National Greenhouse Gas Emissions and Removals Inventory for Malta

2014

Annual Report for Submission under the United Nations Framework Convention on Climate Change

Report prepared by the Climate Change Unit at the Malta Resources Authority for the Ministry for Sustainable Development, the Environment and Climate Change

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Preface

This report is Malta's National Inventory Report (NIR) submitted in April 2014 to the United Nation Framework Convention on Climate Change. It contains national estimates of greenhouse gas emissions from sources and removals by sinks for the period 1990-2012, and information on the methods used to produce the estimates. The report is prepared in accordance with Decision 18/CP.8[1] and follows the structure outlined in the document FCCC/SBSTA/2006/9[2].

The Greenhouse Gas Inventory is compiled by the National Inventory Systems Team within the Climate Change Unit of the Malta Resources Authority. The GHG Inventory is compiled according to IPCC 1996 Revised Guidelines [1] and 2006 IPCC Guidelines [3] and the Good Practice Guidance [3] . 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] FCCC Decision 18/CP.8. Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, part I:UNFCCC reporting guidelines on annual inventories. Report of the Conference of the Parties on its Eighth Session, held at New Delhi from 23 October to 1 November 2002. FCCC/CP/2002/7/Add.2 28 March 2003.

[2] Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. See http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf

Executive Summary

ES.1 Background information on greenhouse gas inventories and climate change

The recognition that "*climate change is a common concern of mankind*[3]" and the acknowledgment that "*necessary and timely action should be taken to deal with climate change within a global framework*"[4] 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 changes as of 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. This submission is the first yearly submission provided for under the European Union's Monitoring Mechanism.

Malta's greenhouse gas inventory is compiled by the national greenhouse gas inventory team within the Climate Change Unit of the Malta Resources Authority. This inventory submission contains greenhouse gas emissions and removals estimates for the period 1990 to 2012, 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 six direct greenhouse gases which currently fall within the scope of the Kyoto Protocol, namely:

- Carbon dioxide (CO_2);

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

[4] Ibid.

- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and,
- Sulphur hexafluoride (SF_6);

and the indirect greenhouse gases:

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

Sulphur dioxide (SO_2) emissions are also covered by this inventory.

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 thus:

- 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);
- Chapter 10 provides an overview of improvements made in this submission;
- A number of annexes that present detailed information on certain aspects relating to greenhouse gas inventories, including full detailed tables on key category assessments, uncertainty estimation and completes assessment.

ES.2 Summary of national emission and removal trends

Table ES-1 gives an overview of total national greenhouse gas emissions ('with-' and 'without-' LULUCF) and emissions disaggregated by gas. Table ES-2 highlights the main trends when comparing total emissions and emissions for each gas in 1990 and 2012. Gross (without-LULUCF) emissions in 2012 are 57.5% more than emissions in 1990. Carbon dioxide (CO_2) remains the largest contributor to national emissions (89.5% in 2012) followed by hydrofluorocarbons (HFCs) and methane (CH_4). These three gases also show increases over the whole time series.

Table ES-0-1 Greenhouse gas emissions (Gg CO2 equivalent), by individual gases and total national net (with-LULUCF) and gross (without-LULUCF) emissions for the years 1990 to 2012.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (with-LULUCF)	1,861.55	2,035.50	2,139.95	2,135.91	2,247.35	2,206.27	2,258.44	2,248.51	2,251.87	2,341.32	**2,338.43**
CO_2 (without-LULUCF)	1,866.76	2,042.26	2,146.71	2,142.67	2,254.11	2,213.03	2,265.20	2,255.27	2,258.63	2,348.08	**2,345.19**
CH_4	73.26	79.49	88.09	97.77	106.69	114.35	114.24	122.55	106.06	110.71	**125.47**
N_2O	51.81	56.05	61.05	65.98	71.19	89.42	83.65	88.80	80.62	77.96	**70.52**
HFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	73.87	73.87	73.87	**8.29**
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	**0.00**
SF_6	0.01	0.01	1.50	1.50	1.50	1.51	1.52	1.52	1.54	1.54	**1.54**
Total (with-LULUCF)	**1,986.63**	**2,171.05**	**2,290.58**	**2,301.15**	**2,426.73**	**2,411.55**	**2,457.84**	**2,535.25**	**2,513.95**	**2,605.39**	**2,544.25**
Total (No-LULUCF)	**1,991.84**	**2,177.80**	**2,297.34**	**2,307.91**	**2,433.49**	**2,418.30**	**2,464.60**	**2,542.00**	**2,520.71**	**2,612.15**	**2,551.01**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 (with-LULUCF)	2,458.08	2,477.98	2,656.81	2,611.66	2,697.04	2,663.96	2,749.79	2,708.47	2,635.40	2,633.09	2,660.55	**2,799.44**
CO_2 (without-LULUCF)	2,464.84	2,484.80	2,663.68	2,618.59	2,704.03	2,671.01	2,756.89	2,715.62	2,642.61	2,640.36	2,667.88	**2,806.66**
CH_4	139.98	149.25	158.94	157.78	166.64	173.99	165.99	100.75	139.98	149.25	158.94	**104.25**
N_2O	67.31	66.63	63.65	65.60	67.46	69.21	67.93	64.89	62.33	57.22	56.82	**57.66**
HFCs	15.33	28.62	39.91	60.22	64.32	87.33	105.99	116.55	120.01	121.12	131.51	**171.11**
PFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
SF_6	1.56	1.57	2.16	1.62	1.64	1.65	1.66	1.83	1.57	1.78	4.81	**0.47**
Total (with-LULUCF)	**2,667.79**	**2,701.74**	**2,889.36**	**2,871.27**	**2,970.44**	**2,971.41**	**3,084.31**	**3,049.52**	**2,985.95**	**2,987.20**	**3,019.68**	**3,132.94**
Total (No-LULUCF)	**2,674.54**	**2,708.55**	**2,896.23**	**2,878.20**	**2,977.43**	**2,978.45**	**3,091.41**	**3,056.68**	**2,993.16**	**2,994.47**	**3,027.00**	**3,140.15**

Table ES-0-2 Emissions of greenhouse gases by gas for the years 1990 and 2012 (in Gg CO_2 equivalent) and the corresponding change between the two years.

	1990	2012	% change 1990-2012
CO_2 (with-LULUCF)	1,861.55	2,799.44	**50.38**
CO_2 (without- LULUCF)	1,866.76	2,806.66	**50.35**
CH_4	73.26	104.25	**42.31**
N_2O	51.81	57.66	**11.29**
HFCs	NA,NE,NO	171.11	**100.00**
PFCs	NA,NE,NO	0.00	**100.00**
SF_6	0.01	0.47	**4,149.55**
Total (with-LULUCF)	1,986.63	3,132.94	**57.70**
Total (without-LULUCF)	1,991.84	3,140.15	**57.65**
The value of emissions of PFCs for 2012 is less than 0.1 Gg CO_2 equivalent and actually stands at around 0.00004 Gg. The value of emissions of SF_6 for 1990 is less than 0.1 Gg CO_2 equivalent and actually stands at 0.01 Gg CO_2 equivalent			

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

Table ES-3 gives an overview of emissions and, in the case of sector 5: LULUCF, removals, disaggregated to the level of the main source sectors. Sector 1: Energy remains throughout the period as the sector with the largest contribution to national emissions, this sector including among others, energy industries and road transport, both being among the highest contributing source categories for Malta. A comparison of sectoral emissions for 1990 and 2012, and the overall increase or decrease in emissions between these two years is presented in Table ES-4.

In 2012, sector 1: Energy emissions accounted for around 90% of total national net emissions and emissions for this sector have continued to increase over the time series. The overall contribution of the other sectors is substantially less, though trends vary. Thus, sector 2: Industrial Processes and sector 6: Waste show relatively significant increases between 1990 and 2012 (Waste showing a marked decrease in emissions in 2012 due to increased methane recovery). On the other hand, sector 3: Solvents and Other Product Use and sector 4: Agriculture indicate an overall decreasing emission trend over the period covered by this inventory. Sector 5: LULUCF shows a slight increase in the rate of removal of carbon dioxide.

Table ES-0-3 Emissions of greenhouse gases by sector for the years 1990 to 2012 (in Gg CO_2 equivalent).

	1990	1991	1992	1993	1994	1995	1996	1997
1. Energy	1,878.10	2,054.36	2,159.82	2,156.12	2,267.74	2,226.04	2,278.68	**2,268.69**
2. Industrial Processes	1.58	1.78	2.90	2.94	3.24	3.21	3.04	**77.11**
3. Solvents and Other Product Use	2.48	2.48	2.48	2.48	2.48	2.48	2.48	**2.48**
4. Agriculture	71.83	79.29	90.05	100.33	109.52	133.75	126.90	**138.38**
5. LULUCF	-5.21	-6.76	-6.76	-6.76	-6.76	-6.76	-6.76	**-6.76**
6. Waste	37.84	39.88	42.08	46.04	50.51	52.81	53.49	**55.34**
Total (with-LULUCF)	**1,986.63**	**2,171.05**	**2,290.58**	**2,301.15**	**2,426.73**	**2,411.55**	**2,457.84**	2,535.25

	1998	1999	2000	2001	2002	2003	2004	2005
1. Energy	2,272.74	2,363.35	2,360.56	2,480.70	2,500.77	2,680.35	2,634.63	**2,722.43**
2. Industrial Processes	76.54	75.80	10.11	17.27	30.53	42.29	62.24	**66.34**
3. Solvents and Other Product Use	2.48	2.72	3.01	2.33	2.56	2.38	2.37	**2.26**
4. Agriculture	108.70	109.66	112.93	107.41	106.41	99.34	104.10	**102.64**
5. LULUCF	-6.76	-6.76	-6.76	-6.76	-6.82	-6.87	-6.93	**-6.98**
6. Waste	60.25	60.62	64.40	66.84	68.29	71.88	74.86	**83.76**
Total (with-LULUCF)	**2,513.95**	**2,605.39**	**2,544.25**	**2,667.79**	**2,701.74**	**2,889.36**	**2,871.27**	**2,970.44**

	2006	2007	2008	2009	2010	2011	2012	
1. Energy	2,689.09	2,775.93	2,734.83	2,661.43	2,654.41	2,682.66	2,821.91	
2. Industrial Processes	89.37	107.94	118.55	121.81	123.12	136.57	171.83	
3. Solvents and Other Product Use	2.03	2.71	2.10	1.60	1.29	1.31	1.90	
4. Agriculture	103.21	104.06	95.42	90.68	86.92	79.70	79.44	
5. LULUCF	-7.04	-7.10	-7.15	-7.21	-7.27	-7.32	-7.22	
6. Waste	94.76	100.78	105.77	117.64	128.73	126.76	65.07	
Total (with-LULUCF)	2,971.41	3,084.31	3,049.52	2,985.95	2,987.20	3,019.68	3,132.94	

Table ES-0-4 Emissions of greenhouse gases by sector for the years 1990 and 2012 (in Gg CO_2 equivalent) and the corresponding change between the two years.

	1990	2012	% change 1990-2012
1. Energy	1,878.10	2,821.91	**50.25**
2. Industrial Processes	1.58	171.83	**10,760.87**
3. Solvents and Other Product Use	2.48	1.90	**-23.40**
4. Agriculture	71.83	79.44	**10.59**
5. LULUCF	-5.21	-7.22	**38.63**
6. Waste	37.84	65.07	**71.96**
Total (with-LULUCF)	**1,986.63**	**3,132.94**	**57.70**

ES.4 Other information

Emissions for indirect greenhouse gases and sulphur dioxide are presented in Table ES-5. Trends in estimated emissions vary, with NOx emissions showing a small increase, while emissions of CO, NMVOCs and SO_2 all showing a decrease.

Table ES-0-5 Emissions of indirect greenhouse gases and sulphur dioxide for the years 1990 and 2012 (in Gg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NO_x	7.55	8.12	8.53	8.68	9.06	8.85	9.10	9.15	9.22	9.55	8.38
CO	23.63	25.28	26.95	28.23	29.24	29.93	30.62	30.98	30.70	30.74	29.77
NMVOC	6.20	6.55	6.91	7.23	7.47	7.63	7.94	8.16	7.84	7.79	3.36
SO_2	**15.78**	**17.84**	**19.72**	**20.40**	**23.93**	**27.17**	**28.71**	**29.82**	**30.93**	**27.99**	24.43

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
NO_x	9.11	9.22	9.47	9.05	9.83	9.20	9.74	9.58	9.30	9.33	8.87	8.50
CO	29.01	28.53	28.41	27.88	28.83	28.67	29.92	30.06	31.22	31.82	31.10	6.00
NMVOC	3.39	3.29	3.05	3.11	3.54	3.70	3.59	3.28	2.97	3.45	2.67	1.61
SO_2	26.07	25.34	27.53	11.96	12.31	12.38	12.76	11.69	8.27	7.76	7.88	8.24

Contacts

Compilation of this document and the relevant data collection and estimations of emissions or removals have been carried out by the Climate Change Unit at the Malta Resources Authority. Technical enquiries should be directed to:

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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 particular 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 a number of 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).

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 and a number of islets are situated close to the coastline. The islands together encompass an area of 316 square kilometres with a total shoreline of slightly more than 271 kilometres.

The climate is typically Mediterranean, with hot, dry summers and relatively mild winters with fluctuating rain patterns. Reflecting the general trend, 2012 saw a mean monthly air temperature high in August, at 28.6^{o}C, with the lowest monthly mean observed for February, at 10.2^{o}C. Average monthly relative humidity in 2012 varied 63% in July and 81% in March, again a typical trend. Total rainfall in 2012 was just over 519mm.

With a population standing at 421,364 in 2012, Malta is one of the most densely populated countries in the world, with a population density of 1,333 persons/km^2. Over the past 30 years or so, the islands' small and open economy has shifted from one based principally on manufacturing activities 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 particular interest 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 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.

Two types of greenhouse gases are reported.

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. Six[5] categories of such gases are covered by greenhouse gas inventories, namely:

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

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 presented in Table 1-1.

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. This inventory submission continues to use 2AR GWP values, with 4AR values to start being used as of the submissions that will be made in 2015, in accordance with the applicable decisions taken under the UNFCCC.

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.

Table 1-1 Global Warming Potential (GWP) of direct greenhouse gases included in 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) SAR [FAR]
Carbon dioxide	CO_2	1 [1]
Methane	CH_4	21 [25]
Nitrous oxide	N_2O	310 [298]
Hydrofluorocarbons:		
HFC-23	CHF_3	11,700 [14,800]
HFC-32	CH_2F_2	650 [675]
HFC-125	CHF_2CF_3	2,800 [3,500]
HFC-134a	CH_2FCF_3	1,300 [1,430]
HFC-143a	CH_3CF3	3,800 [4,470]
HFC-227ea	CF_3CHFCF_3	2,900 [3,220]
Perfluorocarbons:		
Perfluoroethane (PFC-116)	C_2F_6	9,200 [12,200]
Perfluoropropane (PFC-218)	C_3F_8	7,000 [8,830]
Sulphur hexafluoride	SF_6	23,900 [22,800]

[5] It is to note that as of 2015, inventory submissions shall also include estimation of emissions of Nitrogen trifluoride (NF_3).

Indirect greenhouse gases, or 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 discussed as separate species.

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.

A number of additional categories, known as 'Memo Items', also form part of an inventory submission. 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 institutional arrangements for inventory preparation.

1.2.1 Overview of institutional, legal and procedural arrangements for compiling the GHG inventory.

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[6], 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'

[6] 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; recently replaced by Regulation (EU) No 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change.

inventory submission by the following 15th March, that may include changes to the January submission; and the submission under the UNFCCC by 15th April.

Following its application in 2009, as of 2010 Malta's status under the UNFCCC changed to that of Annex I Party, which means that as of that date, 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 was initially entrusted to take on this obligation, subsequently followed up by a migration of this and other climate action responsibilities to the Malta Resources Authority (MRA) as of 2010, following a change in Ministerial portfolios at the time. Thus, the Climate Change Unit at MRA is currently responsible for the preparation of the national GHG inventory, including this submission. Political ownership of the national GHG inventory is invested on the Ministry responsible for climate change action and policy, previously the Ministry of Resources and Rural Affairs (MRRA), and as of March of this year, the Ministry for Sustainable Development, Environment and Climate Change (MSDEC). The approval of the report prior to submission is a shared responsibility between the Ministry responsible for climate change affairs and the EU Secretariat (previously within the Office of the Prime Minster and as of March 2013, within the Ministry for European Affairs and the Implementation of the Electoral Manifesto). Figure 1-1 describes, in schematic fashion, the various roles.

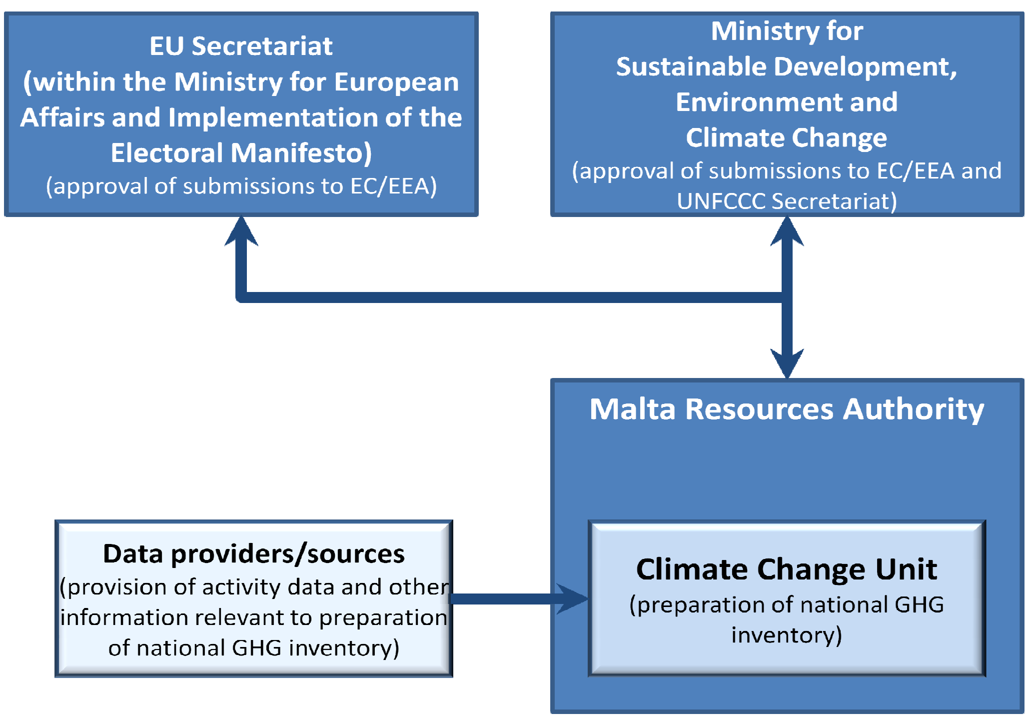

Figure 1-1 Schematic representation of the current institutional arrangements for the preparation and submission of national greenhouse gas inventories of Malta.

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.

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 at the time in order to draw up recommendations for the formal establishment of a national inventory system that would be in accordance with requirements under the Kyoto Protocol; at the time, the intention was to integrate inventory reporting relating to both climate change and air quality obligations. Unfortunately, due to a number of 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 ever more strict 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 has taken the initiative to submit a report "Establishing a National Greenhouse Gas Inventory System for Malta"[7] to the relevant local authorities in order to instigate and inform the decision-making process.

1.2.2 Overview of inventory planning.

Three officers within the Climate Change Unit are responsible for, among other duties, 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, and final submission to the European Environment Agency and the UNFCCC Secretariat.

1.2.3 Overview of inventory preparation and management.

The preparation of the annual inventory submission is spread over a whole year cycle, with work on each year's submission starting immediately after the conclusion of an inventory cycle with the submission of the report to the UNFCCC Secretariat in April. An internal post-submission evaluation identifies areas where improvements need to be carried out, further informed by the results of annual inventory peer reviews. In summer, communications 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 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.

In the absence still of a formal national inventory system, the Climate Change Unit has to manage the inventory process within the limited legal, institutional and administrative capabilities that it has. This is particularly evident in respect of gathering of data. It is anticipated that a formal legal and

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

institutional set-up that is in-line with requirements for national inventory systems will help address such limitations and will facilitate the annual preparation of a much improved national greenhouse gas emissions and removals inventory for Malta.

The current approach to inventory compilation may be schematically represented as in Figure 1-2.

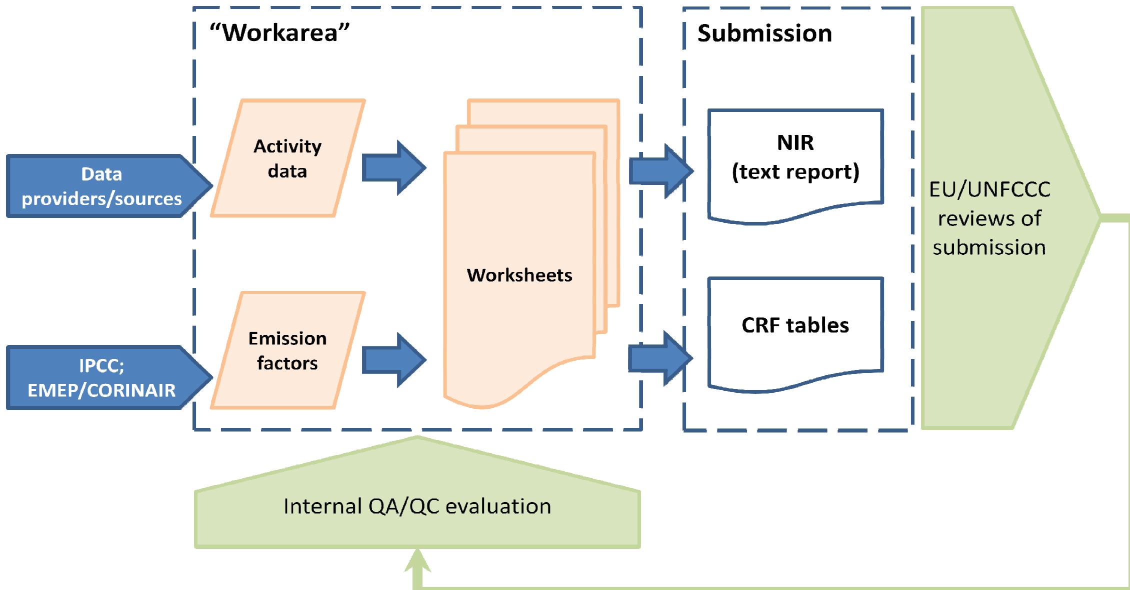

Figure 1-2 Schematic representation of the current approach to greenhouse gas inventory compilation applied by the Climate Change Unit.

1.3 Description of the process of inventory preparation.

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 in order 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 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 latter serves to bring together, in a sequence of very 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 systems maintained by MRA. The server handling this material is housed in a location within MRA offices that has restricted access, 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 have 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.

Following internal 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. It may also be the case 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 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 have to be submitted.

A final submission is then prepared for submission to the UNFCCC Secretariat by mid-April. To the extent possible, this submission is maintained the same as the submission 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 in order 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.

1.4 General description of methodologies 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 derived from either the 'Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories' or the '2006 IPCC Guidelines for National Greenhouse Gas Inventories'. It is also worth noting that this year's submission represents the first time that the estimation modelling system COPERT was used to estimate non-CO_2 emissions from the road transport sector. This approach has, for this submission, been utilised solely for the 2012 emissions, with the aim being to expand its use to previous years in future inventory submissions.

Key data providers include the National Statistics Office (NSO), governed by the Malta Statistics Authority Act of 2000 and serving as the main body responsible for the collection, compilation, analysis and publications of statistical information related to Malta. Ministries and departments within Ministries, 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 1-2.

Table 1-2 Key data providers relevant for this inventory submission.

Sector	Data providers
1. **Energy (including 'Memo Items')**	Enemalta Corporation Fish and Farming Regulation and Control Gozo Channel Individual private industrial establishments Malta International Airport Malta Maritime Authority Malta Resources Authority National Statistics Office Transport Malta Tug Malta
2. **Industrial Processes**	Enemalta Corporation 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**	Malta Environment & Planning Authority Ministry for Gozo Ministry for Sustainable Development, Environment and Climate Change (formerly Ministry for Resources and Rural Affairs)
6. **Waste**	Malta Environment & Planning Authority Malta Resources Authority Malta Shipyards Ministry of Health WasteServ Malta Ltd

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'[8], which was limited to emission source

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

categories. More recently, the reference to 'source' has been largely discontinued in order 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. This submission presents two sets of key category assessments, namely: key category assessments 'with-' and 'without-' LULUCF, for 1990 and the last year covered by this submission, 2012. These are presented in Annex 1 to this report.

The with-LULUCF key category assessment includes 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 ignores 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.

Comparing with-LULUCF and without-LULUCF key category assessments for 1990 (see Table 1-3) shows only one difference in the list of key categories, namely the inclusion of category 5A1: Forest Land in the with-LULUCF key category list as opposed to the without-LULUCF list; this category is obviously not represented in a without-LULUCF inventory. No other difference is noted. It is also interesting to note the respective positions for the fuel-type-disaggregated level contributions of category 1A1a: Energy Industries.

Table 1-3 Level assessment key category list for 1990.

1990 with-LULUCF key category list			**1990 without-LULUCF key category list**		
1A1a	Energy Industries - Residual Fuel Oil	CO2	**1A1a**	Energy Industries - Residual Fuel Oil	CO2
1A1a	Energy Industries - Other Bituminous Coal	CO2	**1A1a**	Energy Industries - Other Bituminous Coal	CO2
1A3b	Road Transportation	CO2	**1A3b**	Road Transportation	CO2
1A4a	Commercial/Institutional	CO2	**1A4a**	Commercial/Institutional	CO2
5A1	Forest Land	CO2	**1A2**	Manufacturing Industries and Construction	CO2
1A2	Manufacturing Industries and Construction	CO2	**1A4b**	Residential	CO2
1A4b	Residential	CO2	**1A1a**	Energy Industries - Gas/Diesel Oil	CO2
1A1a	Energy Industries - Gas/Diesel Oil	CO2	**4A1**	Cattle	CH4
4A1	Cattle	CH4	**6A2**	Unmanaged Waste Disposal on Land	CH4
6A2	Unmanaged Waste Disposal on Land	CH4	**4D1**	Direct Soil Emissions	N2O
4D1	Direct Soil Emissions	N2O	---		

A similar comparison for 2012 (see Table 1-4) again shows the inclusion of category 5A1: Forest Land in the with–LULUCF list. The relative position of the other key categories to each other remains the same between the two lists.

Table 1-4 Level assessment key category list for 2012.

2012 with-LULUCF key category list			**2012 without-LULUCF key category list**		
1A1a	Energy Industries - Residual Fuel Oil	CO2	**1A1a**	Energy Industries - Residual Fuel Oil	CO2
1A3b	Road Transportation	CO2	**1A3b**	Road Transportation	CO2
1A1a	Energy Industries - Gas/Diesel Oil	CO2	**1A1a**	Energy Industries - Gas/Diesel Oil	CO2

2F1	Refrigeration & Air Conditioning Equipment	HFCs	**2F1**	Refrigeration & Air Conditioning Equipment	HFCs
1A2	Manufacturing Industries and Construction	CO2	**1A2**	Manufacturing Industries and Construction	CO2
1A4a	Commercial/Institutional	CO2	**1A4a**	Commercial/Institutional	CO2
1A4b	Residential	CO2	**1A4b**	Residential	CO2
5A1	Forest Land	CO2	**1A3d**	Navigation	CO2
1A3d	Navigation	CO2	**6A2**	Unmanaged Waste Disposal on Land	CH4
6A2	Unmanaged Waste Disposal on Land	CH4	---		

Comparing 1990 and 2012 key category lists highlights a number of important differences between the first year and the most recent year covered by this inventory. As use of coal as an energy source in energy generation was discontinued in the 1990's, this source category does not feature in the 2012 lists. On the other hand, the position of emissions from the use of gas/diesel oil in category 1A1a: Energy Industries relative to other key categories changes, with this category gaining in relative importance. As opposed to the situation in 1990, HFC emissions from category 2F1: Refrigeration & Air Conditioning Equipment features as a prominent key category in 2012. Furthermore, CH_4 emissions from category 4A1: Cattle and N_2O emissions from category 4D1: Direct Soil Emissions also do not feature as key categories for 2012.

An analysis of changes in key categories between 2012 and 2011, the latter being the last year covered by the submission previous to this one (2013 inventory submission), shows the inclusion of CH_4 emissions from category 6A1: Managed Waste Disposal on Land as a key category in 2011, listed, in order of relative contribution after category 2F1: Refrigeration & Air Conditioning Equipment. This category no longer appears in the 2012 key category list. This is due to the fact that in 2012, full scale flaring of methane at the central managed waste disposal site started, reducing substantially the quantity of CH_4 emissions from managed waste disposal activities.

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.

The trend assessments for 2012 (see Table 1-5) with- and without-LULUCF show two important differences, namely the inclusion of CO_2 removals for category 5A1: Forest Land and CH_4 emissions category 4B8: Swine as key trend categories. Compared to the level key category assessment, the trend assessment includes CO_2 emissions for category 1A4c: Agriculture/Forestry/Fisheries, CH_4 emissions from category 4A1: Cattle, CH_4 emissions from category 6A1: Managed Waste Disposal on Land, and, in the case of the with-LULUCF key category list, CH_4 emissions from category 4B8: Swine. The order of significance of categories also varies in some instances between the level and the trend assessments. These differences highlight the usefulness of the two key category assessment approaches in better identifying those categories that warrant special attention in the inventory process.

Table 1-5 Trend assessment key category list for 2012.

2012 with-LULUCF key category list			**2012 without-LULUCF key category list**		
1A1a	Energy Industries - Residual Fuel Oil	CO2	1A1a	Energy Industries - Residual Fuel Oil	CO2
1A1a	Energy Industries - Gas/Diesel Oil	CO2	1A1a	Energy Industries - Gas/Diesel Oil	CO2
2F1	Refrigeration & Air Conditioning Equipment	HFCs	2F1	Refrigeration & Air Conditioning Equipment	HFCs

1A3b	Road Transportation	CO_2	1A3b	Road Transportation	CO_2
1A4a	Commercial/Institutional	CO_2	1A4a	Commercial/Institutional	CO_2
5A1	Forest Land	CO_2	1A4c	Agriculture/Forestry/Fisheries	CO_2
1A4c	Agriculture/Forestry/Fisheries	CO_2	4A1	Cattle	CH_4
4A1	Cattle	CH_4	6A1	Managed Waste Disposal on Land	CH_4
6A1	Managed Waste Disposal on Land	CH_4	1A3d	Navigation	CO_2
1A3d	Navigation	CO_2	1A2	Manufacturing Industries and Construction	CO_2
1A2	Manufacturing Industries and Construction	CO_2	4D1	Direct Soil Emissions	N_2O
4D1	Direct Soil Emissions	N_2O	---		
4B8	Swine	CH_4	---		

1.6 Information on the QA/QC 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*"[9] in order to meet the listed quality criteria.

Admittedly, a formally documented greenhouse gas inventory QA/QC system has yet to be developed in respect of the Maltese inventory process. However, this does not mean that the inventory process is not already subject to quality checks. Indeed, the inventory is subject to at least two peer review processes every year: 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, in particular, those areas where the respective review teams feel that inventory compilation practices need to be further developed in order to ensure better-quality reporting. These review reports form a basis for 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.

Though the formal documentation of inventory processes, in terms of standard operating procedures, is yet to commence, there is already a process for documenting the work performed by the Climate Change Unit in preparing an inventory submission. Besides the spreadsheets that are used to estimate emissions, and thus serving to document the estimation process itself, a number of additional ancillary forms are already in use. These include the forms listed in Table 1-6.

Table 1-6 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.

[9] Ibid.

1.7 General uncertainty evaluation.

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[10] has been applied to uncertainty assessment for this submission. The results of this assessment are presented in Annex 7 to this report.

1.8 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 the most complete picture of emissions and removals from all known sources and sinks within the whole Maltese territory. An assessment of the completeness of this inventory submission is provided in Annex 5. Annex 5 lists source and sink categories for which an estimation could not be performed, including relevant justification why such an estimation could not be carried out. A completeness assessment is presented both for 1990 and 2012.

[10] Ibid.

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 time series covered by this inventory submission, 1990 to 2012, are presented in Table 2-1. Emission trends by gas and total annual with- and without-LULUCF estimates are given.

Table 2-1 Emissions of greenhouse gases by gas for the years 1990 to 2012 (in Gg CO_2 equivalent).

The value of emissions of PFCs for 2000 to 2012 is less than 0.1 Gg CO_2 equivalent and actually stands at around 0.00004 Gg. The value of emissions of SF6 for 1990 and 1991 is less than 0.1 Gg CO2 equivalent and actually stands at 0.01 Gg CO_2 equivalent.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (with-LULUCF)	1,861.55	2,035.50	2,139.95	2,135.91	2,247.35	2,206.27	2,258.44	2,248.51	2,251.87	2,341.32	2,338.43
CO_2 (without-LULUCF)	1,866.76	2,042.26	2,146.71	2,142.67	2,254.11	2,213.03	2,265.20	2,255.27	2,258.63	2,348.08	2,345.19
CH_4	73.26	79.49	88.09	97.77	106.69	114.35	114.24	122.55	106.06	110.71	125.47
N_2O	51.81	56.05	61.05	65.98	71.19	89.42	83.65	88.80	80.62	77.96	70.52
HFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	73.87	73.87	73.87	8.29
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
SF_6	0.01	0.01	1.50	1.50	1.50	1.51	1.52	1.52	1.54	1.54	1.54
Total (with-LULUCF)	**1,986.63**	**2,171.05**	**2,290.58**	**2,301.15**	**2,426.73**	**2,411.55**	**2,457.84**	**2,535.25**	**2,513.95**	**2,605.39**	**2,544.25**
Total (without-LULUCF)	**1,991.84**	**2,177.80**	**2,297.34**	**2,307.91**	**2,433.49**	**2,418.30**	**2,464.60**	**2,542.00**	**2,520.71**	**2,612.15**	**2,551.01**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 (with-LULUCF)	2,458.08	2,477.98	2,656.81	2,611.66	2,697.04	2,663.96	2,749.79	2,708.47	2,635.40	2,633.09	2,660.55	2,799.44
CO_2 (without-LULUCF)	2,464.84	2,484.80	2,663.68	2,618.59	2,704.03	2,671.01	2,756.89	2,715.62	2,642.61	2,640.36	2,667.88	2,806.66
CH_4	139.98	149.25	158.94	157.78	166.64	173.99	165.99	100.75	139.98	149.25	158.94	104.25
N_2O	67.31	66.63	63.65	65.60	67.46	69.21	67.93	64.89	62.33	57.22	56.82	57.66
HFCs	15.33	28.62	39.91	60.22	64.32	87.33	105.99	116.55	120.01	121.12	131.51	171.11
PFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SF_6	1.56	1.57	2.16	1.62	1.64	1.65	1.66	1.83	1.57	1.78	4.81	0.47

Total (with-LULUCF)	**2,667.79**	**2,701.74**	**2,889.36**	**2,871.27**	**2,970.44**	**2,971.41**	**3,084.31**	**3,049.52**	**2,985.95**	**2,987.20**	**3,019.68**	**3,132.94**
Total (without-LULUCF	**2,674.54**	**2,708.55**	**2,896.23**	**2,878.20**	**2,977.43**	**2,978.45**	**3,091.41**	**3,056.68**	**2,993.16**	**2,994.47**	**3,027.00**	**3,140.15**

It is pertinent to note here that the discussion in this Chapter is restricted to national emissions, that is, not including emissions from the so-called memo items (see section 1.1.3 for further clarifications), unless otherwise indicated in the text or captions.

The change in total emissions from base year to the latest reported year for the with-LULUCF estimates represents an increase of 57.52%, while the without-LULUCF estimates represents an increase of 57.48%.

2.1.1 Discussion of overall emission trends.

The general trend for combined emissions remains one of increase over the years concerned. This trend can be more easily observed in Figure 2-1 and Figure 2-2, which represent the overall trends and trends by gas (to be discussed in a subsequent section of this chapter) for the with-LULUCF and the without-LULUCF estimations respectively.

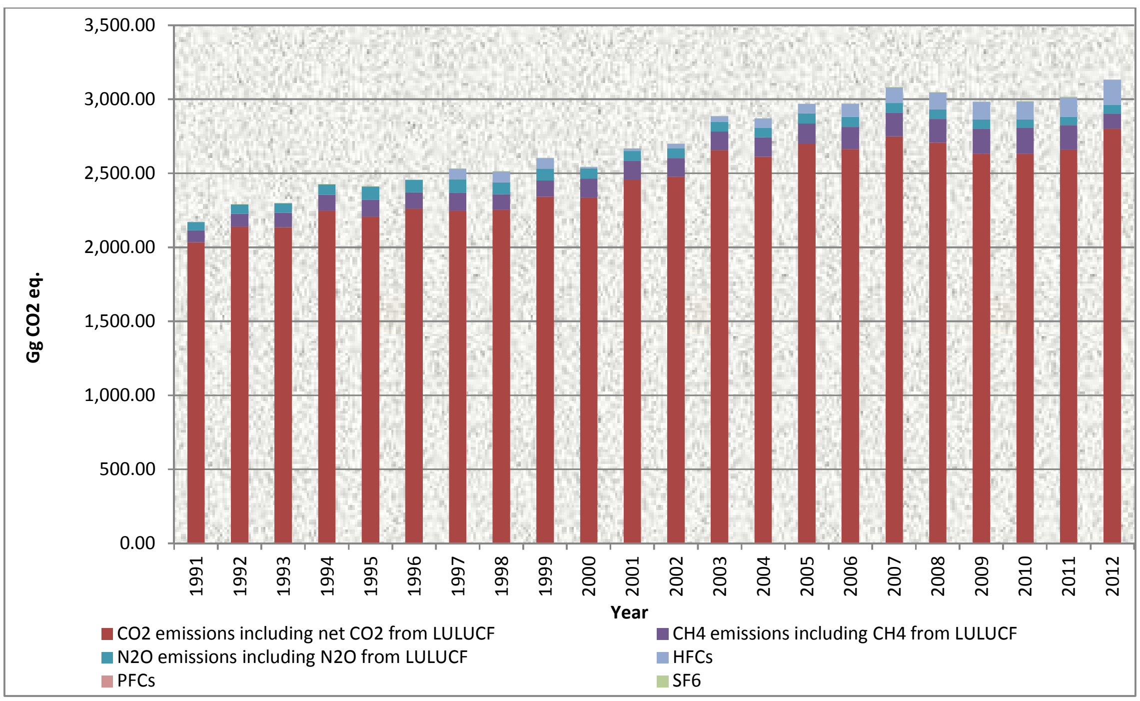

Figure 2-1 Emissions of greenhouse gases, including LULUCF (with-LULUCF), for the years 1990 to 2012 (in Gg CO_2 equivalents), showing overall trend and differentiation by gas.

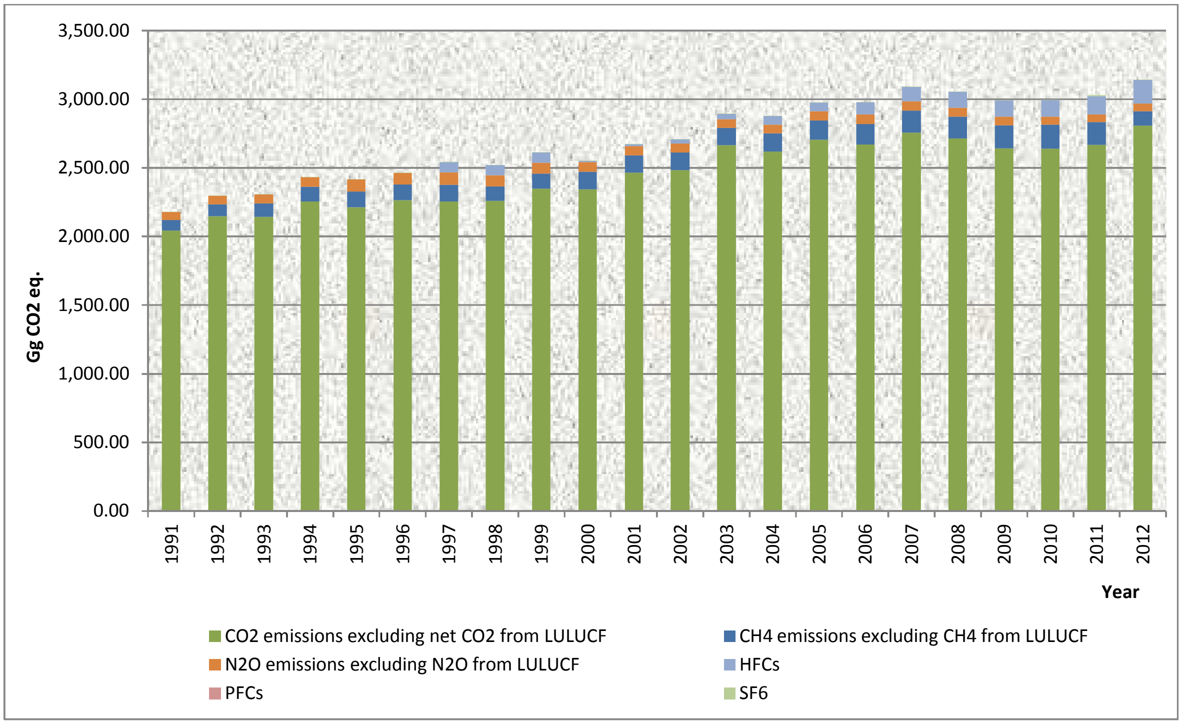

Figure 2-2 Emissions of greenhouse gases, excluding LULUCF (without-LULUCF), for the years 1990 to 2012 (in Gg CO_2 equivalents), showing overall trend and differentiation by gas.

A pictorial analysis of year-to-year increases or decreases in overall emissions (with-LULUCF) is presented in Figure 2-3. The year-to-year variation is very erratic. The highest observed percentage change between two consecutive years is that observed between 1990 and 1991, with 1991 total emissions being just above 9.0% higher than emissions in the previous year. Years 2000 and 2009 show the greatest decrease in emissions compared to previous years, at 2.1% in both instances.

Meanwhile, the periods 1991-1994, 1996-1999, 2001-2003 and 2010-2012 show sustained multi-year increases in emissions. Only the period 2008-2009 shows a decrease in emissions that continues over more than one year.

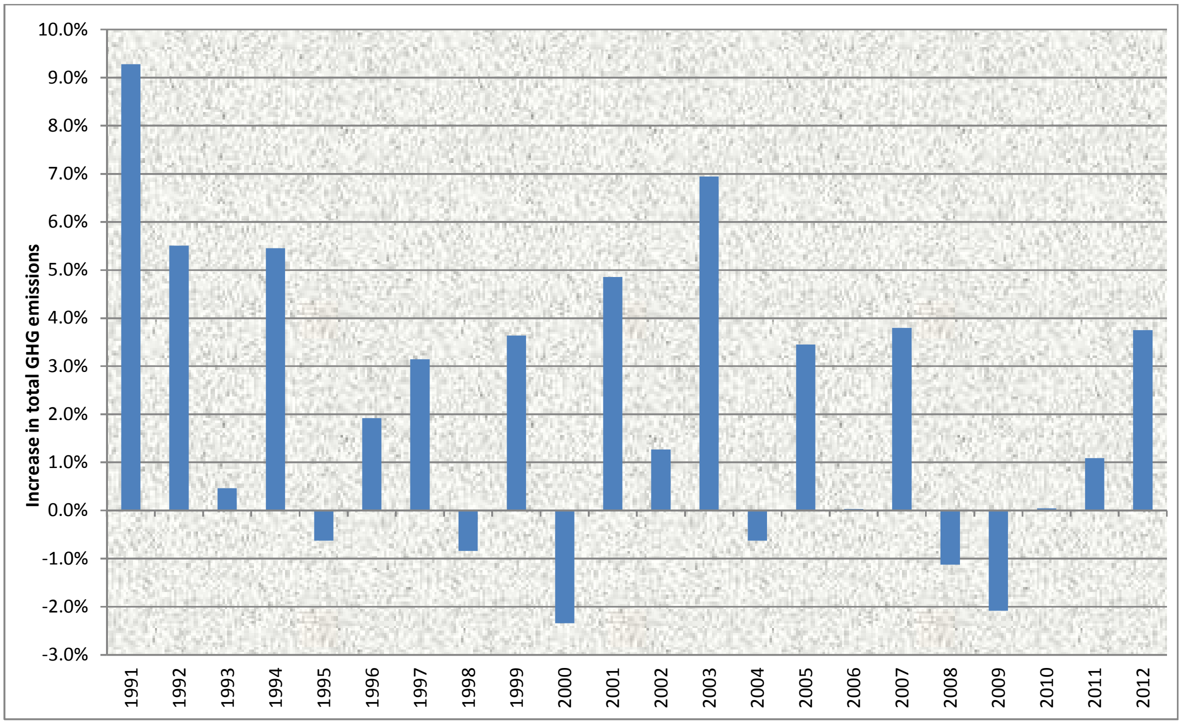

Figure 2-3 Percentage increase or decrease in total greenhouse gas emissions (based on total emissions including LULUCF) for each year compared to the previous year.

It is worthy of note that for the years 1991 to 2001, year-to-year increases were greater in number and, on average, higher, than the year-to-year increases for the years 2002 to 2012. On the other hand, the period 2002-2012 shows more instances of year-to-year decreases than the 1991-2001 period. One may also note that over the period 1990-2001, emissions increased by 34.3% overall, while for the period 2002-2012 the overall increase was of 15.8%, a rate that is less than half that for the 1990-2001 period.

2.1.2 Trend in overall emissions compared to population.

Comparing emissions to demographic development in a country can serve as a useful indicator of the progress in emissions control over a set period of time. Malta's population has seen a sustained growth over the period covered by this inventory submission and this has been coupled by an overall increase in the per capita rate of emissions, as can be observed in Figure 2-4. From a value of 5.5 tonnes CO_2 equivalents per capita in 1990, the per capita emissions have increased to 7.4 tonnes CO_2 equivalents in 2012, a 35.3% increase.

