Residual Fuel Oil	CH4	0.93	0.78	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - bituminous coal	CH4	49.08	0.00	1.00%	0.00%	1.00%	0.000	-0.02%	0.00%	0.00%	0.00%	0.00%
1A2	Manufacturing Industries and Construction	CH4	0.04	0.04	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3a i	Domestic Aviation	CH4	0.00	0.01	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3b	Road Transportation	CH4	2.22	1.57	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3d	Navigation	CH4	0.06	0.16	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4a	Commercial Institutional	CH4	0.34	0.43	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4b	Residential	CH4	0.07	0.21	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4c	Agriculture/Forestry/Fisheries/Fish Farms	CH4	0.01	0.06	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1a	Cattle (Enteric Fermentation)	CH4	28.66	25.08	5.00%	0.00%	5.00%	0.003	0.00%	0.01%	0.00%	0.07%	0.00%

3A1c	Sheep (Enteric Fermentation)	CH4	3.96	2.53	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
3A1d	Goats (Enteric Fermentation)	CH4	0.78	0.62	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1f	Horses (Enteric Fermentation)	CH4	0.43	0.66	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1h	Swine (Enteric Fermentation)	CH4	3.80	1.64	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1i	Poultry (Enteric Fermentation)	CH4	0.38	0.21	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A1j	Others (Rabbits) (Enteric Fermentation)	CH4	0.05	0.18	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2a	Cattle (Manure Management)	CH4	2.14	2.28	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
3A2c	Sheep (Manure Management)	CH4	0.11	0.07	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

3A2d	Goats (Manure Management)	CH4	0.03	0.02	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2f	Horses (Manure Management)	CH4	0.06	0.09	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2h	Swine (Manure Management)	CH4	1.19	0.51	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2i	Poultry (Manure Management)	CH4	1.62	0.90	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2j	Others (Rabbits) (Manure Management)	CH4	0.05	0.18	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
4A1	Managed Waste Disposal on Land	CH4	0.00	123.44	10.00%	0.00%	10.00%	0.307	0.05%	0.05%	0.00%	0.73%	0.01%
4A2	Unmanaged Waste Disposal on Land	CH4	41.50	13.03	10.00%	0.00%	10.00%	0.003	-0.01%	0.01%	0.00%	0.08%	0.00%
4B	Biological Treatment of Solid Waste	CH4	0.00	0.83	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

4D	Domestic and Commercial Wastewater	CH4	17.30	2.40	10.00%	0.00%	10.00%	0.000	-0.01%	0.00%	0.00%	0.01%	0.00%
1A1ai	Energy Industries - Gas/Diesel Oil	N2O	0.19	0.16	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - Residual Fuel Oil	N2O	2.22	1.85	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A1ai	Energy Industries - bituminous coal	N2O	2.93	0.00	1.00%	0.00%	1.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A2	Manufacturing Industries and Construction	N2O	0.10	0.09	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3a i	Domestic Aviation	N2O	0.00	0.01	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3b	Road Transportation	N2O	4.25	4.82	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3d	Navigation	0.05	0.12	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%	0.05
1A4a	Commercial Institutional	0.00	0.00	0.00%	0.00%	0.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%	0.00
1A4b	Residential	0.23	0.28	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%	0.23

1A4c	Agriculture/Forestry/Fisheries/Fish Farms	0.02	0.05	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%	0.02
2G3	Use of N2O for Product uses	N2O	2.39	0.64	3.00%	0.00%	3.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
3A2	Direct emissions (Manure (management)	N2O	6.28	4.82	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
3C4	Direct N2O from Managed Soils	N2O	15.46	15.11	5.00%	0.00%	5.00%	0.001	0.00%	0.01%	0.00%	0.04%	0.00%
3C5	Indirect N2O from Managed Soils	N2O	5.43	5.18	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.02%	0.00%
3C6	Indirect N2O from Manure Management	N2O	6.71	5.79	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.02%	0.00%
4C	Waste Incineration	N2O	0.02	0.16	10.00%	0.00%	10.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
4D	Domestic and Commercial Wastewater	N2O	8.11	5.60	10.00%	0.00%	10.00%	0.001	0.00%	0.00%	0.00%	0.03%	0.00%
2E	Electronics Industry	HFCs	0.00	0.40	2.00%	0.00%	2.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%