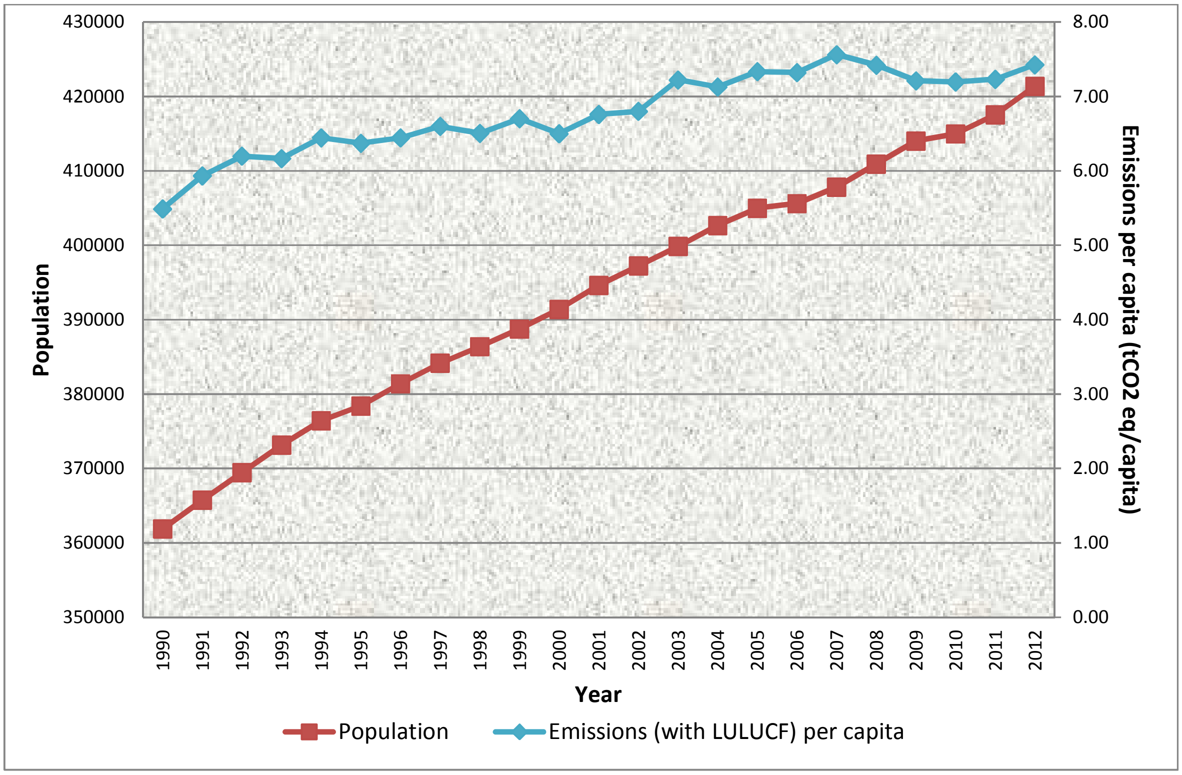

Figure 2-4 Trend in national greenhouse gas emissions (with-LULUCF) per capita.

[Source of population data for 2000 to 2012: NSO StatDB, accessed 03/01/2014]

2.1.3 Trend in overall emissions compared to economic development.

Another important indicator is the comparison of the trend in emissions of greenhouse gases and the economic development of the country, which can be represented in terms of Gross Domestic Product (GDP). The relationship between these two parameters, or the 'emissions intensity' of Malta's economy, is presented in Figure 2-5.

Contrary to the situation for per capita emissions, the emissions intensity of the Maltese economy has seen a downward trend, starting at 1046 thousand tonnes CO_2 equivalent per unit €billion GDP in 1990, and growing down to 460 thousand tonnes CO_2 equivalent per unit €billion GDP in 2012, more than halving the emissions intensity. This can be interpreted as a sign of decoupling of national total emissions from the country's economic development trends.

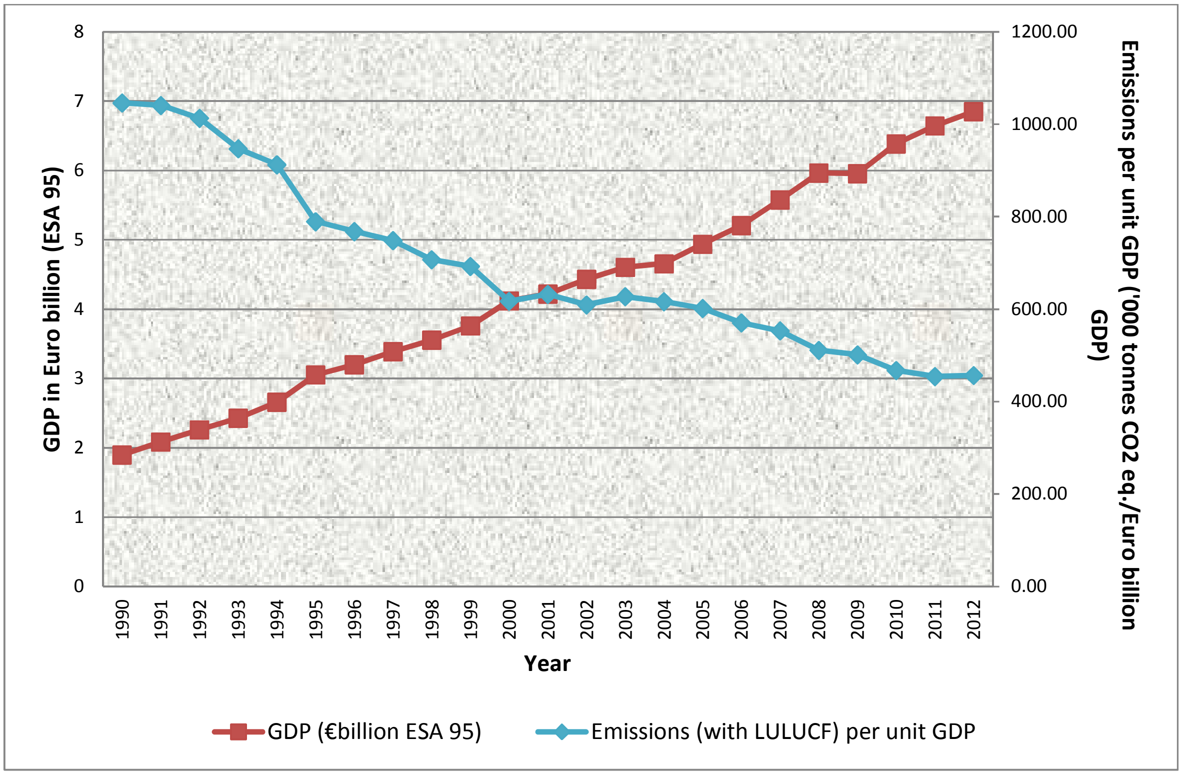

Figure 2-5 Relationship between national greenhouse gas emissions (with-LULUCF) and Gross Domestic Product.

(Source of GDP data for 1995 to 2012: NSO StatDB, accessed 03/01/2014)

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 have been 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 2012 (in Gg CO_2 equivalent) and the corresponding change between the two years.

	1990	2012	% change 1990-2012
CO_2 (with-LULUCF)	1,861.55	2,799.44	**50.38**
CO_2 (without- LULUCF)	1,866.76	2,806.66	**50.35**
CH_4	73.26	104.25	**42.31**
N_2O	51.81	57.66	**11.29**
HFCs	NA,NE,NO	171.11	**100.00**
PFCs	NA,NE,NO	0.00	**100.00**
SF_6	0.01	0.47	**4,149.55**
Total (with-LULUCF)	1,986.63	3,132.94	**57.70**
Total (without-LULUCF)	1,991.84	3,140.15	**57.65**

The value of emissions of PFCs for 2012 is less than 0.1 Gg CO_2 equivalent and actually stands at around 0.00004 Gg.
The value of emissions of SF_6 for 1990 is less than 0.1 Gg CO_2 equivalent and actually stands at 0.01 Gg CO_2 equivalent

Table 2-1 and Table 2-2 also highlight the major contribution that carbon dioxide has in the national emissions total. The status of this greenhouse gas as the highest contributor has been maintained throughout the years. This can also be observed in Figure 2-6. The growth in emissions of carbon dioxide over the period 1990 to 2012 coupled with the relative contribution of the gas to total national emissions represents the strong influence that this gas has on the national emissions trends.

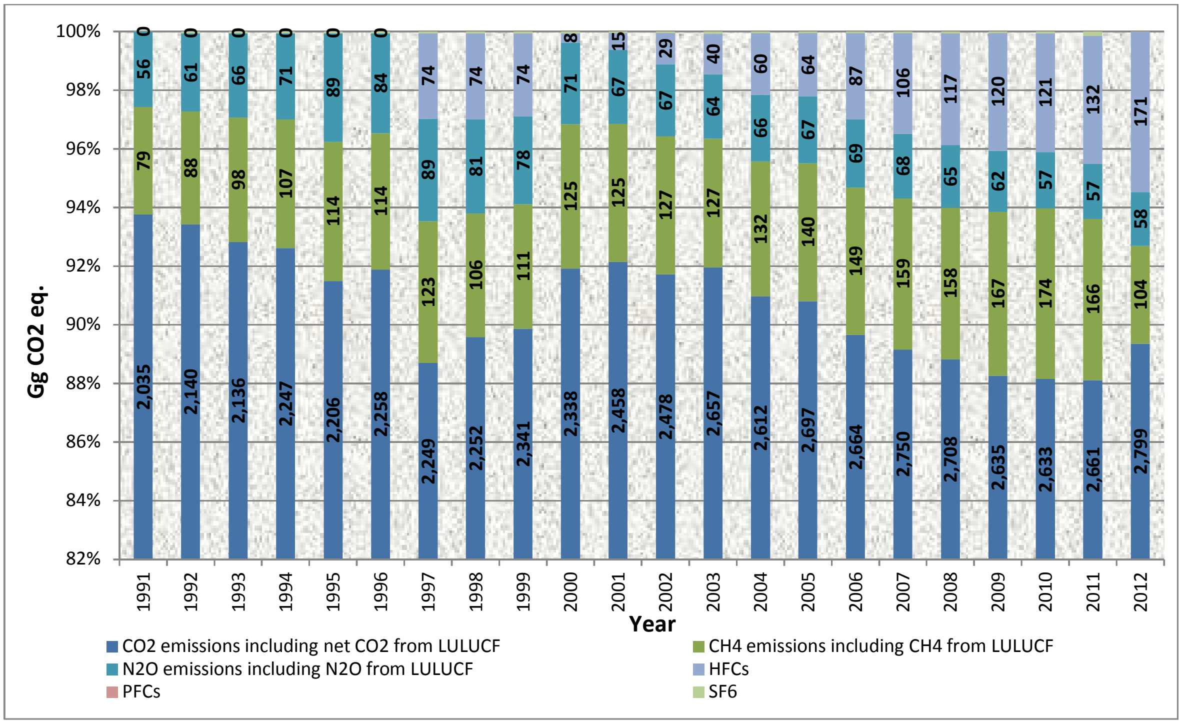

Figure 2-6 Percentage contribution of each greenhouse gas (in terms of CO_2 equivalent) to total national greenhouse gas emissions (with LULUCF).

Data values in the chart represent the absolute emissions for each of the four most important contributing greenhouse gases, in Gg CO_2 equivalent.

2.2.2. Carbon dioxide emissions and removals.

The overall pattern of carbon dioxide emissions by sources and removals by sinks is presented in pictorial form in Figure 2-7. It is obvious that emissions far outweigh removals – indeed, removals of carbon dioxide by the LULUCF sector offset a little more than 0.2% (2012 figures) of emissions of this gas.

As has already been observed, net total emissions of carbon dioxide have the highest share of total national emissions (see Figure 2-6). One does notice a slight overall decrease in this contribution (1990: 93.7% with-LULUCF, 94% without-LULUCF; 2012: 89.5% with-LULUCF, 89.5% without-LULUCF) despite the general increase in emissions in absolute terms (50.3%). The decrease in the share of carbon dioxide can be explained by a growing relative contribution of other greenhouse gas species to national emissions, in particular HFCs.

Sectorally, the principal contributor to carbon dioxide emissions is the sector 1: Energy. Carbon dioxide emissions from this sector account for more than 99.9% of total gross national carbon dioxide emissions. Within this sector, the category 1A1: Energy Industries represents the highest overall contribution of carbon dioxide emissions, followed by category 1A3: Transport.

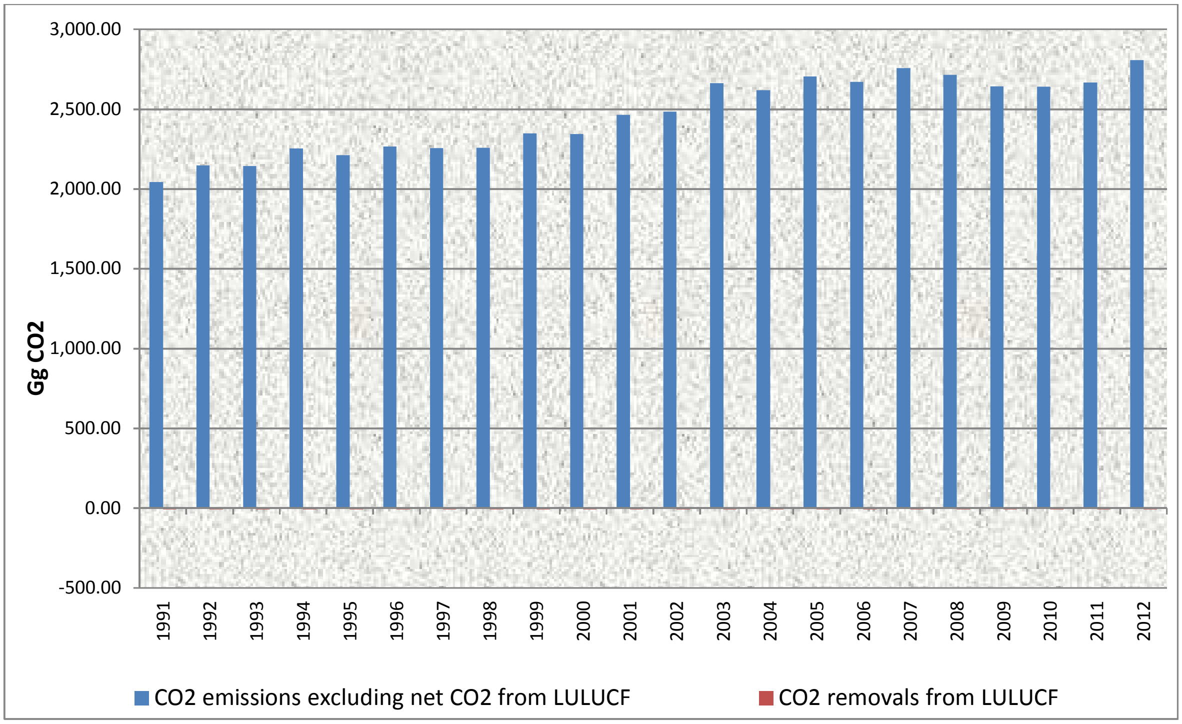

Figure 2-7 Trends in emissions by sources and removals by sinks for carbon dioxide.

2.2.3. Methane emissions.

For most of the period under consideration, methane has maintained the status of the greenhouse gas with the second highest share of national total emissions (in terms of CO_2 equivalent). This situation has however changed in 2012, its place being taken by HFCs (see Figure 2-6).

The trend in methane emissions (in Gg CH_4), including sectoral contributions is presented in Figure 2-8. Until recently, the general trend reflected an increase in emissions of methane. However, the situation has been reversed in the last two years, with the reduction in methane emissions being particularly marked for 2012. This is due to the reduction in emissions of this greenhouse gas from the sector 6: Waste, as a result of increase flaring of methane in local managed landfilling activities (category 6A1: Managed Waste Disposal on Land).

Sector 4: Agriculture is another important emitter of methane via categories 4A: Enteric Fermentation and 4B: Manure Management. Estimated absolute emissions of methane from this sector peaked in 2000, with estimated emissions in 2012 being the lowest recorded since 1990.

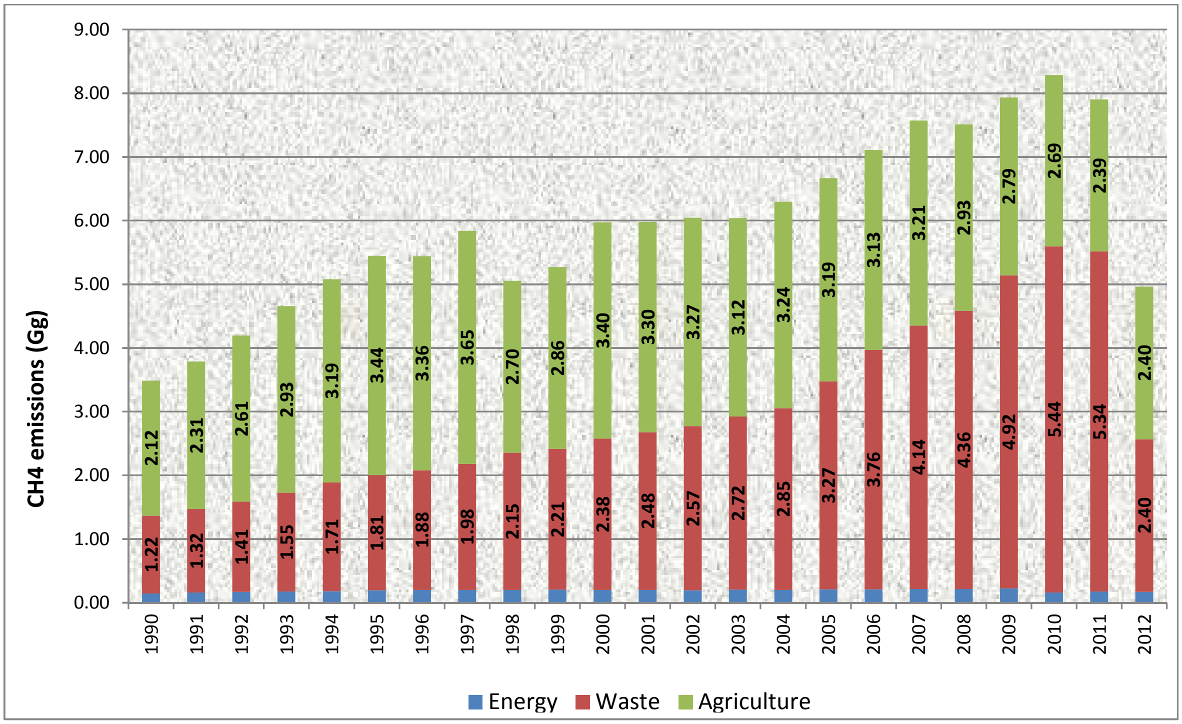

Figure 2-8 **Trends in emissions of methane.**

2.2.4. Nitrous oxide emissions.

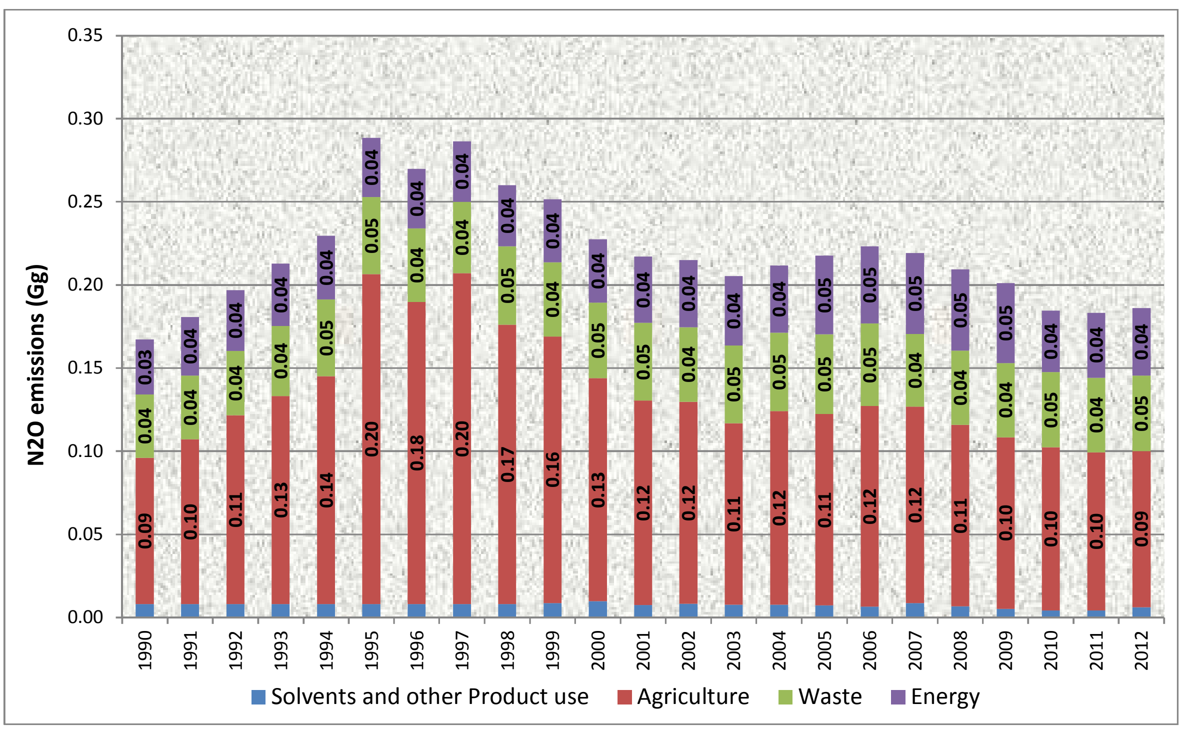

Figure 2-9 Trends in emissions of nitrous oxide.

Until the middle of the last decade, nitrous oxide was the gas with the third highest share of total national emissions (in terms of CO_2 equivalent), until superseded by emissions of HFCs (see Figure 2-6.

Figure 2-9 presents the general trend of nitrous oxide emissions (in Gg N_2O). Estimated emissions peaked in 1998. Sectorally, the highest contributor is sector 4: Agriculture, with emission of this greenhouse gas mainly from category 4D: Agricultural Soils, and, to a lesser extent, category 4B: Manure Management. Further contributions to national total nitrous oxide emission are given by sectors 6: Waste, 1: Energy and 3: Solvents and Other Product Use, in descending order of contribution.

2.2.5. Emissions of fluorinated gases.

Whereas in 1990 and for a number of years afterwards, fluorinated greenhouse gas emissions had a minimal share in total national emissions, the contribution of such gases increased significantly in more recent years to the extent that the combined share of such gases in total national emissions in 2012 is second highest behind carbon dioxide. The percentage changes observed for all three gas types between 1990 and 2012 (see Table 2-2) clearly reflect this trend. The main driving force behind this change in scenario is the substantial increase observed for hydrofluorocarbons. The high global warming potentials of fluorinated gases further bolster their overall share in total emissions.

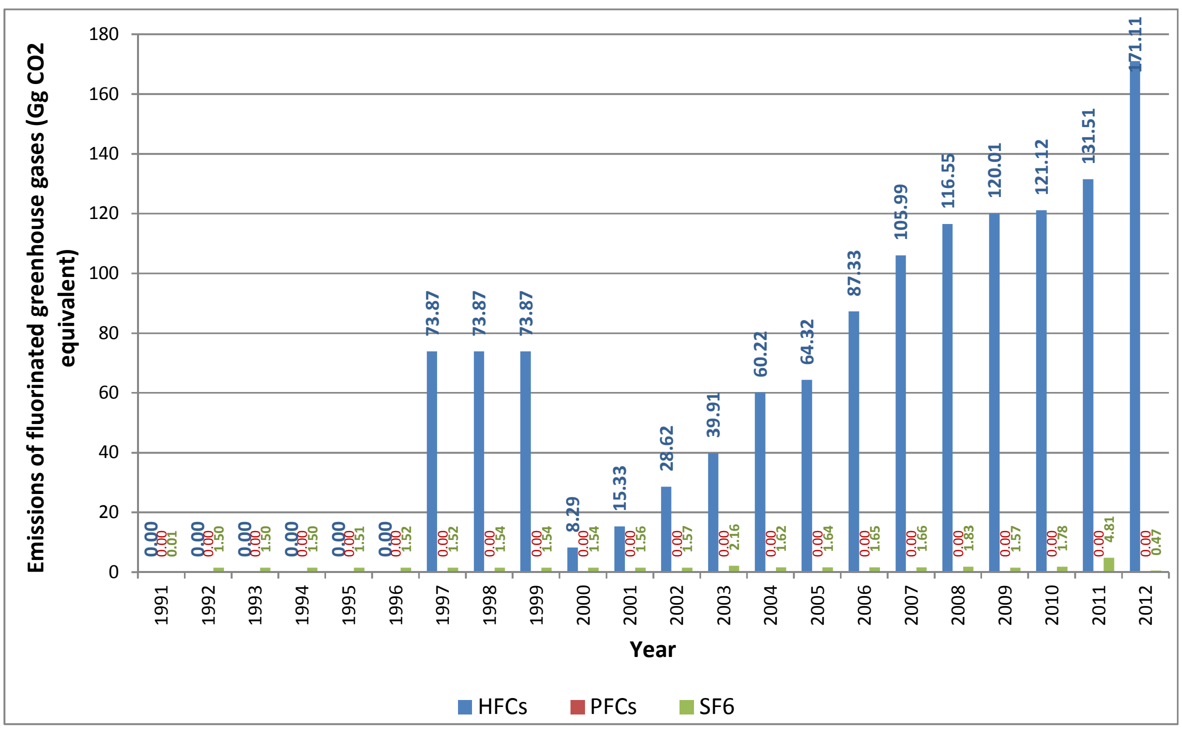

Figure 2-10 Trends in emissions of the three types of fluorinated greenhouse gases covered by this inventory.

For the years 1997 to 1999, 'potential' emissions of HFCs are presented, in the absence of reliable data on consumption of HFCs for these years which would have allowed an estimation of 'actual' emissions. Until 1999, no emissions of PFCs are reported. The value of emissions of PFCs for 2000 to 2012 is less than 0.1 Gg CO_2 equivalent and actually stands at around 0.00004 Gg.

Within the group of fluorinated gases, HFCs have by far the largest share of emissions. The increase in emissions of HFCs (please refer to caption for Figure 2-10 for an explanation of the trend for 1997 to 1999) is mainly due to the use of such gases as replacements for ozone depleting substances and to the greater utilisation if these gases in refrigeration equipment. Indeed, HFCs have the highest share of total emissions for the sector 2: Industrial Processes, where they feature as the main emissions for source category 2F: Consumption of Halocarbons and SF_6.

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 pictorially in Figure 2-11.

Table 2-3 Emissions of greenhouse gases by sector for the years 1990 to 2012 (in Gg CO_2 equivalent).

	1990	1991	1992	1993	1994	1995	1996	1997
1. Energy	1,878.10	2,054.36	2,159.82	2,156.12	2,267.74	2,226.04	2,278.68	**2,268.69**
2. Industrial Processes	1.58	1.78	2.90	2.94	3.24	3.21	3.04	**77.11**
3. Solvents and Other Product Use	2.48	2.48	2.48	2.48	2.48	2.48	2.48	**2.48**
4. Agriculture	71.83	79.29	90.05	100.33	109.52	133.75	126.90	**138.38**
5. LULUCF	-5.21	-6.76	-6.76	-6.76	-6.76	-6.76	-6.76	**-6.76**
6. Waste	37.84	39.88	42.08	46.04	50.51	52.81	53.49	**55.34**
Total (with-LULUCF)	**1,986.63**	**2,171.05**	**2,290.58**	**2,301.15**	**2,426.73**	**2,411.55**	**2,457.84**	2,535.25
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Energy	2,272.74	2,363.35	2,360.56	2,480.70	2,500.77	2,680.35	2,634.63	**2,722.43**
2. Industrial Processes	76.54	75.80	10.11	17.27	30.53	42.29	62.24	**66.34**
3. Solvents and Other Product Use	2.48	2.72	3.01	2.33	2.56	2.38	2.37	**2.26**
4. Agriculture	108.70	109.66	112.93	107.41	106.41	99.34	104.10	**102.64**
5. LULUCF	-6.76	-6.76	-6.76	-6.76	-6.82	-6.87	-6.93	**-6.98**
6. Waste	60.25	60.62	64.40	66.84	68.29	71.88	74.86	**83.76**
Total (with-LULUCF)	**2,513.95**	**2,605.39**	**2,544.25**	**2,667.79**	**2,701.74**	**2,889.36**	**2,871.27**	**2,970.44**
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	2012	
1. Energy	2,689.09	2,775.93	2,734.83	2,661.43	2,654.41	2,682.66	2,821.91	
2. Industrial Processes	89.37	107.94	118.55	121.81	123.12	136.57	171.83	
3. Solvents and Other Product Use	2.03	2.71	2.10	1.60	1.29	1.31	1.90	
4. Agriculture	103.21	104.06	95.42	90.68	86.92	79.70	79.44	

5. LULUCF	-7.04	-7.10	-7.15	-7.21	-7.27	-7.32	-7.22	
6. Waste	94.76	100.78	105.77	117.64	128.73	126.76	65.07	
Total (with-LULUCF)	2,971.41	3,084.31	3,049.52	2,985.95	2,987.20	3,019.68	3,132.94	

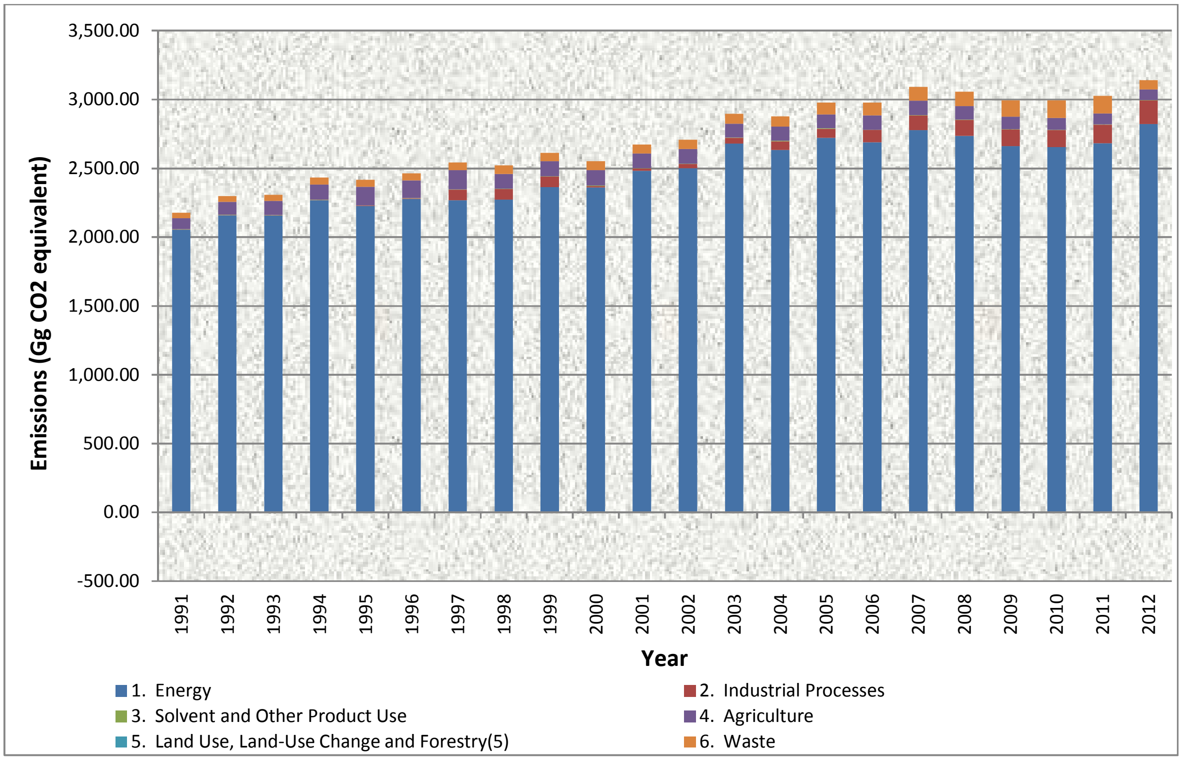

Figure 2-11 Emissions by sector.

The most obvious feature that comes out of Table 2-3 and Figure 2-11 is the predominance of emissions from sector 1: Energy in total national emissions. This has remained the case throughout the period covered here albeit a small decrease in the share of Energy sector of total emission has decreased to a certain extent over the years (1990: 94.3%; 2012: 90.2%). A second important feature is that sector 5: LULUCF presents a net sink for greenhouse gases.

Overall sectoral trends are given in Table 2-4. The spectacular increase for sector 2: Industrial Processes is explained by the substantial increase in emissions of HFCs, as already explained in an earlier section. Sectors 1: Energy and 6: Waste have experienced a more moderate, though still significant overall increase in emissions. Emissions from sectors 3: Solvents and Other Product Use and 4: Agriculture on the other hand have seen an overall decrease. The level of net removals for sector 5: LULUCF can be said to have remained relatively stable over the time series as borne out by both the figures presented for this sector in Table 2-3 and the relative change between 1990 and 2012.

More clarity on the reasons underpinning the observed sectoral trends can be obtained 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 2012 (in Gg CO_2 equivalent) and the corresponding change between the two years.

	1990	2012	% change 1990-2012
1. Energy	1,878.10	2,821.91	**50.25**
2. Industrial Processes	1.58	171.83	**10,760.87**
3. Solvents and Other Product Use	2.48	1.90	**-23.40**
4. Agriculture	71.83	79.44	**10.95**
5. LULUCF	-5.21	-7.22	**38.63**
6. Waste	37.84	65.07	**71.96**
Total (with-LULUCF)	1,986.63	3,132.94	57.70

2.4 Description and interpretation of emissions trends for indirect greenhouse gases and SO_2.

Table 2-5 presents emissions of indirect greenhouse gases and sulphur dioxide for the time series 1990 to 2012 (see also Figure 2-12).

Table 2-5 Emissions of indirect greenhouse gases and sulphur dioxide for the years 1990 and 2012 (in Gg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NO_x	7.55	8.12	8.53	8.68	9.06	8.85	9.10	9.15	9.22	9.55	**8.38**
CO	23.63	25.28	26.95	28.23	29.24	29.93	30.62	30.98	30.70	30.74	**29.77**
NMVOC	6.20	6.55	6.91	7.23	7.47	7.63	7.94	8.16	7.84	7.79	**3.36**
SO_2	15.78	17.84	19.72	20.40	23.93	27.17	28.71	29.82	30.93	27.99	**24.43**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
NO_x	9.11	9.22	9.47	9.05	9.83	9.20	9.74	9.58	9.30	9.31	9.12	**8.86**
CO	29.01	28.53	28.41	27.88	28.83	28.67	29.92	30.06	31.22	5.57	7.56	**6.46**
NMVOC	3.39	3.29	3.05	3.11	3.54	3.70	3.59	3.28	2.97	3.43	3.26	**4.21**
SO_2	**26.07**	**25.34**	**27.53**	**11.96**	**12.31**	**12.38**	**12.76**	**11.69**	**8.27**	**7.76**	**7.88**	**8.25**

Among these four gases, the most significant trends are those of CO and SO_2. Both gases usually 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). The most important factor in the changes observed for SO_2 is the sulphur content of fossil fuels used in these activities. [For CO, the substantial decrease observed between 2011 and 2012 is mainly due to a change in methodological approach, with the COPERT emission estimation method being used for the first time, to estimate 2012 emissions.]

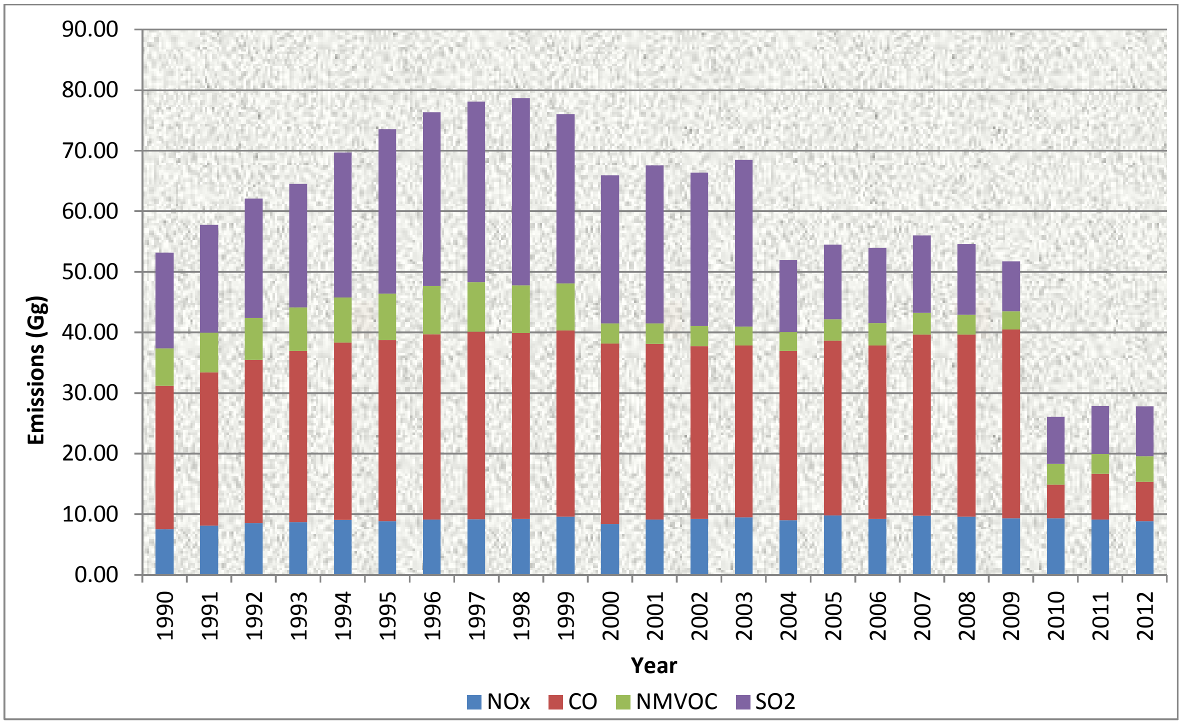

Figure 2-12 Emissions of indirect greenhouse gases and SO_2.

Chapter 3. ENERGY (CRF Sector 1)

3.1 Overview of Sector

As already illustrated in Chapter 2 the Energy sector is the most significant contributor of greenhouse gas emissions in Malta. Emissions trends for this sector, included for sectoral categories, are presented in Figure 3-1.

In 2012, the category Energy Industries (1A1) accounted for 73.4% of the overall greenhouse gas emissions in the Energy sector as a whole. This category has the greatest influence on overall energy emission trends and, consequent to the relative importance of the Energy sector, on national emission trends.

The second highest contributor under this sector is Transport (1A3), incorporating Road Transport (1A3b), National Navigation (1A3dii) and Domestic Aviation (1A3aii), and which accounts for 19.0% of this sector's emissions. Transport is thus another major contributor to overall national emissions.

The Manufacturing Industries category (1A2) accounts for 2.6%. The other categories, i.e. Commercial/Institutional (1A4a), Residential (1A4b) and the Agriculture/Forestry/Fisheries (1A4c) together account for 5.0% of the Energy sector emissions.

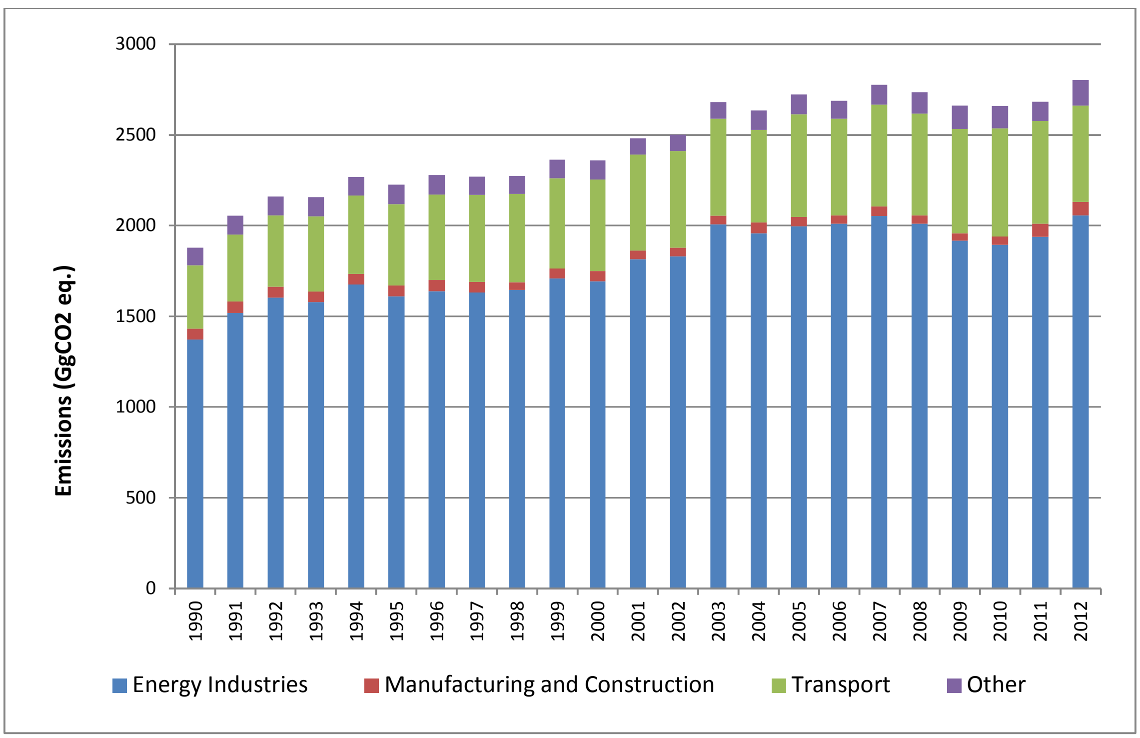

Figure 3-1 Emission trends in the sector 1: Energy by source category.

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

3.1.1 General methodological issues: Oxidation factors

As a general rule for the estimation of emissions from fuel combustion, an Oxidation factor of 1.00 is used across the whole energy sector, unless otherwise stated.

3.2 Fuel Combustion (1A)

3.2.1 Comparison of Sectoral and Reference approaches

The Reference Approach uses a top-down approach to calculating emissions of CO_2, using the country's energy supply data. The Reference Approach serves as a comparison to estimations for individual categories using a bottom-up approach, the Sectoral Approach, with emissions estimated from activity statistics (mostly fuel consumption) obtained for the various economic sectors and processes incorporated into each category. Further information on how the Reference Approach was estimated is provided in Annex 4 to this Annex 4 to this report.

Table 3-1 and Figure 3-2 show the comparison between the Reference Approach and the Sectoral Approach. In principle the Reference Approach Total can be compared with the Sector 1AA Total. The Reference Approach produces CO_2 emissions estimates which are 4% lower than the Sectoral Approach estimate. The reference approach includes data obtained from importers of fuels. The difference could be due to statistical differences.

Table 3-1 Difference between results for the reference and sectoral approaches to estimation of fuel combustion emissions.

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)	35.78	2701.24	36.86	2788.88	-3.52	-3.73

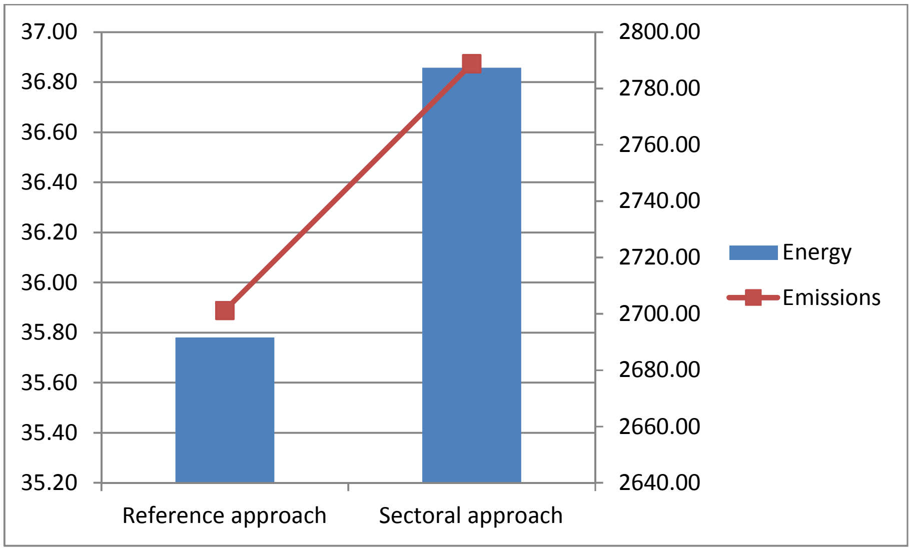

Figure 3-2 Comparison between sectoral and reference approach for CO2 emissions and fuel consumption.

3.2.2 International Bunkers (1C)

As already indicated previously in this report, emissions for the category 1C: International Bunkers are considered as 'Memo Items' and not taken into account when speaking in terms of 'national' emissions of greenhouse gases.

3.2.2.1 Source Category Description

For international marine bunkers, emissions reported for the period between 1990 and 2000 are those submitted for the 1st National Communication to the UNFCCC. Data between 2001 and 2010 is taken from statistics of either Port Authorities or Customs. For the years 2011 and 2012 some major bunkering operators provided own information on fuel sales which was used in conjunction with data from Port Authorities.

Emissions from international aviation activities have been estimated based on fuel sales. Activity data for the years 1993-2012 was provided directly by suppliers of aviation fuel, whereas data for the years 1990-1992 was obtained from the 1st National Communication.

Estimated emissions for international maritime and aviation bunkers are presented in Figure 3-3.

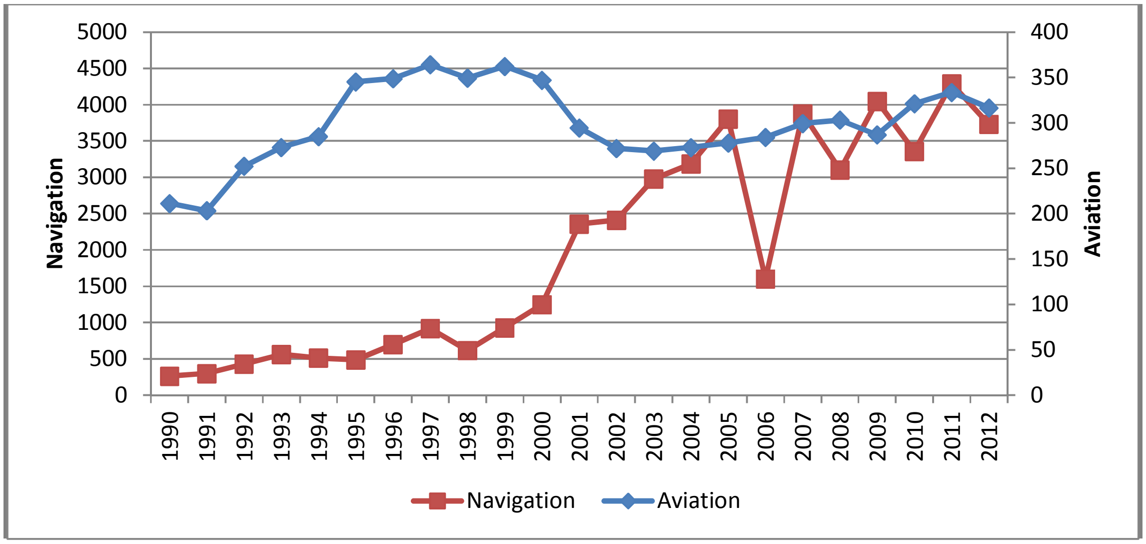

Figure 3-3 Emissions from international aviation and maritime bunkers for 1990 to 2012.

3.2.2.2 Methodological Issues

- *International Bunkers - Aviation*

The method used complies with the Tier 1 approach summarised in the 2006 IPCC Guidelines and identical to the Revised 1996 Guidelines methodology. This methodology estimates emissions by multiplying total consumption of fuel (assumed to be equivalent to total sales for international aviation as provided by the relevant data providers) by a default emission factor. Data for total fuel sales were obtained through the MRA fuel regulatory function. To date only one supplier is licensed to sell aviation-related fuels. Furthermore, in Malta, only Aviation Gasoline and Jet Kerosene (Jet-A1) are sold for aviation purposes.

- *International Bunkers - Marine*

For the purposes of estimating emissions, figures for sales were used in lieu of figures for fuel consumption. Data on sales of gas/diesel oil and heavy fuel oil for international marine bunkers is routinely collected from the major local bunker operators by Transport Malta (the local Port Authority). This data is made available to MRA for various purposes, including for greenhouse gas inventory compilation purposes. The data provided includes information of the mode of bunker fuel delivery (whether by road-bowser or a bunker barge), the name of the receiving vessel and type of vessel and the amount of fuel received. This level of information made it easier to distinguish between supply of fuels for national and international navigation purposes. Emissions from fuels delivered to fishing vessels are excluded from this category.

Emission factors used for gas oil and heavy fuel oil are those from 2006 IPCC Guidelines, whilst for petrol emission factors from the IPPC 1996 guidelines are used (shown in Table 3-2), and correlated directly to the type of fuel used, without consideration to the engine type. The type of vessels covered by the international marine bunker category include container vessels, cargo vessels, RORO, supply vessels, research vessels, catamaran, high speed craft and towing vessels. Foreign navy vessels were also included.

Table 3-2 Emission Factors for International Bunkers - Marine

Fuel	C (TC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)
Gas Oil	20.2	7.0	2.0	1500.0	1000.0	200.0
Heavy Fuel Oil	21.1	7.0	2.0	1500.0	1000.0	200.0
Petrol	18.9	5.0	0.6	1500.0	1000.0	200.0

The sulphur content of the fuels for the years from 2008 was obtained from the results of sampling of fuels from marine vessels routinely carried out by MRA for quality control purposes in accordance with EU legislation. In fact, for these years, a recalculation of sulphur dioxide emissions was performed due to the receipt of actual data on fuel sulphur content.

For the years 2004-2007 no actual data on sulphur content of marine bunker fuels was available; therefore a conservative recalculation of sulphur dioxide emissions was made on the basis of the maximum permissible sulphur content according to the relevant legislation at the time.

For the period previous to 2004 an assumption was taken that the sulphur content of bunkered marine fuels was similar to that of the same types of fuels as available for inland purposes.

3.2.2.3 Source Specific Recalculations

- *International Bunkers - Aviation*

No re-calculations over the previous years were done for this sector.

- *International Bunkers - Marine*

Recalculations (see Table 3-3) have been performed in respect of emissions of sulphur dioxide for the years 2004 to 2012 due to the availability of actual sulphur content data for 2008-2012 or the assumption made for 2004-2007, as explained above.

Table 3-3 Recalculations for SO_2 emissions from International Bunkers - Marine.

Year	SO_2 emissions Gg as reported in the 2013 GHG Inventory submission	SO_2 emissions Gg as reported in the 2014 GHG Inventory submission	Percentage change in reported emissions (%)
2004	17.23	58.14	28.50
2005	21.08	71.57	42.12
2006	7.79	25.56	-4.93
2007	21.53	73.13	43.70
2008	17.09	43.35	3.93
2009	21.87	27.89	-50.55
2010	17.26	36.80	-10.12
2011	22.83	52.10	8.28
2012	17.23	---	---

3.2.3 Feedstock and non-energy use of Fuels

No activities that use fuels as feedstock or for non-energy purposes were identified within the geographic scope of this report.

3.2.4 Capture and storage of CO2 from Flue gases

In Malta, there are currently no activities that include the capture or storage of CO_2 emitted from flue gases.

3.2.5 Country specific issues

Where relevant, country specific issues are discussed under the relevant headings.

3.2.6 Source Category 1A1 – Energy Industries

3.2.6.1 Source 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 are currently run on liquid fossil fuels: residual fuel oil (RFO) and gas oil (GO). It should however be noted that until 1995, bituminous coal was also used for electricity generation in one of these plants.

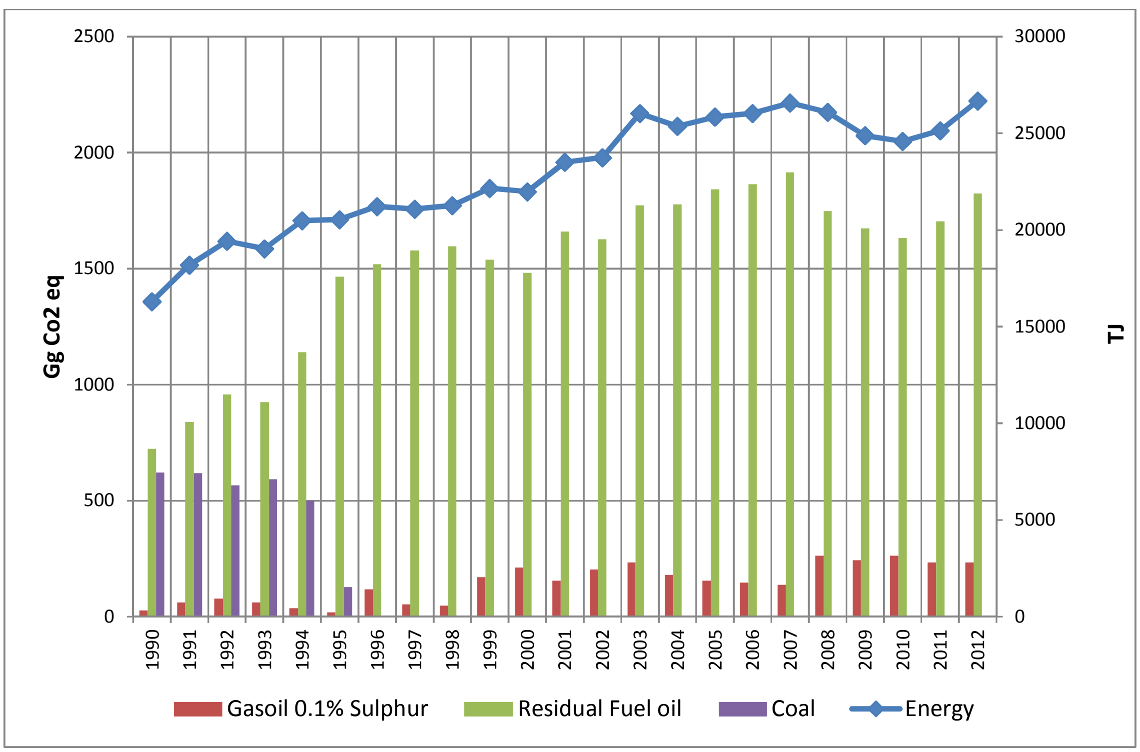

Figure 3-4 Trend of emissions from the category Energy Industries compared with fuel consumption for energy industries

Estimated greenhouse gas emissions show a good correlated with fuel consumption trends, in particular the trend for utilization of RFO as depicted in Figure 3-4. Comparing CO_2 emissions against electricity generated (Figure 3-5) shows two main trends over the period covered by this inventory: an almost continuous decrease in the rate of emissions per unit generated until 2000, and a relatively stable level of efficiency in terms of emissions for the period up to the present.

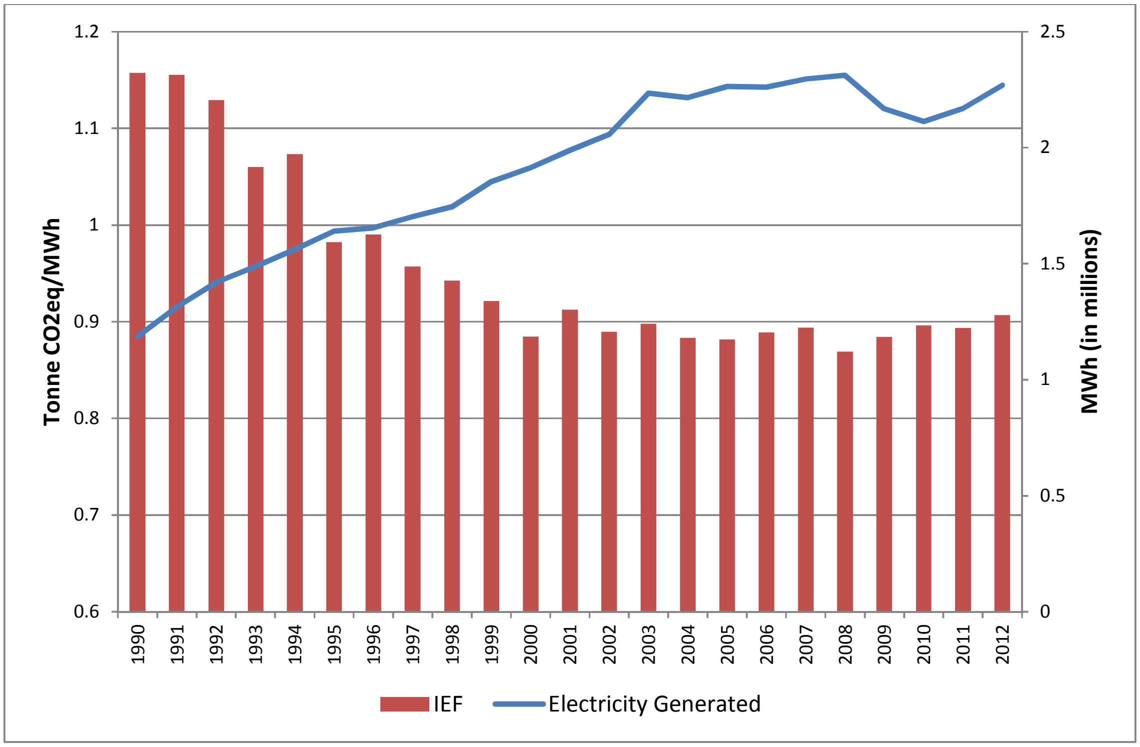

Figure 3-5 Public Energy Industry CO_2 emissions trend compared with electricity generated

3.2.6.2 Methodological Issues

Emissions for the sub-category Public Electricity and Heat Production have been compiled using fuel consumption data provided by Enemalta Corporation (the operator of the two local power plants). It is important to note that for the years 2005 to 2012, fuel consumption data used is that reported annually by Enemalta pursuant to European Union Directive 2003/87/EC[11]. The Directive requires that data reported by operators of stationary installations that fall within the scope of the directive is duly verified by accredited, independent verification bodies.

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 to the 2006 IPCC Guidelines. For the years 2009 onwards, the calorific values and oxidation factor identified in the verified emission reports submitted pursuant to EU Directive 2003/87/EC have been used for estimating greenhouse gas inventory emissions.

[11] 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 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. The emission factors for NO_X, CO and NMVOC were provided from IPCC 1996. The percentage sulphur content was taken from data provided by Enemalta.

The emission factors used for emission estimation under this sub-category are shown in Table 3-4.

Table 3-4 Emission Factors for the category Energy Industries

Fuel	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
Residual Fuel Oil	21.1	3.0	0.6	200.0	15.0	5.0

For 2012, the category Energy Industries, even when disaggregated t the level of the separate liquid fuels considered here, represents a key category. For 1990, combustion of solid fuels for electricity generation is also a key category.

3.2.6.3 Source Specific Recalculations

The CRF data included for this sector was recalculated to remove errors identified during internal review all changes had an effect of less than 1% on the final value. This change affected all Activity data in the public electricity and heat production sector but only emissions of CO_2 for the years 2008, 2009 and 2010.

3.2.7 Source Category 1A2 - Manufacturing Industries and Construction

3.2.7.1 Source Category Description

This category comprises emissions from fuel combustion in manufacturing industries and construction. Fuels used in this sector are various, the main ones being automotive diesel and gas oil, fuel oil, liquefied petroleum gas (LPG), kerosene, and biodiesel. Until 2008, light heating oil was also utilised in local industry, but this practice was discontinued from 2009. Biodiesel is also included for 2006 and subsequent years.

3.2.7.2 Methodological Issues

Fuel data (i.e. fuel sold to industry) for the source category Manufacturing Industries and Construction was previously provided by the Petroleum Division of Enemalta Corporation, which for many years was the sole importer of fuels used in industry. In more recent years, data has been obtained from the Malta Resources Authority which is now collating national energy related data. 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 the country, discussions are ongoing between the MRA and NSO to carry out a detailed survey among fuel end-users, which survey should provide scope for significant improvements in emission estimations for the covered source categories.

The default emission factors and calorific values provided in the IPCC 2006 guidelines (where available) have been used for the whole time-series. The other emission factors and calorific values were based on the IPCC 1996 guidelines. For the year 2012, 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.

The emissions of biodiesel have normally been reported under the heading of biomass in the Manufacturing and Construction Sector; however for this submission, data for this fuel type was not available in oil balance statistics and therefore no emissions could be calculated. It is however the intention to address this gap in future, as soon as data is made available.

All the emissions of the manufacturing and construction industries have been reported in the CRF under 1AA 2F 'all industry' since sub-division of end-user fuel consumption according to ISIC/NACE codes was not possible for all fuels in this sector.

Table 3-5 Emission Factors and Oxidation Factor for category Manufacturing Industry and Construction

Fuel	C (TC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)	Oxidation Factor
LPG / Propane	17.2	1.0	0.1	150.0	30.0	5.0	1
Residual Fuel Oil	21.1	3.0	0.6	200.0	10.0	5.0	1
Kerosene	19.5	3.0	0.6	200.0	10.0	5.0	1
Automotive Diesel	20.2	3.0	0.6	200.0	10.0	5.0	1
Gas Oil (0.1% Sulphur)	20.2	3.0	0.6	200.0	10.0	5.0	1

In the case of biodiesel, the calorific value used to convert the mass of fuel into the required energy equivalent is in accordance with LN 278 of 2007 to convert weight of fuel into energy equivalent. The calculation factors used for biodiesel are presented in Table 3-6.

Table 3-6 Biodiesel Emission Factors for Manufacturing Industry, Construction

Fuel	Calorific Value (TJ/unit)	Carbon factor emission factor (tC)	CH_4 Emission Factor (kg CH_4/TJ)	N_2O Emission Factor (kg N_2O /TJ)
Biodiesel	0.037	19.3	3	0.6

3.2.7.3 Source Specific Recalculations

No recalculations were performed for the category Manufacturing Industries and Construction.

3.2.8 Source Category 1A3 - Transport

3.2.8.1 Source Category Description

This category covers transport activities within the territory of the country concerned, thus including road transport, domestic aviation, national navigation and other relevant transport modes, such as rail, where direct emissions from such modes occur.

In the case of Malta, this sector is dominated by emissions from sub-category Road Transport (see Figure 3-6), with CO_2 as the gas that accounts for the bulk of overall GHG emissions for this sub-category (see Figure 3-7). Road transport is also identified as a key source, both for 1990 and 2012, in respect of CO_2 emissions.

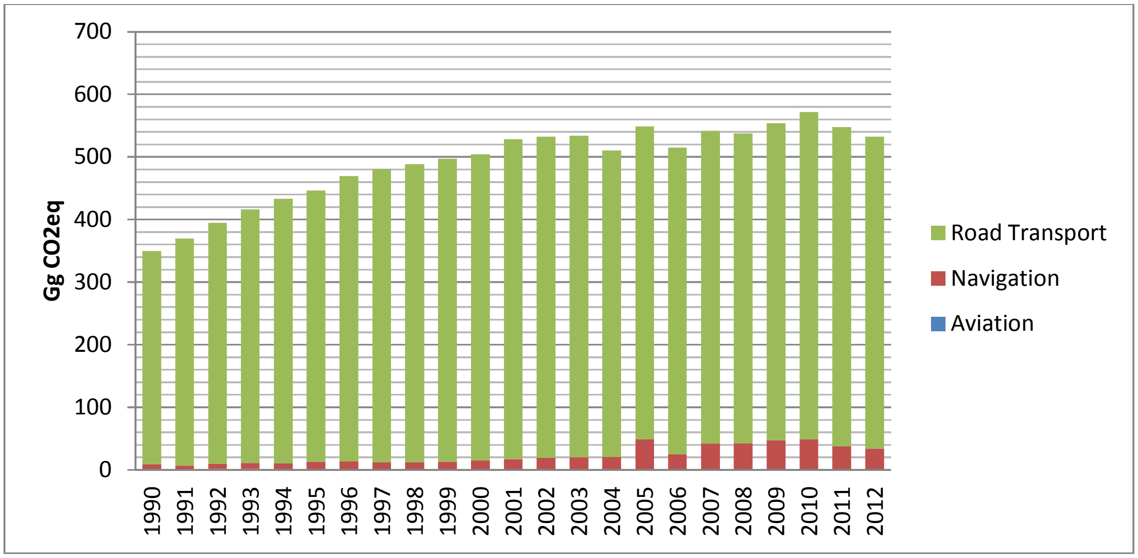

Figure 3-6 Emission trends in Transport Sector by sub-category

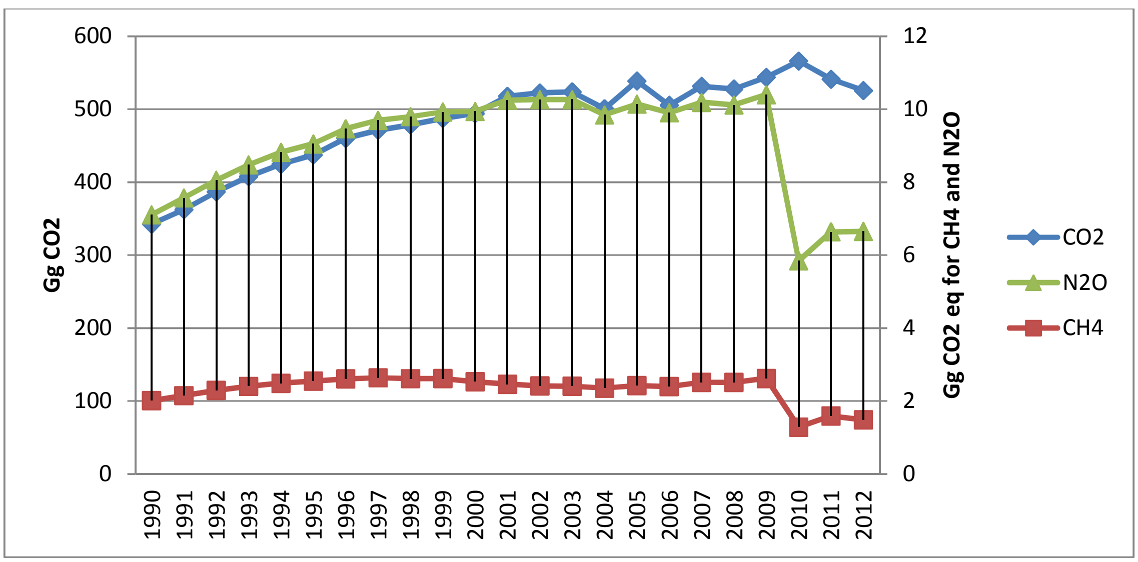

Figure 3-7 Emission trends in Road Transport by gas

As regards road transport, the market is almost equally shared between petrol and diesel. The use of biodiesel had been on the decline however the Malta Resources Authority introduced a substitution obligation for importers/wholesalers of transport diesel (EN590) and petrol (EN228). The substitution obligation for 2011 was a minimum of 1.5% of the total energy content petroleum placed on the market. For 2011, 1470 tons of biodiesel from waste were placed on the market. This figure is approximately 0.78 % by energy content which is well within regulations as the regulation provides that the energy content of biofuel made from waste would be considered twice for regulation purposes.

Diesel is the principal fuel for national navigation albeit a small portion of petrol being also reported. Data for the national navigation was obtained from MRA. The types of vessels which were accounted for in the national navigation are the pleasure cruises, small yachts, pilot boats and ferries. Jet kerosene (Jet A1) and aviation gasoline are used in domestic aviation.

3.2.8.2 Methodological Issues

- Road Transport

The Tier 1 approach has been used to calculate GHG emissions for the 1990-2009 period using IPCC 2006 [3] emission factors.

Data for petrol and diesel consumed in road transport in Malta were obtained from the Petroleum Division of Enemalta Corporation and the Malta Resources Authority. The emission factors used in respect of greenhouse gas emissions from road transport are listed in

Table 3-7

Table 3-7 Fuel based emission factors used to estimate emissions of greenhouse gases from road transport

Fuel	C (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)
Diesel	74100	3.9	3.9
Petrol	69300	33.0	3.2
Biodiesel	70800	3	0.6

- *Estimating emissions for the years 2000-2009*

For the years 2000 to 2009 emissions of NO_x, SO_2 and NMVOC are calculated using the 2006 EMEP/CORINAIR Guidebook [9], applying a basic Tier 3 methodology. A bespoke model was developed to calculate emissions by vehicle class based on distance travelled per class and grams of fuel/km.

The annual fuel use for a vehicle in each EC Legislation class was obtained by multiplying the estimated vehicle km/year data (Table 3-8) by the grams of fuel/km (Table 3-9) for different vehicle technology types grouped according to Euro emission standards classes. Table 3-10 shows the relevant European Union vehicle emission regulations that have come into force up to 2011 for each vehicle type.

Table 3-8 Estimated Vehicle km/year data by vehicle type

Vehicle Type	Estimated vehicle km data per year
cars (petrol)	10989
cars (DERV)	12698

vans (petrol)	11423
vans (DERV)	25480
Rigid lorries	39150
Articulated lorries	39150
Coaches and buses	25052
minibuses	38148
mopeds	2000
motorcycles	4000

Table 3-9 Fuel Consumption Factors for Vehicle types grouped by EC Legislation Class

Vehicle Type	Vehicle EC Legislation Class	Grams fuel used / km
Petrol cars	pre ECE	96
	ECE 15.00	81
	ECE 15.01	81
	ECE 15.02	79
	ECE 15.03	79
	ECE 15.04	71
	EURO I	70
	EURO II	68
	EURO III	64
	EURO IV	57
	EURO V	47
Diesel car	Pre-Euro I	68
	EURO I	66
	EURO II	65
	EURO III	58
	EURO IV	53
	EURO V	49
Petrol LGV	Pre-Euro I	73
	Euro I	92
	Euro II	94
	Euro III	90
	Euro IV (~2005)	83
Diesel LGV	Pre-Euro I	94
	Euro I	94
	Euro II	94
	Euro III	86
	Euro IV (~2005)	81
Rigid HGV	Pre-1988	232
	88/77/EEC	229
	Euro I	301
	Euro II	281
	Euro III	281
	Euro IV (~2005)	272
	Euro V	264
Articulated HGV	Pre-1988	232
	88/77/EEC	229
	Euro I	301
	Euro II	281
	Euro III	281
	Euro IV (~2005)	272

	Euro V	264
Bus	Pre-1988	186
	88/77/EEC	181
	Euro I	201
	Euro II	200
	Euro III	200
	Euro IV (~2005)	194
	Euro V	188
Minibus petrol	Pre-Euro I	73
	Euro I	92
	Euro II	94
	Euro III	90
	Euro IV (~2005)	83
Minibus diesel	Pre-Euro I	94
	Euro I	94
	Euro II	94
	Euro III	86
	Euro IV (~2005)	81
Mopeds	Pre-Euro1	25
	97/24/EC	25
Motorcycles	Pre-Euro1	30
	97/24/EC	26

Table 3-10 Vehicle types and applicable European Union emission regulations

Vehicle Type	Regulation	Date of vehicle entry into market
Cars	pre ECE vehicles	up to 1971
	ECE 15 00 & 01	1972 to 1977
	ECE 15 02	1978 to 1980
	ECE 15 03	1981 to 1985
	ECE 15 04	1985 to 1992
	Euro I	01/07/1992
	Euro II	01/01/1997
	Euro III	01/01/2000
	Euro IV	01/01/2006
	Euro V	01/01/2011
LGVs	Pre Euro I	Before 1994
	Euro I	01/10/1994
	Euro II	01/01/1998
	Euro III	01/01/2001
	Euro IV	01/01/2006
HGVs and buses	Pre-1988	Before 1988
	88/77/EEC	1988-1993
	Euro I	01/10/1993
	Euro II	01/10/1996
	Euro III	01/01/2001
	Euro IV	01/10/2005
	Euro V	01/10/2008
Motorcycles and Mopeds	Pre-Euro1	Pre 2000
	97/24/EC	After 2000

Actual vehicle fleet composition is obtained from the National Statistics Office Using the vehicle numbers of each vehicle type in each class, the annual fuel use by a vehicle was used to calculate total annual fuel use by all the vehicles in each vehicle class. To ensure consistency with actual fuel sales, a weighting procedure is used. The emission factors shown in Table 3-11 were then used to estimate NO_x and NMVOC emissions.

The total SO_2 emissions for petrol and diesel used in road transport for each inventory year were obtained by working out the weighted averages based on percentage sulphur in different fuel batches. The amount of fuel and percentage sulphur in each batch was obtained from fuel sampled by the Licensing and Enforcement Unit of the Malta Resources Authority. This was then used to calculate the SO_2 emissions depending on amount of fuel used by each vehicle type in each different vehicle class.

Table 3-11 Emission Factors for Road Transport NOx and NMVOC (tonnes of pollutant/tonne of fuel)

Vehicle Type	Vehicle EC Legislation Class	NOx t/t of fuel	NMVOC t/t of fuel
Petrol cars	pre ECE	0.0235	0.0250
	ECE 15.00	0.0270	0.0224
	ECE 15.01	0.0270	0.0224
	ECE 15.02	0.0245	0.0241
	ECE 15.03	0.0263	0.0241
	ECE 15.04	0.0246	0.0212
	EURO I	0.0039	0.0008
	EURO II	0.0036	0.0006
	EURO III	0.0019	0.0004
	EURO IV	0.0012	0.0003
	EURO V	0.0012	0.0003
Diesel car	Pre-Euro I	0.0097	0.0023
	EURO I	0.0085	0.0012
	EURO II	0.0090	0.0010
	EURO III	0.0100	0.0008
	EURO IV	0.0070	0.0000
	EURO V	0.0070	0.0000
Petrol LGV	Pre-Euro I	0.0209	0.0184
	Euro I	0.0039	0.0007
	Euro II	0.0034	0.0004
	Euro III	0.0018	0.0002
	Euro IV (~2005)	0.0006	0.0002
Diesel LGV	Pre-Euro I	0.0140	0.0030
	Euro I	0.0109	0.0013
	Euro II	0.0103	0.0013
	Euro III	0.0084	0.0011
	Euro IV (~2005)	0.0065	0.0003
Rigid HGV	Pre-1988	0.0562	0.0144
	88/77/EEC	0.0250	0.0071
	Euro I	0.0317	0.0026
	Euro II	0.0271	0.0021
	Euro III	0.0186	0.0014
	Euro IV (~2005)	0.0179	0.0005
	Euro V	0.0103	0.0001
Articulated HGV	Pre-1988	0.0526	0.0093
	88/77/EEC	0.0430	0.0037
	Euro I	0.0582	0.0045
	Euro II	0.0434	0.0040
	Euro III	0.0299	0.0028
	Euro IV (~2005)	0.0186	0.0000
	Euro V	0.0107	0.0005
Bus	Pre-1988	0.0419	0.0182
	88/77/EEC	0.0353	0.0046

	Euro I	0.0343	0.0041
	Euro II	0.0339	0.0033
	Euro III	0.0234	0.0023
	Euro IV (~2005)	0.0178	0.0000
	Euro V	0.0107	0.0001
Petrol minibus	Pre-Euro I	0.0209	0.0184
	Euro I	0.0039	0.0007
	Euro II	0.0034	0.0004
	Euro III	0.0018	0.0002
	Euro IV (~2005)	0.0006	0.0002
Diesel minibus	Pre-Euro I	0.0140	0.0030
	Euro I	0.0109	0.0013
	Euro II	0.0103	0.0013
	Euro III	0.0084	0.0011
	Euro IV (~2005)	0.0065	0.0003
Mopeds	Pre-Euro1	0.0012	0.4834
	97/24/EC	0.0009	0.2417
Motorcycles	Pre-Euro1	0.0055	0.0571
	97/24/EC	0.0084	0.0276

- *Implementation of the COPERT model for emissions from road transport*

Following recommendations made during inventory peer reviews for previous inventory submissions, it has been decided to start implementing a tier 3 approach based on the 2013 EMEP/CORINAIR Guidebook. The COPERT A model, published by EEA and Emisia SA estimates exhaust emissions from passenger cars (1A3bi), light goods vehicles (1A3bii), heavy duty vehicles including buses and coaches (1A3biii) and motorcycles (1A3biv). A Tier 2 methodology is used for calculating evaporative emissions (1A3bv) from petrol vehicles. Emission factors for this year have been obtained from diverse sources related to COPERT 4 i.e. EMEP/EEA Emission Inventory Guidebook and Emisia SA datasets and other EFs used in previous years.

Traffic activity data was carried forward from the data used in previous years. Total fuel sales for petrol, diesel and autogas for road transport used were obtained from the Malta Resources Authority.

It is pertinent to note that in respect of this submission, the COPERT model has been used for determining of relevant emissions for 2010-2012 only. It is expected that future submission will include an extension of the use of this model to previous years in the time series.

- *Fuel-based emissions*

The estimation of CO2 and SO2 emissions is based on fuel consumption of petrol and automotive diesel,, with the carbon content (by mass) of the fuel and the sulphur content of the fuel serving as additional calculation parameters for the two gases respectively. For SO2, sulphur content values used reflect the highest permissible limits.

Emissions of CO_2 and SO_2 can be broken down by vehicle type based on estimated fuel consumption factors and traffic data in a manner similar to the traffic-based emissions described below for other pollutants.

- *Fuel consumption factors for petrol and diesel vehicles*

Emissions of CO_2 reported under 1.A.3.b Road Transportation are computed from the amounts of petrol, diesel autogas and biofuels given under road transport in the national oil balance and country-specific emission factors for these fuels as shown in Table A3-1 in Annex 3.

The CH_4 and N_2O emissions from road traffic are estimated in the COPERT 4v.10 model, The COPERT 4v.10 model estimates emissions of CH_4 and N_2O on the basis of distance travelled using a detailed bottom-up approach (Tier 3) that accounts for such factors as 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 model is applied annually in Ireland to derive CH_4 and N_2O emissions estimates. The same model is also used to calculate indirect GHG emissions (excluding SO_2).

- *Uncertainty estimation*

Malta has a relatively small fleet of vehicles in absolute terms and good data with regards to the composition of this fleet. It is thus assumed that the level of uncertainty is comparable with that of countries with similar data accuracy; thus the uncertainty was assumed to be equivalent to that quoted in Kouridis et al (2010) based on good vehicle statistics with fuel correction.

Table 3-12 Uncertainty levels for Emissions using COPERT 4

Gas	CO_2	CH_4	N_2O	CO	NOx	NMVOC	SO_2
Uncertainty (%)	4%	34%	26%	19%	10%	12%	4%

- National Navigation

Emissions from national navigation are estimated using a Tier 1 approach for estimating CO_2 emissions, and IPCC 1996 [1] default emission factors for CH_4 and N_2O. The emission factors used are shown in Table 3-13.

Fuel sales data for national navigation purposes is provided to MRA (and thus made available for inventory compilation purposes) by Transport Malta. Data on any sales of petrol for national navigation purposes from 1990 to 2004 is not available.

Data regarding fishing vessels previously reported under National Navigation was removed (for 2002 onwards) and included under Agriculture/Forestry and Fisheries in accordance with Good Practice Guidelines.

Table 3-13 Emission Factors for National Navigation

Fuel	C (TC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)	SO_2 (kg/TJ)
Gas Oil	20.2	5.0	0.6	1500.0	1000.0	200.0	0.05
Petrol	18.9	5.0	0.6	1500.0	1000.0	200.0	0.4
Residual Oil	21.2	5.0	0.6	1500.0	1000.0	200.0	2.12

- Civil Aviation

This source category covers emissions in respect of flights that depart from and arrive at aerodromes within Maltese territory. The methodology for estimating emissions from civil aviation is a Tier 1 approach [4] using the following formula:

$$Emmisions = \sum_{j} \left(Fuel_j \times EF_j \right)$$

Where:

j – is the fuel type used for aviation purposes

Fuel – is the total consumption in TJ of fuel j

EF – Emission factor for fuel j

Data for fuel consumption is collected through the Malta Resources Authority from the relevant Aviation Fuel Suppliers, currently only one supplier is active on the Maltese Islands and this situation has been unchanged throughout the inventory period (1990-2012). 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 Jet A1 emissions are calculated using emission factors of Domestic Cruise (Average fleet).

- Railways

This sector does not occur in Malta.

- Other Transport

Data for specific fuel consumption by major users of diesel for airport ground support equipment (2011 only) and port machinery (2005-2011) was available and was forwarded to MRA. Emissions for this sector are estimated using a Tier 1 approach for estimating CO_2 emissions using default factors and IPCC 1996 default emission factors for CH_4, N_2O and the indirect gases. The emission factors used are shown in table below. Data for 2012 was not available and thus activity was considered as equivalent to 2011.

Table 3-14 Emission Factors used in other Transport

Fuel	C (TC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)	SO_2 (kg/TJ)
Diesel	20.2	5.0	0.6	1200.0	1000.0	200.0	0.354

3.2.8.3 Source Specific Recalculations

- Road Transport

  As described in the methodological section and further detail provided in Annex 3, a major methodological change was implemented for road transport by the implementation of COPERT IV model based on the 2013 EMEP/CORINAIR Guidebook. The model was implemented only for the yeas 2010-2012. Resultant recalculations are detailed in

Table 3-15 Road Transport Recalculations

Year	CO_2 Gg			CH_4 Gg CO_2 eq			N_2O Gg CO_2 eq		
	Previous Submission	Current Submission	% Change	Previous Submission	Current Submission	% Change	Previous Submission	Current Submission	% Change
2010	518.03	517.48	-0.11%	2.6	1.21	-53.46%	8.00	4.43	-44.63%
2011	504.24	503.69	-0.11%	2.53	1.54	-39.13%	7.80	4.95	-36.54%

3.2.9 Source Category 1A4 – Other Sectors

3.2.9.1 Source Category Description

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

LPG is used in the commercial, institutional and residential categories. Other liquid fuels, particularly FO, Gas Oil and diesel are also common, together with small amounts of kerosene. While the commercial and institutional categories operate on a varied mix of fuels: (LPG, FO, Kerosene, Diesel, Gas oil and Heavy Fuel Oil), the residential category is almost wholly dependent on LPG for fossil fuel requirements. The sub division of fuel usage for the Manufacturing Industries/ Construction and the Commercial/Institutional categories has shown that in 2010 and 2011 the share of fuel usage in the residential sector was not limited to LPG and kerosene only but includes small quantities of gas/diesel oil and thin fuel oil. For 2012, thin fuel oil was not considered as such, because national oil balance data used as a source for fuel usage in the residential sector considers the components of thin fuel oil separately. Activity data for solid biomass for the years 2005-2011 has been included for the residential sector. No date was yet made available on biomass use in the residential sector at the time of submission of this report. The segregation of biomass data has not been possible. As a result, it has been assumed that the majority of biomass is utilised in the residential sector.

For the year 2012, the fuel mix in the agriculture/forestry/fisheries category has increased to include small quantities of kerosene, gas/diesel oil and thin fuel oil with its major fuel contributor (automotive diesel). This was a result of the segregation of fuel usage in different categories.

Diesel consumed in marine harbours for non-road mobile machinery has been removed from the Commercial/Institutional category and has been included under category 1A3e 'Other Transportation'.

3.2.9.2 Methodological Issues

Activity data for the commercial, institutional and residential sectors, in terms of fuel sold was previously sourced from the Petroleum Division of Enemalta Corporation, the sole fuel importer throughout the period; for more recent years data has been obtained from the Malta Resources Authority which is now collating national energy related data.

For the years 2005-2009 data provided by fuel importers was reviewed in order to calculate the GHG emissions for Manufacturing and Construction Industries and the Commercial and Institutional sectors.

As a result the fuel quantities for the years 2005-2009 were adjusted according to the new set of data provided. Segregation of data for the years 2005-2009 was based on the sectoral consumption of the year 2010.

The activity data for the year 2011 has been obtained directly through the fuel suppliers and distributors. As a result, there have been some shifts of fuel volumes from one sector to the other.

Table 3-16 illustrates the emission factors used for each fuel. The default emission factors and calorific values provided in the IPCC 2006 guidelines (where available) have been used for the whole time-series. The other emission factors and calorific values were based on the IPCC 1996 guidelines. For the year 2011, the percentage sulphur content was obtained from the Malta Resources Authority. The thin fuel oil emission factors and calorific values were calculated according to the weighted average of its constituent's fuels (i.e. diesel/gas oil and residual fuel oil).

Work is ongoing by the Malta Resources Authority in collaboration with suppliers, distributors and other entities to ensure greater reliability of data available for this sector, particularly in respect of the use of certain fuels in the Commercial, Institutional and Residential categories.

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, gaseous fuels and other fuels does not occur in the Commercial/Institutional and Agriculture/Forestry/Fisheries categories. The burning of solid fuels occurs in the Residential sector.

Data on fuel usage in the Agriculture/Fisheries/Forestry was mainly taken from the national oil balance except for the case of fisheries, sourced directly as fuel supplied data from the Fishing and Farming Regulation and Control Department which is responsible for managing fuel subsidies for fishing vessels.

Table 3-16 Emission Factors for Residential and Agriculture/Forestry/Fisheries Sectors

Fuel	C (TC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)	Oxidation factor
LPG / Propane	17.2	5.0	0.1	50.0	50.0	5.0	1
Kerosene	19.5	10.0	0.6	100.0	20.0	5.0	1
Automotive Diesel	20.2	10.0	0.6	100.0	20.0	5.0	
Gasoil 0.1% sulphur	20.2	10.0	0.6	100.0	20.0	5.0	1
Thin fuel oil	20.88	10.0	0.6	100.0	20.0	5.0	1

3.2.9.3 Source Specific Recalculations

There were no recalculations in the Commercial and Institutional, Residential and Agriculture/Forestry/fisheries sectors. .

3.2.10 Source Category 1A5 – Other

This source category is not applicable to Malta.

3.3. Fugitive Emissions from Fuels (1B)

3.3.1 Source Category Description

Malta has no fuel Refining/Abstraction processes of fuels and thus limited possibilities for fugitive emissions except for the retailing of Gasoline which is considered as a source of NMVOCs.

3.3.2 Methodological issues

Emissions from this sector are related to the total volume of gasoline distributed for consumption through the retail network. Thus the total amount of Gasoline reported within the retail sectors is used and an emission factor of $0.022Gg/10^3m^3$ of gasoline sold is considered. The EF is extracted from Table 4.2.4 of Volume 2 of the 2006 IPCC guidelines [3].

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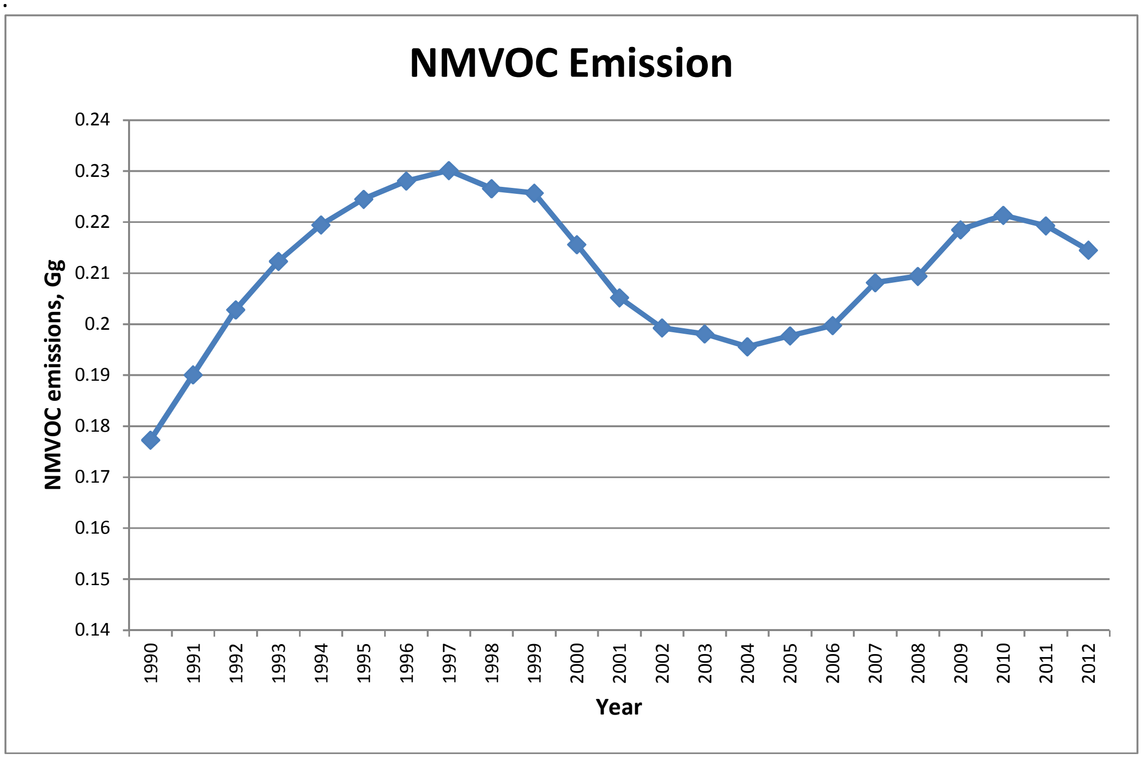

Figure 3-8 Transport fugitive emission trends

Source specific Recalculations

There were no recalculations in this sector.

Chapter 4. INDUSTRIAL PROCESSES (CRF Sector 2)

4.1 Overview of the Sector

Emissions within the Industrial Processes Sector comprise direct and indirect greenhouse gas emissions as by-products of industrial processes. The sub-categories Lime Production (2A2), Soda Ash Production and Use (2A4), Road Paving with Asphalt (2A6) and Carbide Production (2B4) include activities that do take place in Malta and result in carbon dioxide emissions. The sub-categories Refrigeration and Air Conditioning Equipment (2F1), Foam Blowing (2F2), Fire Extinguishers (2F3), Metered Dose Inhalers (2F4), Semiconductor Manufacture (2F7), Electrical Equipment (2F8) and Other (Medical Applications) (2F9) also occur in Malta and lead to fluorinated gases emissions. Indirect greenhouse gas emissions of non-methane volatile organic compounds (NMVOC) result from the following sub-categories: Road Paving with Asphalt (2A6) and Food and Drink (2D2).

The emissions contribution from the industrial processes sector to the total national GHG emissions in Malta amounted to 5.5% in the year 2012.

When assessing contributions by gas within this sector, in terms of carbon dioxide equivalent, the fluorinated gases Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6), because of their high global warming potentials, contribute to almost 100% of the direct GHG emissions from the industrial processes sector. Figure 4-1 shows direct GHG emissions in this sector increasing continuously over the whole time series.

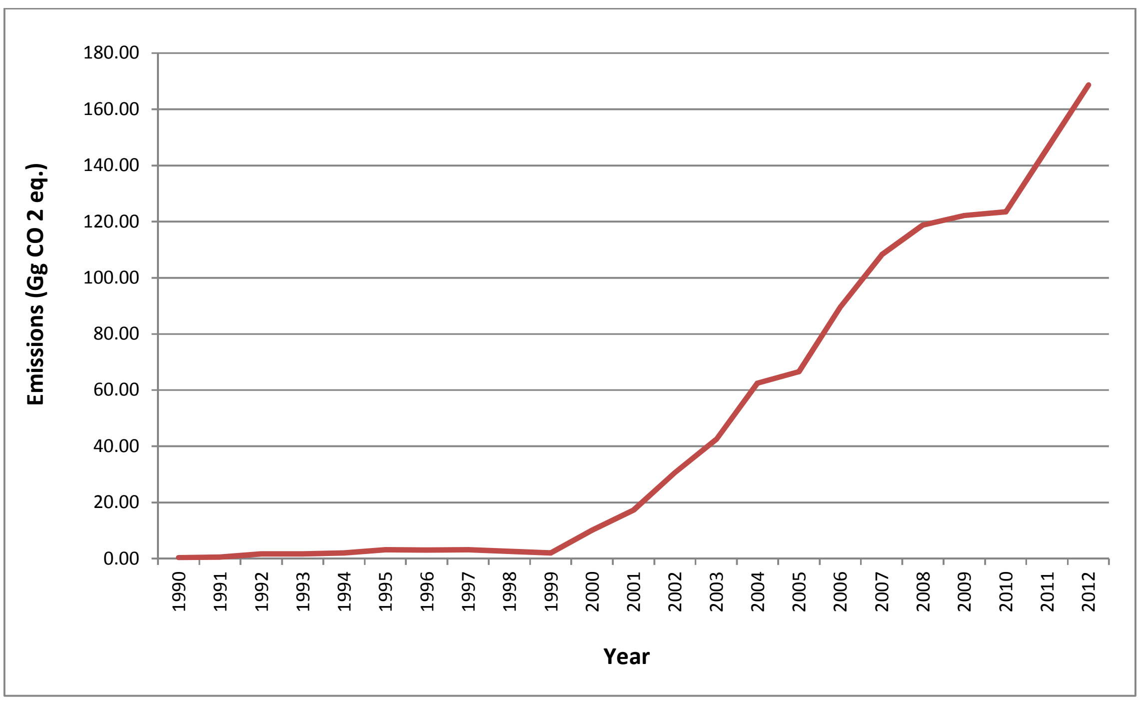

Figure 4-1 Direct GHG Emissions from the Industrial Processes Sector

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). The relatively high NMVOC emissions for the years 1995 to 1998, when compared to the other years in the time series can be explained by the fact that for these years relatively high bread production statistics have been recorded by the National Statistics Office, leading to higher NMVOC emissions for those years.