2F1	Refrigeration and Air Conditioning	HFCs	0.00	241.07	10.00%	0.00%	10.00%	1.172	0.10%	0.10%	0.00%	1.43%	0.02%
2F2	Foam Blowing Agents	HFCs	0.00	1.03	50.00%	0.00%	50.00%	0.001	0.00%	0.00%	0.00%	0.03%	0.00%
2F3	Fire Protection	HFCs	0.00	2.72	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.01%	0.00%
2F4	Aerosols and Solvents (MDIs)	HFCs	0.00	1.78	30.00%	0.00%	30.00%	0.001	0.00%	0.00%	0.00%	0.03%	0.00%
2G1	Electrical Equipment	SF6	0.00	0.00	5.00%	0.00%	5.00%	0.000	0.00%	0.00%	0.00%	0.00%	0.00%
Total emissions	All GHGs		2380.05	2226.67				5.143				0.04%	0.04%
						Percentage uncertainty in Total inventory		2.268			Trend Uncertainty		2.01%

NOTE: a small discrepancy may be observed between the total GHG emissions values reported in this table and the total GHG emissions reported in the CRF. This discrepancy arises due to rounding issues in the method utilised to assess uncertainty.

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ANNEX 3. DETAILED METHODOLOGICAL DESCRIPTIONS FOR INDIVIDUAL SOURCE OR SINK CATEGORIES

This annex includes additional detailed information specific to individual sectors and categories discussed in chapters 3 to 8. The information presented under this annex should be read in conjunction with the respective sector or category discussions presented in chapters 3 to 8.

A-3-1 ENERGY (CRF CATEGORY 1)

QUESTIONNAIRE FOR THE SURVEY ON THE USE OF PETROLEUM PRODUCTS IN THE ECONOMIC SECTORS

As highlighted in the main text, a detailed survey was carried out in 2014 to obtain the quantity of fuel used by the various NACE categories within the economy for the years 2010-2013. The results from this survey formed the basis of the data reported under 1A2 and 1A4, as well as, the normalisation exercise undertaken to backcast this data to 1990 and thus improve consistency in the time series. The questionnaire shown below was sent to approximately 4000 economic operators of various sized. A statistically significant number of responses were received, which enabled the extrapolation of fuel use over the whole economy.

		Fuel Use															
		Automotive Purposes[1]				Spatial Heating Purposes[2]				Industrial Processing[3]				Other Purposes[4]			
		2010	2011	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013
Fuel Type	Petrol																
	Diesel																
	Biodiesel (B100)																
	Autogas (LPG)																
	Kerosene																
	Gasoil																
	Fuel Oil																
	Liquified Petroleum Gas																
	Propane																
	Other Fuel Type																

Explanatory Notes:

(1)	Automotive Purposes pertains to fuels used in passenger vehicles, delivery trucks, bowsers, forklifts and any other vehicle type
(2)	Spatial Heating Purposes pertains to fuels used to heat the premises of the company. It excludes those fuels used for water heating
(3)	Industrial Processing pertains to fuels used in the operation of machinery, generators or other engine type, apart from vehicle engines, that are required to produce goods & services
(4)	Other purposes include fuels used for all the other purposes not listed in the above table such as fuels used for aviation operations & maintenance, marine operations and fuels used for non-combustion purposes

COPERT 5 INPUT PARAMETERS

As stated in Section 3 above, the COPERT 5 model requires a number of parameters in order to be able to estimate emissions using a Tier 3 approach. These parameters are listed in the following table:

Parameter	Unit
MIN_TEMPERATURE	[°C]
MAX_TEMPERATURE	[°C]
HUMIDITY	[%]
REID_VAPOR_PRESSURE	[kPa]
TRIP_LENGTH	[km]
TRIP_DURATION	[hour]
STOCK	[n]
MEAN_ACTIVITY	[km]
LIFETIME_CUMULATIVE_ACTIVITY	[km]
URBAN_OFF_PEAK_SPEED	[km/h]
URBAN_PEAK_SPEED	[km/h]
RURAL_SPEED	[km/h]
HIGHWAY_SPEED	[km/h]
URBAN_OFF_PEAK_SHARE	[%]
URBAN_PEAK_SHARE	[%]
RURAL_SHARE	[%]
HIGHWAY_SHARE	[%]
FUEL_TANK_SIZE	[l]
CANISTER_SIZE	[l]
FUEL_INJECTION	[%]
EVAPORATION_CONTROL	[%]
URBAN_OFF_PEAK_EVAPORATION_SHA	[%]
URBAN_PEAK_EVAPORATION_SHARE	[%]
RURAL_EVAP_SHARE	[%]
HIGHWAY_EVAP_SHARE	[%]
URBAN_OFF_PEAK_LOAD	[%]
URBAN_PEAK_LOAD	[%]
RURAL_LOAD	[%]
HIGHWAY_LOAD	[%]
URBAN_OFF_PEAK_ROAD_SLOPE	[%]
URBAN_PEAK_ROAD_SLOPE	[%]
RURAL_ROAD_SLOPE	[%]
HIGHWAY_ROAD_SLOPE	[%]
NO_OF_AXELS	[n]
VEHICLES_WITH_AC	[%]

AC_USAGE	[%]
PRIMARY_FUEL_BIFUEL_SHARE	[%]
SECONDARY_FUEL_BIFUEL_SHARE	[%]
FIRST_BLEND	
SECOND_BLEND	
FIRST_BLEND_ENERGY_SHARE	[%]
SECOND_BLEND_ENERGY_SHARE	[%]
FIRST_TECHNOLOGY_SHARE	[%]
SECOND_TECHNOLOGY_SHARE	[%]
THIRD_TECHNOLOGY_SHARE	[%]
ENERGY_CONTENT	[MJ/kg]
DENSITY	[kg/m3]
HC_RATIO	[-]
OC_RATIO	[-]
S_CONTENT	[ppm wt]
PB_CONTENT	[ppm wt]
CD_CONTENT	[ppm wt]
CU_CONTENT	[ppm wt]
CR_CONTENT	[ppm wt]
NI_CONTENT	[ppm wt]
SE_CONTENT	[ppm wt]
ZN_CONTENT	[ppm wt]
HG_CONTENT	[ppm wt]
AS_CONTENT	[ppm wt]
TOTAL_FUEL_SALES	[TJ]

CLASSIFICATION BETWEEN NATIONAL NAVIGATION AND INTERNATIONAL NAVIGATION OF MARINE-GOING VESSELS

In order to estimate the marine bunkering fuels that are expected to be used within territorial waters (national navigation) and those outside Maltese waters (international navigation), a bottom-up methodological approach is used whereby the destination of the receiving vessel is, a priori, assumed. The total fuel sold to each receiving vessel is subsequently summed up and classified accordingly. The table below lists the assumed destination of different types of receiving vessels, together with the source of the classification.

Receiving Vessel Type	Classification	Source of Classification
Fishing Boat	Fishing Purposes	Transport Malta
Fishing Trawler	Fishing Purposes	Transport Malta
Fishing Vessel	Fishing Purposes	Transport Malta
Air Cushion Vessel	International Navigation	Transport Malta
Anchor Handling Vessel	International Navigation	Transport Malta
Asphalt Tanker	International Navigation	Assumed
Breakbulk Vessel	International Navigation	Transport Malta
Bulk Carrier	International Navigation	Transport Malta
Cable Layer	International Navigation	Transport Malta
Cargo Ship	International Navigation	Transport Malta
Catamaran	International Navigation	Transport Malta
Carrier	International Navigation	Transport Malta
Chemical Tanker	International Navigation	Transport Malta
Coast Guard Ship	International Navigation	Transport Malta
Combat Vessel	International Navigation	Assumed
Container Ship	International Navigation	Transport Malta
Crude Oil Tanker	International Navigation	Transport Malta
Cruise Liner	International Navigation	Transport Malta
DRILLING SHIP	International Navigation	Transport Malta
DRY CARGO VESSEL	International Navigation	Transport Malta
Gas Carrier	International Navigation	Transport Malta
gas tanker	International Navigation	Transport Malta
General Cargo	International Navigation	Transport Malta
Live Stock Carrier	International Navigation	Transport Malta
LPG Tanker	International Navigation	Transport Malta
Military vessel	International Navigation	Transport Malta
Multi Purpose Offshore Vessel	International Navigation	Assumed
Naval Vessel	International Navigation	Transport Malta
Oil Products Tanker	International Navigation	Transport Malta
Passenger Ship	International Navigation	Transport Malta
Reefer	International Navigation	Transport Malta
Research/Survey Vessel	International Navigation	Transport Malta
Rig	International Navigation	Transport Malta
Ro-Ro Vessel	International Navigation	Transport Malta
Tanker Vessel	International Navigation	Transport Malta
Trawler	International Navigation	Transport Malta
Vehicle Carrier	International Navigation	Transport Malta