From Figure 4-2 one also notes that up until 2003, where emissions of NMVOCs from road paving as reported, these have represented significantly minor contributions. From 2004 large scale roads reconstruction projects were initiated leading to the marked increase in NMVOC emissions from the sub-category Road Paving with Asphalt.

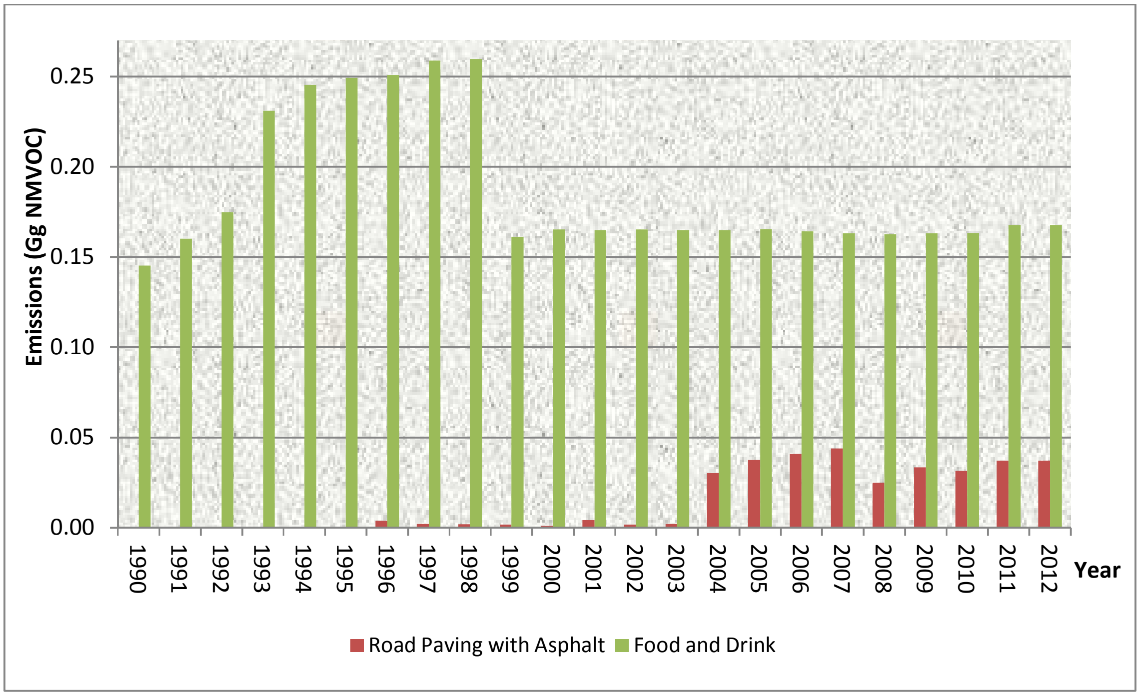

Figure 4-2 Indirect GHG Emissions from the Industrial Processes Sector

In Figure 4-3, the carbon dioxide emissions from Lime Production, Soda Ash Use, Road Paving with Asphalt and Carbide Production are presented. This figure shows the very small contribution of these four sub-categories to the total national GHG inventory emissions, amounting to less than 0.30Gg CO_2 emissions in 2012.

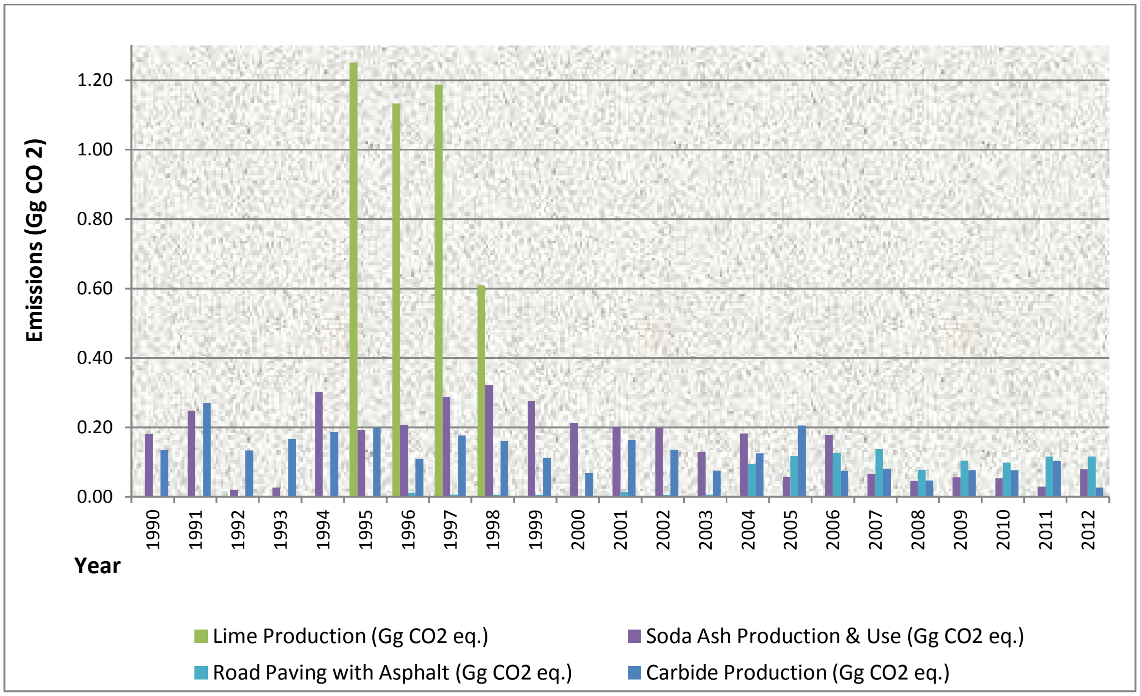

Figure 4-3 Carbon Dioxide Emissions from Lime Production, Soda Ash Use, Road Paving with Asphalt and Carbide Production

4.2 Mineral Products (2A)

4.2.1 Source Category 2A1 – Cement Production

This sector does not occur in Malta.

4.2.2 Source Category 2A2 - Lime Production

4.2.2.1 Source Category Description

Lime production (Quick Lime) was commonplace in Malta in the past. 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 [7] from data provided by the National Office of Statistics.

CO_2 emissions from this activity during the period 1995-1998 have been reported. For the years 1990 till 1994 emissions have been reported, but since at the time only two lime production plants were operational and hence the quantities of lime produced were not possible to obtain from the operators due to their confidentiality and perceived market sensitivity data was projected backwards from available data.

4.2.2.2 Methodological Issues

The 2006 IPCC Guidelines [3] 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] 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 Source Specific Recalculations

As suggested in reviews for the previous years, the years prior to 1995 were lime production did occur but was not estimated were projected back assuming that in all years from the period 1990-1994 the production was equivalent to the average of the following years of production (1995-1997).

Recalculation **Year**	**Emissions (Gg CO2 eq.) as reported in the 2013 inventory report**	**Emissions (Gg CO2 eq.) as reported in the 2014 inventory report**	**Percentage change in reported emissions (%)**
1990	NE	1.254	NA
1991	NE	1.254	NA
1992	NE	1.254	NA
1993	NE	1.254	NA
1994	NE	1.254	NA

4.2.3 Source Category 2A3 – Limestone and Dolomite use

Limestone is a raw material commonly found on the Maltese islands and is extensively used as a construction material. In the past, this material was also a raw material for the production of lime with relevant emissions from this sector being included under source category 2A2. No other use of limestone is reported.

No activities involving heating of dolomite and, or, emissions of CO_2 are known to occur in Malta.

4.2.4 Source Category 2A4 - Soda Ash Production and Use

4.2.4.1 Source Category Description

Soda ash (sodium carbonate) is used as a raw material in a large number of industries but more commonly in soap and detergent manufacture, for water treatment and glass manufacture. Soda ash is not produced in Malta but is only imported.

4.2.4.2 Methodological Issues

Data on soda ash imports by year for the whole time series were obtained from the National Statistics Office. For the purposes of inventory compilation, it is assumed that 95% of soda ash imported during a particular calendar year is actually processed locally, in a manner that results in emissions relevant for inventory purposes, during that same year. Therefore, the activity data used in respect of soda ash emissions represents soda ash import figures multiplied by 0.95

The following process takes place when soda ash is heated:

$$Na_2CO_3 \xrightarrow{\text{heat}} Na_2O + CO_2$$

The default IPCC 1996 [1] emission factor has been applied, where 415kg CO_2 is emitted per tonne Na_2CO_3 used.

4.2.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.2.5 Source Category 2A5 – Asphalt roofing

This sector does not occur in Malta.

4.2.6 Source Category 2A6 - Road Paving with Asphalt

4.2.6.1 Source Category Description

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

For the years 1995 to 2003, the quantity of asphalt used was derived from data of asphalt imports. This data was compiled under the 1st inventory estimation carried under the scope of the First National Communication by Gauci [7]. This data was not available for the years prior to 1995. For the years 2004 and onwards, the activity data has been provided by Transport Malta.

4.2.6.2 Methodological Issues

The default IPCC 1996 [1] emission factor for NMVOC emissions for road surface (320kg NMVOC per tonne asphalt applied to the road surface) is considered an overestimate of the emission factor in the case of road paving with asphalt as practiced locally. In this inventory submission, the emission factor for both the production phase and the application phase of the asphalt to road surfaces, as used in the Italian GHG inventory, was applied to the Maltese activity data. The Italian emission factor (0.272kg/tonne asphalt produced) was derived by actual field studies [15]. Until the 2009 GHG inventory submission [16], Malta only reported NMVOC emissions from asphalt production and application to road surfaces. Since the subsequent inventory submission, Malta has additionally reported the estimate of CO_2 emissions, using the methodology provided in the 2009 Portuguese GHG Inventory Report [17]. 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% of carbon content, which is the normal carbon content for medium linear simple hydrocarbons. Through multiplication, one can therefore estimate the resulting CO_2 emissions:

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

4.2.6.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.2.7 Source Category 2A7 – Other

This sector does not occur in Malta.

4.3 Chemical Industry (2B)

This category includes emissions from Carbide Production (2B4). The IPCC (1996) [1] categories Ammonia Production (2B1), Nitric Acid Production (2B2) and Adipic Acid Production (2B3) do not take place in Malta and have therefore not been included in this inventory process.

4.3.1 Source Category 2B1 – Ammonia Production

This sector does not occur in Malta.

4.3.2 Source Category 2B2 – Nitric Acid Production

This sector does not occur in Malta.

4.3.3 Source Category 2B3 – Adipic acid Production

This sector does not occur in Malta.

4.3.4 Source Category 2B4 – Carbide Production

4.3.4.1 Source Category Description

No facility for Carbide Production (2B4) exists in Malta. Calcium carbide (CaC_2) is however imported mainly for the production of ethyne. This report considers emissions from this use.

4.3.4.2 Methodological Issues

CO_2 emissions from ethyne combustion:

$$CaC_2 + 2H_2O \longrightarrow \underset{\text{ethyne}}{C_2H_2} + Ca(OH)_2$$

$$2C_2H_2 + 5O_2 \longrightarrow 2H_2O + 4CO_2$$

1.375 tonnes of CO_2 are emitted when one tonne of calcium carbide is used to produce ethyne.

Import figures of calcium carbide for the period 1990 to 2012 were calculated from data available at the National Statistics Office. It has been assumed that the calcium carbide imported in Malta is 100% utilised for ethyne production. An emission factor of 1.375 tonnes CO_2 emitted per tonne CaC_2 imported was used [1].

4.3.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

4.3.5 Source Category 2B5 – Other

This sector does not occur in Malta.

4.4 Metal Production (2C)

This sector does not occur in Malta.

4.5 Other Production (2D)

This category includes emissions from the Food and Drink (2D2) sub-category. The IPCC (1996) [1] sub-category Pulp and Paper (2D1) does not occur in Malta.

4.5.1 Source Category 2D1 - Pulp and Paper

This sector does not occur in Malta.

4.5.2 Source Category 2D2 - Food and Drink

4.5.2.1 Source category description

Various processes related to the production of food and drink products give rise to emissions of NMVOCs. For this inventory, this source category includes emissions from the local production of wine and beer.

Bread production involves a fermentation reaction and ethanol (a NMVOC) is released, emissions of which are included in this inventory.

4.5.2.2 Methodological Issues

The quantities of wine produced in Malta from the year 2000 onwards were available from Eurostat [18]. Beer production does take place in Malta; however, no activity data was available until 2011 for inventory compilation purposes due to commercial confidentiality concerns in the light of the existence of only two local breweries. In 2011 agreement was reached with NSO to overcome the confidentiality issues by reporting aggregated emissions data for the two sub-categories. At the time of compiling this report, no activity data had yet been provided on beer production for 2012.

Default IPCC 1996 [1] emission factors for red wine (0.08 kg NMVOC per hectolitre beverage) and white wine (0.035 kg NMVOC per hectolitre beverage) and beer (0.035 kg NMVOC per hectolitre beverage) have been used.

Data on bread production has not always been readily available for inventory purposes. Until 1998, bread production figures were provided by NSO. Since 1999, changes in data collection approaches by NSO, mainly the collection of production figures in monetary terms, which, due to the nature of the bread production industry, makes it difficult to estimate actual quantity of bread produced, led to a potential gap in activity data availability. This gap was resolved to a certain extent through assistance provided by the Maltese Bakers' Cooperative. It was estimated that in 2006, 19,656 tonnes of traditional Maltese bread were produced (based on the fact that 7,000 sacks of flour per week were used on average, each sack weighing 50kg and an average 100 loaves, each weighing 540 grams, being produced per flour sack – the estimated quantity of bread produced per sack was determined through a survey carried out among 93 local bakeries during 2007). Similarly it was determined that in the same year, 9,100 tonnes of soft-dough bread was produced (3,500 sacks of flour used per week for such type of bread). These values were used as is for the years going back to 1999 and for years up to 2012, on the basis of communications with the bread producers' organization.

Default IPCC 2006 [1] emissions factor for white bread (4.5kg NMVOC per tonne of bread produced) and sponge bread (8kg NMVOC per tonne of bread produced) have been used.

4.5.2.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.6 Production of Halocarbons and Sulphur Hexafluoride (2E)

This sector does not occur in Malta.

4.7 Consumption of Halocarbons and Sulphur Hexafluoride (2F)

4.7.1 Overview of Sector

Current areas of application of HFCs and PFCs include refrigeration and air conditioning equipment, foam blowing applications, fire extinguishers, metered-dose inhalers, semiconductor manufacture and other less significant sources, such as medical applications. A primary use of SF_6 is in gas insulated switch gear and circuit breakers. Figure 4-4 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 been 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. More detailed information on the outcome of this improvement process is presented in the following source category discussions.

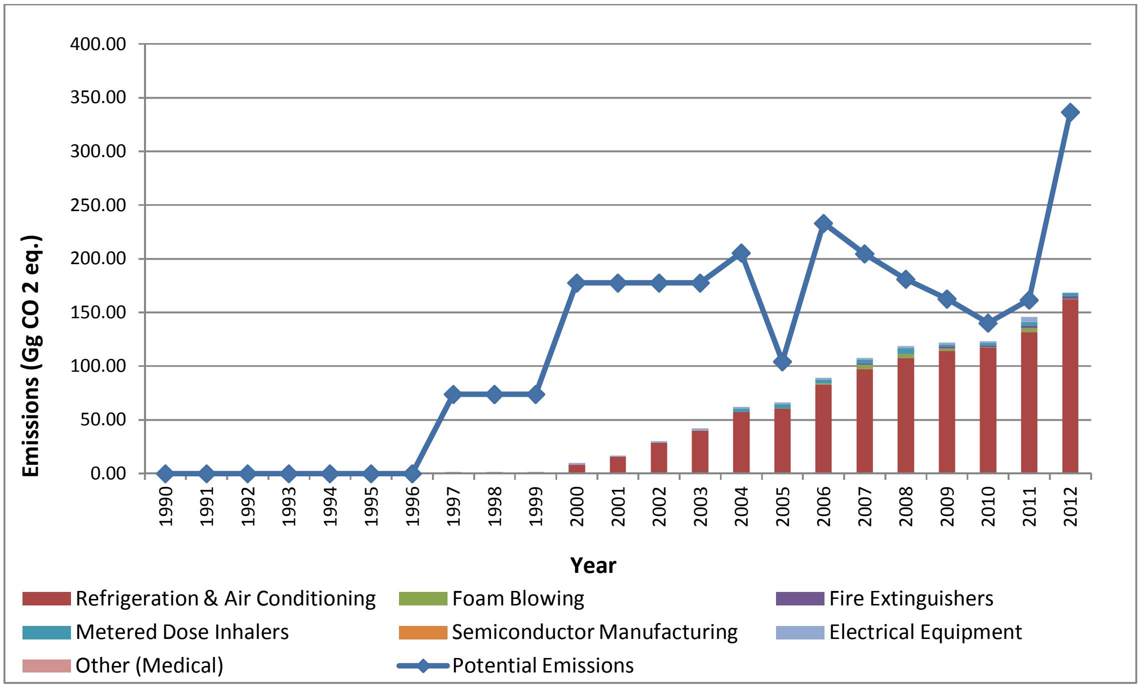

Figure 4-4 Actual and potential Emissions from HFCs, PFCs and SF_6

4.7.2 Source Category 2FP - Potential Fluorinated Gases Emissions – RAC (Refrigeration and Air-conditioning)

4.7.2.1 Source Category Description

Potential fluorinated gas emissions are used as an indicator of the actual F-gas emissions although it is widely recognised that the estimation of potential emissions greatly overestimates emissions from this sector compared to estimation of actual emissions.

4.7.2.2 Methodological issues

Annual leakages of fluorinated gases from refrigeration banks represent fugitive emissions. Such emissions include leaks from fittings, joints, shaft seals, but also rupture of pipes or heat exchangers leading to partial or full release of the refrigerant gas to the atmosphere.

To compile data on such releases, a questionnaire was sent to the local businesses involved in the importation of such gases, asking for information on consumption of fluorinated gases, be they in blends or otherwise. This exercise has now been extended to an annual data collection exercise. To confirm completeness of the data collected a list of possible importers is compared with trade data for importers which import products under CN code 1076 1417 (Mixtures containing perfluorocarbons "PFCs" or hydrofluorocarbons "HFCs", but not containing chlorofluorocarbons "CFCs" or hydrochlorofluorocarbons "HCFCs"). This comparison is only indicative of coverage but potentially facilitates the identification of possible gaps in collected data.

4.7.2.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.7.3 Source Category 2F1 - Refrigeration and Air Conditioning Equipment

4.7.3.1 Source Category Description

This section includes the estimate of fluorinated gases emissions from refrigeration and air conditioning (RAC) equipment. Such applications include:

- Domestic (household) refrigeration;
- Commercial refrigeration including different types of equipment, from vending machines to centralised refrigeration systems in supermarkets;
- Industrial processes including chillers, cold stores and industrial heat pumps;
- Transport refrigeration including equipment and systems used in refrigeration trucks and containers;
- Mobile air conditioning systems used in passenger cars, truck cabins and buses.

Unavailability of reliable data specific to activities under this source category, due to lack of regulation of this sector prior to 2005 and unaccounted importation/exportation of gases under the refrigeration equipment CN codes give rise to a number of assumptions to be considered in this sector.

The current emissions scenario reflects the evolution of the local market for refrigeration and air conditioning equipment market, characterised by a rapid growth and boom in various sectors particularly the industrial, commercial, hospitality and domestic sectors.

4.7.3.2 Methodological issues

For this submission the Tier 1 method from the 2006 IPCC Guidelines' is used. This method utilises a modelling approach that uses past and present import, export and destruction data to calculate the current year's emissions and recalculations for previous years.

The modelling approach applied here for estimating emissions for this source category takes into account the following assumptions:

- Servicing of equipment containing the refrigerant does not commence until 3 years after the equipment is installed;
- Emissions from banked refrigerants average 15% annually across the whole Refrigeration and Air-Conditioning application area ('install base');
- In a mature market two thirds of the sales of a refrigerant are used for servicing and one third is used to charge new equipment;
- Equipment is in wide use, and there are relationships between suppliers and users to purchase and service equipment;
- The average equipment lifetime is 15 years. This assumption is also estimated to be a weighted average across all sub-applications;
- The complete transition to a new refrigerant technology will take place over a 10 year period.

The year of introduction of the different refrigerants in the Maltese market has been identified through importation data. It is assumed that the year of introduction in equipment is equivalent to the first year for which importation data is recorded. Importation data has been obtained from importers. Importers were asked to provide data from 1990 onwards but since no HFCs were used in the early years the data provided did not cover that period. This assumption is based on the fact that through consultation with importers of bulk gases it was assumed that following the phase out of CFCs under the Montreal Protocol, the drop in gases used was not changed during this period, also including the fact that the major shift to use of HFCs was implemented following Malta's Accession to the European Union in 2004.

In 2012 the inventory team engaged local experts to re-evaluate a number of assumptions taken in the modelling used to calculate the RAC sector. The re-evaluation confirmed some assumptions, including the lifetime of equipment (15 years), but rejected the assumption of 10% leakage from install base as previously used and suggested the use of a 15% rate.

Currently a process to upgrade the inventory methodology to a Tier 2/3 methodology is being undertaken by consultants engaged by MRA which is expected to be completed for the upcoming March submission.

4.7.3.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.7.4 Source Category 2F2 - Foam Blowing

4.7.4.1 Source Category Description

HFCs are increasingly 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 a minority of 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.

4.7.4.2 Methodological issues

Estimating emissions for the two different types of foam requires a different methodological approach. In this regards emissions from open cell foams can be estimated through sales/imports of gases for use in open cell foam blowing. Local open cell foam manufacturers use a mix of HFC365mfc (93%)/ HFC 227ea (7%) mix and identified importers submit their yearly imports of blend. In 2010 no such importation has been recorded presumably due to stockpiling done in previous years and the relative slowdown of the market in 2010. This was confirmed with importers who reported imports in 2011. All imported blend is assumed to be used in the year of import thus an emission factor of 1 is used in this case and potential and actual emissions are equivalent in this sub-sector.

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 started being used in recent years for locally 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% of 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.

Activity data for this sector was collected by contacting all foam sector businesses registered with the Malta Resources Authority, a list is of which is available at http://www.mra.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 thought that the vast majority of the local foam blowing market is covered by the data actually gathered.

A project to upgrade the estimation methodology for this source category to a Tier 2 or 3 approach is currently in hand, with support by external consultants. This project is expected to deliver a first substantial improvement in the submission of the national greenhouse gas inventory of April 2014.

4.7.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.7.5 Source Category 2F3 - Fire Extinguishers

4.7.5.1 Source 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 is growing and is resulting in an accumulating bank of future potential emissions.

4.7.5.2 Methodological issues

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

It has been difficult to identify all the establishments that have fire protection systems containing HFC-227ea installed on their premises. However, the annual leakages of HFC-227ea during fire instances or accidental releases were reported by the local businesses, with annual activity data reported since the year 2004. From this inventory compilation those who did not report use in previous submissions were not contacted, only firms which reported the use of HFCs in fire extinguishing media (filling stations) were contacted.

4.7.5.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

4.7.6 Source Category 2F4 – Aerosols and Metered Dose Inhalers

4.7.6.1 Source Category 2F4.1 - Metered Dose Inhalers

4.7.6.1.1 Source 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 are emitted [19].

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.

4.7.6.1.2 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. Annual emissions in CO_2 equivalents are presented in Table 4-1 below. 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.

Table 4-1 HFC-134a Emissions in CO2 Equivalents from Use of MDIs

Year	Emissions of HFC-134a (Gg CO_2 eq.)
2004	2.99
2005	3.86
2006	3.58
2007	3.39
2008	5.26
2009	2.01
2010	2.54
2011	2.90
2012	3.16

4.7.6.1.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

4.7.6.2 Source Category 2F4.2 – Aerosols

This category does not occur in Malta.

4.7.6.3 Source Category 2F5 – Solvents

This category does not occur in Malta.

4.7.6.4 Source Category 2F6 – Other Applications Using ODS Substitutes

This category does not occur in Malta.

4.7.6.5 Source Category 2F7 - Semiconductor Manufacture

It has been noted, particularly as a finding in the report of the peer review carried out on the 2013 inventory submission, that the PFC use in the local semiconductor manufacturing industry is not covered by the scope of the greenhouse gas inventory. To this effect, emissions reported in previous submission have been deleted and the notification key "NO" introduced in the CRF instead.

4.7.6.6 Source Category 2F8 - Electrical Equipment

4.7.6.6.1 Source 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 Corporation is identified as the main local user and emitter of SF_6 gas from switchgear equipment (emitting around 99% of the total estimated in 2012). Such switchgear equipment is found in the two local power generation plants operated by this organisation (Delimara and Marsa Power Station) 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) and a number of private establishments.

4.7.6.6.2 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 (installation dates, maintenance procedures and leakage rates) per equipment type have been 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 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 default emission factors have been used.

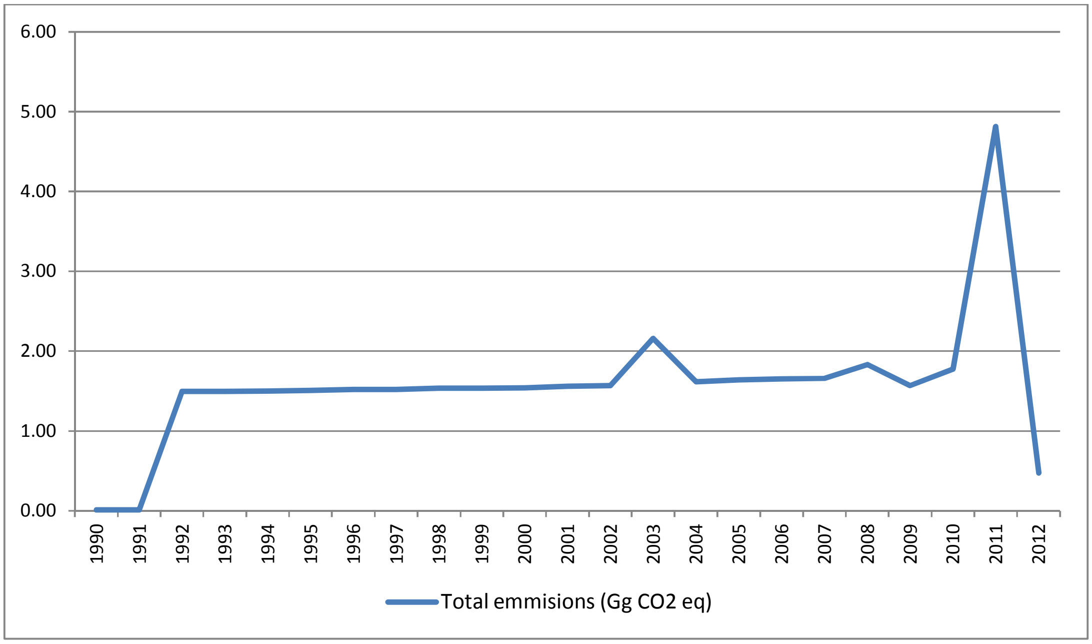

Figure 4-5 SF_6 Emissions in CO_2 Equivalents from Electrical Equipment

5 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 results 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 could be duly closed.

In 2012 a sharp decline in emissions of SF_6 is noted mainly attributed to actions taken by Enemalta Corporation to reduce SF_6 emissions through an upgrade of existing installed equipment. It must also be noted, that the majority of the equipment installed is of the sealed type that does not require regular refilling and limits emissions during its operational lifetime.

4.7.6.6.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.7.6.7 Source Category 2F9 - Other (2F9.CS.3 Medical)

4.7.6.7.1 Source 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. Emissions of such gases are being reported for the years 2007 to 2010.

4.7.6.7.2 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.

4.7.6.7.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

Chapter 5. SOLVENT AND OTHER PRODUCT USE (CRF SECTOR 3)

5.1 Overview of Sector

The Solvent and Other Product Use sector includes emissions from the use of nitrous oxide for anaesthetic use and non-methane volatile organic compounds emissions from the use of solvents and solvent-containing products.

5.2 Mineral Industry (3A)

No relevant activity reported in this sector.

5.3 Degreasing and Dry Cleaning (3B)

No relevant activity reported in this sector.

5.4 Chemical Products, Manufacture and Processing (3C)

No relevant activity reported in this sector.

5.5 Other (3D)

5.5.1 Source Category 3D1 -Use of N2O for Anaesthesia

5.5.1.1 Source Category Description

In Malta, medical grade nitrous oxide is used for anaesthetic use, for analgesic use and for veterinary use.

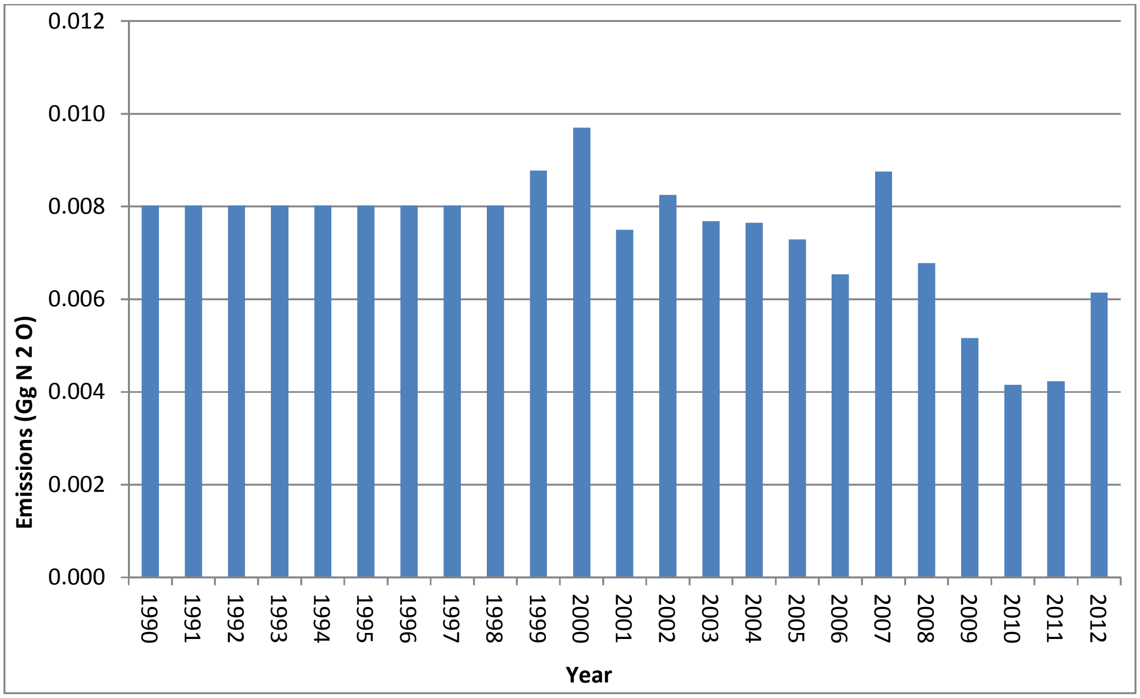

Figure 5-1 Nitrous Oxide Emissions from Anaesthetic Use

Figure 5-1 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 N2O for this scope is being observed from 2008 onwards.

5.5.1.2 Methodological Issues

The use of medical grade nitrous oxide in government 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 [1] 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 [1]. It is also assumed that the quantity of medical grade 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.

5.5.1.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

5.5.2 Source Category 3D2 - N2O from Fire extinguishers

No relevant activity reported in this sector.

5.5.3 Source Category 3D3 - N2O from Aerosol cans

No relevant activity reported in this sector.

5.5.4 Source Category 3D4 – Other use of N2O

No relevant activity reported in this sector.

5.5.5 Source Category 3D5 - Total Solvent Use

5.5.5.1 Source Category Description

Estimated non-methane volatile organic compounds 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 in household use. All of these activities and applications make use of chemicals that contain significant amounts of NMVOC. Emissions are produced through evaporation of the volatile chemicals when these products are exposed to air.

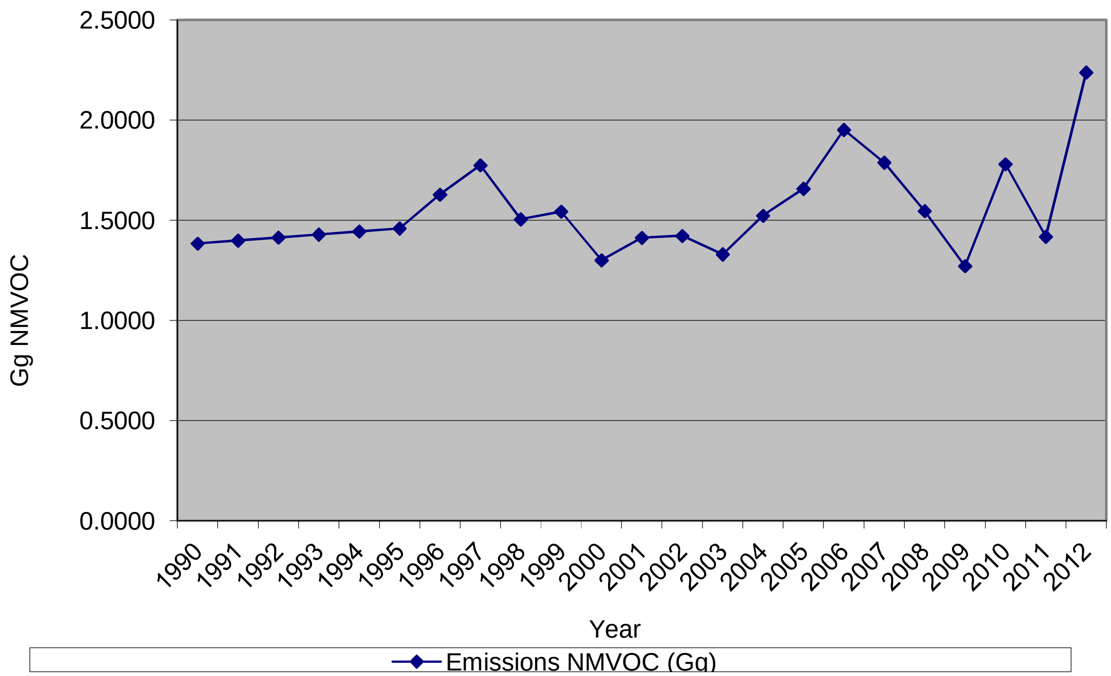

Figure 5-2 NMVOC Emissions from the Use of Solvents and Solvent-containing Products

Figure 5-2 shows a gradual increase in NMVOC emissions over the inventory 1990 to 2012 time series.

5.5.5.2 Methodological Issues

The EMEP/EEA (2007) Guidebook [10] 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 as available in the document by Micallef [20] has been used as reference list for volatile chemicals that may be potentially imported annually in Malta. This list of chemicals was then double checked with the National Statistics Office. The yearly Solvent Import quantities have been forwarded by the International Trade Unit within the National Statistics Office.

5.5.5.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

Chapter 6. AGRICULTURE (CRF Sector 4)

6.1 Overview of the Sector

In this chapter information on the estimation of greenhouse gas (GHG) emissions from the sector Agriculture is given. Emissions are estimated for source categories Enteric Fermentation (4A), Manure Management (4B) and Agriculture Soils (4D). The source categories Rice Cultivation (4C), Prescribed Burning of Savannas (4E) and Field Burning of Agricultural Residues (4F) do not take place in Malta. No emissions have been included under the source category Other Sources (4G). Gases estimated and reported are methane (CH_4) and nitrous oxide (N_2O). The characterization of the agriculture sector in Malta is based on figures taken from the Census of Agriculture [26] [37], the Farm Structure Survey [32], the Cattle Survey [40], the Pig Census [41] the Sheep and Goats Survey [42], Agriculture and Fisheries 2010 [36].

Figure 6-1 shows the emissions in carbon dioxide equivalents from the Agriculture sector for the years 1990 till 2012. The Agriculture sector in Malta contributes around 2.5% of the total national GHG emissions. Greenhouse gas emissions mainly result from Enteric Fermentation (36.4%) with almost equal contributions by Manure Management (31.6%) and Agricultural Soils (31.9%). Total emissions decreased by 0.26 Gg CO_2 eq. from 2011 to 2012.

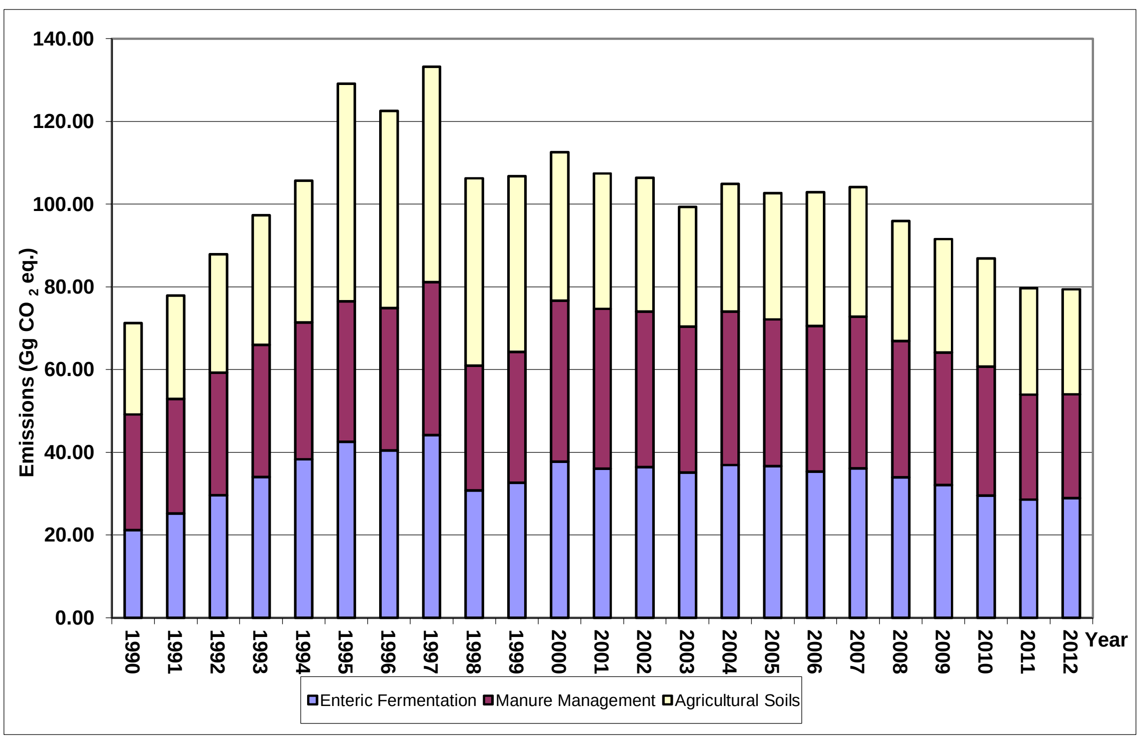

Figure 6-1 Total emissions for the Agriculture sector from 1990 to 2012

6.2 Enteric Fermentation (4A)

6.2.1 Source 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 source. The amount of CH_4 that is released depends upon the type, age and weight of the animal and the quantity and quality of the feed consumed.

Emissions from wild animals and pets are not included in the inventory. In Malta, as reported in the National Rural Development Strategy 2007-2013 [22], the two most important livestock types reared for meat production are swine and poultry (broiler production) while cows are generally reared for milk, with beef production being a by-product of this activity.

In 2012, total CH_4 emissions from this source category were 28.94 Gg CO_2 eq.

6.2.2 Methodological Issues

Livestock categories for which emissions are estimated are dairy cows, other cattle, sheep, goats, horses, swine, poultry and rabbits. Annual average animal numbers have been used to calculate methane emissions from enteric fermentation. The time-series of figures are a combination of data froma past GHG inventory compilation [7] and data from the National Statistics Office [23-42]. The activity data is represented in Table 6-1. Data from an unpublished agricultural census is available for 1991. Prior to that year, the last agricultural census was carried out in 1983. The inventory referred to above presents figures collected by the Department of Veterinary Services for the years 1984 to 2001. These figures are partially complete, and where data is available this has been used to fill the gaps in the time series. The remaining gaps in the time series were filled by interpolating between available numbers, and extrapolating using the same annual difference up to 1990. In the case of horses, poultry and rabbits, extrapolation was also carried out for the years 2011 and 2012. The interpolated and extrapolated figures are shown in italics in the table.

The method used was Tier 1 of the 1996 IPCC guidelines.

Table 6-1 Annual animal numbers

Year	Livestock type and animal numbers								
	Total cows	Dairy Cows	Other Cattle	Sheep	Goats	Horses	Swine	Poultry	Rabbits
1990	*10352*	*4348*	*6004*	*2086*	*1744*	*953*	61607	*1508521*	*26609*
1991	12891	*5414*	*7477*	4623	3429	944	53549	1513713	29213
1992	*15431*	*6481*	*8950*	*7161*	*5114*	*935*	54794	*1518905*	*31817*
1993	*17970*	*7547*	*10423*	*9698*	*6799*	*926*	57748	*1524096*	*34421*
1994	*20510*	*8614*	*11896*	*12236*	*8484*	*917*	55726	*1529288*	*37025*
1995	23049	*9681*	*13368*	14773	10169	*908*	52578	*1534479*	*39629*
1996	21894	*9195*	*12699*	12330	8436	*899*	58027	*1539671*	*42234*
1997	24197	*10163*	*14034*	14980	6407	*889*	62460	*1544863*	*44838*
1998	15486	*6504*	*8982*	12590	5738	*880*	56887	*1550054*	*47442*
1999	16902	*7099*	*9803*	11840	5110	*871*	59229	*1555246*	*50046*
2000	19380	8796	10584	12490	4599	*862*	80074	*1560437*	*52650*

2001	18423	8338	10085	10376	3930	853	81841	1565629	55254
2002	18770	8033	10737	12253	5163	*953*	78303	1529100	*50292*
2003	17940	7607	10333	14861	5374	*1053*	73067	1381544	*45329*
2004	19408	7835	11573	14130	5635	*1153*	76853	*1216779*	*40367*
2005	19742	7832	11910	14642	6272	*1253*	73025	1052013	*35405*
2006	19233	7494	11739	12172	5828	*1354*	73683	*1138140*	*30442*
2007	19442	7545	11897	12315	6227	*1454*	76900	1224267	*25480*
2008	17777	7247	10530	12843	6361	*1554*	65511	*1139608*	*20518*
2009	16264	6931	9333	12889	5983	*1654*	65918	*1054950*	*15555*
2010	14954	6362	8592	12379	5110	1754	70583	970291	10593
2011	15074	6308	8766	11887	4938	*1854*	46287	*885632*	*5631*
2012	15593	6320	9273	11697	4847	*1954*	45209	*800974*	*668*

6.2.3 Activity Data

- Cattle

This category refers to dairy cows that are reared for milk and also includes all other cattle. In Malta, 65.2% of the total cattle stock is found on farms with 100 cattle or more [40]. In the 1990s, only one Agriculture Census was carried out in Malta. Referred to as the 1991 Agriculture Census [23]; this took place in the years 1990 to 1991. The first comprehensive cattle census, held by the National Statistics Office took place in June 2000 on all cattle farms, where Eurostat's [43] classification of the animal categories was followed. Following the year 2000, the census was then carried out on an annual basis. The data regarding headcount refer to the number of animals that were present on the farm at the time of the survey. Through a derogation obtained in 2005, Malta compiles statistics on cattle in line with Council Directive 93/24/EEC which is a directive on the statistical survey which has to be carried out on bovine animal production [44] from the bovine register, which is maintained by the Department of Veterinary Services. The cattle stock as at December 2012 amounted to 15,593 heads on 308 holdings, an increase of 3.4% over 2011 [40]. The methane emissions from enteric fermentation for cattle are estimated using a Tier 1 approach as in 1996 IPCC guidelines.

Figure 6-2 is a graphical representation of the average annual cattle figures as reported in this inventory process. The apparent trend in recent years is a decrease in the both the number of dairy cows and other cattle. The number of dairy cows has increased by 12 heads between 2011 and 2012. For other cattle an increase in headcount is observed between 2011 and 2012 amounting to an increase of 507 heads.

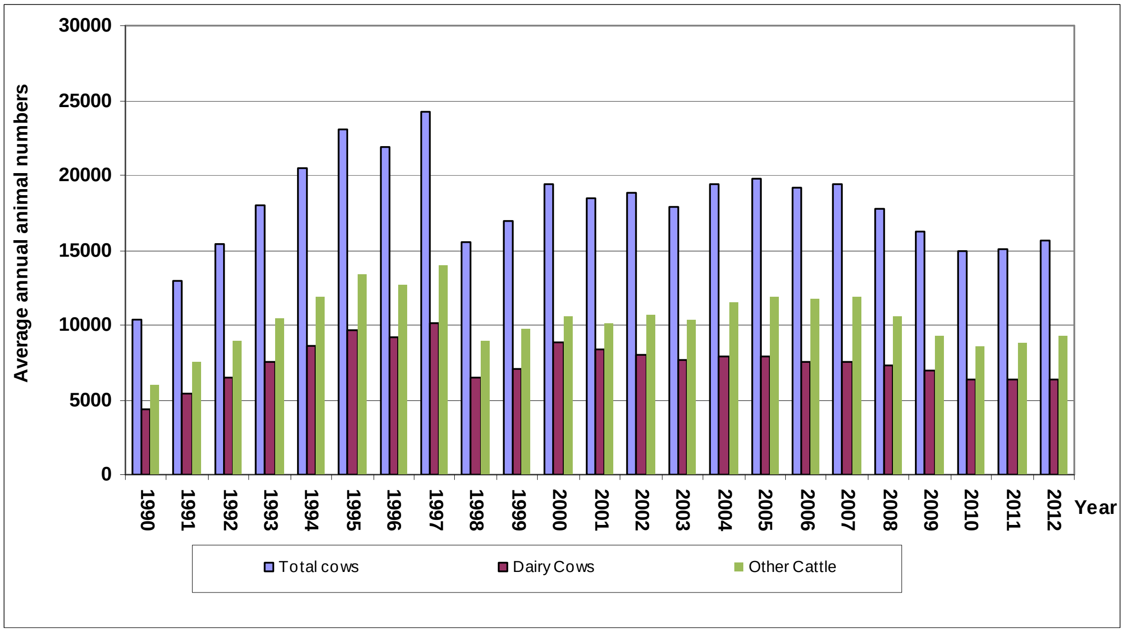

Figure 6-2 Average annual cattle numbers

- Sheep and Goats

Sheep and goats are mainly reared for the production of the traditional Maltese cheeselets, mainly marketed by the producers themselves. Through Council Directive 93/25/EEC which is a directive on the statistical surveys which is has to be carried out on sheep and goat stocks [45], the annual stock of all sheep and goats is being monitored. The Agriculture and Fisheries Unit, within the National Statistics Office conducts annual sample surveys based on the list provided by the Department of Veterinary Services.

The data available from the Sheep and Goats Survey 2012 [42] shows that in 2012 there were 1,392 holdings involved in sheep rearing. Just over 78% of these holdings have less than 10 sheep and amount for 31.5% of the sheep population. On the other hand, while only 21.6% of all holdings have more than 10 sheep they account for 68.5% of the sheep stock. The distribution of the goat stock is somewhat similar, where 44.2% of all goats are on holdings having less than 10 goats, which holdings amount to 86.7% of all goat rearing holdings whereas the remaining 55.8% of the goat population is on holdings with 10 goats or more.

Figures are available from 1995 Malta's past GHG Inventory [7] whilst from 2001figures are available from the National Statistics Office. The figure for 1991 is taken from the 1991 Agricultural Census. The remaining figures are calculated through interpolation and the same annual change is used to extrapolate to 1990. In December 2012, the sheep population amounted to 11,697 heads, a decline of 1.6 % over 2011. As for the goat population, it stood at 4,847 heads, down by 1.8% over the previous years. Figure 6-3 shows that there seems to be a fluctuating trend in the average annual animal numbers for both sheep and goats over the whole time series and this is to be reflected in the resulting methane emissions, since the same emission factors are being applied across the whole time series.

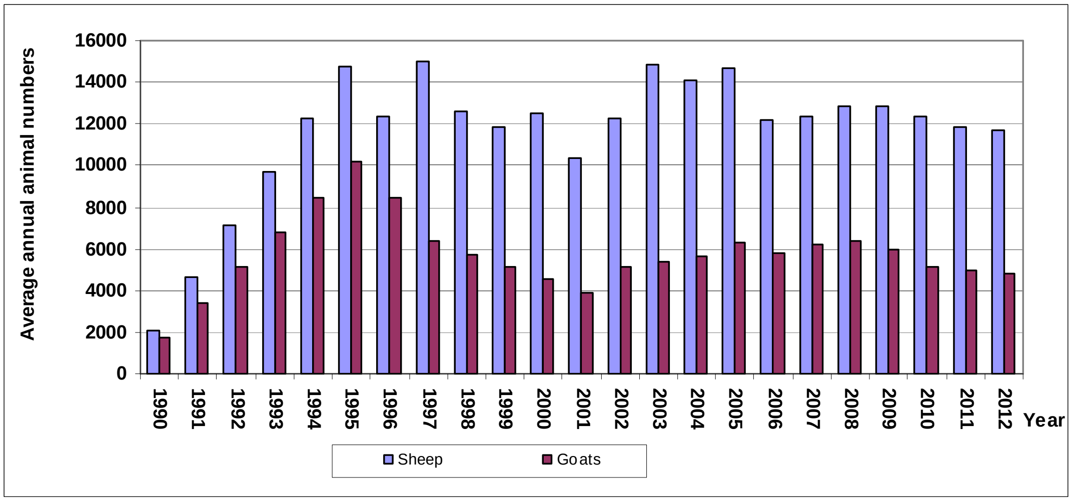

Figure 6-3 Average annual sheep and goat figures

- Swine

In the pig industry, the term 'producer' refers to breeders who breed boars and gilts and who sell their grown pigs to a market weight. The term fattener refers to farms that purchase pigs and fatten them to a market weight. For the year 1990, the figure of pigs as available from the 1991 Agriculture Census is being used. The figures reported for the years 1991 to 1999, are estimates worked out by the Department of Agriculture as worked out from the allocated quotas for sows, gilts, boars and piglets to fatteners (MRRA, personal communication, January 2009). A pig census was undertaken by the National Statistics Office in April 2000. All farms were visited and a 100% response rate was registered. Following the year 2000, the pig census is being carried out on an annual basis by the National Statistics Office.

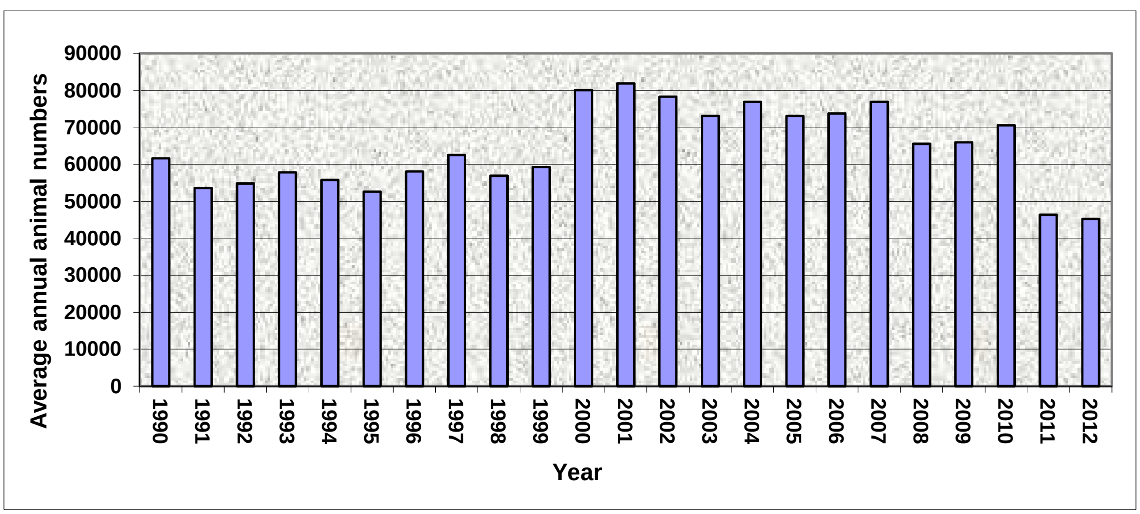

Figure 6-4 Average annual swine figures

Figure 6-4 is a graphical representation of the swine annual figures. The figures available for the 1990s are relatively lower to the figures available for the year 2000 and onwards. The 1990s figures are based on quota estimates whereas the figures for the year 2000 and onwards are actual figures as available from the animal surveys.

In 2012, the pig population amounted to 45,209 heads, down by 2.3% which translates to 1,078 pigs.

- Poultry

The poultry figures include broilers, laying hens and all other poultry. Data is available from the Agricultural Census for 1991 ans 2001, and the gap has been filled by interpolation. The annual change has been used to extrapolate to 1990. As can be observed from Figure 6-5 and also as confirmed from animal slaughtering figures, there is a decline in the number of broilers on poultry farms. This is mainly due to increased competition from cheaper-priced imports since EU accession that have impacted very significantly on the local production of broilers [22]. From 2001 until 2003 an annual census was carried out. Following 2003, this was carried out on a biennial basis. The missing data is interpolated.

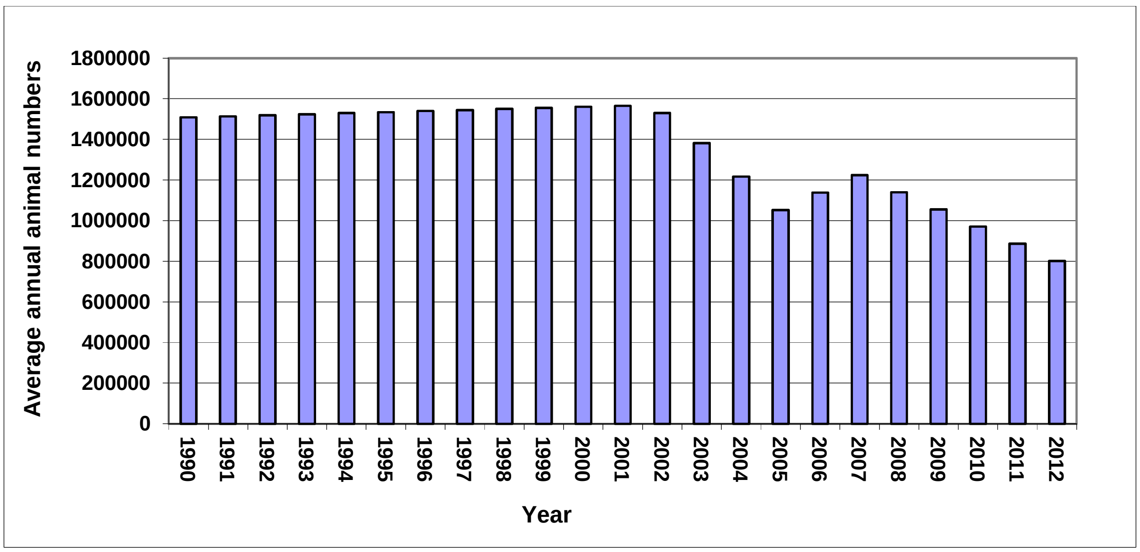

Figure 6-5 Average annual poultry figures

- Rabbits and Horses

The equine population is very small and includes foal, mare, stallion and donkeys. The rabbits and horses annual figures being used in this inventory process are those reported in the 1991 Agriculture Census [23], in the 2001 Agriculture Census [26] and in the 2010 Agriculture Census [37]. The data regarding headcount refers to the number of animals that were present on the farm on the 30th September 2001 for the 2001 Agriculture Census. The reference date for the 2010 Agriculture Census was 31st August 2010. The figures for intervening years are interpolated between these known figures, and figures at the edges of the time series are extrapolated using the same annual difference immediately following or preceding the extrapolation. The classification of all animal categories was collected strictly according to Eurostat's classification for the 2001 Agriculture

Census. All definitions and classification used in the 2010 Agriculture Census are in compliance with EU legislation on agricultural statistics. The latest rabbit numbers are represented in the 2010 Agriculture Census [36].

6.2.4 Emission factors

The emission factors used are presented in Table 6-2

Table 6-2 Annual Average Methane Emission Factors from Enteric Fermentation

Animal	Emission Factor used (kg CH_4/animal)	Source of Emission Factor
Dairy Cows	100	IPCC, 1996 [1]
Other Cattle	48	IPCC, 1996 [1]
Sheep	8	IPCC, 1996 [1]
Goats	5	IPCC, 1996 [1]
Horses	18	IPCC, 1996 [1]
Swine	1.5	IPCC, 1996 [1]
Poultry	0.1	IPCC, 1996 [1]
Rabbits	0.08	APAT, 2005 [15]

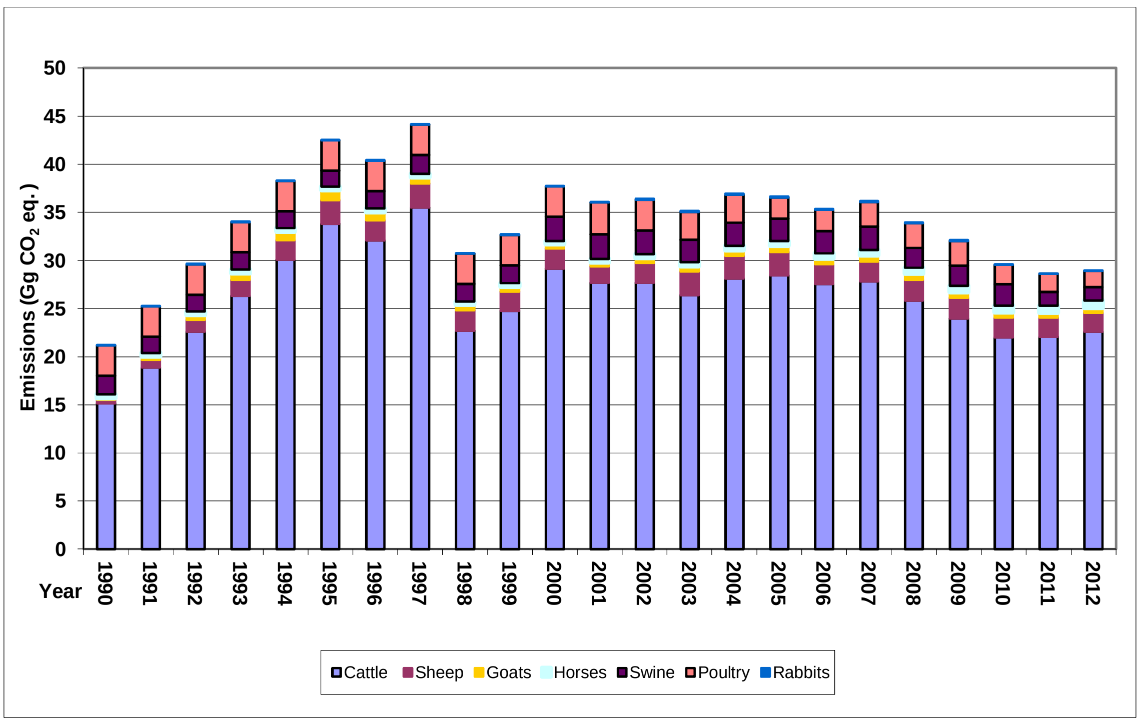

Figure 6-6 Methane emissions from enteric fermentation

Figure 6-6 describes the yearly methane emissions arising from the different livestock in Malta. As can be observed cattle is the major contributor of the resulting emissions, contributing to about 78% of those emissions, followed by the contribution from poultry, sheep and swine. One also notes the very small contribution of goats, horses and rabbits. Over the whole time series, a number of fluctuations in emissions from enteric fermentation can be observed, with a decrease being observed since 2007.

6.2.5 Specific Recalculations

Recalculations have been made with respect to animal numbers. These have resulted in significant changes particularly in the early years of the time series. **Year**	**Enteric Fermentation (Gg CO2 eq.) as reported in the 2013 inventory report**	**Enteric Fermentation (Gg CO2 eq.) as reported in the 2014 inventory report**	**Percentage change in reported emissions (%)**
1990	33.70	21.22	-37.05
1991	33.45	25.29	-24.41
1992	33.89	29.65	-12.50
1993	34.00	34.07	0.18
1994	33.78	38.33	13.47
1995	35.76	42.55	19.01
1996	35.32	40.43	14.48
1997	35.67	44.18	23.85
1998	35.02	30.75	-12.19
1999	34.89	32.71	-6.25
2000	37.67	37.77	0.26
2001	36.11	36.11	0.00
2002	36.39	36.42	0.10
2003	35.07	35.15	0.22
2004	36.82	36.94	0.31
2005	36.50	36.65	0.41
2006	35.17	35.36	0.54
2007	35.97	36.20	0.63
2008	33.71	33.97	0.79
2009	31.82	32.12	0.95
2010	29.58	29.58	0.00
2011	28.77	28.63	-0.52

6.2.6 Source-specific planned improvements

The calculation of emissions from enteric fermentation using a higher tier will require detailed information on livestock characteristics. Efforts will be made to proceed towards this approach.

6.3 Manure Management (4B)

6.3.1 Source Category Description

This category reports emissions of methane from animal manures as well as emissions from their manures 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. These conditions often occur when a large number of animals are managed in a confined area (e.g. dairy farms, swine and poultry farms). 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. Figure 6-7 includes the methane and nitrous oxide emissions from manure management in CO_2 equivalents.

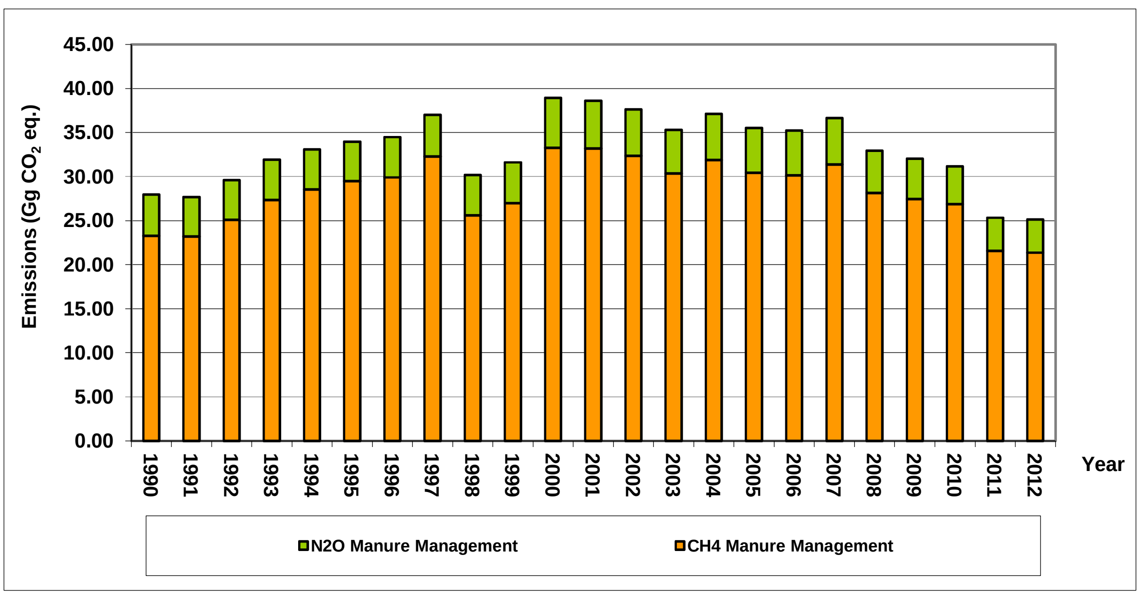

Figure 6-7 Methane and nitrous oxide emissions from manure management

6.3.2 Methodological Issues

6.3.4 Methane Emissions from Manure Management

To estimate methane emissions from livestock manure, livestock population data by animal category, in combination with default emission factors have been used. **Error! Reference source not found.** includes the methane emission factors used.

Table 6-3 Annual Average Methane Emission Factors from Manure Management

Animal	Emission Factor used (kg CH_4/animal)	Source of Emission Factor
Dairy Cows	44	IPCC, 1996 [1]
Other Cattle	20	IPCC, 1996 [1]
Sheep	0.28	IPCC, 1996 [1]
Goats	0.18	IPCC, 1996 [1]
Horses	2.08	IPCC, 1996 [1]
Swine	10	IPCC, 1996 [1]
Poultry	0.117	IPCC, 1996 [1]
Rabbits	0.08	APAT, 2005 [15]

6.3.5 Nitrous Oxide Emissions from Manure Management

This section includes the estimate details for direct N_2O emissions during the storage and treatment of manure before it is applied to land. Direct N_2O emissions occur via combined nitrification and denitrification of nitrogen contained in the manure. A Tier 2 method, with country-specific nitrogen excretion rates for the different livestock categories was used. Direct N_2O emissions have been calculated for the animal categories cattle, swine and poultry. The calculation of direct N_2O emissions from manure management was based on the following equation, as taken from the IPCC 2006 guidelines [3].

EQUATION 10.25
DIRECT N_2O EMISSIONS FROM MANURE MANAGEMENT

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)} \right) \right] \bullet EF_{3(S)} \right] \bullet \frac{44}{28}$$

where:

$N_2O_{D(mm)}$ = direct N_2O emissions from Manure Management in the country, kg N_2O yr^{-1}
$N_{(T)}$ = number of head of livestock species/category T in the country
$Nex_{(T)}$ = annual average N excretion per head of species/category T in the country, kg N $animal^{-1}$ yr^{-1}
$MS_{(T, S)}$ = fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless
$EF_{3(S)}$ = emission factor for direct N_2O emissions from manure management system S in the country, kg N_2O-N/kg N in manure management system S
S = manure management system
T = species/category of livestock
44/28 = conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

The nitrogen excretion rates used for poultry and cattle are presented in Table 6-4 below.

Table 6-4 Nitrogen Excretion Rates

Animal Category	Nitrogen Excretion Rates
Poultry – Broilers	0.35 – 0.82 kg N / place
Poultry – Layers	0.87 kg N / place
Cattle – Solid Manure	63 kg N / Livestock Unit
Cattle – Liquid Manure	65 kg N / Livestock Unit

[Source: Sustech [46]]

For swine, nitrogen excretion rates by the age class were applied. The following figures for fresh animal manure production per day were used: piglets – 1.2kg; young pigs – 2.4kg; fattening pigs – 4.2kg and breeding stock – 10.2kg [47]. The total amount of pig slurry was estimated at 4.2 times the estimated amount of pig manure produced and the nitrogen content in pig slurry was estimated at 0.18% of the total pig slurry [48].

Default emission factors for direct N_2O emissions from manure management, as available in the IPCC 2006 guidelines were applied to the quantities of kg N generated annually by cattle, swine and poultry. The emission factors used are presented in Table 6-5 below.

Table 6-5 Default Emission Factors for Direct N_2O Emissions from Manure Management

Animal Category	Default Emission Factor (kg N_2O-N/kg N excreted)
Cattle	0.005
Swine	0.005
Poultry	0.001

The volume of slurry and solid manure produced per livestock category was obtained with the average production of slurry and solid manure per livestock category per day and the days of storage of slurry and solid manure.

6.3.6 Source Specific Recalculations

Recalculations have been made with respect to animal numbers. These have resulted in significant changes particularly in the early years of the time series.

Year	Manure Management (Gg CO2 eq.) as reported in the 2013 inventory report	Manure Management (Gg CO2 eq.) as reported in the 2014 inventory report	Percentage change in reported emissions (%)
1990	33.36	27.96	-16.17
1991	31.47	27.70	-11.98
1992	31.77	29.62	-6.78
1993	32.46	31.93	-1.63

1994	31.98	33.08	3.45
1995	31.32	33.97	8.48
1996	32.57	34.50	5.92
1997	33.61	37.00	10.07
1998	32.29	30.17	-6.56
1999	32.83	31.61	-3.72
2000	38.90	38.91	0.03
2001	38.61	38.61	0.00
2002	37.62	37.63	0.01
2003	35.28	35.29	0.02
2004	37.09	37.11	0.04
2005	35.49	35.51	0.05
2006	35.21	35.23	0.06
2007	36.63	36.65	0.07
2008	32.90	32.93	0.09
2009	31.99	32.02	0.11
2010	31.18	31.18	0.00
2011	25.53	25.32	-0.83

6.3.7 Source-specific planned improvements

The calculation of emissions from manure management using a higher tier will require more information on manure management practices. Efforts will be made to proceed towards this approach.

6.4 Rice Cultivation (4C)

This source category does not occur in Malta. Agricultural statistics for this crop production do not report any values.

6.5 Agricultural Soils (4D)

6.5.1 Source Category 4D1 – Direct Soil Emissions

6.5.1.1 Source Category Description

This section includes the direct nitrous oxide emissions (4D1) through an increase in available nitrogen. The following sources are included in the estimates:

- application of synthetic nitrogen fertilisers (F_{SN});
- application of organic nitrogen as fertiliser (animal manure) (F_{ON});
- nitrogen input from N-fixing crops (F_{BN});
- nitrogen input from crop residues (F_{CR}).

Figure 6-8 includes the nitrous oxide emissions over the time period 1990 till 2012. Over the inventory time series there has been a reduction in the use of both manure and synthetic nitrogen based fertilisers that have resulted in a reduction in reported nitrous oxide emissions from both sources.

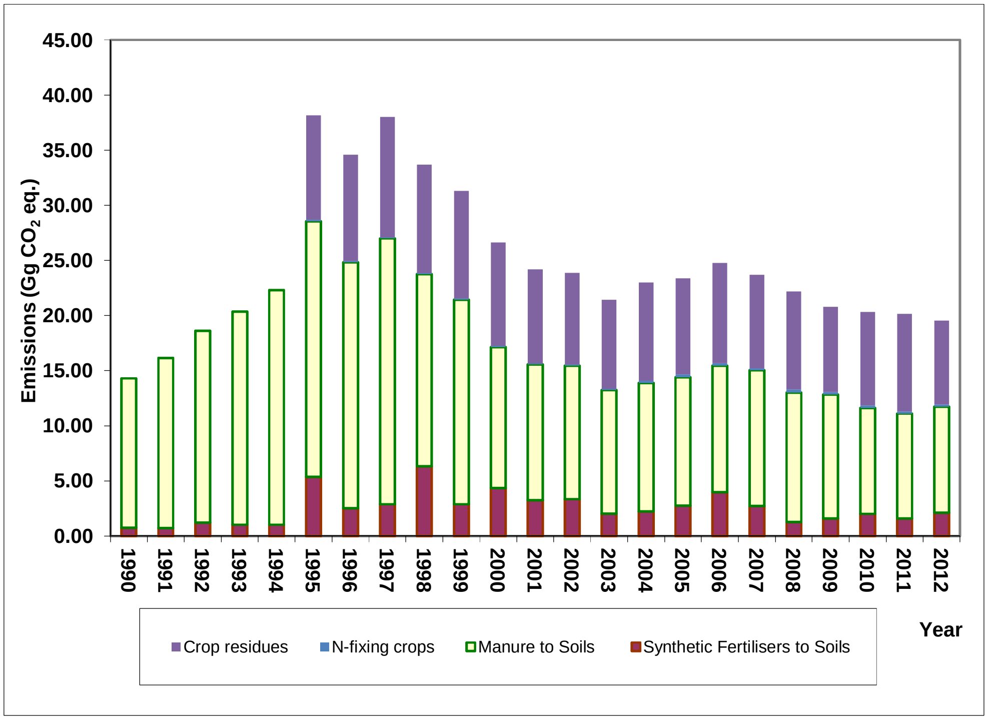

Figure 6-8 Direct Nitrous oxide emissions from agricultural soils

6.5.1.2 Methodological Issues

- Synthetic Nitrogen Fertilisers Applied to Soils

The activity data on nitrogen based fertiliser use per year (F_{SN}) in kg N was obtained as follows:

- for 1990 to 1994: FAOSTAT [49] – Nitrogenous Fertiliser Consumption;
- for 1995 to 2011: Nitrogen fertiliser Import figures, as provided by the National Statistics Office.

In 2013, NSO carried out a survey with companies importing fertiliser, and data on amount of fertiliser imported and nitrogen content was collected for the years 2010, 2011 and 2012. These actual figures were used to replace the figures previously reported for 2010 and 2011. It is being considered whether the apparent trend in consumption should be used to adjust data reported for previous years.

Figures for total quantity of fertilisers imported as obtained from the National Statistics Office (in kg) are corrected to reflect the chemical structure represented by each class and hence the kg N therein.

The activity data on fertiliser use was multiplied with the default emission factor to estimate direct N_2O-N emissions from managed soils (0.01kg N_2O-N per kg N of fertiliser use), as available from the IPCC 2006 guidelines [3].

- Manure Applied to Soils

To calculate the quantities of manure applied to soils, the same methodology used to estimate the quantities of manure generated in Section 6.3 was used. 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 was necessary to reduce the total amount of nitrogen excreted by the animals but lost as volatilisation. Default values for nitrogen loss due to volatilisation of NH_3 and NO_x from the manure, as available in the IPCC 2006 guidelines [2] Table 10.22 were applied for poultry (40%), swine (48%), dairy cows (30%) and other cattle (45%). For swine, it was assumed that only 10% of the total slurry produced tends to be applied to the soils (personal communication, Ministry for Resources and Rural Affairs, September 2009).

The resultant activity data on the manure quantities (kg N) available for soil application was multiplied with the default emission factor to estimate direct N_2O-N emissions from managed soils (0.02 kg N_2O-N per kg N for cattle, poultry and swine), as available from the IPCC 2006 guidelines.

- Nitrogen fixed by crops

Data on N-fixing crops, in particular broad beans, French beans, chickpeas and peas, was obtained for the years 1995 through 2012 from the annual Agriculture and Fisheries publications [24-25, 27-31, 33-36, 38-39] which provide statistics on the agricultural sector. Data on legume production is available going back only to 1995. The gap for 1990 – 1994 could not adequately be filled with figures sourced from FAOStat since those figures are estimates and in the years where both local data and FAO estimates are available, the data does not correlate well. However, efforts are still being made to source the missing data locally.

In order to estimate the amount of nitrogen fixed by N-fixing crops, equation 4.26 of the Good Practice Guidance [3] was used. The values for residue/crop product, dry matter fraction and nitrogen fraction are sourced from the same manual, in Table 4.16.

Table 6-6 Default values for estimating amount of nitrogen fixed by N-fixing crops

Product	Residue/Crop product ratio	Dry Matter Fraction	Nitrogen Fraction
Peas	1.5	0.87	0.0142
Beans	2.1	0.82-0.89	

Broad beans and french beans were estimated using the values for beans, whereas chickpeas and peas were estimated using the value for peas. The nitrogen value for peas was approximated for beans.

Direct N_2O emissions are estimated using the emission factor in Table 4.17 of the Good Practice Guidance where EF_1 = 1.25%.

- Nitrogen in Crop residues returned to soils

Crop production for a variety of crops is sourced for the years 1995 through 2012 from the annual Agriculture and Fisheries publications [24-25, 27-31, 33-36, 38-39]. The data presented by FAOSTAT is mostly estimated and does not correlate well with actual data when available, therefore it was not used to fill gaps prior to 1995. Efforts are made to fill the gaps with local data.

The amount of nitrogen returned to soils is estimated using equation 4.28 of the Good Practice Guidance. Default nitrogen contents for both non-nitrogen-fixing crop and nitrogen-fixing crops are taken from Table 4-19 of the 1996 IPCC Guidelines. The amount of residue nitrogen thus calculated is adjusted by the amount of total aboveground biomass that is removed from the field as product, and is taken as a default value from Table 4-19 of the 1996 IPCC Guidelines. The fraction that is burned is taken to be zero.

Table 6-7 Default values for estimating amount of nitrogen in crop residues returned to soil

Parameter	**Value**
$Frac_{NCRBF}$	0.03 kg N/kg of dry biomass
$Frac_{NCRO}$	0.015 kg N/kg of dry biomass
$Frac_R$	0.45 kg N/kg crop-N

Direct N_2O emissions are estimated using the emission factor in Table 4.17 of the Good Practice Guidance where EF_1 = 1.25%.

6.5.1.3 Specific Recalculations

Recalculations for the years 2010 and 2011 are due to revised data on fertiliser imports, and for the years 1995 to 2011 due to the calculation of nitrogen input from N-fixing crops and crop residues. Furthermore recalculations are also due to revisions in animal numbers.

Table 6-8 Recalculations for source category Direct Soil Emissions

Year	Direct emissions (Gg CO2 eq.) as reported in the 2013 inventory report	Direct Emissions (Gg CO2 eq.) as reported in the 2014 inventory report	Percentage change in reported emissions (%)
1990	13.92	14.30	2.69
1991	13.83	16.15	16.74
1992	14.35	18.61	29.66
1993	14.16	20.36	43.77
1994	14.15	22.29	57.52
1995	18.48	38.17	106.58
1996	15.66	34.61	121.02
1997	16.05	38.03	137.00
1998	19.46	33.70	73.17
1999	16.04	31.33	95.30
2000	17.14	26.66	55.53
2001	15.56	24.19	55.50
2002	15.46	23.90	54.61
2003	13.24	21.43	61.79
2004	13.89	23.01	65.69

2005	14.40	23.36	62.17
2006	15.45	24.78	60.35
2007	15.03	23.70	57.69
2008	13.02	22.19	70.45
2009	12.82	20.80	62.28
2010	11.51	20.35	76.81
2011	11.03	20.16	82.73

6.5.1.4 Source Specific Planned Improvements

Efforts will be made to address the gap in crop production for the years 1990 up to 1994.

6.5.2 Source Category 4D2 – Pasture, Range and Paddock Manure

This category does not occur in Malta.

6.5.3 Source Category 4D3 - Indirect Soil Emissions

6.5.3.1 Source Category Description

Indirect pathways involve nitrogen that is removed in agricultural soils or animal waste management systems via volatilisation, leaching or runoff.

Current activity data used to calculate indirect N_2O emissions include commercial synthetic fertiliser consumption, livestock and poultry populations. N_2O emissions between 1990 and 2012 in this category are presented in Figure 6-9.

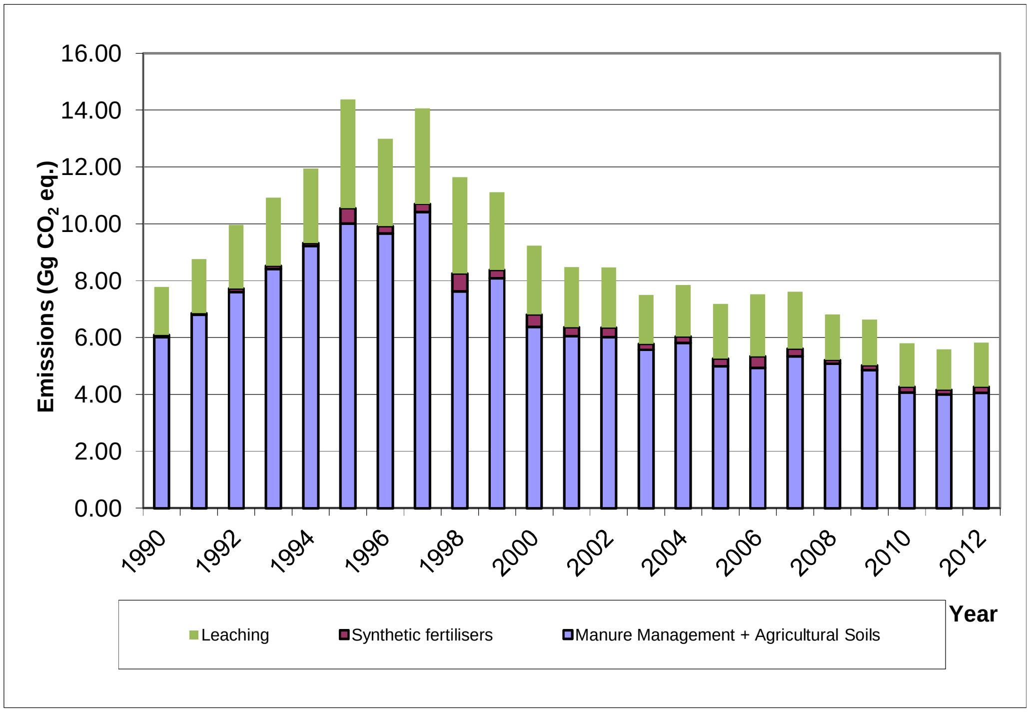

Figure 6-9 Indirect emissions from agricultural soils

6.5.3.2 Methodological Issues

- Indirect N_2O emissions from Managed Soils

Indirect N_2O accounts for manure and fertiliser nitrogen that volatilises as NO_x or NH_3 soon after application to soil, and subsequent redeposition on soil, providing a nitrogen substrate for nitrifiers and denitrifiers.

EQUATION 11.9
N_2O FROM ATMOSPHERIC DEPOSITION OF N VOLATILISED FROM MANAGED SOILS (TIER 1)

$$N_2O_{(ATD)}\text{-}N = \left[(F_{SN} \bullet Frac_{GASF}) + ((F_{ON} + F_{PRP}) \bullet Frac_{GASM})\right] \bullet EF_4$$

where:

$N_2O_{(ATD)}$-N = annual amount of N_2O-N produced from atmospheric deposition of N volatilised from managed soils, kg N_2O-N yr^{-1}

F_{SN} = annual amount of synthetic fertiliser N applied to soils, kg N yr^{-1}

$Frac_{GASF}$ = fraction of synthetic fertiliser N that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied)$^{-1}$

F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, rang
e and paddock, kg N yr^{-1}

$Frac_{GASM}$ = fraction of applied organic N fertiliser materials (F_{ON}) and of urine and dung deposited by grazing animals (F_{PRP}) that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied or deposited)$^{-1}$
EF_4 = emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg $N\text{-}N_2O$ (kg NH_3-N +NO_x-N volatilised)$^{-1}$]

Activity data for synthetic fertilisers and manure applied to soils was used as for section 6.5.1.

Values for manure applied to soils as estimated in section 6.5.1 were used as activity data for F_{ON}. The fraction of applied organic material that volatilises as NH_3 and NO_x ($Frac_{GASM}$) is taken from Table 11.3 of the 2006 IPCC Guidelines as 0.20. The resultant value was multiplied with the default emission factor to estimate indirect N_2O-N emissions from managed soils EF_4 taken to be 0.010 from Table 11.3 of the 2006 IPCC Guidelines.

Nitrogen values for fertilisers applied were multiplied by $Frac_{GASF}$ equivalent to 0.10 from Table 11.3 of the 2006 IPCC Guidelines. Default emission factor EF_4 to estimate indirect emissions was taken to be 0.010 from Table 11.3 of the 2006 IPCC Guidelines.

- ### Indirect N_2O emissions from Manure Management

Tier 1 methodology from IPCC guidelines was used. This method is applied using country specific nitrogen excretion data and default fraction of N losses from manure management systems due to volatilisation.

Calculation of N volatilisation in forms of NH_3 and NO_x from manure management systems is based on multiplication of the amount of nitrogen excreted and managed in each manure management system by a fraction of volatilised nitrogen.

N LOSSES DUE TO VOLATILISATION FROM MANURE MANAGEMENT

$$N_{volatilization-MMS} = \sum_{S}\left[\sum_{T}\left[\left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}\right) \bullet \left(\frac{Frac_{GasMS}}{100}\right)_{(T,S)}\right]\right]$$

Where:

$N_{volatilization-MMS}$ = amount of manure nitrogen that is lost due to volatilisation of NH_3 and NO_x, kg N yr^{-1}
$N_{(T)}$ = number of head of livestock species/category *T* in the country
$Nex_{(T)}$ = annual average N excretion per head of species/category *T* in the country, kg N animal^{-1} yr^{-1}
$MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless
$Frac_{GasMS}$ = percent of managed manure nitrogen for livestock category *T* that volatilises as NH3 and NOx in the manure management system *S*, %.

Activity data and methodology used are the same as those used in Section 6.5.1 $Frac_{GRASM}$ was applied as 0.20 from Table 11.3 of the 2006 IPCC Guidelines. The indirect N_2O emissions from volatilisation of N are estimated by multiplying the resulting figures with EF_4 taken to be 0.010 from Table 11.3 of the 2006 IPCC Guidelines.

- Leaching

Another issue is that of leaching and runoff from land of nitrogen from synthetic and organic fertiliser additions, crop residues, and mineralisation of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices. Urine and dung deposition from grazing does not occur in Malta. Some of the inorganic N on or in the soil, mainly in the NO_3^- form, may bypass biological retention mechanisms in the soil/vegetation system by transport in overland water flow (runoff) and/or flow through soil macropores or pipe drains. The nitrification and denitrification processes transform some of the NH_4^+ and NO_3^- to N_2O. This may take place in the groundwater below the land, to which N was applied, or in riparian zones receiving drain or runoff water, or in the ditches into which the land drainage water flows (IPCC Guidelines 2006).Total N applied to soil through mineral fertilisers and manure is multiplied by $Frac_{LEACH-(H)}$ from Table 11.3 of the 2006 IPCC Guidelines with a value of 0.30 and multiplied by EF_5 0.0075 also from the same table. Conversion to N_2O is achieved by multiplying by 44/28.

6.5.3.3 Source Specific Recalculations

Recalculations in 2010 and 2011 are due to revised data on fertiliser imports, and for the years 1995 to 2011 due to the calculation of nitrogen input from N-fixing crops and crop residues. Furthermore recalculations are also due to revisions in animal numbers.

Table 6-9 Recalculations for source category Indirect Soil Emissions

Year	Indirect emissions (Gg CO2 eq.) as reported in the 2013 inventory report	Indirect Emissions (Gg CO2 eq.) as reported in the 2014 inventory report	Percentage change in reported emissions (%)
1990	5.17	6.09	17.79
1991	5.14	6.87	33.58
1992	5.20	7.73	48.76
1993	5.19	8.53	64.42
1994	5.18	9.33	80.08
1995	5.60	10.56	88.41
1996	5.34	9.92	85.98
1997	5.39	10.71	98.77
1998	5.71	8.26	44.66
1999	5.38	8.38	55.82
2000	6.82	6.82	0.00
2001	6.37	6.37	0.00
2002	6.36	6.36	0.00
2003	5.78	5.78	0.00
2004	6.04	6.04	0.00
2005	5.26	5.26	0.00
2006	5.34	5.34	0.00
2007	5.61	5.61	0.00
2008	5.22	5.22	0.00

2009	5.02	5.02	0.00
2010	4.26	4.28	0.29
2011	4.16	4.17	0.16

6.6 Prescribed Burning of Savannas (4E)

This category does not occur in Malta.

6.7 Field Burning of Agricultural Residues (4F)

This category does not occur in Malta.

6.8 Other (4G)

This category does not occur in Malta.

Chapter 7. LULUCF (CRF Sector 5)

7.1 Overview of the Sector

CO_2 emissions and removals occur as a result of changes in landuse and from forestry. This sector is responsible for -7.22 of CO_2 removals in 2012. The 2003 IPCCC GPG for the LULUCF has been entirely applied for all the categories of this sector as data were available from national statistics and from the Corine Land Cover 1990, 2000 and 2006.

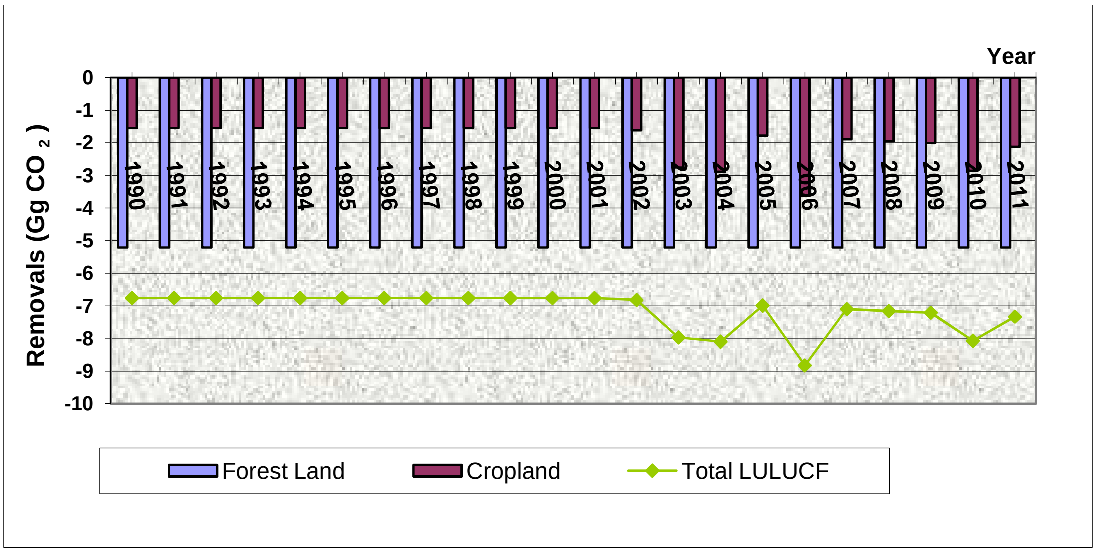

Figure 7-1 LULUCF Carbon Dioxide Removal

Figure 7-1 shows the carbon dioxide removals by vegetation in the LULUCF sector for Malta. A mean figure of -7.1 Gg CO_2 has been estimated to be sequestered annually by Maltese vegetation during the time series 1990 to 2012. In this year's submission Settlement and grassland were not included in the calculation; further details are given in the relevant section. In this inventory process, carbon dioxide removals from above ground biomass are being reported for the IPCC source categories Forestland (5A) and Cropland (5B).

Each section of this chapter will discuss carbon stock change. Planned improvements to the inventory are described in the relevant category.

7.1.1 The land use transition matrix

Further to the ERT comments a land use matrix was created to show the land use conversion Table 7.1. The matrices have allowed pointing out the areas of transition land, separately from each initial and final landuse (i.e. forest land, grassland and so on). Annual figure for areas in transition between different land uses have been derived by a hierarchy of basic assumption with expert judgement of land-use changes in Malta as well as the need for the total national area to remain constant. Landuse Change matrices for each year of the period 1990-2012 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetland and settlement areas. The following are the assumptions taken for the matrix;

- Any category could change to Settlement

- The subcategory Other Grassland goes to Annual Cropland, woody Cropland, maquis and other land.
- The new forest land area can only come from grassland.
- New settlement areas are coming from any land use
- New maquis area come from annual crops
- New other land areas come from annual crops.

Concerning wetlands category, there is no occurrence of land transition to and from wetlands, considering that most of them are natural reserves, Legal Notice 311 of 2006 as amended (Flora, Fauna and Natural Habitats Protection Regulation) and Legal Notice 194 of 2004.

In order to determine the lands converting to other land use categories in 20years, land use categories in 20 years, land use change matrices have also been prepared, taking into account the area in conversion over a period of 20years.

Areas of land use and land use change are compiled from the various sources. Areas of forest land, Grassland, Wetland and Settlement come from the Corine Land Cover 1990, 2000 and 2006. Areas of cropland are taken from the National Statistics Office.