Warships	International Navigation	Transport Malta
Bunkering Tanker	National Navigation	Transport Malta
Comm	National Navigation	Transport Malta
Dive Vessel	National Navigation	Transport Malta
Ferry	National Navigation	Transport Malta
Floating Storage	National Navigation	Transport Malta
Motor Yacht	National Navigation	Transport Malta
Patrol vessel	National Navigation	Transport Malta
PILOT BOATS	National Navigation	Transport Malta
Pleasure Craft	National Navigation	Transport Malta
Pleasure Yacht	National Navigation	Transport Malta
Sailing Boat	National Navigation	Transport Malta
Sailing Vessel	National Navigation	Transport Malta
Supply Vessel	National Navigation	Transport Malta
Tourist Boat	National Navigation	Transport Malta
Towing Vessel	National Navigation	Transport Malta
Tug Boat	National Navigation	Transport Malta
Yacht	National Navigation	Transport Malta

A-3-2 WASTE (CRF CATEGORY 5)

BACK EXTRAPOLATION OF ACTIVITY IN SOLID WASTE DISPOSAL SITES

As highlighted in the main text weighbridges for the accurate measurement of waste entering waste disposal sites on land became operational only in 1997. Data prior to this date is both scant and only indicative. Therefore, in order to ensure completeness and time series consistency, the values for deposited amounts were back extrapolated using reliable and validated available data. Due to the type of model being used for the estimation of emissions from such sites the back extrapolation was required for the period 1950-1997. The extrapolation is based on UN data on population and GDP as referred to in section 3.2.2 of the 2006 IPCC Guidelines Volume 5.

Data for population was obtained from the United Nations POPIN Database (http://www.un.org/popin/data.html). Waste generation trends were calculated extrapolating the waste generation rates (/capita) in recent years to previous periods. The waste generation rates calculated and the actual rates are summarised in Figure 17-1.

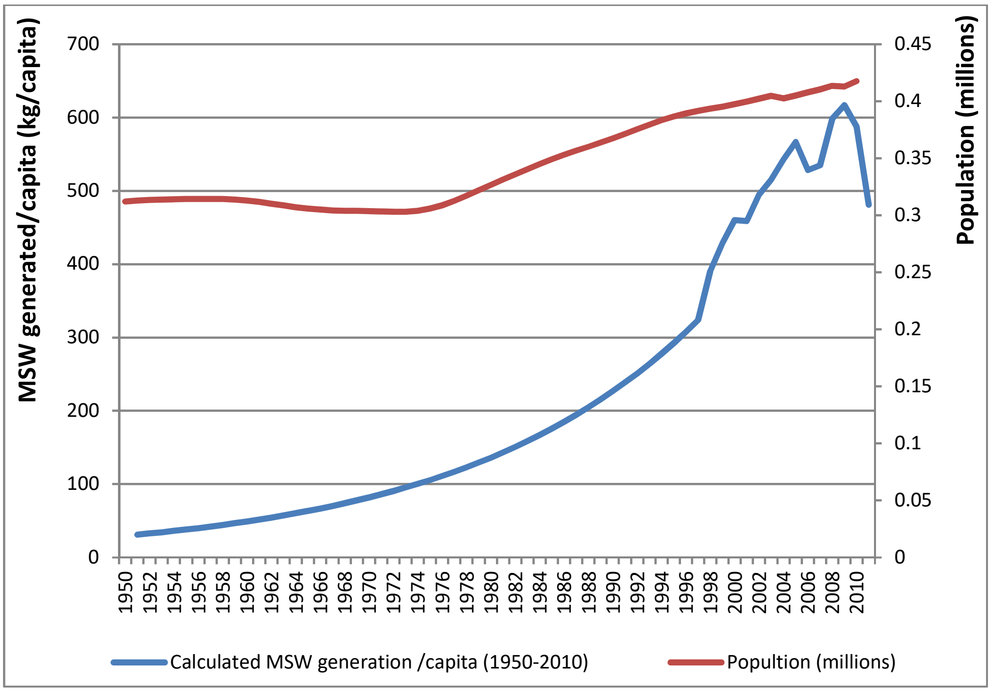

Figure 17-1 Trend of municipal solid waste generation/capita

Multiplying the population estimate by the generation rate, the actual estimate for MSW generation is obtained.

For industrial waste, GDP is more indicative of activity than population, thus GDP was used instead of population. Similar to the above the trends in Waste generation/GDP were calculated and back extrapolated with GDP estimates used to calculate the industrial waste activity over the period 1950-1997 (later data was available from weighbridges).

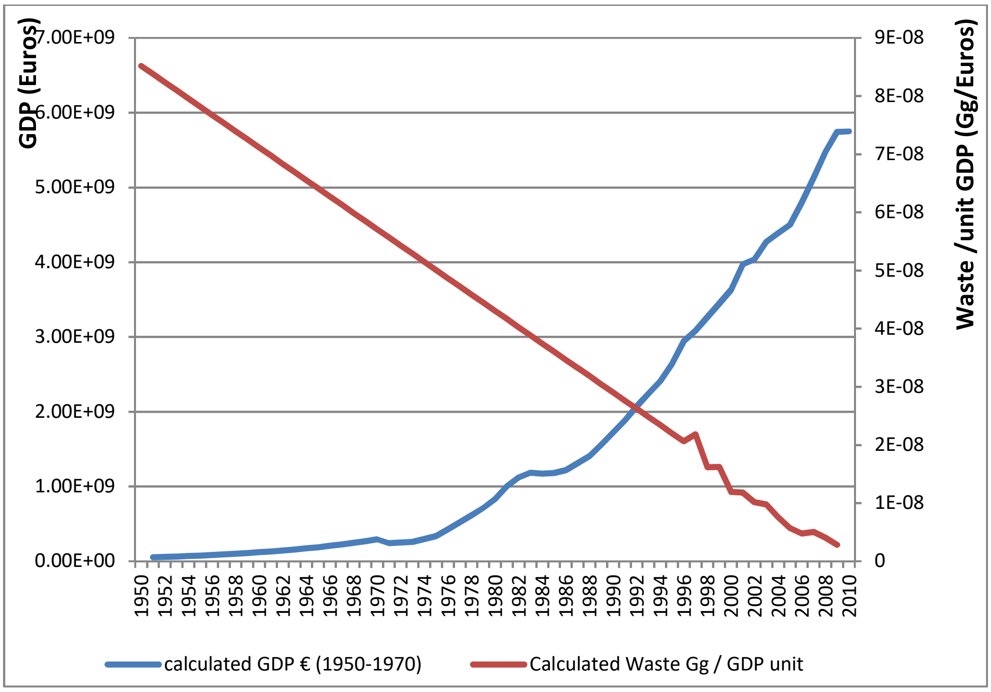

Figure 17-2 Trend of industrial waste/unit GDP for 1950-2010 compared to GDP

Following the combination of the two above mentioned calculations Figure 17-2 depicts the final activity amounts used in the FOD model.