Table 7-1 Landuse change matrices for the years 1990-2012

	YEAR 1990-1991										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1990
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4951			8		4958
	Other GL						7774		15		7789
	WL							38	1		39
	SL								8602		8602
	OL								7	419	426
	Total end 1991	67	143	917	8594	4951	7774	38	8633	419	31535

	YEAR 1991-1992										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1991
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4943			8		4951
	Other GL						7758		15		7774
	WL							36	1		38
	SL								8633		8633
	OL								7	412	419

	Total end 1992	67	143	917	8594	4943	7758	36	8664	412	31535

	YEAR 1992-1993										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1992
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4935			8		4943
	Other GL						7743		15		7758
	WL							35	1		36
	SL								8664		8664
	OL								7	405	412
	Total end 1993	67	143	917	8594	4935	7743	35	8696	405	31535

	YEAR 1993-1994										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1993
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4928			8		4935
	Other GL						7728		15		7743
	WL							34	1		35
	SL								8696		8696
	OL								7	399	405
	Total end 1994	67	143	917	8594	4928	7728	34	8727	399	31535

	YEAR 1994-1995										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1994
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4920			8		4928
	Other GL						7712		15		7728
	WL							32	1		34
	SL								8727		8727
	OL								7	392	399
	Total end 1995	67	143	917	8594	4920	7712	32	8758	392	31535

	YEAR 1995-1996										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1995
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917

	Annual crops				8594						8594
	Maquis					4913			8		4920
	Other GL						7697		15		7712
	WL							31	1		32
	SL								8758		8758
	OL								7	385	392
	Total end 1996	67	143	917	8594	4913	7697	31	8789	385	31535

	YEAR 1996-1997										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1996
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquia					4905			8		4913
	Other GL						7681		15		7697
	WL							29	1		31
	SL								8789		8789
	OL								7	379	385
	Total end 1997	67	143	917	8594	4905	7681	29	8820	379	31535

	YEAR 1997-1998										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquia	Other GL	WL	SL	OL	Total end 1997
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquia					4898			8		4905
	Other GL						7666		15		7681
	WL							28	1		29
	SL								8820		8820
	OL								7	372	379
	Total end 1998	67	143	917	8594	4898	7666	28	8851	372	31535

	YEAR 1998-1999										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1998
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4890			8		4898
	Other GL						7651		15		7666
	WL							27	1		28
	SL								8851		8851
	OL								7	365	372
	Total end 1999	67	143	917	8594	4890	7651	27	8882	365	31535

	YEAR 1999-2000										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 1999
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4883			8		4890
	Other GL						7635		15		7651
	WL							25	1		27
	SL								8882		8882
	OL								7	358	365
	Total end 2000	67	143	917	8594	4883	7635	25	8913	358	31535

	YEAR 2000-2001										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2000
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			917							917
	Annual crops				8594						8594
	Maquis					4883					4883
	Other GL			33	161	14	7410		12	5	7635
	WL							25			25
	SL								8913		8913
	OL									358	358
	Total end 2001	67	143	951	8755	4897	7410	25	8925	363	31535

	YEAR 2001-2002										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2001
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			951							951
	Annual crops				8755						8755
	Maquis					4897					4897
	Other GL			33	161	14	7185		12	5	7410
	WL							25			25
	SL								8925		8925
	OL									363	363
	Total end 2002	67	143	984	8915	4911	7185	25	8937	368	31535

	YEAR 2002-2003										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2002
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			984							984
	Annual crops				8915						8915
	Maquis					4911					4911
	Other GL			33	161	14	6960		12	5	7185

	WL							25			25
	SL								8937		8937
	OL									368	368
	Total end 2003	67	143	1017	9076	4926	6960	25	8949	372	31535

	YEAR 2003-2004										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2003
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1017							1017
	Annual crops				9076						9076
	Maquis					4926					4926
	Other GL			33	161	14	6735		12	5	6960
	WL							25			25
	SL								8949		8949
	OL									372	372
	Total end 2004	67	143	1051	9237	4940	6735	25	8960	377	31535

	YEAR 2004-2005										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2004
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1051							1051
	Annual crops				9237						9237
	Maquis					4940					4940
	Other GL			33	161	14	6510		12	5	6735
	WL							25			25
	SL								8960		8960
	OL									377	377
	Total end 2005	67	143	1084	9398	4955	6510	25	8972	382	31535

	YEAR 2005-2006										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2005
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1084							1084
	Annual crops				9398						9398
	Maquis					4955					4955
	Other GL			33	161	14	6285		12	5	6510
	WL							25			25
	SL								8972		8972
	OL									382	382
	Total end 2006	67	143	1118	9559	4969	6285	25	8984	386	31535

	YEAR 2006-2007										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2006
FROM	Coniferous	67									67

	forest										
	Mixed forest		143								143
	Woody crops			1118							1118
	Annual crops				9559						9559
	Maquis					4969					4969
	Other GL			33	161	14	6060		12	5	6285
	WL							25			25
	SL								8984		8984
	OL									386	386
	Total end 2007	67	143	1151	9719	4984	6060	25	8996	391	31535

	YEAR 2007-2008										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2007
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1151							1151
	Annual crops				9719						9719
	Maquis					4984					4984
	Other GL			33	161	14	5835		12	5	6060
	WL							25			25
	SL								8996		8996
	OL									391	391
	Total end 2008	67	143	1184	9880	4998	5835	25	9008	395	31535

	YEAR 2008-2009										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2008
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1184							1184
	Annual crops				9880						9880
	Maquis					4998					4998
	Other GL			33	161	14	5610		12	5	5835
	WL							25			25
	SL								9008		9008
	OL									395	395
	Total end 2009	67	143	1218	10041	5012	5610	25	9020	400	31535

	YEAR 2009-2010										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2009
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1218							1218
	Annual crops				10041						10041
	Maquis					5012					5012
	Other GL			33	161	14	5384		12	5	5610
	WL							25			25
	SL								9020		9020
	OL									400	400
	Total end 2010	67	143	1251	10202	5027	5384	25	9031	405	31535

	YEAR 2010-2011										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2010
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1251							1251
	Annual crops				10202						10202
	Maquis					5027					5027
	Other GL			33	161	14	5159		12	5	5384
	WL							25			25
	SL								9031		9031
	OL									405	405
	Total end 2011	67	143	1285	10362	5041	5159	25	9043	409	31535

	YEAR 2011-2012										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2011
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1285							1285
	Annual crops				10362						10362
	Maquis					5041					5041
	Other GL			33	161	14	4934		12	5	5159
	WL							25			25
	SL								9043		9043
	OL									409	409
	Total end 2012	67	143	1318	10523	5056	4934	25	9055	414	31535

	YEAR 2012-2013										
	TO	Coniferous forest	Mixed forest	Woody crops	Annual crops	Maquis	Other GL	WL	SL	OL	Total end 2012
FROM	Coniferous forest	67									67
	Mixed forest		143								143
	Woody crops			1318							1318
	Annual crops				10523						10523
	Maquis					5056					5056
	Other GL			33	161	14	4709		12	5	4934
	WL							25			25
	SL								9055		9055
	OL									414	414
	Total end 2013	67	143	1351	10684	5070	4709	25	9067	419	31535

7.2 Forest Land (5A)

7.2.1 Forest remaining Forest (5A1)

7.2.1.1 Source Category Description

This category is reporting into category 5.A.1 Forest remaining Forest land. Under this category, CO_2 emissions, from living biomass, dead organic matter and soils, from forest land remaining forest land were calculated. The Forest Land category includes carbon dioxide removals from forest land and shrub land above-ground biomass in Malta. No harvest or logging industries exist in Malta and woodland is protected by legislation. The highest expression is the evergreen woodland dominated by trees such as the Evergreen oak (*Quercus ilex*) and Aleppo pine (*Pinus halepensis*); however very few old oak trees still exist. As for this year submission shrubland was removed from forest and was included in grassland. It was done by on expert judgement. The area for forest remaining forest is taken from the Corine Land Cover 2006.

In Malta nitrogen fertilizers are not generally applied to native woodland and mature forest, so emissions of N_2O from N fertilization of forest for 5.A.1 are reported as not occurring. As regards controlled burning of forest, it does not take place in Malta, so it is also not occurring.

7.2.1.2 Information on approaches used for representing land areas and land-use databases used for the inventory participation

For this inventory Approach 1 (IPCC 2006) was used for the representation of land use areas. It identifies the total areas for each individual land-use category. The agency which is responsible for land uses areas in Malta is the Malta Environment and Planning Authority (MEPA). MEPA is the "National Reference Centre on Landcover" for the European Environment Agency (EEA). In this function the Agency supports European institutions dealing with land cover, land monitoring and land use.

MEPA has been working on issues like European wide homogenous data sets emphasising on land cover topics for several years. Land cover plays an important role for environmental spatial and territorial analysis. As MEPA is composed of both the land-use planning and environment agencies, it has a wider responsibility in having up-to date data about land-use and land-cover at very high detail, nominally at the 1:1000. There was a project through an European Regional Development Fund project which partly consisted of a baseline studies with 100% scan coverage of the Maltese islands conducted in the areas of water, radiation, noise and soils, together with terrestrial spatial surveys and bathmetric surveys of coastal waters with in 1 nautical mile. This project was finalized by 2013 and further analysis needs to be processed. It was a bit late to be used in this NIR.

Data sources used in conjunction with the EEA/Joint Research Centre imagery include the national maps and ancillary data available at MEPA that include orthorectified imagery (2004), topographic maps, landuse-maps as produced for local plans, habitats, agricultural, environmental datasets, development planning parcels, amongst other datasets. The last Corine Landcover (CLC) survey was in 2006. In the Maltese context, while CLC information assists with understanding land cover in Malta and monitoring large scale change over longer timeframes, the large scale (25ha) of the grid used does not permit analysis that is sensitive enough, to monitor short-term land use change in the Maltese context with a great deal of accuracy.

7.2.1.3 Methodological Issues

Area coverage of Coniferous wooded land and Mixed Forest was obtained from the Corine Landcover (CLC) data 1990, 2000 and 2006 as available from the Malta Environment and Planning

Authority (MEPA). As it was stated previous shrubland was removed from this category and it was inserted in section 5C (details will be given in section 5C) The methodologies used as available in the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry have been followed [50]. Table 7.2 summarises the Removal Factors used to estimate the carbon sink from Forest Land in Malta. The removal factors are default values.

Table 7-2 Removal Factors used to Estimate Carbon Sink from Forest Land

Factor	Coniferous Wooded Land	Mixed Forest
Volume of growing stock (m^3/ha)		
Above ground biomass default figure (tonnes dry matter / ha / yr)	3.0	4.0
Biomass Expansion Factor (BEF)		
Default carbon fraction of dry matter	0.5	0.5
Wood Basic Density (tonnes/m^3)		

Removal Factors are default [50]

Equations 1 and 2 have been used to estimate CO_2 emissions from Coniferous Wooded Land and from Mixed Forest:

(1) Biomass Accumulation (tonnes Carbon) = Size of land (ha) * Above ground biomass (tonnes dry matter / ha / yr) * Default carbon fraction of dry matter

(2) CO_2 Removal (Gg CO_2) = Biomass Accumulation (tonnes Carbon) * (44/12) / 1000

Table 7-2 summarises the Removal Factors used to estimate the carbon sink from Forest Land in Malta. For the calculation of dead wood, litter and mineral soils for forest remaining forest Tier 1 was used. In the CRF it is annotated as NE. As for soil organic it is not occurring in Malta. Organic soils are low or non existent in Malta. No long term data is available to assess whether organic matter in Maltese soils in fact declining. Baseline data show that 58% of soils have a soil organic carbon content below the threshold of 2% [58].

Equation 3.2.11 of the Good Practice Guidance was estimated and option 1 was estimated.

Annual change in carbon stocks in dead wood in forest land remaining forest land, tonnes Cyr^{-1}= size of land (ha) * (Average annual transfer into dead wood tonnes d.m ha-1) * carbon fraction of dry matter (default=0.5), tonnes C.

As regards litter, it was calculated as:

Annual change in carbon stocks in litter= (stable litter stock, under pervious state tonnes C ha^{-1} – stable litter stock, under current state j tonnes C ha^{-1}) * size of land (ha) / time period of the transition from state. The default is 20 yrs.

It was assumed that the average transfer rate into the litter pool is equal to the transfer rate out of the litter pool so the net change is zero. This assumption means that magnitude of the litter pool need not be quantified.

As for the mineral soils, the calculation used was:

Annual change in carbon stocks in mineral soils tonnes Cyr^{-1}= (stable soil organic carbon stock, under previous state, tonnes C ha^{-1}– stable soil organic carbon stock, under current tonnes C ha^{-1}) * size of land (ha)/ time period of transition from state.

The same as in other perimeters the default is 20 years. Under Tier 1 it is assumed that when forest remains forest the carbon stock in soil organic matter does not change regardless of changes in forest management, types and disturbance regimes in other words that the carbon stock in mineral soil remains constant as long as the land remains forest.

Using Tier 1, no net gains as gain is equal to loss. As it was mentioned previously in Malta there are no harvested wood products in forest remaining forest. Data on wildfires that happen in this category is not available so in the CRF is NE.

7.2.1.4 Land-use definitions and the classification system used and their correspondence to the LULUCF categories

For the moment Malta is using the IPCC definitions which are open and vast but it is planned for the next submission that a national definition will be set and there will be a clear line on certain issues that arise especially on a size of forest. All this is continuously being discussed with the responsible Ministry and related entities. For this submission Forest land includes all land with woody vegetation consistent with thresholds used to define the forest land in the national GHG inventory by ecosystem type as specified in the IPCC guidelines. According to the CLC 2006 forested areas account for 2.1km^2 (0.7%) on the land cover type in the Maltese Islands [0]. In Malta till present there is no available data on land biomass burning or controlled burning.

7.2.1.5 Source Specific Recalculations

Recalculations for the years 1990 till 2011 are due to revised data on the classification of the land use. Shrubland was removed from this category. Table 7.3 refers to the percentage change.

Table 7-3 Recalculations for sinks in forest remaining forest

ear	Sinks (Gg CO_2) as reported in the 2013 inventory report	Sinks (Gg CO_2 as reported in the 2014 inventory report	Percentage change in reported sinks (%)
1990	-48.68	-5.21	-89.30
1991	-48.68	-5.21	-89.30
1992	-48.68	-5.21	-89.30
1993	-48.68	-5.21	-89.30
1994	-48.68	-5.21	-89.30
1995	-48.68	-5.21	-89.30

1996	-48.68	-5.21	-89.30
1997	-48.68	-5.21	-89.30
1998	-48.68	-5.21	-89.30
1999	-48.68	-5.21	-89.30
2000	-48.68	-5.21	-89.30
2001	-48.68	-5.21	-89.30
2002	-48.68	-5.21	-89.30
2003	-48.68	-5.21	-89.30
2004	-48.68	-5.21	-89.30
2005	-48.68	-5.21	-89.30
2006	-48.68	-5.21	-89.30
2007	-48.68	-5.21	-89.30
2008	-48.68	-5.21	-89.30
2009	-48.68	-5.21	-89.30
2010	-48.68	-5.21	-89.30
2011	-48.68	-5.21	-89.30

7.2.1.6 Source Specific planned improvements

Malta as an improvement plan its going to set a national definition for forest. This will help in reporting the proper areas under the forest. Also in In Malta, data on forestry is scarce or non existent. As for the coming years Malta would like to improve the collection of forest information about the loss of carbon in living biomass in forest land if they fall under this definition. Moreover will also be included the afforestation projects under other land converted to forestland. The afforestation projects aims to regenerate the areas and improve biodiversity. An afforestation project was started in Malta in the year 2005 and through this project indigenous trees are being planted in order to increase the surface area with permanent vegetation. From 2005 till 2012, more than 88,890 trees and shrubs have been planted. There were 4710 trees and shrubs planted in 2012. With a presence of a definition will help if these area falls under the forest or else under the category Settlement.

7.3 Cropland (5B)

7.3.1 Cropland remaining Cropland (5B1)

7.3.1.1 Source Category Description

Under this category, CO_2 emissions from living biomass, dead organic matter and soils, from cropland remaining cropland and other land to cropland have been reported. Removals are almost entirely due to cropland remaining cropland.

In Malta cropland can be split into three categories:

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.

For inventory purpose this category was split between two; the annual crops and the perennial woody crops.

Annual crops are harvested each year, and as from this year it was included. Perennial woody vegetation (e.g. in orchards and vineyards) can store significant carbon in long lived biomass. In this inventory process, only the carbon dioxide removal from land under permanent crops has been estimated. Data is taken from the Census of Agriculture 2010 from the National Statistics Office. Permanent crops and kitchen gardens made up 10.9% and 9.8% of utilised agricultural area (UAA). Permanent crops amounted to 1,318ha and arable crops area amount to 10,523ha.

A significant feature of the Maltese agriculture is that the majority of agriculture holding in Malta and Gozo are relatively small. The main perennial crops taken for this inventory is vineyards as it is the more cultivated and there was not enough time to make the split.

In this year submission there was land converted to cropland from grassland. This was due to the land use classification matrix. As for Field Burning of Agriculture Residues are not reported as the data that is available is not sufficient enough so it is considered as NE.

7.3.1.2 Methodological Issues

Cropland includes all annual crops as well as perennial crops. The change in biomass has from perennial woody crops and annual crops were estimated.

As from this year the methodology used was Method 2 of the IPCC Good Practice Guidance Equation 3.2.4 for the annual increase in carbon stock due to biomass increment. The Joint Research Centre (JRC) provided the dry matter for certain tree species. Vineyards dry matter as it is the most abundant was used for Malta. The split of the crops is one of the main aims for the improvement plan for next submission.

As for the Mineral soils we took the Tier 1 method and it resulted that it is zero so in the CRF is annotated as NE.

Activity data on perennial crops coverage as available from the 1991 Agriculture Census [23] has been used for the years 1990 to 1998, whereas for the years 1999 onwards, the activity data on Perennial crops as published by the National Statistics Office has been made use of [24 - 26, 28, 31, 33,57] .

Liming of agricultural soils is not applicable to Malta as soils have a large calcium carbonate content. Malta soils are leptosols, vertisols, calcisols, luvisols, cambisols, regosols and arensols (data derived from the MALSIS database) [56].

By 2012, the National Statistics Office issued the Agriculture Census which resulted that Cropland area size has changed. The soil organic carbon stock was not estimated due to the fact that no factor was available for category Other Land converted to Cropland in the LULUCF Good Practice Guidance.

7.3.1.3. Source Specific planned improvements

As an improvement plan we need to investigate the common practice in crop-residue burning and the frequency. Also one has to examine the data that is present at the national statistics office and the agriculture department. Investigation on management practices through time needs to be taken into consideration so SOC can be calculated. At present it is equal to zero because till now the management practices were assumed that it remained the same through time. Another task will be that the perennial crops will be split into various crops and by using the JRC method data on emissions and removals will be more accurate.

7.3.1.4 Source Specific Recalculations

Recalculations for the years 1990 till 2012 are due to revised classification of the landuse and the development of the land matrix. Figure 7.4 and Figure 7.5 shows recalculations for the sink in cropland remaining cropland.

Table 7-4 Recalculations for sink in cropland remaining cropland

Year	Sinks (Gg CO_2) as reported in the 2013 inventory report	Sinks (Gg CO_2 as reported in the 2014 inventory report	Percentage change in reported sinks (%)
1990	-7.86	NE	NA
1991	-7.86	-1.55	-80.25
1992	-7.86	-1.55	-80.25
1993	-7.86	-1.55	-80.25
1994	-7.86	-1.55	-80.25
1995	-7.86	-1.55	-80.25
1996	-7.86	-1.55	-80.25
1997	-7.86	-1.55	-80.25
1998	-7.86	-1.55	-80.25
1999	-7.22	-1.55	-78.50
2000	-7.22	-1.55	-78.50
2001	-7.22	-1.55	-78.50
2002	-7.22	-1.61	-77.72
2003	-7.22	-1.67	-76.94
2004	-8.32	-1.72	-79.31
2005	-8.39	-1.78	-78.81
2006	-8.39	-1.83	-78.13
2007	-10.18	-1.89	-81.42
2008	-10.18	-1.95	-80.87
2009	-10.18	-2.00	-80.31
2010	-10.98	-2.06	-81.23
2011	-10.98	-2.12	-80.72

7.3.2 Land converted to Cropland (5B2)

Through an expert judgement land converted to cropland is coming from other grassland. The conversion started as from 2001. There was an increase of 194ha each year. Methodology used was the same as the cropland remaining cropland. Hence in the CRF it is annotated as Included Elsewhere.

7.4 Grassland (5C)

7.4.1 Source Category Description

As from this year shrubland was included in grassland. The reason being that there is no national definition and by using the ipcc definition it falls under grassland. *"This category includes rangelands and pastures land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold use in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category.* As reported in the National Rural Development Strategy 2007-2013 [22], the extensive permanent grass areas or pastures that are typical of most European countries are non-existent in Malta. This is due to the shallow depth of the Maltese soils, the small size of the agriculture land parcels and also because of the prevailing semi-arid climate.

This category is split into other grassland and maquis. The maquis data was taken from the Corine Land Cover 2006 as the sclerophllous vegetation. Moreover as one can notice from the matrix that there were instances were there was cropland converted to grassland.

7.4.2 Methodological Issues

Grassland remaining Grassland

This category included the grazing land and other wood land that do not fulfil the forest definitions. It was assumed that the increase in biomass stocks in a single year is equal to biomass losses from mortality in that same year so in the CRF it was annotated at NE. The change in area of grassland it was assumed to be converted to settlement.

7.4.3 Source Specific planned improvements

As an improvement plan in this category is to formulate a national definition. Moreover more research needs to be done and that it will be reported in more detail in the coming submission.

7.5 Wetlands (5D)

7.5.1 Source Category Description

In the Maltese Islands there are no major wetland areas as defined by the IPCC guidelines and therefore no emissions or removals will be reported for the IPCC source category Wetlands (5D). Wetlands in Malta are mostly salines which are not expected to have a large carbon pool. In the CRF only area is reported.

7.6 Settlements (5E)

7.6.1 Source Category Description

Further to the first UNFCCC review the definition for settlement under the IPCC definition was used. The definition includes all developed land, including transportation infrastructure and human settlement of any size. The land-use category Settlements includes all classes of urban tree formations, namely trees grown along road and streets, in public and private gardens and in cemeteries. This year it was included also with Settlement Remaining Settlement airports, constructions sites, dumpsites, industrial or commercial units, port areas and sport, leisure facilities.

7.6.2 Methodological Issues

Only the areas (ha) are reported under this category the reason being is that certain parameters are missing. Area is reported in the CRF.

7.6.3 Source Specific planned improvements

It is planned that in the coming years this category will be reported.

7.7 Other Land (5F)

7.7.1 Source Category Description

This section includes bare soil, rock, and all unmanaged land areas that do not fall into any other five categories. It allows the total of identified land areas to match the national area, where data are available. Change in carbon stocks and non-CO_2 emissions and removals are not considered, assuming that it is typically unmanaged. [42] In this case for Malta mineral extraction sites are in this category. Area is reported in the CRF.

7.8 Other (5G)

This sector does not occur in Malta.

Chapter 8. WASTE (CRF Sector 6)

8.1 Overview of the Sector

In the waste sector, emissions generated from waste management practices over the period 1990 to 2012 are presented. Emission sources include Solid waste disposal (6A), Wastewater handling (6B), Waste incineration (6C) and Compost production (6D).

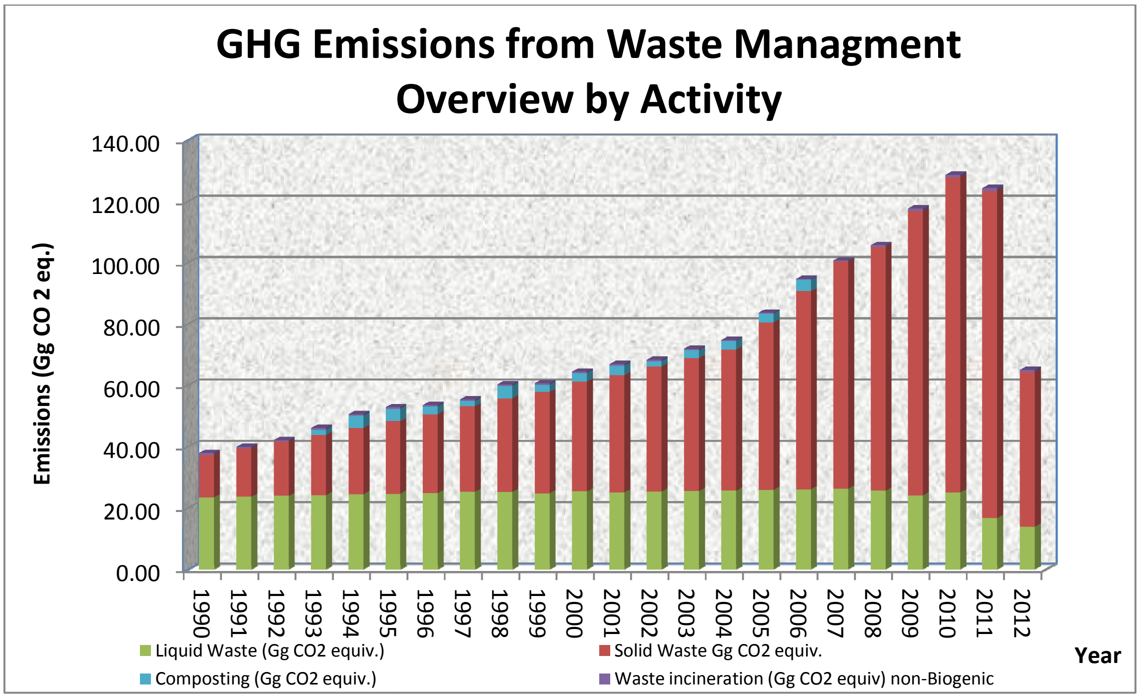

Figure 8-1 Total emissions for waste sector

Figure 8-1 depicts the main trends in emissions, in terms of CO_2 equivalents, from the various waste categories for the years 1990 to 2012. The waste sector contributes 2.1% to the total GHG inventory emissions. Within this sector, the largest portion of emissions for the reporting year 2012 results from the solid waste category (77.4%), the emissions from this sector trended upwards throughout the period because of the unmanaged practices which were used in the first part of the period, later on (from 2004 onwards) managed practices were being implemented and are now resulting into reduction in emissions, this thanks to better gas collection and flaring. This is especially relevant for 2012. Second to SWDS, the contribution from liquid waste (21.4%) is due mainly to human sewage and wastewater management. Up to 2011 a part of or nearly all of Wastewater went untreated, in 2012, all plants for wastewater treatment were fully online and stabilised, this resulting in a 100% wastewater treatment and a significant drop in emissions. A much less significant contribution to emissions resulted from waste incineration (1.2%). Composting is a practice which was relevant for a short period in the time-series covered by this inventory. As explained later on in this chapter Composting was carried out at a relevant scale in the period 1994-2006. Greenhouse gas emissions have increased by 41.2% from 1990 to the year 2000, with a change in trend in the latest years, where a decrease in emissions resulted in a contained increase of 0.9% in 2012 over 1990.

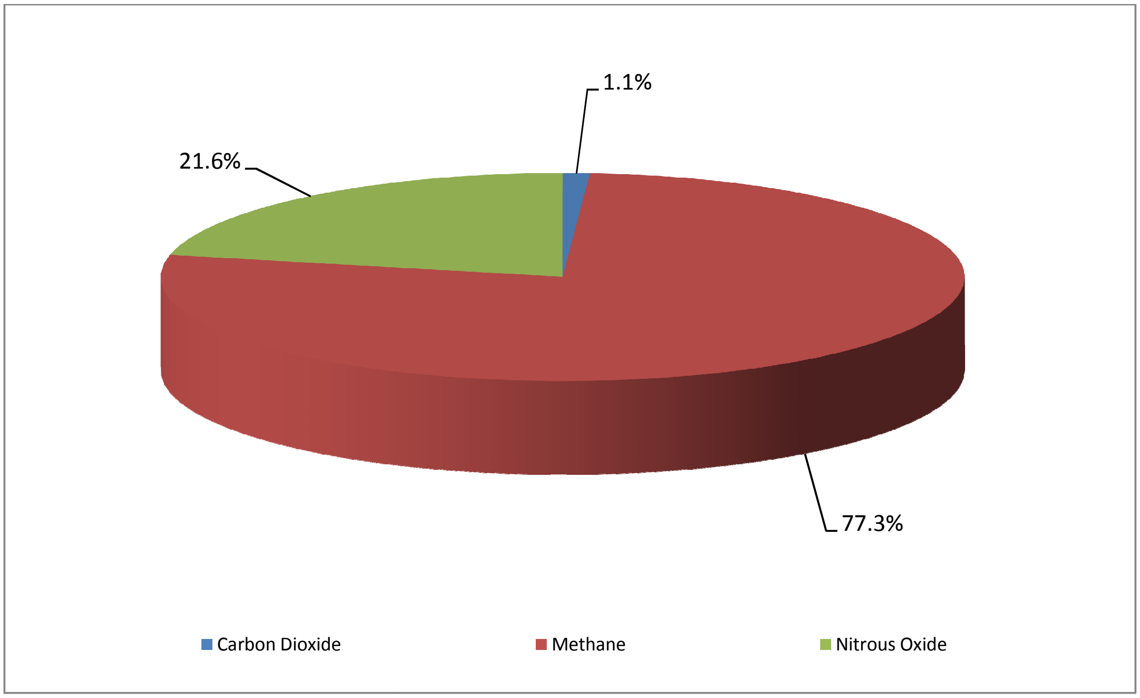

Figure 8-2 GHG emissions for Waste (in % share by gas, based on CO_2 equivalents)

Figure 8-2 GHG emissions for Waste (in % share by gas, based on CO2 equivalents)

shows the percentage contribution in carbon dioxide equivalents of carbon dioxide, methane and nitrous oxide emissions in the year 2012 from the waste sector. The waste sector largely comprises methane emissions that mainly result from solid waste disposal. Waste management practices are currently being reviewed with newer technologies being planned and implemented mainly in the solid waste treatment, with an increased amount or organic fraction being directed to alternative processes (such as Biodigestion, 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.

- *Waste generation trends*

A general overlook to the waste generation trends locally shows a relative stability in the totals of waste disposed (excluding recycled waste). The amount of waste being landfilled has stabilised at present following a sharp decrease in previous years, though it is expected to further decrease in view of the implementation of number of measures related to increased recycling, treatment of waste and diversion from landfilling. The figure below illustrates this scenario.

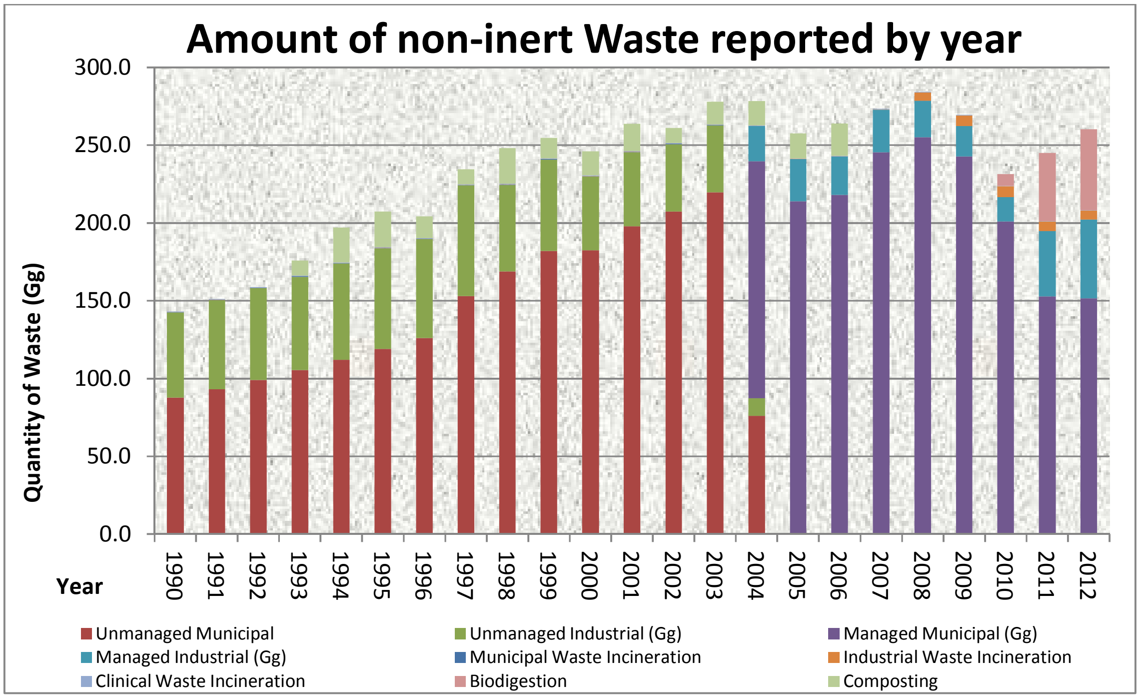

Figure 8-3 Waste disposal trends

8.2 Solid Waste Disposal on Land (6A)

8.2.1 Source Category Description

Solid waste disposal on land in Solid Waste Disposal sites (SWDSs) leads to CH_4 emissions. From 1990 to 1996, solid waste was deposited into three unmanaged landfills: 'Magħtab' and 'Wied Fulija' in Malta and 'Qortin' in Gozo. In 1997 waste stopped being deposited at Wied Fulija and thereafter, until 2004, all the waste generated between the years 1997 to 2004 was deposited at Magħtab and Qortin. Eventually, from 2004, waste deposition in unmanaged landfills stopped and between the period 2004 and 2006 the waste was deposited at the Ta' Żwejra managed landfill. The Għallis non-hazardous managed landfill has been operational since 2007. Magħtab, Żwejra and Għallis landfills form part of the Magħtab complex and are geographically adjacent to each other. Magħtab, Wied Fulija, Qortin, Żwejra and Għallis Landfills are under the responsibility of one operator, namely Wasteserv Malta Ltd. The Operator is responsible for the permitting reporting of the closed sites.

As from the year 2008, the Regenerative Thermal Oxidiser (RTO) gas compound at the Magħtab environmental complex has become operational, following that combined heat and power (CHP) generation facility was also installed in the same area to generate energy from the landfill gases oxidised. Methane generated in the Magħtab landfill is being directed to the RTO. Gases from other landfills in the complex are being directed to the CHP for energy purposes. Through ongoing communication with Wasteserv Malta Ltd, 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 Qortin Landfill. In 2012 Wasteserv Malta Ltd scaled up the collection of gas from Għallis landfill, which increased greatly the amount of gas being flared on site. This was the main reason behind the greatly reduced emissions from the sector. 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.

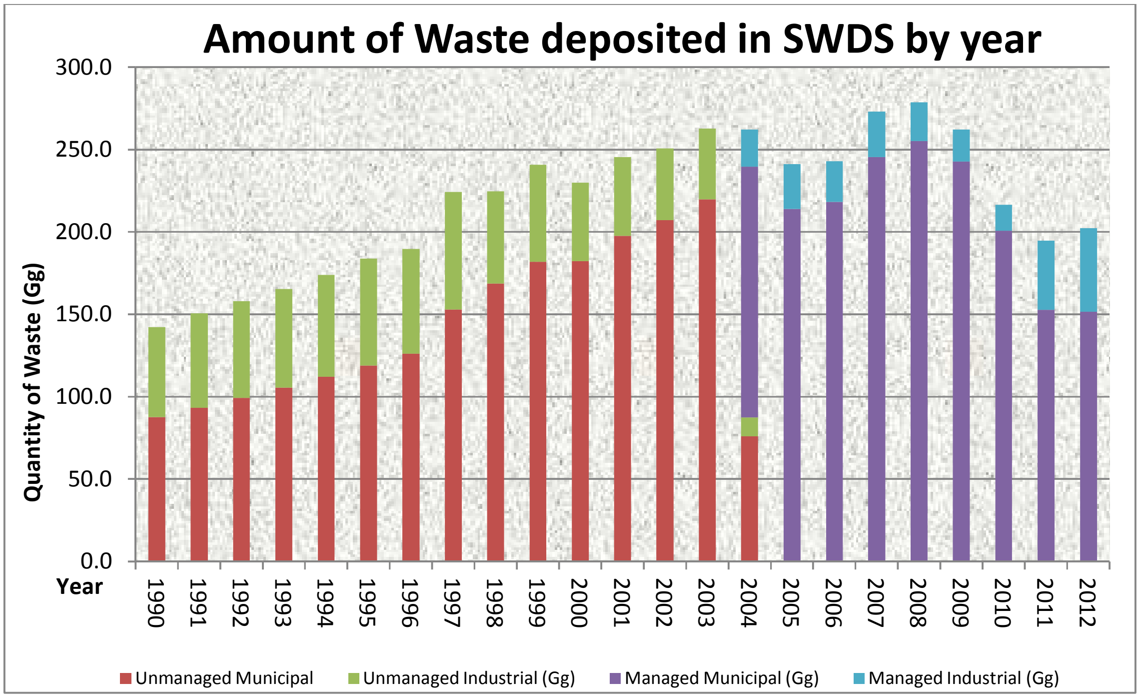

Figure 8-4 Amounts of waste deposited in SWDS by SWDS type

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 8-4 above a significant decrease in the amounts of municipal and industrial waste land filled is visible from 2009 onwards.

For the years prior to 1997 Activity data was extrapolated using GDP and population, and waste/capita, waste/GDP data available. The data was back extrapolated to 1950.

Figure 8-4 shows the per capita waste deposited in SWDSs which showed a net positive trend from 1990 onwards but showed a decrease from 2009.

8.2.2 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 1996 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. Waste generation levels were calculated using back extrapolation of GDP (for industrial waste and population data for municipal waste. The extrapolation is based on UN data on population and GDP as referred to in 3.2.2 of the 2006 IPCC Guidelines Volume 5 [2]. Actual data (1997-2010) on population, GDP and waste generated were used to calculate Generation rates (per unit GDP for industrial and per million inhabitants for Municipal. The results were then back extrapolated to estimate historic rates of waste production. These rates were then multiplied by the relevant factor to obtain an estimate of the waste produced.

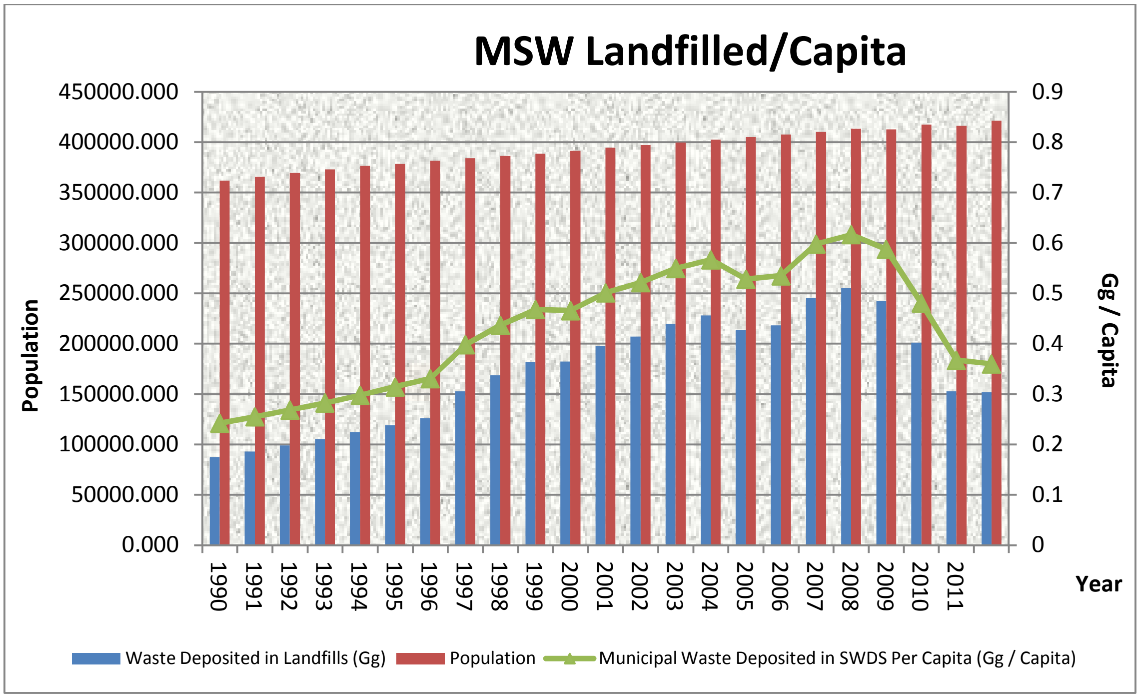

Figure 8-5 Solid waste deposited in SWDSs per capita

The following parameters have been chosen in the spreadsheet model used:

- 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
    - 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 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) = 0.6
- Oxidation Factor (OX) (managed)= 0

- % content of paper in industrial waste = 14%
- % content of wood in industrial waste = 5%

It is notable that the OX factor for unmanaged waste deposition sites is set to a higher value than that stipulated in the guidelines. This modification is based on the findings of a study carried out on behalf of the operator following the installation of the Regenerative Thermal Oxidation (RTO) plant in Magħtab, which claims that more than 50% of the landfill gas produced is actually treated by the RTO and 90% of the methane treated is actually destroyed. Additionally the findings in the study above are in line with the findings in Oonk (2012), where the RTO collection efficiency varies between 45-75%.

Based on statistics for 2008, where 0.619 Gg of methane were treated by the RTO, It is also noted that during surface monitoring for the study mentioned prior, a relatively low CH_4 content and a high CO_2 content of the deep well emissions has been identified. These findings were submitted to Prof. Alfred Vella of the University of Malta, following which an expert judgment was issued stating that:

- Oxidation is evidently occurring at the sub-surface levels of the landfill which is more efficient than the biological oxidation process which occurs at the surface of the landfill. To account for this effect the OX factor has to account for oxidation other than simply surface oxidation.
- Estimates suggest an oxidation factor of 0.6 would be adequate and would near the true value.

To date little or no evidence is available to reflect this same finding in managed landfills.

Additionally the findings in the study above are in line with the findings in Oonk (2012), where the RTO collection efficiency varies between 45-75%.

Municipal waste composition data from waste composition surveys of 2002 and provisional data from 2011[12] used to calculate waste composition. Below Table 8-1 illustrates the results of the two reports mentioned above:

Table 8-1 NSO Municipal waste composition survey 2002 and 2011 results

	Survey results %	
	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

[12] Base on National Statistics Office News Release 156/2012

Data from these reports was used in the model as illustrated below in Table 8-2 below:

Table 8-2 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

The parameters in Table 8-2 were only used in managed waste data, this 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 it is also included the landfilling of industrial waste and waste water sludge from aerobic treatment of waste.

Uncertainty is estimated using IPCC good practice, 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 gate.

Uncertainty issues for SWDS		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 CH4 generated at Landfill		5.00%	5.00%
OX factor		NA	50.00%
Half life		20.00%	20.00%
Totals		24.87%	76.10%

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

8.2.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

8.3 Wastewater Handling (6B)

8.3.1 Source Category Description

The sub-category Domestic and Commercial Wastewater (6B2) includes methane emissions from wastewater handling and indirect nitrous oxide emissions from human sewage. Carbon dioxide emissions from wastewater are not considered in the IPCC Guidelines because such emissions from the wastewater are of biogenic origin and should not be estimated or included in national total emissions [2].

Malta's sewerage infrastructure consists of two main networks that collect both domestic and industrial wastewaters, as well as some storm water runoff. During the inventory years 1990 till 2007, a single sewage treatment plant was in operation and catering for a fraction of the total sewage generated on the Maltese Islands. The sewerage 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 being reflected in an increase in the percentage of treated sewage in the year 2008 and 2010, when compared to earlier years. The third and largest plant came in operation in late 2010 and was fully operational in 2011. This is very visible in the reduction of methane emissions in 2011 compared to other years. These infrastructural developments represent treatment of all sewage generated, resulting in no emissions of methane from this source category,

Emissions from the wastewater category contribute 13.18% of the emissions in the waste sector. 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 done since no data specific to this period is available. For the years 2007 onwards, annual wastewater generation and treatment figures have been provided by the Water Services Corporation.

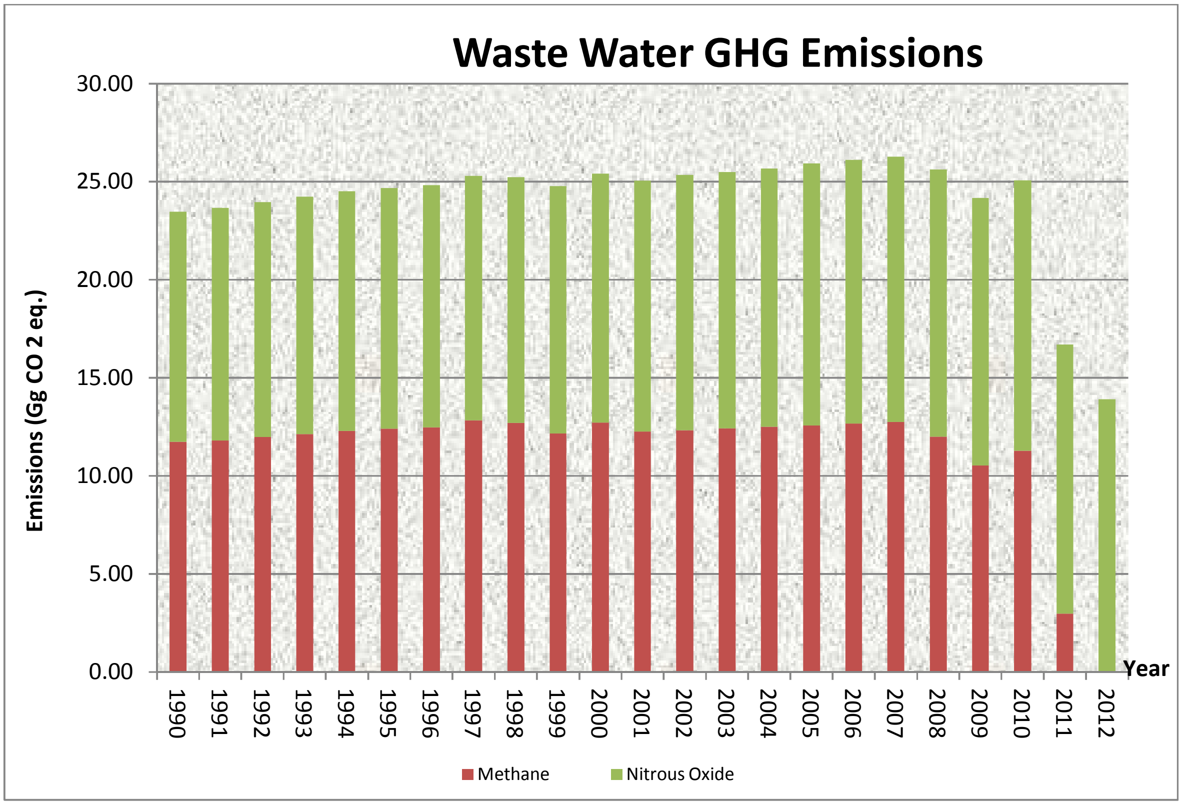

Figure 8-6 Waste water GHG emissions

8.3.2 Methodological Issues

- *Indirect Nitrous Oxide Emissions from Human Sewage*

For the reporting period 1990 to 2011, indirect nitrous oxide emissions from human sewage have been worked out using the calculation template from the 1996 IPCC Guidelines [1], as presented in Figure 8-7.