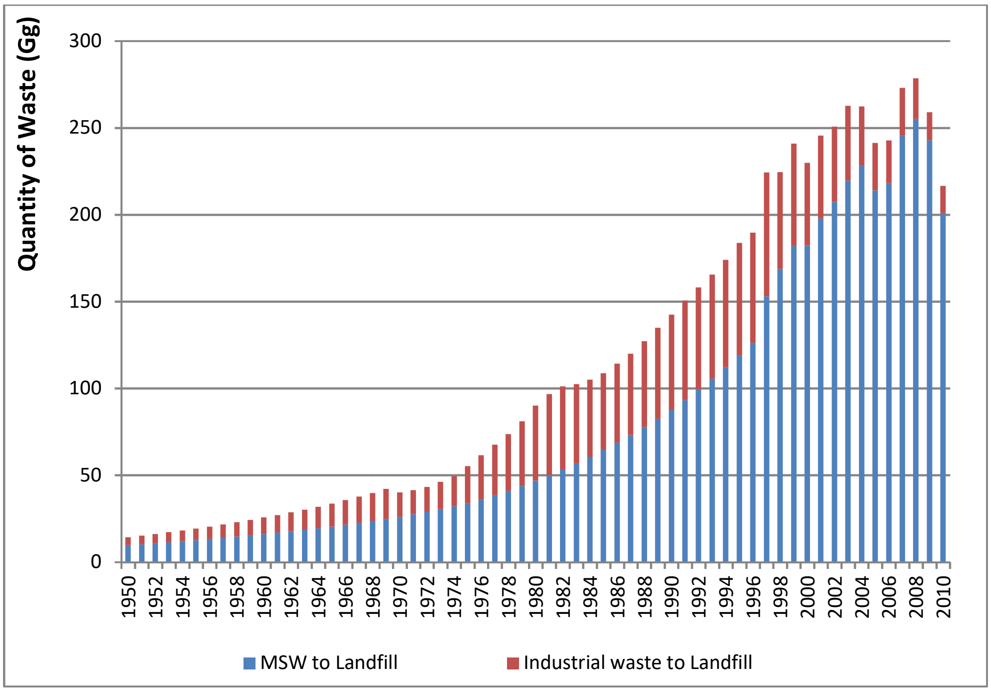

Figure 17-3 Waste deposited in landfills for 1950-2010

MUNICIPAL SOLID WASTE COMPOSITION

Results extracted from waste composition surveys carried out in 2002 and 2011 used to calculate waste composition. Table 17-9 illustrates the results of the two reports mentioned above:

Table 17-9 Municipal solid waste composition results from NSO surveys in 2002 and 2011

	Waste composition shares (%)	
	2002	2011
Plastic	9.6	11.6
Paper + cardboard	12.7	17.6
Food Remains	59.6	52.1
Glass	4	5.5
Metal	3.7	3.7
Textile	3.4	2.3
Hazardous	2.8	0.5
Others	4.2	6.7

Data from these reports was used in the model as illustrated below in Table 17-10 below:

Table 17-10 Implementation of waste composition data in current FOD model

	Food	Garden	Paper	Wood	Textile	Nappies	Plastics other inert	Used in Model Years
2002	59.6	0	12.7	0	3.4	0	24.3	Prior to 2002
2011	52.1	0	17.6	0	2.3	0	28	2011 onwards
Average 2002/2011 data	55.85	0	15.15	0	2.85	0	26.15	2003-2010

INCINERATION EMISSION FACTORS

- ***Municipal Waste***

Table 17-11 Example calculation for CO_2 emissions of municipal waste from incineration

Year	A: Total Amount of municipal waste incinerated (wet weight) (Gg)	B: Dry Matter Content (fraction)	C: Fraction of Carbon in Dry Matter (fraction)	D: Fraction of fossil carbon in total carbon (fraction)	E: Oxidation Factor (fraction)	F: Conversion Factor	G: Emission Factor (Gg CO_2/ Gg waste) (B*C*D*E*F)	H: Emissions of CO_2 (Gg) (A*G)
1990	0.25	0.4	0.38	0.15	1	3.67	0.0836	0.0209

The following emission factors have been used to calculate CH_4 emissions: (6500g CH_4/tonne waste for 1990 to 2003; 0.2g CH_4/tonne waste for 2008) and N_2O emissions (221g N_2O/tonne waste for 1990 to 2003; 8g N_2O/tonne waste for 2008), as available in the IPCC 2006 guidelines.