MODULE	WASTE				
SUBMODULE	INDIRECT NITROUS OXIDE EMISSIONS FROM HUMAN SEWAGE				
WORKSHEET	6-4				
SHEET	1 OF 1				
	A Per Capita Protein Consumption (Protein in kg/person/yr)	B Population (number)	C Fraction of Nitrogen in Protein $Frac_{NPR}$ (kg N/kg protein)	D Emission factor EF_6 (kg N_2O-N/kg sewage-N produced)	E Total Annual N_2O Emissions (Gg N_2O/yr)
					$E = (A \times B \times C \times D) \times 44/28 \times 10^{-6}$
Total					

Figure 8-7 Example Calculation for N_2O emissions from Waste Water

The following sources of data were used for the respective parameters:

Per Capita Protein Consumption: Protein supply in Maltese diet – Based on FAO data
Population: Maltese population figures [51]
Fraction of Nitrogen in Protein: Default IPCC 1996 - 0.16 kg N / kg protein
Emission Factor: Default IPCC 1996 - 0.01 kg N_2O-N / kg sewage-N produced

- *Methane Emissions from Wastewater*

Wastewater can be a source of methane when treated or disposed of anaerobically. In Malta the sewers are closed and underground, but are not believed to be a significant source of CH_4 emissions. For the local scenario, emissions from domestic and industrial wastewater have been calculated in aggregated form, since the local sewage consists of a mixture of both sources. The IPCC 2006 calculation for CH_4 emissions from wastewater is being adapted taking into consideration the treated sewage and untreated sewage fraction, where for the treated sewage fraction of the wastewater the Methane Correction Factor (MCF) is taken to be zero and therefore resulting in nil emissions.

Where relevant, the calculation of CH_4 emissions from the untreated fraction of the wastewater has been worked out as follows:

Step 1: The sewage generation rate in m^3/capita/year is determined for the years 1992 and 2005/6.

Sewage Generation Rate of 1992	
Total Population in 1992 [51]	369 455
Untreated Sewage (m3) [52]	24 787 000
Sant Antnin Sewage Treated (m^3) [52]	1 587 000
Total Sewage in 1992 (m^3)	26 374 000
Rate	71.39 m^3/capita/year
Sewage Generation Rate of 2005/6	
Average Total Population for 2005/6 [51]	406 408
Sewage Daily in 2005/6 (m^3/day) (Water Services Corporation, as provided in 2007)	61 700
Total Sewage (m^3) (2005/6)	22 520 500
Rate	55.41 m^3/capita/year

Step 2: Through the use of annual population figures, the sewage generation rate for 1992 is used to calculate the total sewage generated annually in the period 1990 till 2000. The rate of sewage generation for 2005/2006 is used to calculate the sewage generation in the period 2001 to 2006. For the year 2007, annual wastewater generation and treatment figures have been provided by the Water Services Corporation.

Step 3: Calculation of the Total Organics in the Wastewater (TOW):

TOTAL ORGANICALLY DEGRADABLE MATERIAL IN DOMESTIC WASTEWATER
$TOW = P \bullet BOD \bullet 0.001 \bullet I \bullet 365$

where:

TOW = total organics in wastewater in inventory year (kg BOD/yr)
P = country population in inventory year (persons)
BOD = country-specific per capita Biological Oxygen Demand in inventory year (g/person/day), where the Biological Oxygen Demand for Raw Sewage (520.43g/m^3) as per Gauci [7] is used
0.001 = conversion from grams BOD to kg BOD
I = correction factor for additional industrial BOD discharged into sewers = 1.25 [1]

Step 4: Calculation of CH_4 Emissions:

$$\text{Emissions (kg } CH_4\text{)} = TOW * A * B * C$$

where:

A = Maximum methane producing capacity (kg CH_4/kg BOD) = 0.6 [1]
B = Methane Correction Factor for Untreated Sewage = 0.1 [1]
C = Fraction of waste not treated by the handling system

Year	Total Organics in wastewaters (TOW in kg BOD/year)	Maximum methane producing capacity (kg CH_4/kg BOD)	Methane Correction Factor for Untreated Sewage	Fraction of waste not treated by the handling system	Methane Emissions (Gg CH_4)
1990	16806797.72	0.6	0.1	0.94	0.95

- *Emissions from wastewater sludge*

Emissions from waste water sludge is accounted for in Solid Waste Disposal to Land (6A) since all wastewater sludge which is generated is currently being landfilled (refer to section 0).

8.3.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

8.4 Waste Incineration (6C)

8.4.1 Source Category Description

Waste incineration is defined as the combustion of solid and liquid waste in controlled incineration facilities. In the period 1990 to 2008 the contribution from waste incineration to the total emissions in the waste sector is minimal. 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). 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 due to the lacking and unregulated infrastructure which was in place at the time.

A major improvement took place in early 2008 with the commissioning of a Thermal Treatment Facility that treats waste by incineration at high temperatures. This incinerator allowed for the decommissioning of old non-compliant local incinerators.

Figure 8-8 shows the emissions in CO_2 equivalents from the combustion of municipal, clinical and industrial waste. The major source of emissions is the combustion of Clinical waste over the years until 2007, whereas from 2008 onwards Industrial waste incineration (primarily abattoir waste and meat processing industry waste incineration) seized as the major source of emissions. Municipal waste combustion is being reported for the years 1990 to 2003 and 2008 to 2011. The interim between the latter sets is due to the unavailability of waste treatment facilities.

Figure 8-9 includes the indirect emissions from the combustion of municipal, clinical and industrial waste.

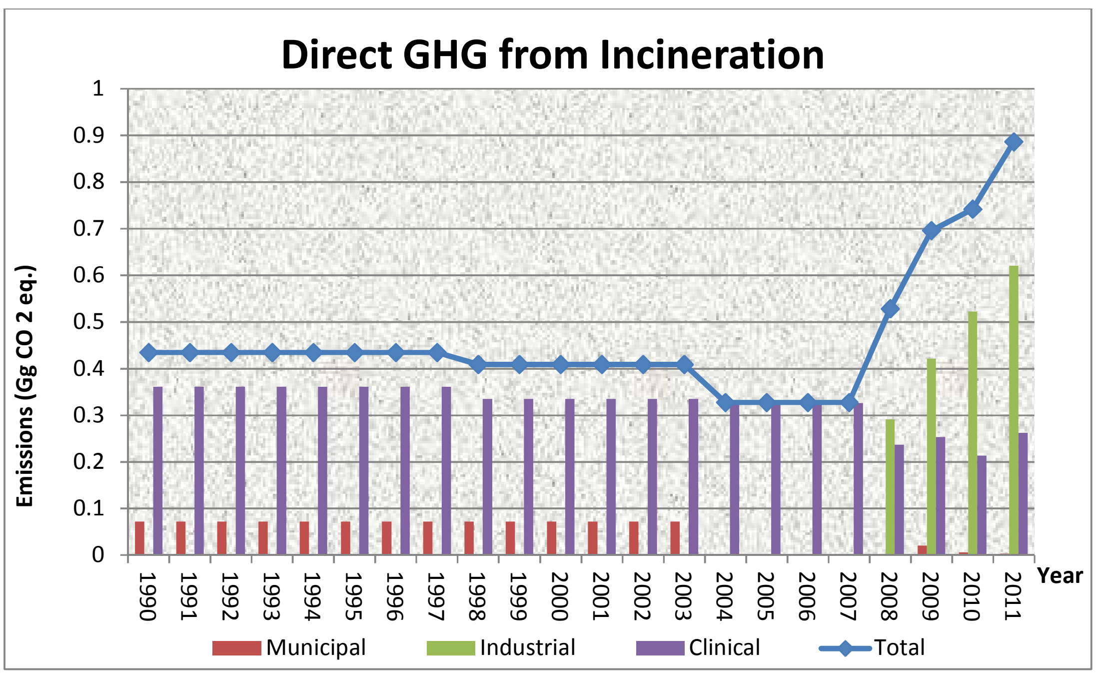

Figure 8-8 Direct GHG emissions from incineration

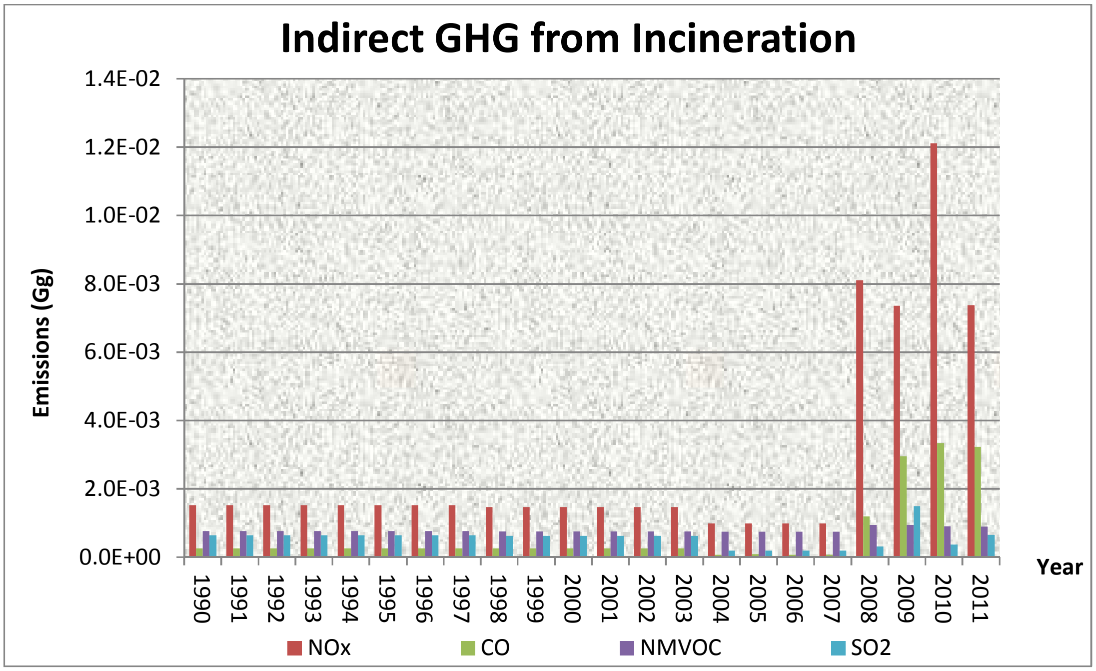

Figure 8-9 Indirect GHG emissions from incineration

8.4.2 Methodological Issues

- *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.
- 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 8-3 for the year 1990.

Table 8-3 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 [2].

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 [11]. 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 MEPA each end of 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. The following Table 8-4 illustrated the emission factors used.

Table 8-4 Emission factors for indirect GHGs in incineration

Year	**NO_x**	**CO**	**NMVOC**	**SO_2**
2008	1.427651466	0.210435193	0.166072	0.05630373
2009	1.024760875	0.410684483	0.131448	0.207989123
2010	1.669023434	0.459281732	0.124069	0.051238336
2011	1.14354485	0.499764569	0.138538	0.101359305

- *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 [53]. 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 [52] 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 the Table 8-5 for the year 1990.

Table 8-5 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 [11]. Following 2007 emissions factors listed in Table 8-4 were used.

- *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 were incinerated annually (personal communication, Private industry, October 2007). Details of this private facility are not listed for reasons of data protection.

For the year 2008, emissions from the incineration of about 5.4Gg industrial waste at the Thermal Treatment Facility, of which 0.081Gg of fossil origin are being reported.

For the Year 2009, emissions from the incineration of circa 6.9Gg industrial waste, of which 0.14Gg of fossil origin, are being reported.

CO_2 incineration emissions are calculated using the default IPCC 2006 method, as presented in Table 8-6 for the year 1990.

Table 8-6 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 [2].

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 [11]. Following 2007 emissions factors listed in Table 8-4 were used.

8.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

8.5 Other Waste - Biological treatment of solid Waste (6D)

8.5.1 Composting

8.5.1.1 Source Category Description

In this section methane and nitrous oxide emissions from compost production are reported. 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 land filled.

The organic fraction was composted using the open window system with the product raw compost being refined and left in the open to mature [54]. 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 very early 2007 and is presently undergoing an upgrading process and thus emissions for this sub-category are not being reported for the year 2007 onwards.

8.5.1.2 Methodological Issues

Data on biological solid waste treated at 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- 0.3 g N_2O/kg waste composted) respectively.

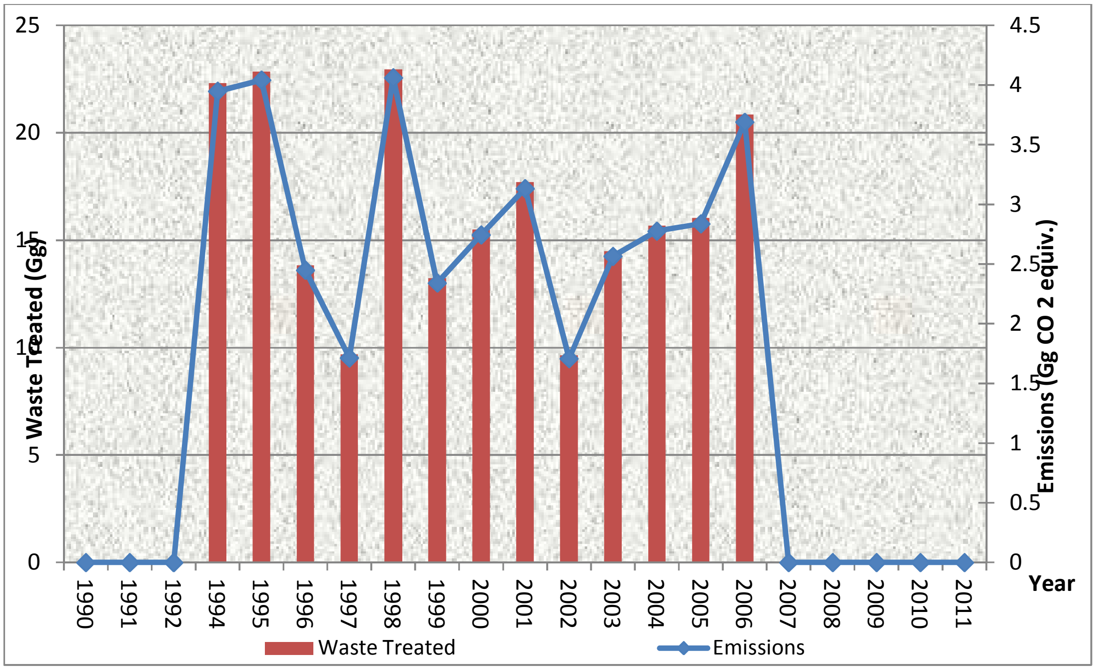

Figure 8-10 Waste treated and emissions from Composting

Figure 8-10 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.

8.5.1.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

8.5.2 Anaerobic Biodigestion of Waste

8.5.2.1 Source 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 in operation one plant (S. Antnin Waste treatment plant) operating this process. The operator of the plant (WasteServ Malta Ltd) is the same operator as for the operational 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 elsewhere treated.

8.5.2.2 Methodological Issues

The calculation used is based on a 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 and the proportion of which is used for energy is transferred to the specific sub sector in the energy sector. In 2012, 433 tons of CH4 were flared through this process, most of which is used for energy generation, though mainly for self use, thus 0% of the emissions was transferred to Energy sector.

8.5.2.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

8.5.3 Biogenic Emissions from Waste

8.5.3.1 Source 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. In recent years the amount of emissions considered of biogenic origin have increased drastically mainly because of the changes in waste management practices and implementation of flaring in closed landfills. Prior to 2008 only a very small fraction of waste was incinerated as described in section 0.

8.5.3.2 Methodological Issues

The major contributors of Biogenic CO_2 in the waste sector are incineration of non-fossil fraction 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 8-11 summarises the emission of Biogenic CO_2 from 1990.

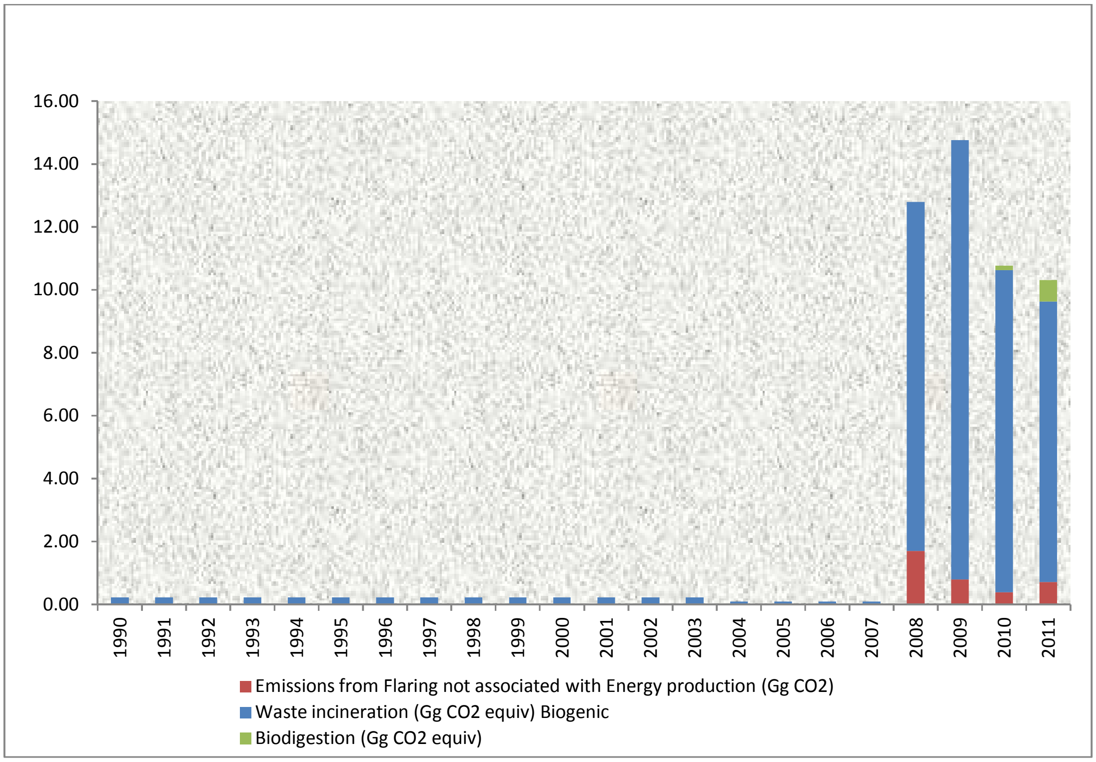

Figure 8-11 CO2 Emissions of biogenic origin from Waste processes

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 [2]. From 2007 onwards the estimation was done using the distribution and types of waste actually incinerated.

8.5.5.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

Chapter 9. OTHER (CRF Sector 7)

For this submission, no greenhouse emissions or removals have been estimated that do not fall within the scope of any of the sectors and source categories described in Chapters 3 to 9.

Chapter 10. RECALCULATIONS AND IMPROVEMENTS

Efforts have been made to continuously improve the national GHG inventory. Such improvements result in recalculations in the reported emissions along the inventory time series. Recalculations are presented in the individual sectors' chapters, as well as in the CRF tables Table 8(a) and Table 8(b).

Additionally, Table 10-1 below documents the major changes in methodological descriptions as compared to the previous inventory submission.

Table 10-1 Major Changes in Methodological Descriptions

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries			
2. Manufacturing Industries and Construction			
3. Transport	√	√	COPERT methodology was implemented for the years 2010-2012
4. Other Sectors			
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products			
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6			
G. Other			

3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation	√	√	Animal numbers have been revised using statistical methodologies.
B. Manure Management	√	√	Animal numbers have been revised using statistical methodologies.
C. Rice Cultivation			
D. Agricultural Soils	√	√	Animal numbers have been revised using statistical methodologies; estimates have been provided for emission from N-fixing crops and crop residues.
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land	√	√	Shrubland was removed from this category into Grassland.
B. Cropland	√	√	Emissions from biomass for perennial and annual cropland were calculated.
C. Grassland			
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land			
B. Waste-water Handling			
C. Waste Incineration			

D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO_2 Emissions from Biomass			

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A1 ANNEX 1: KEY CATEGORIES

A1-1 Key category level assessment

Table A1-0-1 Key category level assessment: 1990 with-LULUCF

IPCC Source Categories		Activity	GHG	Base Year Estimate (Gg CO2 eq.) 1990	Current Year Estimate (Gg CO2 eq.) 1990	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	710.73	0.36	**0.36**
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CO2	617.92	617.92	0.32	**0.68**
1A3b	Road Transportation	All fuels	CO2	333.26	333.26	0.17	**0.85**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	61.58	0.03	**0.88**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	35.00	0.02	**0.90**
1A4b	Residential	All fuels	CO2	34.55	34.55	0.02	**0.92**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	27.38	0.01	**0.93**
4A1	Cattle	Population Size	CH4	15.18	15.18	0.01	**0.94**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	13.94	13.94	0.01	**0.94**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	13.92	0.01	**0.95**
4B8	Swine	Population Size	CH4	12.94	12.94	0.01	0.96
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.74	11.74	0.01	0.96
6B	Domestic and Commercial Wastewater	Population Size	CH4	11.73	11.73	0.01	0.97
1A3d	Navigation	Liquid Fuel	CO2	8.42	8.42	0.00	0.97
4B1	Cattle	Population Size	CH4	6.54	6.54	0.00	0.98
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	6.09	6.09	0.00	0.98

5A1	Forest Land	Land Coverage	CO2	-5.21	-5.21	0.00	0.98
1A3b	Road Transportation	All fuels	N2O	5.07	5.07	0.00	0.99
4B9	Poultry	Population Size	CH4	3.69	3.69	0.00	0.99
4A9	Poultry	Population Size	CH4	3.15	3.15	0.00	0.99
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	3.04	3.04	0.00	0.99
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	2.48	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.48	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	2.21	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.00	2.00	0.00	1.00
4A8	Swine	Population Size	CH4	1.94	1.94	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	1.73	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.69	1.69	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	0.71	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	0.58	0.58	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.37	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.36	0.00	1.00
4A3	Sheep	Population Size	CH4	0.35	0.35	0.00	1.00
4A4	Goats	Population Size	CH4	0.18	0.18	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.18	0.18	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.17	0.17	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.17	0.17	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.14	0.14	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CH4	0.14	0.14	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.08	0.08	0.00	1.00

1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.07	0.07	0.00	1.00
1A4b	Residential	All fuels	CH4	0.06	0.06	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.05	0.05	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.05	0.05	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.03	0.03	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.03	0.03	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.03	0.03	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.02	0.02	0.00	1.00
1A4b	Residential	All fuels	N2O	0.02	0.02	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.02	0.02	0.00	1.00
4B3	Sheep	Population Size	CH4	0.01	0.01	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.01	0.01	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	0.01	0.00	1.00
4B4	Goats	Population Size	CH4	0.01	0.01	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.00	0.00	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CH4	0.00	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.00	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.00	0.00	0.00	1.00
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	0.00	0.00	1.00
2F2	Foam Blowing	Consumption Figures	HFCs	0.00	0.00	0.00	1.00
2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	0.00	0.00	1.00

2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	SF6	0.00	0.00	0.00	1.00
5B1	Cropland	Land Coverage	CO2	0.00	0.00	0.00	1.00
5E1	Settlements	Land Coverage	CO2	0.00	0.00	0.00	1.00
5F	Other Land	Land Coverage	CH4	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00

Table A1-0-2 Key category level assessment: 1990 without-LULUCF

IPCC Source Categories		Activity	GHG	Base Year Estimate (Gg CO2 eq.) 1990	Current Year Estimate (Gg CO2 eq.) 1990	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	710.73	0.36	**0.36**
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CO2	617.92	617.92	0.32	**0.68**
1A3b	Road Transportation	All fuels	CO2	333.26	333.26	0.17	**0.85**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	61.58	0.03	**0.88**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	35.00	0.02	**0.90**
1A4b	Residential	All fuels	CO2	34.55	34.55	0.02	**0.92**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	27.38	0.01	**0.93**
4A1	Cattle	Population Size	CH4	15.18	15.18	0.01	**0.94**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	13.94	13.94	0.01	**0.95**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	13.92	0.01	**0.95**
4B8	Swine	Population Size	CH4	12.94	12.94	0.01	0.96
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.74	11.74	0.01	0.97
6B	Domestic and Commercial Wastewater	Population Size	CH4	11.73	11.73	0.01	0.97
1A3d	Navigation	Liquid Fuel	CO2	8.42	8.42	0.00	0.98
4B1	Cattle	Population Size	CH4	6.54	6.54	0.00	0.98
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	6.09	6.09	0.00	0.98
1A3b	Road Transportation	All fuels	N2O	5.07	5.07	0.00	0.99
4B9	Poultry	Population Size	CH4	3.69	3.69	0.00	0.99
4A9	Poultry	Population Size	CH4	3.15	3.15	0.00	0.99

1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	3.04	3.04	0.00	0.99
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	2.48	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.48	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	2.21	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.00	2.00	0.00	1.00
4A8	Swine	Population Size	CH4	1.94	1.94	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	1.73	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.69	1.69	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	0.71	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	0.58	0.58	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.37	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.36	0.00	1.00
4A3	Sheep	Population Size	CH4	0.35	0.35	0.00	1.00
4A4	Goats	Population Size	CH4	0.18	0.18	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.18	0.18	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.17	0.17	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.17	0.17	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.14	0.14	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CH4	0.14	0.14	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.08	0.08	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.07	0.07	0.00	1.00
1A4b	Residential	All fuels	CH4	0.06	0.06	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.05	0.05	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.05	0.05	0.00	1.00

4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.03	0.03	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.03	0.03	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.03	0.03	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.02	0.02	0.00	1.00
1A4b	Residential	All fuels	N2O	0.02	0.02	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.02	0.02	0.00	1.00
4B3	Sheep	Population Size	CH4	0.01	0.01	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.01	0.01	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	0.01	0.00	1.00
4B4	Goats	Population Size	CH4	0.01	0.01	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.00	0.00	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CH4	0.00	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.00	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.00	0.00	0.00	1.00
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	0.00	0.00	1.00
2F2	Foam Blowing	Consumption Figures	HFCs	0.00	0.00	0.00	1.00
2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	0.00	0.00	1.00
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	PFCs	0.00	0.00	0.00	1.00

2F9	Other (Medical Applications)	Consumption Figures	SF6	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00

Table A1-0-3 Key category level assessment: 2012 with-LULUCF

IPCC Source Categories		Activity	GHG	Base Year Estimate (Gg CO2 eq.) 1990	Current Year Estimate (Gg CO2 eq.) 2012	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	1,818.08	0.58	**0.58**
1A3b	Road Transportation	All fuels	CO2	333.26	491.40	0.16	**0.74**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	232.37	0.07	**0.82**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	161.88	0.05	**0.87**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	72.99	0.02	**0.89**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	67.24	0.02	**0.91**
1A4b	Residential	All fuels	CO2	34.55	49.83	0.02	**0.93**
1A3d	Navigation	Liquid Fuel	CO2	8.42	32.87	0.01	**0.94**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	13.94	27.31	0.01	**0.95**
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	22.80	0.01	0.96
4A1	Cattle	Population Size	CH4	15.18	22.62	0.01	0.96
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	19.71	0.01	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.74	13.91	0.00	0.97
4B1	Cattle	Population Size	CH4	6.54	9.73	0.00	0.98
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	9.60	0.00	0.98
4B8	Swine	Population Size	CH4	12.94	9.49	0.00	0.98
5A1	Forest Land	Land Coverage	CO2	-5.21	-5.21	0.00	0.99
1A3b	Road Transportation	All fuels	N2O	5.07	5.03	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	4.37	0.00	0.99
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	6.09	4.27	0.00	0.99

2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	3.16	0.00	0.99
2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	2.26	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.04	0.00	0.99
5B1	Cropland	Land Coverage	CO2	0.00	-2.01	0.00	0.99
4B9	Poultry	Population Size	CH4	3.69	1.97	0.00	0.99
4A3	Sheep	Population Size	CH4	0.35	1.97	0.00	0.99
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	1.90	0.00	1.00
4B12	Liquid Systems	Manure Generation	N2O	2.21	1.72	0.00	1.00
4A9	Poultry	Population Size	CH4	3.15	1.68	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	0.58	1.48	0.00	1.00
1A3b	Road Transportation	All fuels	CH4	2.00	1.46	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.69	1.43	0.00	1.00
4A8	Swine	Population Size	CH4	1.94	1.42	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	1.30	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.74	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.62	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.07	0.58	0.00	1.00
4A4	Goats	Population Size	CH4	0.18	0.51	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	0.47	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.02	0.20	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.03	0.18	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.08	0.17	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.17	0.16	0.00	1.00
2F2	Foam Blowing	Consumption Figures	HFCs	0.00	0.15	0.00	1.00

2A6	Road Paving with Asphalt	Product Use	CO2	0.00	0.14	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.14	0.12	0.00	1.00
1A4b	Residential	All fuels	CH4	0.06	0.10	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.09	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.02	0.08	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.18	0.08	0.00	1.00
4B3	Sheep	Population Size	CH4	0.01	0.07	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.00	0.06	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.03	0.06	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.00	0.06	0.00	1.00
1A4b	Residential	All fuels	N2O	0.02	0.05	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.01	0.05	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.17	0.03	0.00	1.00
4B4	Goats	Population Size	CH4	0.01	0.02	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.05	0.00	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.05	0.00	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CH4	0.00	0.00	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.03	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CH4	0.14	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CO2	617.92	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	3.04	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00

2F9	Other (Medical Applications)	Consumption Figures	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	SF6	0.00	0.00	0.00	1.00
5E1	Settlements	Land Coverage	CO2	0.00	0.00	0.00	1.00
5F	Other Land	Land Coverage	CO2	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6B	Domestic and Commercial Wastewater	Population Size	CH4	11.73	0.00	0.00	1.00

Table A1-0-4 Key category level assessment: 2012 without-LULUCF

IPCC Source Categories		Activity	GHG	Current Year Estimate (Gg CO2 eq.) 2012	Base Year Estimate (Gg CO2 eq.) 1990	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	1818.08	710.73	0.59	**0.59**
1A3b	Road Transportation	All fuels	CO2	491.40	333.26	0.16	**0.74**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	232.37	27.38	0.07	**0.82**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	161.88	0.00	0.05	**0.87**
1A2	Manufacturing Industries and Construction	All fuels	CO2	72.99	35.00	0.02	**0.89**
1A4a	Commercial/Institutional	All fuels	CO2	67.24	61.58	0.02	**0.92**
1A4b	Residential	All fuels	CO2	49.83	34.55	0.02	**0.93**
1A3d	Navigation	Liquid Fuel	CO2	32.87	8.42	0.01	**0.94**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	27.31	13.94	0.01	**0.95**
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	22.80	0.00	0.01	0.96
4A1	Cattle	Population Size	CH4	22.62	15.18	0.01	0.97
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	19.71	0.00	0.01	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	13.91	11.74	0.00	0.98
4B1	Cattle	Population Size	CH4	9.73	6.54	0.00	0.98
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	9.60	13.92	0.00	0.98
4B8	Swine	Population Size	CH4	9.49	12.94	0.00	0.99
1A3b	Road Transportation	All fuels	N2O	5.03	5.07	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	4.37	1.73	0.00	0.99
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	4.27	6.09	0.00	0.99

2F4	Metered Dose Inhalers	Consumption Figures	HFCs	3.16	0.00	0.00	0.99
2F3	Fire Extinguishers	Consumption Figures	HFCs	2.26	0.00	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.04	2.48	0.00	0.99
4B9	Poultry	Population Size	CH4	1.97	3.69	0.00	0.99
4A3	Sheep	Population Size	CH4	1.97	0.35	0.00	0.99
3D1	Use of N2O for Anaesthesia	Product Use	N2O	1.90	2.48	0.00	1.00
4B12	Liquid Systems	Manure Generation	N2O	1.72	2.21	0.00	1.00
4A9	Poultry	Population Size	CH4	1.68	3.15	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	1.48	0.58	0.00	1.00
1A3b	Road Transportation	All fuels	CH4	1.46	2.00	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.43	1.69	0.00	1.00
4A8	Swine	Population Size	CH4	1.42	1.94	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	1.30	0.71	0.00	1.00
4A6	Horses	Population Size	CH4	0.74	0.36	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.62	0.37	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.58	0.07	0.00	1.00
4A4	Goats	Population Size	CH4	0.51	0.18	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.47	0.01	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.20	0.02	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.18	0.03	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.17	0.08	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.16	0.17	0.00	1.00
2F2	Foam Blowing	Consumption Figures	HFCs	0.15	0.00	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.14	0.00	0.00	1.00

1A4a	Commercial/Institutional	All fuels	N2O	0.12	0.14	0.00	1.00
1A4b	Residential	All fuels	CH4	0.10	0.06	0.00	1.00
4B6	Horses	Population Size	CH4	0.09	0.04	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.08	0.02	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.08	0.18	0.00	1.00
4B3	Sheep	Population Size	CH4	0.07	0.01	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.06	0.00	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.06	0.03	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.06	0.00	0.00	1.00
1A4b	Residential	All fuels	N2O	0.05	0.02	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.05	0.01	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.03	0.17	0.00	1.00
4B4	Goats	Population Size	CH4	0.02	0.01	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.00	0.05	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.00	0.05	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CH4	0.00	0.00	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.00	0.03	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CH4	0.00	0.14	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CO2	0.00	617.92	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	0.00	3.04	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	PFCs	0.00	0.00	0.00	1.00

2F9	Other (Medical Applications)	Consumption Figures	SF6	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6B	Domestic and Commercial Wastewater	Population Size	CH4	0.00	11.73	0.00	1.00

A1-2 Key category trend assessment

Table A1-0-5 Key category trend assessment: 2012 with-LULUCF

IPCC Source Categories		Activity	GHG	Base Year Estimate (Gg CO2 eq.) 1990	Current Year Estimate (Gg CO2 eq.) 2010	Trend Assesment	Cumulative trend assesment
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	1,818.08	0.54	**0.54**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	232.37	0.15	**0.69**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	161.88	0.13	**0.82**
1A3b	Road Transportation	All fuels	CO2	333.26	491.40	0.03	**0.85**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	67.24	0.02	**0.87**
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	22.80	0.02	**0.89**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	19.71	0.02	**0.90**
1A3d	Navigation	Liquid Fuel	CO2	8.42	32.87	0.02	**0.92**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	72.99	0.01	**0.93**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	9.60	0.01	**0.94**
4B8	Swine	Population Size	CH4	12.94	9.49	0.01	**0.95**
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	6.09	4.27	0.00	0.96
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	13.94	27.31	0.00	0.96
1A4b	Residential	All fuels	CO2	34.55	49.83	0.00	0.96
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.74	13.91	0.00	0.97
4B9	Poultry	Population Size	CH4	3.69	1.97	0.00	0.97
4A9	Poultry	Population Size	CH4	3.15	1.68	0.00	0.97
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	3.16	0.00	0.98
5A1	Forest Land	Land Coverage	CO2	-5.21	-5.21	0.00	0.98

1A3b	Road Transportation	All fuels	N2O	5.07	5.03	0.00	0.98
2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	2.26	0.00	0.98
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	1.90	0.00	0.98
5B1	Cropland	Land Coverage	CO2	0.00	-2.01	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.04	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	1.72	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.00	1.46	0.00	0.99
4A8	Swine	Population Size	CH4	1.94	1.42	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	4.37	0.00	0.99
4A1	Cattle	Population Size	CH4	15.18	22.62	0.00	0.99
4A3	Sheep	Population Size	CH4	0.35	1.97	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.69	1.43	0.00	1.00
4B1	Cattle	Population Size	CH4	6.54	9.73	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	0.58	1.48	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.07	0.58	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	0.47	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.17	0.03	0.00	1.00
4A4	Goats	Population Size	CH4	0.18	0.51	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.18	0.08	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	1.30	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.74	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.02	0.20	0.00	1.00
2F2	Foam Blowing	Consumption Figures	HFCs	0.00	0.15	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.00	0.14	0.00	1.00

6C	Waste Incineration	Waste Burning	N2O	0.03	0.18	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.14	0.12	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.17	0.16	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.05	0.00	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.05	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.00	0.06	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.00	0.06	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.03	0.00	0.00	1.00
4B3	Sheep	Population Size	CH4	0.01	0.07	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.02	0.08	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.08	0.17	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.01	0.05	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.62	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.09	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.03	0.06	0.00	1.00
1A4b	Residential	All fuels	N2O	0.02	0.05	0.00	1.00
4B4	Goats	Population Size	CH4	0.01	0.02	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
1A4b	Residential	All fuels	CH4	0.06	0.10	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CH4	0.00	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CH4	0.14	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CO2	617.92	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	3.04	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	0.00	0.00	0.00	1.00

2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	SF6	0.00	0.00	0.00	1.00
5E1	Settlements	Land Coverage	CO2	0.00	0.00	0.00	1.00
5F	Other Land	Land Coverage	CO2	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6B	Domestic and Commercial Wastewater	Population Size	CH4	11.73	0.00	0.00	1.00

Table A1-0-6 Key category trend assessment: 2012 without-LULUCF

IPCC Source Categories		Activity	GHG	Current Year Estimate (Gg CO2 eq.) 2010	Base Year Estimate (Gg CO2 eq.) 1990	Trend Assessment	Cumulative Trend Assessment
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	1818.08	710.73	0.54	**0.54**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	232.37	27.38	0.15	**0.69**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	161.88	0.00	0.13	**0.82**
1A3b	Road Transportation	All fuels	CO2	491.40	333.26	0.03	**0.85**
1A4a	Commercial/Institutional	All fuels	CO2	67.24	61.58	0.02	**0.88**
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	22.80	0.00	0.02	**0.89**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	19.71	0.00	0.02	**0.91**
1A3d	Navigation	Liquid Fuel	CO2	32.87	8.42	0.02	**0.92**
1A2	Manufacturing Industries and Construction	All fuels	CO2	72.99	35.00	0.01	**0.94**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	9.60	13.92	0.01	**0.95**
4B8	Swine	Population Size	CH4	9.49	12.94	0.01	0.96
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	4.27	6.09	0.00	0.96
4D3.1	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	27.31	13.94	0.00	0.96
1A4b	Residential	All fuels	CO2	49.83	34.55	0.00	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	13.91	11.74	0.00	0.97
4B9	Poultry	Population Size	CH4	1.97	3.69	0.00	0.98
4A9	Poultry	Population Size	CH4	1.68	3.15	0.00	0.98
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	3.16	0.00	0.00	0.98
1A3b	Road Transportation	All fuels	N2O	5.03	5.07	0.00	0.98

2F3	Fire Extinguishers	Consumption Figures	HFCs	2.26	0.00	0.00	0.98
3D1	Use of N2O for Anaesthesia	Product Use	N2O	1.90	2.48	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.04	2.48	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	1.72	2.21	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	1.46	2.00	0.00	0.99
4A8	Swine	Population Size	CH4	1.42	1.94	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	4.37	1.73	0.00	0.99
4A1	Cattle	Population Size	CH4	22.62	15.18	0.00	0.99
4A3	Sheep	Population Size	CH4	1.97	0.35	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.43	1.69	0.00	1.00
4B1	Cattle	Population Size	CH4	9.73	6.54	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	1.48	0.58	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.58	0.07	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.47	0.01	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.03	0.17	0.00	1.00
4A4	Goats	Population Size	CH4	0.51	0.18	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.08	0.18	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	1.30	0.71	0.00	1.00
4A6	Horses	Population Size	CH4	0.74	0.36	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.20	0.02	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.14	0.00	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.18	0.03	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.12	0.14	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.16	0.17	0.00	1.00

4A10	Rabbits	Population Size	CH4	0.00	0.05	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.00	0.05	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.06	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.06	0.00	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.00	0.03	0.00	1.00
4B3	Sheep	Population Size	CH4	0.07	0.01	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.08	0.02	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.17	0.08	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.05	0.01	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.62	0.37	0.00	1.00
4B6	Horses	Population Size	CH4	0.09	0.04	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.06	0.03	0.00	1.00
1A4b	Residential	All fuels	N2O	0.05	0.02	0.00	1.00
4B4	Goats	Population Size	CH4	0.02	0.01	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
1A4b	Residential	All fuels	CH4	0.10	0.06	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CH4	0.00	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CH4	0.00	0.14	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CO2	0.00	617.92	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	0.00	3.04	0.00	1.00
2F2	Foam Blowing	Consumption Figures	HFCs	0.15	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F9	Other (Medical Applications)	Consumption Figures	PFCs	0.00	0.00	0.00	1.00

2F9	Other (Medical Applications)	Consumption Figures	SF6	0.00	0.00	0.00	1.00
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CO2	0.00	0.00	0.00	1.00
6B	Domestic and Commercial Wastewater	Population Size	CH4	0.00	11.73	0.00	1.00

A2 ANNEX 2: DETAILED DISCUSSION OF METHODOLOGY AND DATA FOR ESTIMATING CO2 EMISSIONS FROM FOSSIL FUEL COMBUSTION

Methodology for estimating CO2 emissions from fossil fuel combustion is discussed together with the methodologies for other emissions in Chapter 3. This is because the underlying methodology for such estimates applies to a range of pollutants and not just CO2.

A3 ANNEX 3: OTHER DETAILED METHODOLOGIES DESCRIPTIONS FOR INDIVIDUAL SOURCE OR SINK CATEGORIES

The methods used to estimate emissions in for Malta's GHG inventory have been included in the main text of the report under each relevant section.

Information specific to source category 1A3b: Road Transportation

As noted in Chapter 3, the emissions modelling system COPERT was used to estimate emissions of a number of direct and indirect greenhouse gases for the source category 1A3b: Road Transportation, in respect of 2012. The activity data used as input to the model is presented in Table A3-1.