The following emission factors have been used to calculate NO_x emissions (1.8 kg NO_x/Mg waste), CO emissions (0.7 kg CO/Mg waste), NMVOC emissions (0.02 kg NMVOC/Mg waste) and SO_2 emissions (1.7 kg SO_2/Mg waste, as available in EMEP/EEA. From 2008 onwards emission factors for, CO, NO_x and SO_2 were taken from plant specific data reported in the E-PRTR of the plant submitted to the Malta Environment and Planning Authority at the end of each year, and EF for NMVOC was extrapolated from the IPPC permit specific TOC emission limit (correcting for the CH_4 emissions), this assuming the plant operated to the limit for the whole number of hours of operation as reported in the E-PRTR report. Table 17-12 illustrates the emission factors used.

Table 17-12 Emission factors for indirect GHGs in incineration

Year	NO_x	CO	NMVOC	SO_2
2008	1.4277	0.2104	0.1661	0.0563
2009	1.0248	0.4107	0.1314	0.2080
2010	1.6690	0.4593	0.1241	0.0512
2011	1.1435	0.4998	0.1385	0.1014
2012	1.4002	0.2221	0.1185	0.1197
2013	1.5269	0.3554	0.1059	0.0969
2014	1.2442	0.0938	0.1127	0.0677

- ***Clinical Waste***

Table 17-13 Example of calculation for CO_2 emissions of clinical waste from incineration

Year	A: Total Amount of clinical waste incinerated (wet weight) (Gg)	B: Dry Matter Content (fraction)	C: Fraction of Carbon in Dry Matter (fraction)	D: Fraction of fossil carbon in total carbon (fraction)	E: Oxidation Factor (fraction)	F: Conversion Factor	G: Emission Factor (Gg CO_2/ Gg waste) (C*D*E*F)	H: Emissions of CO_2 (Gg) (A*G)
1990	1.99	NA	0.6	0.4	1	3.67	0.88	1.75

The following emission factors have been used to calculate CH_4 emissions (60kg CH_4/Gg waste for 1990 to 2007; 0.2kg CH_4/Gg waste for 2008) and N_2O emissions (100g N_2O/tonne waste), as available in the IPCC 2006 guidelines.

The following emission factors have been used to calculate NO_x emissions (2.3kg NO_x/Mg waste for 1990 to 2007), CO emissions (0.19 kg CO/Mg waste for 1990 to 2007), NMVOC emissions (0.7kg NMVOC/Mg waste for 1990 to 2007) and SO_2 emissions (0.54kg SO_2/Mg waste for 1990 to 2007), as available in EMEP/EEA [Ref tbc]. Following 2007 emissions factors listed in Table 17-12 were used.

- ***Industrial Waste***

Table 17-14 Example of calculation for CO_2 emissions of Industrial waste from incineration

Year	A: Total amount of waste incinerated (Gg waste)	B: Dry Matter Content (fraction)	C: Fraction of Carbon in Dry Matter (fraction)	D: Fraction of Fossil Carbon in Total Carbon (fraction)	E: Oxidation Factor (fraction)	F: Conversion Factor	G: Emission Factor for CO_2 emissions (Gg CO_2 / Gg Waste) (B*C*D*E*F)	H: Emissions (Gg CO_2) (A*G)
1990	0.066	0.9	0.46	0.01	1	3.67	0.015	0.001

The following emission factors have been used to calculate CH_4 emissions (60kg CH_4/Gg waste for 1990 to 2007; 0.2kg CH_4/Gg waste for 2008) and N_2O emissions (10g N_2O/tonne waste for 1990 to 2007; 100g N2O/tonne waste for 2008), as available in the IPCC 2006 guidelines.

The following emission factors have been used to calculate NO_x emissions (2.5kg NO_x/Mg waste for 1990 to 2007), CO emissions (0.13 kg CO/Mg waste for 1990 to 2007), NMVOC emissions (7.4kg NMVOC/Mg waste from 1990 - 2007) and SO_2 emissions (0.07kg SO_2/ Mg waste for 1990 to 2007), as available in EMEP/EEA . Following 2007, emission factors listed in Table 17-12 were used.

ANNEX 4. NATIONAL ENERGY BALANCE

The information provided below pertains to the National Oil Balance as compiled by the National Statistics Office and submitted to Eurostat pursuant to Regulation 1099/2008 (EC).

The Annual National Oil Balance reports are the main data source for the estimation of the Reference Approach and the CO_2 emissions calculated there from. The monthly data on the fuel products released in the inland market is collected by the Regulator for Energy and Water Services (formerly the Malta Resources Authority) from the operators that are regulated under Legal Notice 278 of 2007 'Petroleum for the Inland (Wholesale) Fuel Market Regulations, 2007' and Legal Notice 270 of 2010 'Bunkering (Authorisation) Regulations, 2010' and as enabled by Regulation 17 of Legal Notice 278 of 2007 and Regulation 15 of Legal Notice 270 of 2010 which oblige such operators to submit data in the form as requested by the relevant authorities. Subsequently, this information is provided to the National Statistics Office which compiles the required reports to be submitted to Eurostat pursuant to Regulation 1099/2008 (EC) on Energy Statistics.

The Annual National Oil Balance for 2015 is provided in Table 17-15 below.

Table 17-15 National Oil Balance for Malta (2015)

Metric Tonnes		Liquified Petroleum Gas	Petrol	Jet A1	Aviation Gasoline	Kerosene	Diesel	Biodiesel	Gasoil	Fuel Oil	Propane	Crude Oil	HVO
Imports	+	22,697	77,404	116,387	51	-	197,066	4,426	388,652	1,565,263	989	-	1,814
Imports - Tickets held in Malta	+	-	-	-	-	-	47,399	-	104,388	200,000	-	-	-
Exports	-	-	-	-	-	-	95,132	-	60,998	5,054	-	-	-
Exports - Tickets held in Malta	-	-	-	-	-	-	47,399	-	113,500	210,000	-	-	-
International Marine Bunkering	-	-	-	-	-	-	433	-	259,762	1,330,268	-	-	-
Indigenous Production	+	-	-	-	-	-	-	929	-	-	-	-	-
Inter-Product Transfers:		(261)	(15)	571	8	(571)	(4,941)	4,370	2,042	(2,162)	261	-	
Reductions	+	4	-	571	8	-	127	4,370	2,337	7,277	265	-	698
Additions		265	15	-	-	571	5,068	-	296	9,439	4	-	-
Intra-Installation Movements:		-	-	-	-	-	0	-	(0)	0	-	-	
Reductions	+	-	9	302,108	8	-	57,550	-	20,055	90,671	-	-	698
Additions		-	9	302,108	8	-	57,550	-	20,055	90,671	-	-	698
Third-Party Product Transfers:		-	(224)	-	-	(84)	(1,740)	(2)	(585)	(551)	-	-	
Sales	+	-	1,948	-	-	52	3,377	968	13,411	112,130	-	-	-
Purchases		-	2,172	-	-	136	5,116	970	13,996	112,680	-	-	-
Stock Change:		(198)	1,139	1,845	6	49	(2,169)	(113)	(7,232)	(42,359)	291	-	1,121
Total Closing Stock as at 31st December	+	2,758	10,880	11,543	15	91	18,294	6	35,245	94,128	718	-	1,121
Total Opening Stock as at 1st January		2,956	9,740	9,698	9	42	20,463	119	42,477	136,488	427	-	-
Returns to Petrochemical Industry	-	-	11	-	-	1	286	-	3,929	787	-	-	-
Product Gains/(Losses)	+	444	(49)	378	0	21	(2)	-	-	-	-	-	5
Gross Inland Consumption (Calculated)	=	23,599	76,443	114,349	36	626	110,062	1,100	60,627	264,226	437	-	(0)

Metric Tonnes		Liquified Petroleum Gas	Petrol	Jet A1	Aviation Gasoline	Kerosene	Diesel	Biodiesel	Gasoil	Fuel Oil	Propane	Crude Oil	HVO
Biodiesel (Blended):		-	-	-	-	-	(5,069)	4,371	-	-	-	-	698
Gross Inland Consumption (Adjusted)		23,599	76,444	114,349	36	626	104,993	5,471	60,627	264,226	437	-	698
Statistical Difference		0	1	-	(0)	(0)	(2)	0	0	-	0	-	0
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
Gross Inland Consumption (Observed)	=	23,599	76,444	114,349	36	626	110,061	1,100	60,628	264,226	437	-	-

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