Table A3-0-1 Activity data used for estimation of emissions from road transport for 2012 using COPERT IV model

Sector	Subsector	Technology	Population	Distance travelled /year	Fleet mileage	Urban speed	Rural speed	Urban Driving share	Rural Driving share
			units	km	km	km/hr	km/hr	%	%
Passenger Cars	Gasoline <0,8 l	PRE ECE	67	3237	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	ECE 15/00-01	34	4197	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	ECE 15/02	29	4338	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	ECE 15/03	119	4134	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	ECE 15/04	1552	5421	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	PC Euro 1 - 91/441/EEC	124	6731	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	PC Euro 2 - 94/12/EEC	1610	7938	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	PC Euro 3 - 98/69/EC Stage2000	2318	8338	50000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	PC Euro 4 - 98/69/EC Stage2005	132	12080	25000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	PC Euro 5 - EC 715/2007	0	0	10000	25	60	50	50
Passenger Cars	Gasoline <0,8 l	PC Euro 6 - EC 715/2007	0	0	10000	25	60	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	PRE ECE	2354	3237	50000	25	61	50	50

Passenger Cars	Gasoline 0,8 - 1,4 l	ECE 15/00-01	1598	4197	50000	26	62	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	ECE 15/02	1068	4338	50000	26	63	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	ECE 15/03	2776	4134	50000	27	64	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	ECE 15/04	17723	5421	150754	28	65	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	Improved Conventional	0	0	50000	27	63	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	Open Loop	0	0	50000	27	63	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	PC Euro 1 - 91/441/EEC	18164	6731	134865	29	66	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	PC Euro 2 - 94/12/EEC	20860	7938	116078	29	66	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	PC Euro 3 - 98/69/EC Stage2000	33270	8338	86517	29	66	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	PC Euro 4 - 98/69/EC Stage2005	24144	12080	35499	29	66	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	PC Euro 5 - EC 715/2007	0	0	17903	29	66	50	50
Passenger Cars	Gasoline 0,8 - 1,4 l	PC Euro 6 - EC 715/2007	0	0	0	29	66	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	PRE ECE	780	2260	50000	29	62	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	482	3468	50000	30	63	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	386	3817	50000	30	64	50	50

Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	901	3356	199387	30	65	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	4317	5256	176747	30	66	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	Improved Conventional	0	0	0	30	65	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	Open Loop	0	0	0	30	65	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	6150	7417	152938	31	67	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	4122	7468	128677	31	67	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	9260	9563	97986	31	67	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	4691	13125	34596	31	67	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	0	0	20134	31	67	50	50
Passenger Cars	Gasoline 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	0	0	0	31	67	50	50
Passenger Cars	Gasoline >2,0 l	PRE ECE	368	2145	50000	30	63	50	50
Passenger Cars	Gasoline >2,0 l	ECE 15/00-01	129	2625	50000	31	64	50	50
Passenger Cars	Gasoline >2,0 l	ECE 15/02	30	3119	50000	31	65	50	50
Passenger Cars	Gasoline >2,0 l	ECE 15/03	120	4131	219129	32	66	50	50
Passenger Cars	Gasoline >2,0 l	ECE 15/04	420	4787	206174	32	67	50	50

Passenger Cars	Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	340	5605	178486	33	68	50	50
Passenger Cars	Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	275	6543	140413	33	68	50	50
Passenger Cars	Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	846	9725	108696	33	68	50	50
Passenger Cars	Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	438	11500	38341	33	68	50	50
Passenger Cars	Gasoline >2,0 l	PC Euro 5 - EC 715/2007	0	0	21153	33	68	50	50
Passenger Cars	Gasoline >2,0 l	PC Euro 6 - EC 715/2007	0	0	0	33	68	50	50
Passenger Cars	Diesel <1,4 l	Conventional	284	6660	50000	27	62	50	50
Passenger Cars	Diesel <1,4 l	PC Euro 1 - 91/441/EEC	13	8132	50000	29	63	50	50
Passenger Cars	Diesel <1,4 l	PC Euro 2 - 94/12/EEC	8	9296	50000	29	64	50	50
Passenger Cars	Diesel <1,4 l	PC Euro 3 - 98/69/EC Stage2000	2615	10872	50000	29	64	50	50
Passenger Cars	Diesel <1,4 l	PC Euro 4 - 98/69/EC Stage2005	1850	22323	50000	29	64	50	50
Passenger Cars	Diesel <1,4 l	PC Euro 5 - EC 715/2007	0	0	N/A	29	64	50	50
Passenger Cars	Diesel <1,4 l	PC Euro 6 - EC 715/2007	0	0	N/A	29	64	50	50
Passenger Cars	Diesel 1,4 - 2,0 l	Conventional	16289	6660	448727	27	62	50	50
Passenger Cars	Diesel 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	3242	8132	403177	29	63	50	50

Passenger Cars	Diesel 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	10430	9296	355072	29	64	50	50
Passenger Cars	Diesel 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	17320	10872	280660	29	64	50	50
Passenger Cars	Diesel 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	7996	22323	103144	29	64	50	50
Passenger Cars	Diesel 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	0	0	67020	29	64	50	50
Passenger Cars	Diesel 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	0	0	0	29	64	50	50
Passenger Cars	Diesel >2,0 l	Conventional	1903	7848	481296	27	63	50	50
Passenger Cars	Diesel >2,0 l	PC Euro 1 - 91/441/EEC	456	8854	436998	29	64	50	50
Passenger Cars	Diesel >2,0 l	PC Euro 2 - 94/12/EEC	1031	10396	374800	29	65	50	50
Passenger Cars	Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	2683	14419	282773	29	65	50	50
Passenger Cars	Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	2339	23025	120488	29	65	50	50
Passenger Cars	Diesel >2,0 l	PC Euro 5 - EC 715/2007	1	23025	69974	29	65	50	50
Passenger Cars	Diesel >2,0 l	PC Euro 6 - EC 715/2007	0	0	0	29	65	50	50
Passenger Cars	LPG	PC Euro 5 - EC 715/2007	2	10832	50000	30	67	50	50
Passenger Cars	LPG	PC Euro 6 - EC 715/2007	0	0	0	30	67	50	50
Passenger Cars	2-Stroke	Conventional	0	0	31784	29	64	50	50

Passenger Cars	Hybrid Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	29	64	50	50
Passenger Cars	Hybrid Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	2022	10832	48862	31	67	50	50
Passenger Cars	Hybrid Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	31	67	50	50
Light Commercial Vehicles	Gasoline <3,5t	Conventional	532	5344	184982	25	60	50	50
Light Commercial Vehicles	Gasoline <3,5t	LD Euro 1 - 93/59/EEC	263	7125	169242	25	60	50	50
Light Commercial Vehicles	Gasoline <3,5t	LD Euro 2 - 96/69/EEC	65	9200	142241	25	60	50	50
Light Commercial Vehicles	Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	111	8375	96811	25	60	50	50
Light Commercial Vehicles	Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	70	9558	47008	25	60	50	50
Light Commercial Vehicles	Gasoline <3,5t	LD Euro 5 - 2008 Standards	0	0	20271	25	60	50	50
Light Commercial Vehicles	Gasoline <3,5t	LD Euro 6	0	0	0	25	60	50	50
Light Commercial Vehicles	Diesel <3,5 t	Conventional	11968	7566	347404	25	60	50	50
Light Commercial Vehicles	Diesel <3,5 t	LD Euro 1 - 93/59/EEC	8045	7755	358694	25	60	50	50

Light Commercial Vehicles	Diesel <3,5 t	LD Euro 2 - 96/69/EEC	2040	12363	258658	25	60	50	50
Light Commercial Vehicles	Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	3791	15726	188497	25	60	50	50
Light Commercial Vehicles	Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	1991	21202	99565	25	60	50	50
Light Commercial Vehicles	Diesel <3,5 t	LD Euro 5 - 2008 Standards	0	0	42399	25	60	50	50
Light Commercial Vehicles	Diesel <3,5 t	LD Euro 6	0	0	0	25	60	50	50
Heavy Duty Trucks	Gasoline >3,5 t	Conventional	0	0	0	24	60	50	50
Heavy Duty Trucks	Rigid <=7,5 t	Conventional	2397	11443	296300	24	60	50	50
Heavy Duty Trucks	Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	2044	11778	276326	24	60	50	50
Heavy Duty Trucks	Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	48	17916	230011	24	60	50	50
Heavy Duty Trucks	Rigid <=7,5 t	HD Euro III - 2000 Standards	218	24659	165174	24	60	50	50
Heavy Duty Trucks	Rigid <=7,5 t	HD Euro IV - 2005 Standards	161	18549	87580	24	60	50	50
Heavy Duty Trucks	Rigid <=7,5 t	HD Euro V - 2008 Standards	87	7415	54548	24	60	50	50
Heavy Duty Trucks	Rigid <=7,5 t	HD Euro VI	0	0	0	24	60	50	50

Heavy Duty Trucks	Rigid 7,5 - 12 t	Conventional	393	11443	296300	24	60	50	50
Heavy Duty Trucks	Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	61	11778	276326	24	60	50	50
Heavy Duty Trucks	Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	129	17916	230011	24	60	50	50
Heavy Duty Trucks	Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	176	24659	165174	24	60	50	50
Heavy Duty Trucks	Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	174	18549	87580	24	60	50	50
Heavy Duty Trucks	Rigid 7,5 - 12 t	HD Euro V - 2008 Standards	103	7415	54548	24	60	50	50
Heavy Duty Trucks	Rigid 7,5 - 12 t	HD Euro VI	0	0	0	24	60	50	50
Heavy Duty Trucks	Rigid 12 - 14 t	Conventional	272	11443	296300	24	60	50	50
Heavy Duty Trucks	Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	17	1178	276326	24	60	50	50
Heavy Duty Trucks	Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	18	17916	230011	24	60	50	50
Heavy Duty Trucks	Rigid 12 - 14 t	HD Euro III - 2000 Standards	11	24659	165174	24	60	50	50
Heavy Duty Trucks	Rigid 12 - 14 t	HD Euro IV - 2005 Standards	9	18549	87580	24	60	50	50
Heavy Duty Trucks	Rigid 12 - 14 t	HD Euro V - 2008 Standards	15	7415	54548	24	60	50	50
Heavy Duty Trucks	Rigid 12 - 14 t	HD Euro VI	0	0	0	24	60	50	50
Heavy Duty Trucks	Rigid 14 - 20 t	Conventional	813	11443	296300	25	60	50	50

Heavy Duty Trucks	Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	78	11778	276326	25	60	50	50
Heavy Duty Trucks	Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	60	17916	230011	25	60	50	50
Heavy Duty Trucks	Rigid 14 - 20 t	HD Euro III - 2000 Standards	57	24659	165174	25	60	50	50
Heavy Duty Trucks	Rigid 14 - 20 t	HD Euro IV - 2005 Standards	34	18549	87580	25	60	50	50
Heavy Duty Trucks	Rigid 14 - 20 t	HD Euro V - 2008 Standards	40	7415	54548	25	60	50	50
Heavy Duty Trucks	Rigid 14 - 20 t	HD Euro VI	0	0	0	25	60	50	50
Heavy Duty Trucks	Rigid 20 - 26 t	Conventional	262	11443	296300	25	60	50	50
Heavy Duty Trucks	Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	33	11778	276326	25	60	50	50
Heavy Duty Trucks	Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	44	17916	230011	25	60	50	50
Heavy Duty Trucks	Rigid 20 - 26 t	HD Euro III - 2000 Standards	24	24659	165174	25	60	50	50
Heavy Duty Trucks	Rigid 20 - 26 t	HD Euro IV - 2005 Standards	9	18549	87580	25	60	50	50
Heavy Duty Trucks	Rigid 20 - 26 t	HD Euro V - 2008 Standards	2	7415	54548	25	60	50	50
Heavy Duty Trucks	Rigid 20 - 26 t	HD Euro VI	0	0	0	25	60	50	50
Heavy Duty Trucks	Rigid 26 - 28 t	Conventional	0	11443	296300	25	60	50	50
Heavy Duty Trucks	Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	0	11778	276326	25	60	50	50

Heavy Duty Trucks	Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	0	17916	230011	25	60	50	50
Heavy Duty Trucks	Rigid 26 - 28 t	HD Euro III - 2000 Standards	0	24659	165174	25	60	50	50
Heavy Duty Trucks	Rigid 26 - 28 t	HD Euro IV - 2005 Standards	0	18549	87580	25	60	50	50
Heavy Duty Trucks	Rigid 26 - 28 t	HD Euro V - 2008 Standards	0	7415	54548	25	60	50	50
Heavy Duty Trucks	Rigid 26 - 28 t	HD Euro VI	0	0	0	25	60	50	50
Heavy Duty Trucks	Rigid 28 - 32 t	Conventional	184	11443	296300	25	60	50	50
Heavy Duty Trucks	Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	77	11778	276326	25	60	50	50
Heavy Duty Trucks	Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	53	17916	230011	25	60	50	50
Heavy Duty Trucks	Rigid 28 - 32 t	HD Euro III - 2000 Standards	28	24659	165174	25	60	50	50
Heavy Duty Trucks	Rigid 28 - 32 t	HD Euro IV - 2005 Standards	31	18549	87580	25	60	50	50
Heavy Duty Trucks	Rigid 28 - 32 t	HD Euro V - 2008 Standards	27	7415	54548	25	60	50	50
Heavy Duty Trucks	Rigid 28 - 32 t	HD Euro VI	0	0	0	25	60	50	50
Heavy Duty Trucks	Rigid >32 t	Conventional	290	11443	296300	25	60	50	50
Heavy Duty Trucks	Rigid >32 t	HD Euro I - 91/542/EEC Stage I	185	11778	276326	25	60	50	50
Heavy Duty Trucks	Rigid >32 t	HD Euro II - 91/542/EEC Stage II	268	17916	230011	25	60	50	50

Heavy Duty Trucks	Rigid >32 t	HD Euro III - 2000 Standards	129	24659	165174	25	60	50	50
Heavy Duty Trucks	Rigid >32 t	HD Euro IV - 2005 Standards	117	18549	87580	25	60	50	50
Heavy Duty Trucks	Rigid >32 t	HD Euro V - 2008 Standards	75	7415	54548	25	60	50	50
Heavy Duty Trucks	Rigid >32 t	HD Euro VI	0	0	0	25	60	50	50
Buses	Urban Buses Midi <=15 t	Conventional	733	49741	0	24	60	50	50
Buses	Urban Buses Midi <=15 t	HD Euro I - 91/542/EEC Stage I	115	49530	0	24	60	50	50
Buses	Urban Buses Midi <=15 t	HD Euro II - 91/542/EEC Stage II	129	89002	0	24	60	50	50
Buses	Urban Buses Midi <=15 t	HD Euro III - 2000 Standards	124	61806	0	24	60	50	50
Buses	Urban Buses Midi <=15 t	HD Euro IV - 2005 Standards	132	9215	0	24	60	50	50
Buses	Urban Buses Midi <=15 t	HD Euro V - 2008 Standards	230	90753	0	24	60	50	50
Buses	Urban Buses Midi <=15 t	HD Euro VI	0	0	0	24	60	50	50
Mopeds	2-stroke <50 cm^3	Conventional	0	0	0	20	30	50	50
Mopeds	2-stroke <50 cm^3	Mop - Euro I	0	0	0	20	30	50	50
Mopeds	2-stroke <50 cm^3	Mop - Euro II	0	0	0	20	30	50	50
Mopeds	2-stroke <50 cm^3	Mop - Euro III	0	0	0	20	30	50	50

Mopeds	4-stroke <50 cm³	Conventional	0	0	0	20	30	50	50
Mopeds	4-stroke <50 cm³	Mop - Euro I	0	0	0	20	30	50	50
Mopeds	4-stroke <50 cm³	Mop - Euro II	0	0	0	20	30	50	50
Mopeds	4-stroke <50 cm³	Mop - Euro III	0	0	0	20	30	50	50
Motorcycles	2-stroke >50 cm³	Conventional	28	1273	0	30	55	50	50
Motorcycles	2-stroke >50 cm³	Mot - Euro I	19	3576	0	30	55	50	50
Motorcycles	2-stroke >50 cm³	Mot - Euro II	5	3576	0	30	55	50	50
Motorcycles	2-stroke >50 cm³	Mot - Euro III	36	3576	0	30	55	50	50
Motorcycles	4-stroke <250 cm³	Conventional	4432	1273	45415	30	55	50	50
Motorcycles	4-stroke <250 cm³	Mot - Euro I	1146	3576	34624	30	55	50	50
Motorcycles	4-stroke <250 cm³	Mot - Euro II	1230	3576	16117	30	55	50	50
Motorcycles	4-stroke <250 cm³	Mot - Euro III	3258	3576	9343	30	55	50	50
Motorcycles	4-stroke 250 - 750 cm³	Conventional	1668	1273	46536	30	55	50	50
Motorcycles	4-stroke 250 - 750 cm³	Mot - Euro I	395	3576	35747	30	55	50	50
Motorcycles	4-stroke 250 - 750 cm³	Mot - Euro II	576	3576	16289	30	55	50	50

Motorcycles	4-stroke 250 - 750 cm³	Mot - Euro III	1249	3576	9244	30	55	50	50
Motorcycles	4-stroke >750 cm³	Conventional	660	1273	55305	30	55	50	50
Motorcycles	4-stroke >750 cm³	Mot - Euro I	308	3576	39713	30	55	50	50
Motorcycles	4-stroke >750 cm³	Mot - Euro II	350	3576	16458	30	55	50	50
Motorcycles	4-stroke >750 cm³	Mot - Euro III	395	3576	10545	30	55	50	50

A4 ANNEX 4: COMPARISON OF CO_2 REFERENCE AND SECTORAL APPROACHES

A discussion of the differences between the Reference and sectoral approaches to estimating emissions of carbon dioxide from fuel combustion may be found in section 3.2.1.

A5 ANNEX 5 ASSESSMENT OF COMPLETENESS

Table A5-0-1 Sources and sinks not estimated (NE) Year 2012 Submission 2014

Sources and sinks not estimated (NE)[1]			
GHG	**Sector[2]**	**Source/sink category [2]**	**Explanation**
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier1
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Details in NIR
Carbon	5 LULUCF	5.B.1 Annual Crops	Using Tier 1
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier1
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Details in NIR
Carbon	5 LULUCF	5.B.1 Annual Crops	Using Tier 1
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Using Tier1
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier1
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	
Carbon	5 LULUCF	5.B.1 Perennial Woody Crops	Tier 1 due to woody crop in balance.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Details in NIR
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Using Tier1
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier1
Carbon	5 LULUCF	5.B.1 Annual Crops	Using Tier 1

Carbon	5 LULUCF	5.B.1 Perennial Woody Crops	Using Tier 1
CH4	1 Energy	1.B.2.A.5 Distribution of oil products	Data unavailable
CH4	4 Agriculture	4.D.3 Indirect Emissions	Data unavailable
CH4	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
CO2	1 Energy	1.B.2.A.5 Distribution of oil products	Data unavailable
CO2	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data in not available in Malta.
CO2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
N2O	3 Solvent and Other Product Use	3.D.3 N2O from Aerosol Cans	Data unavailable
N2O	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailablle
PFCs	2 Industrial Processes	2.F.1 Refrigeration and Air Conditioning Equipment	Import data not identified
SF6	2 Industrial Processes	2.F.P2.1 In bulk	Data unavailable
SF6	2 Industrial Processes	2.F.P2.2 In products	Data unavailable

Table A5-0-2 Sources and sinks not estimated (NE) Year 1990 Submission 2014

Sources and sinks not estimated (NE)[1]			
GHG	**Sector[2]**	**Source/sink category [2]**	**Explanation**
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier1
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Details in NIR
Carbon	5 LULUCF	5.B.1 Annual Crops	Using Tier 1
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier1
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.B.1 Annual Crops	Using Tier 1
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Using Tier1
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier 1
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.B.1 Perennial Woody Crops	Tier 1 due to woody crop in balance.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Using Tier1
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Using Tier1
Carbon	5 LULUCF	5.B.1 Annual Crops	Explanation given in NIR
Carbon	5 LULUCF	5.B.1 Perennial Woody Crops	Using Tier 1
CH4	1 Energy	1.B.2.A.5 Distribution of oil products	Data unavailable
CH4	1 Energy	1.AA.3.D 1.AA.3.D Navigation	Data unavailable
CH4	1 Energy	1.AA.4.B 1.AA.4.B Residential	No sufficient data
CH4	1 Energy	1.AA.4.C 1.AA.4.C Agriculture/Forestry/Fisheries	Data unavailable
CH4	1 Energy	1.AA.2.F All industry	No sufficient data

CH4	4 Agriculture	4.D.3 Indirect Emissions	Data unavailable
CH4	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
CO2	1 Energy	1.B.2.A.5 Distribution of oil products	Data unavailable
CO2	1 Energy	1.AA.3.D 1.AA.3.D Navigation	Data unavailable
CO2	1 Energy	1.AA.4.B 1.AA.4.B Residential	No sufficient data
CO2	1 Energy	1.AA.4.C 1.AA.4.C Agriculture/Forestry/Fisheries	Data unavailable
CO2	1 Energy	1.AA.2.F All industry	No sufficient data
CO2	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data is not available in Malta
CO2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
N2O	1 Energy	1.AA.3.D 1.AA.3.D Navigation	Data unavailable
N2O	1 Energy	1.AA.4.B 1.AA.4.B Residential	No sufficient data
N2O	1 Energy	1.AA.4.C 1.AA.4.C Agriculture/Forestry/Fisheries	Data unavailable
N2O	1 Energy	1.AA.2.F All industry	No sufficient data
N2O	3 Solvent and Other Product Use	3.D.3 N2O from Aerosol Cans	Data unavailable
N2O	4 Agriculture	4.D.1.3 N-fixing Crops	Data unavailable
N2O	4 Agriculture	4.D.1.4 Crop Residue	Data unavailable
N2O	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
PFCs	2 Industrial Processes	2.F.1 Refrigeration and Air Conditioning Equipment	Import data not identified
SF6	2 Industrial Processes	2.F.P2.1 In bulk	Data unavailable
SF6	2 Industrial Processes	2.F.P2.2 In products	Data unavailable

A6 ANNEX 6: ADDITIONAL INFORMATION – ACCOUNTING OF EMISSIONS UNDER THE EUROPEAN UNION EMISSIONS TRADING SCHEME AND USE OF PROJECT CREDITS FROM KYOTO PROTOCOL MECHANISMS

A6.1 Maltese participation in the European Union Emissions Trading Scheme

Malta fully implements Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community (EU ETS Directive). In previous inventory reports, reference was always made to the applicability of this Directive to stationary installations; it is however pertinent to note that as of 2012, aviation activities have also come within the scope of this scheme.

A6.2 EU ETS for stationary installations

Only two stationary installations that are situated in territory of Malta actually fall within the scope of the EU ETS Directive, and have done so since the inception of the scheme in 2005. These are the two local electricity generation plants which also account for all emissions under CRF source category 1A1a.

Allocations of allowances to these two installations for the first two phases of the scheme (2005-2007; 2008-2012) were notified to the European Commission via the respective phases' National Allocation Plans.

The total allocation for the first phase amounted to 8.827 million allowances, of which 6.538 million allowances were distributed directly to the two installations, for free, while 2.288 million allowances were set aside as a new entrants' reserve. No allowances from the new entrants' reserve were actually allocated. Allowances allocated and emissions reported for all years of the first phase on the EU ETS are presented in Table A4-1. All emissions reported were accounted for by allowances surrendered.

Table A6-0-1 Annual quantity of allowances allocated and reported emissions for the EU ETS period 2005-2007

Year	Quantity of allowances allocated (Mt CO_2 eq.)	Reported emissions ($Mt\ CO_2$ eq.)
2005	2.086	1.971
2006	2.167	1.986
2007	2.286	2.027

The allocation for the second phase amounted to a total of 10.715 million allowances, allocated entirely to the two installations. Annual allocations and emissions reported during this phase are presented in Table A6-2.

Table A6-0-2 Annual quantity of allowances allocated and reported emissions for the EU ETS period 2008-2012

Year	Quantity of allowances allocated (Mt CO_2 eq.)	Reported emissions ($Mt\ CO_2$ eq.)
2008	2.108	2.019
2009	2.121	1.897
2010	2.159	1.878
2011	2.168	1.931
2012	2.159	2.052

It is to note that in respect of compliance requirements for the year 2012, a quantity of Kyoto Protocol units was surrendered in lieu of EU ETS allowances to account for reported EU ETS emissions. The total quantity of such units (1.071 million) reflects the limit on use of international credits as set in the National Allocation Plan for the second phase.

A6.3 EU ETS for aviation activities

2012 represents the year when aviation activities were first required by the EU ETS Directive to fully account for emissions. The original scope of the directive covered all flights to, or from, aerodromes situated in the territory of EU Member States, whichever the original point of departure or final destination, respectively. However, legislative amendments adopted in reaction to developments in discussions taking place at the International Civil Aviation Organisation (ICAO) provided the possibility of limiting the scope of emission monitoring and reporting for 2012 to intra-EU flights, if aircraft operators so wished.

Not all aircraft operators participating in the scheme were allocated allowances for free, as this was subject to a formal application for free allowances being made by the respective operators. Furthermore, a quantity of allowances was earmarked for allocation through auctions; however, the legislative developments led to a delay in the actual auctioning of 2012 aviation allowances.

Emissions reported by aircraft operators under the administrative responsibility of Malta for 2012 amount to a total of just under 0.228 million allowances, with 0.199 million allowances and 0.029 million international credits surrendered in respect of these reported emissions.

A7 ANNEX 7: TIER 1 UNCERTAINTY ESTIMATION

Table A7-0-1 Tier 1 Uncertainty Estimate (with LULUCF)

A		B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source Category			Base Year emissions 1990	Year t emissions 2012	Activty Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined uncertainty as % of total national emissions 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
		Gas	CO2 eq. (Gg)	CO2 eq. (Gg)	%	%	%	%	%	%	%	%	%
1A1a	Energy Industries - Gas/Diesel Oil	CO2	27.38	232.37	1	3	3.16E+00	5.63E-02	9.64E-02	1.18E-01	2.89E-01	1.67E-01	1.12E-01
1A1a	Energy Industries - Residual Fuel Oil	CO2	710.73	1818.08	1	3	3.16E+00	3.45E+00	3.54E-01	9.26E-01	1.06E+00	1.31E+00	2.84E+00
1A1a	Energy Industries - bituminous coal	CO2	617.92	0.00	1	3	3.16E+00	0.00E+00	-4.95E-01	0.00E+00	-1.48E+00	0.00E+00	2.20E+00
1A2	Manufacturing Industries and Construction	CO2	35.00	72.99	5	12	1.30E+01	9.39E-02	9.06E-03	3.72E-02	1.09E-01	2.63E-01	8.09E-02
1A3a	Civil Aviation	CO2	0.71	1.30	8	30	3.10E+01	1.69E-04	9.13E-05	6.61E-04	2.74E-03	7.48E-03	6.35E-05
1A3b	Road Transportation	CO2	333.26	491.40			4.00E+00	4.03E-01	-1.74E-02	2.50E-01	0.00E+00	0.00E+00	0.00E+00
1A3d	Navigation	CO2	8.42	32.87	5	30	3.04E+01	1.04E-01	9.98E-03	1.67E-02	2.99E-01	1.18E-01	1.04E-01
1A4a	Commercial/Institutional	CO2	61.58	67.24	5	12	1.30E+01	7.97E-02	-1.52E-02	3.43E-02	-1.83E-01	2.42E-01	9.20E-02
1A4b	Residential	CO2	34.55	49.83	5	12	1.30E+01	4.38E-02	-2.37E-03	2.54E-02	-2.84E-02	1.80E-01	3.30E-02
1A4c	Agriculture/Forestry/Fisheries	CO2	0.00	22.80	5	12	1.30E+01	9.16E-03	1.16E-02	1.16E-02	1.39E-01	8.21E-02	2.62E-02
2A4	Soda Ash Use	CO2	0.18	0.08	15	15	2.12E+01	2.95E-07	-1.06E-04	4.04E-05	-1.59E-03	8.57E-04	3.25E-06
2A6	Road Paving with Asphalt	CO2	0.00	0.14	15	15	2.12E+01	8.89E-07	6.98E-05	7.01E-05	1.05E-03	1.49E-03	3.31E-06

2B4	Carbide Production	CO2	0.17	0.03	15	15	2.12E+01	3.39E-08	-1.22E-04	1.37E-05	-1.83E-03	2.90E-04	3.43E-06
5A1	Forest Land Remaining Forest Land	CO2	-5.21	-5.21	18	50	5.31E+01	7.99E-03	1.53E-03	-2.65E-03	7.66E-02	-6.75E-02	1.04E-02
5B1	Cropland Remaining Cropland	CO2	0.00	-2.01	5	50	5.02E+01	1.07E-03	-1.02E-03	-1.02E-03	-5.12E-02	-7.24E-03	2.68E-03
5E1	Settlements Remaining Settlements	CO2	0.00	0.00	18	50	5.31E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5F	Other Land	CO2	0.00	0.00	18	50	5.31E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6C	Waste Incineration	CO2	0.37	0.00	15	50	5.22E+01	0.00E+00	-2.97E-04	0.00E+00	-1.49E-02	0.00E+00	2.21E-04
TOTAL		**CO2**	**1825.07**	**2781.91**				**2.06E+00**					

1A1a	Energy Industries - Gas/Diesel Oil	CH4	0.02	0.20	1	3	3.16E+00	4.08E-08	8.18E-05	1.01E-04	2.45E-04	1.42E-04	8.05E-08
1A1a	Energy Industries - Residual Fuel Oil	CH4	0.58	1.48	1	3	3.16E+00	2.29E-06	2.84E-04	7.54E-04	8.53E-04	1.07E-03	1.87E-06
1A1a	Energy Industries - bituminous coal	CH4	0.14	0.00	1	3	3.16E+00	0.00E+00	-1.10E-04	0.00E+00	-3.31E-04	0.00E+00	1.09E-07
1A2	Manufacturing Industries and Construction	CH4	0.03	0.06	5	12	1.30E+01	6.25E-08	7.19E-06	3.03E-05	8.62E-05	2.14E-04	5.34E-08
1A3a	Civil Aviation	CH4	0.00	0.00	8	30	3.10E+01	3.67E-12	1.23E-08	9.73E-08	3.68E-07	1.10E-06	1.35E-12
1A3b	Road Transportation	CH4	2.00	1.46			3.40E+01	2.55E-04	-8.64E-04	7.41E-04	0.00E+00	0.00E+00	0.00E+00
1A3d	Navigation	CH4	0.01	0.05	5	30	3.04E+01	2.10E-07	1.42E-05	2.38E-05	4.26E-04	1.68E-04	2.09E-07
1A4a	Commercial/Institutional	CH4	0.17	0.16	5	12	1.30E+01	4.53E-07	-5.37E-05	8.17E-05	-6.44E-04	5.77E-04	7.48E-07
1A4b	Residential	CH4	0.06	0.10	5	12	1.30E+01	1.65E-07	3.89E-07	4.93E-05	4.67E-06	3.48E-04	1.21E-07
1A4c	Agriculture/Forestry/Fisheries	CH4	0.00	0.06	5	12	1.30E+01	7.34E-08	3.29E-05	3.29E-05	3.94E-04	2.32E-04	2.10E-07
4A1	Cattle	CH4	15.18	22.62	5	15	1.58E+01	1.33E-02	-6.75E-04	1.15E-02	-1.01E-02	8.15E-02	6.74E-03
4A3	Sheep	CH4	0.35	1.97	5	15	1.58E+01	1.01E-04	7.20E-04	1.00E-03	1.08E-02	7.08E-03	1.67E-04
4A4	Goats	CH4	0.18	0.51	5	15	1.58E+01	6.76E-06	1.12E-04	2.59E-04	1.68E-03	1.83E-03	6.19E-06
4A6	Horses	CH4	0.36	0.74	5	15	1.58E+01	1.42E-05	8.68E-05	3.76E-04	1.30E-03	2.66E-03	8.78E-06
4A8	Swine	CH4	1.94	1.42	5	15	1.58E+01	5.29E-05	-8.34E-04	7.25E-04	-1.25E-02	5.13E-03	1.83E-04

4A9	Poultry	CH4	3.15	1.68	5	15	1.58E+01	7.38E-05	-1.67E-03	8.57E-04	-2.51E-02	6.06E-03	6.67E-04
4A10	Rabbits	CH4	0.05	0.00	5	15	1.58E+01	3.29E-11	-3.89E-05	5.72E-07	-5.83E-04	4.04E-06	3.40E-07
4B1	Cattle	CH4	6.54	9.73	5	15	1.58E+01	2.47E-03	-2.95E-04	4.96E-03	-4.42E-03	3.51E-02	1.25E-03
4B3	Sheep	CH4	0.01	0.07	5	15	1.58E+01	1.23E-07	2.52E-05	3.50E-05	3.78E-04	2.48E-04	2.04E-07
4B4	Goats	CH4	0.01	0.02	5	15	1.58E+01	8.75E-09	4.04E-06	9.33E-06	6.06E-05	6.60E-05	8.02E-09
4B6	Horses	CH4	0.04	0.09	5	15	1.58E+01	1.90E-07	1.00E-05	4.35E-05	1.51E-04	3.07E-04	1.17E-07
4B8	Swine	CH4	12.94	9.49	5	15	1.58E+01	2.35E-03	-5.56E-03	4.84E-03	-8.34E-02	3.42E-02	8.12E-03
4B9	Poultry	CH4	3.69	1.97	5	15	1.58E+01	1.01E-04	-1.96E-03	1.00E-03	-2.94E-02	7.09E-03	9.13E-04
4B10	Rabbits	CH4	0.05	0.00	5	15	1.58E+01	3.29E-11	-3.89E-05	5.72E-07	-5.83E-04	4.04E-06	3.40E-07
6A1	Managed Waste Disposal on Land	CH4	0.00	19.71	10	87	8.78E+01	3.12E-01	1.00E-02	1.00E-02	8.76E-01	1.42E-01	7.87E-01
6A2	UnManaged Waste Disposal on Land	CH4	13.94	27.31	10	117	1.17E+02	1.07E+00	2.71E-03	1.39E-02	3.16E-01	1.97E-01	1.39E-01
6B	Domestic and Commercial Wastewater	CH4	13.94	0.00	5	70	7.02E+01	0.00E+00	-1.12E-02	0.00E+00	-7.84E-01	0.00E+00	6.15E-01
6C	Waste Incineration	CH4	11.73	0.00	15	15	2.12E+01	2.95E-14	-9.42E-03	1.28E-08	-1.41E-01	2.71E-07	2.00E-02
TOTAL		**CH4**	**87.11**	**100.89**				**1.18E+00**					

1A1a	Energy Industries - Gas/Diesel Oil	N2O	0.07	0.58	1	3	3.16E+00	3.55E-07	2.41E-04	2.97E-04	7.24E-04	4.20E-04	7.01E-07
1A1a	Energy Industries - Residual Fuel Oil	N2O	1.73	4.37	1	3	3.16E+00	1.99E-05	8.40E-04	2.23E-03	2.52E-03	3.15E-03	1.63E-05
1A1a	Energy Industries - bituminous coal	N2O	3.04	0.00	1	3	3.16E+00	0.00E+00	-2.44E-03	0.00E+00	-7.32E-03	0.00E+00	5.36E-05
1A2	Manufacturing Industries and Construction	N2O	0.08	0.17	5	12	1.30E+01	5.36E-07	2.12E-05	8.88E-05	2.54E-04	6.28E-04	4.59E-07
1A3a	Civil Aviation	N2O	0.01	0.01	8	30	3.10E+01	1.28E-08	7.24E-07	5.74E-06	2.17E-05	6.50E-05	4.70E-09
1A3b	Road Transportation	N2O	5.07	5.03			2.60E+01	1.78E-03	-1.51E-03	2.56E-03	0.00E+00	0.00E+00	0.00E+00
1A3d	Navigation	N2O	0.02	0.08	5	30	3.04E+01	6.60E-07	2.51E-05	4.21E-05	7.54E-04	2.98E-04	6.57E-07

1A4a	Commercial/Institutional	N2O	0.14	0.12	5	12	1.30E+01	2.47E-07	-5.42E-05	6.02E-05	-6.51E-04	4.26E-04	6.05E-07
1A4b	Residential	N2O	0.02	0.05	5	12	1.30E+01	4.10E-08	6.54E-06	2.46E-05	7.85E-05	1.74E-04	3.64E-08
1A4c	Agriculture/Forestry/Fisheries	N2O	0.00	0.06	5	12	1.30E+01	5.76E-08	2.91E-05	2.91E-05	3.49E-04	2.06E-04	1.64E-07
3D1	Use of N2O for Anaesthesia	N2O	2.48	1.90	2	2	2.83E+00	3.03E-06	-1.03E-03	9.70E-04	-2.05E-03	2.74E-03	1.17E-05
4B12	Liquid Systems	N2O	2.21	1.72	5	15	1.58E+01	7.76E-05	-8.98E-04	8.78E-04	-1.35E-02	6.21E-03	2.20E-04
4B13	Solid Storage and Dry Lot	N2O	2.48	2.04	5	15	1.58E+01	1.08E-04	-9.54E-04	1.04E-03	-1.43E-02	7.35E-03	2.59E-04
4D1	Direct Soil Emissions	N2O	13.92	9.60	5	15	1.58E+01	2.40E-03	-6.29E-03	4.89E-03	-9.44E-02	3.46E-02	1.01E-02
4D3.1	Indirect emissions Atmospheric Deposition	N2O	6.09	4.27	5	15	1.58E+01	4.76E-04	-2.72E-03	2.18E-03	-4.08E-02	1.54E-02	1.90E-03
4D3.2	Indirect emissions Nitrogen Leaching and run - off	N2O	1.69	1.43	5	15	1.58E+01	5.32E-05	-6.34E-04	7.28E-04	-9.51E-03	5.15E-03	1.17E-04
6B	Domestic and Commercial Wastewater	N2O	0.00	0.00	5	70	7.02E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6C	Waste Incineration	N2O	11.74	13.91	15	15	2.12E+01	9.08E-03	-2.35E-03	7.08E-03	-3.52E-02	1.50E-01	2.38E-02
TOTAL		**N2O**	**50.80**	**45.35**				**1.18E-01**					

2F1	Refrigeration & Air Conditioning Equipment	HFCs	0.00	161.88	50	50	7.07E+01	1.37E+01	8.25E-02	8.25E-02	4.12E+00	5.83E+00	5.10E+01
2F2	Foam Blowing	HFCs	0.00	0.15	40	40	5.66E+01	7.53E-06	7.65E-05	7.65E-05	3.06E-03	4.33E-03	2.81E-05
2F3	Fire Extinguishers	HFCs	0.00	2.26	5	5	7.07E+00	2.67E-05	1.15E-03	1.15E-03	5.76E-03	8.15E-03	9.96E-05
2F4	Metered Dose Inhalers	HFCs	0.00	3.16	5	5	7.07E+00	5.22E-05	1.61E-03	1.61E-03	8.06E-03	1.14E-02	1.95E-04
2F7	Semiconductor Manufacture	HFCs	0.00	0.00	5	5	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2F7	Semiconductor Manufacture	PFCs	0.00	0.00	5	5	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2F9	Other (Medical Applications)	PFCs	0.00	0.00	5	5	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2F8	Electrical Equipment	SF6	0.01	0.47	2	10	1.02E+01	2.43E-06	2.32E-04	2.41E-04	2.32E-03	6.82E-04	5.85E-06
2F9	Other (Medical Applications)	SF6	0.00	0.00	5	5	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL		**HFCs, PFCs and SF6**	**0.01**	**167.93**				**3.70E+00**					

								58.13
TOTAL UNCERTAINTIES				Overall uncertainty in the Inventory (%)	4.40		Trend uncertainty (%)	7.62

Table A7-0-2 Tier 1 Uncrertainty estimation (No LULUCF)

IPCC Source Category		Gas	Base Year emissions 1990	Year t emissions 2012	Activty Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined uncertainty as % of total national emissions 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
			CO2 eq. (Gg)	CO2 eq. (Gg)	%	%	%	%	%	%	%	%
1A1a	Energy Industries - Gas/Diesel Oil	CO2	27.38	232.37	1	3.00E+00	3.16E+00	5.61E-02	9.61E-02	1.18E-01	2.88E-01	1.67E-01
1A1a	Energy Industries - Residual Fuel Oil	CO2	710.73	1818.08	1	3.00E+00	3.16E+00	3.43E+00	3.53E-01	9.24E-01	1.06E+00	1.31E+00
1A1a	Energy Industries - bituminous coal	CO2	617.92	0.00	1	3.00E+00	3.16E+00	0.00E+00	-4.93E-01	0.00E+00	-1.48E+00	0.00E+00
1A2	Manufacturing Industries and Construction	CO2	35.00	72.99	5	1.20E+01	1.30E+01	9.35E-02	9.04E-03	3.71E-02	1.09E-01	2.62E-01
1A3a	Civil Aviation	CO2	0.71	1.30	8	3.00E+01	3.10E+01	1.69E-04	9.12E-05	6.59E-04	2.74E-03	7.46E-03
1A3b	Road Transportation	CO2	333.26	491.40	5	1.50E+01	1.58E+01	6.27E+00	-1.73E-02	2.50E-01	-2.59E-01	1.77E+00
1A3d	Navigation	CO2	8.42	32.87	5	3.00E+01	3.04E+01	1.04E-01	9.95E-03	1.67E-02	2.99E-01	1.18E-01
1A4a	Commercial/Institutional	CO2	61.58	67.24	5	1.20E+01	1.30E+01	7.93E-02	-1.52E-02	3.42E-02	-1.82E-01	2.42E-01
1A4b	Residential	CO2	34.55	49.83	5	1.20E+01	1.30E+01	4.36E-02	-2.36E-03	2.53E-02	-2.83E-02	1.79E-01
1A4c	Agriculture/Forestry/Fisheries	CO2	0.00	22.80	5	1.20E+01	1.30E+01	9.12E-03	1.16E-02	1.16E-02	1.39E-01	8.19E-02
2A4	Soda Ash Use	CO2	0.18	0.08	15	1.50E+01	2.12E+01	2.94E-07	-1.05E-04	4.03E-05	-1.58E-03	8.54E-04
2A6	Road Paving with Asphalt	CO2	0.00	0.14	15	1.50E+01	2.12E+01	8.85E-07	6.96E-05	6.99E-05	1.04E-03	1.48E-03
2B4	Carbide Production	CO2	0.17	0.03	15	1.50E+01	2.12E+01	3.38E-08	-1.22E-04	1.37E-05	-1.82E-03	2.90E-04
6A1	Managed Waste Disposal on Land	CO2	0.00	0.00	1	1.00E+01	1.00E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6A2	UnManaged Waste Disposal on Land	CO2	0.00	0.00	1	1.50E+01	1.50E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6C	Waste Incineration	CO2	0.37	0.00	15	5.00E+01	5.22E+01	0.00E+00	-2.96E-04	0.00E+00	-1.48E-02	0.00E+00
TOTAL			**1830.27**	**2789.12**								

1A1a	Energy Industries - Gas/Diesel Oil	CH4	0.02	0.20	1	3.00E+00	3.16E+00	4.06E-08	8.16E-05	1.00E-04	2.45E-04	1.42E-04
1A1a	Energy Industries - Residual Fuel Oil	CH4	0.58	1.48	1	3.00E+00	3.16E+00	2.28E-06	2.84E-04	7.52E-04	8.52E-04	1.06E-03
1A1a	Energy Industries - bituminous coal	CH4	0.14	0.00	1	3.00E+00	3.16E+00	0.00E+00	-1.10E-04	0.00E+00	-3.30E-04	0.00E+00
1A2	Manufacturing Industries and Construction	CH4	0.03	0.06	5	1.20E+01	1.30E+01	6.22E-08	7.17E-06	3.03E-05	8.61E-05	2.14E-04
1A3a	Civil Aviation	CH4	0.00	0.00	8	3.00E+01	3.10E+01	3.65E-12	1.23E-08	9.70E-08	3.68E-07	1.10E-06
1A3b	Road Transportation	CH4	2.00	1.46	5	1.50E+01	1.58E+01	5.50E-05	-8.62E-04	7.39E-04	-1.29E-02	5.23E-03
1A3d	Navigation	CH4	0.01	0.05	5	3.00E+01	3.04E+01	2.09E-07	1.42E-05	2.37E-05	4.25E-04	1.68E-04
1A4a	Commercial/Institutional	CH4	0.17	0.16	5	1.20E+01	1.30E+01	4.51E-07	-5.35E-05	8.14E-05	-6.42E-04	5.76E-04
1A4b	Residential	CH4	0.06	0.10	5	1.20E+01	1.30E+01	1.64E-07	4.04E-07	4.91E-05	4.85E-06	3.47E-04
1A4c	Agriculture/Forestry/Fisheries	CH4	0.00	0.06	5	1.20E+01	1.30E+01	7.31E-08	3.28E-05	3.28E-05	3.93E-04	2.32E-04
4A1	Cattle	CH4	15.18	22.62	5	1.50E+01	1.58E+01	1.33E-02	-6.70E-04	1.15E-02	-1.00E-02	8.13E-02
4A3	Sheep	CH4	0.35	1.97	5	1.50E+01	1.58E+01	1.00E-04	7.18E-04	9.98E-04	1.08E-02	7.06E-03
4A4	Goats	CH4	0.18	0.51	5	1.50E+01	1.58E+01	6.72E-06	1.12E-04	2.59E-04	1.68E-03	1.83E-03
4A6	Horses	CH4	0.36	0.74	5	1.50E+01	1.58E+01	1.42E-05	8.67E-05	3.75E-04	1.30E-03	2.65E-03
4A8	Swine	CH4	1.94	1.42	5	1.50E+01	1.58E+01	5.26E-05	-8.31E-04	7.24E-04	-1.25E-02	5.12E-03
4A9	Poultry	CH4	3.15	1.68	5	1.50E+01	1.58E+01	7.34E-05	-1.67E-03	8.55E-04	-2.50E-02	6.04E-03
4A10	Rabbits	CH4	0.05	0.00	5	1.50E+01	1.58E+01	3.27E-11	-3.87E-05	5.70E-07	-5.81E-04	4.03E-06
4B1	Cattle	CH4	6.54	9.73	5	1.50E+01	1.58E+01	2.46E-03	-2.92E-04	4.95E-03	-4.39E-03	3.50E-02
4B3	Sheep	CH4	0.01	0.07	5	1.50E+01	1.58E+01	1.23E-07	2.51E-05	3.49E-05	3.77E-04	2.47E-04
4B4	Goats	CH4	0.01	0.02	5	1.50E+01	1.58E+01	8.71E-09	4.03E-06	9.31E-06	6.04E-05	6.58E-05
4B6	Horses	CH4	0.04	0.09	5	1.50E+01	1.58E+01	1.89E-07	1.00E-05	4.34E-05	1.50E-04	3.07E-04
4B8	Swine	CH4	12.94	9.49	5	1.50E+01	1.58E+01	2.34E-03	-5.54E-03	4.82E-03	-8.31E-02	3.41E-02

4B9	Poultry	CH4	3.69	1.97	5	1.50E+01	1.58E+01	1.01E-04	-1.95E-03	1.00E-03	-2.93E-02	7.07E-03
4B10	Rabbits	CH4	0.05	0.00	5	1.50E+01	1.58E+01	3.27E-11	-3.87E-05	5.70E-07	-5.81E-04	4.03E-06
6A1	Managed Waste Disposal on Land	CH4	0.00	19.71	10	2.48E+01	2.67E+01	2.88E-02	1.00E-02	1.00E-02	2.48E-01	1.42E-01
6A2	UnManaged Waste Disposal on Land	CH4	13.94	27.31	10	7.61E+01	7.68E+01	4.56E-01	2.71E-03	1.39E-02	2.06E-01	1.96E-01
6B	Domestic and Commercial Wastewater	CH4	13.94	0.00	5	7.00E+01	7.02E+01	0.00E+00	-1.12E-02	0.00E+00	-7.82E-01	0.00E+00
6C	Waste Incineration	CH4	11.73	0.00	15	1.50E+01	2.12E+01	2.94E-14	-9.39E-03	1.27E-08	-1.41E-01	2.70E-07
TOTAL		**CH4**	**87.11**	**100.89**								

1A1a	Energy Industries - Gas/Diesel Oil	N2O	0.07	0.58	1	3.00E+00	3.16E+00	3.54E-07	2.41E-04	2.96E-04	7.23E-04	4.19E-04
1A1a	Energy Industries - Residual Fuel Oil	N2O	1.73	4.37	1	3.00E+00	3.16E+00	1.98E-05	8.38E-04	2.22E-03	2.51E-03	3.14E-03
1A1a	Energy Industries - bituminous coal	N2O	3.04	0.00	1	3.00E+00	3.16E+00	0.00E+00	-2.43E-03	0.00E+00	-7.30E-03	0.00E+00
1A2	Manufacturing Industries and Construction	N2O	0.08	0.17	5	1.20E+01	1.30E+01	5.33E-07	2.11E-05	8.86E-05	2.54E-04	6.26E-04
1A3a	Civil Aviation	N2O	0.01	0.01	8	3.00E+01	3.10E+01	1.27E-08	7.24E-07	5.73E-06	2.17E-05	6.48E-05
1A3b	Road Transportation	N2O	5.07	5.03	5	1.50E+01	1.58E+01	6.56E-04	-1.51E-03	2.55E-03	-2.26E-02	1.81E-02
1A3d	Navigation	N2O	0.02	0.08	5	3.00E+01	3.04E+01	6.57E-07	2.51E-05	4.20E-05	7.52E-04	2.97E-04
1A4a	Commercial/Institutional	N2O	0.14	0.12	5	1.20E+01	1.30E+01	2.45E-07	-5.40E-05	6.01E-05	-6.49E-04	4.25E-04
1A4b	Residential	N2O	0.02	0.05	5	1.20E+01	1.30E+01	4.09E-08	6.53E-06	2.45E-05	7.83E-05	1.73E-04
1A4c	Agriculture/Forestry/Fisheries	N2O	0.00	0.06	5	1.20E+01	1.30E+01	5.73E-08	2.90E-05	2.90E-05	3.48E-04	2.05E-04
3D1	Use of N2O for Anaesthesia	N2O	2.48	1.90	2	2.00E+00	2.83E+00	3.01E-06	-1.02E-03	9.68E-04	-2.05E-03	2.74E-03
4B12	Liquid Systems	N2O	2.21	1.72	5	1.50E+01	1.58E+01	7.72E-05	-8.95E-04	8.76E-04	-1.34E-02	6.20E-03
4B13	Solid Storage and Dry Lot	N2O	2.48	2.04	5	1.50E+01	1.58E+01	1.08E-04	-9.51E-04	1.04E-03	-1.43E-02	7.33E-03
4D1	Direct Soil Emissions	N2O	13.92	9.60	5	1.50E+01	1.58E+01	2.39E-03	-6.27E-03	4.88E-03	-9.41E-02	3.45E-02
4D3.1	Indirect emissions Atmospheric Deposition	N2O	6.09	4.27	5	1.50E+01	1.58E+01	4.73E-04	-2.71E-03	2.17E-03	-4.07E-02	1.53E-02

4D3.2	Indirect emissions Nitrogen Leaching and run - off	N2O	1.69	1.43	5	1.50E+01	1.58E+01	5.30E-05	-6.32E-04	7.26E-04	-9.48E-03	5.13E-03
6B	Domestic and Commercial Wastewater	N2O	0.00	0.00	5	7.00E+01	7.02E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6C	Waste Incineration	N2O	11.74	13.91	15	1.50E+01	2.12E+01	9.04E-03	-2.34E-03	7.07E-03	-3.51E-02	1.50E-01
TOTAL			**50.80**	**45.35**								
2F1	Refrigeration & Air Conditioning Equipment	HFCs	0.00	161.88	50	5.00E+01	7.07E+01	1.36E+01	8.22E-02	8.22E-02	4.11E+00	5.82E+00
2F2	Foam Blowing	HFCs	0.00	0.15	40	4.00E+01	5.66E+01	7.50E-06	7.63E-05	7.63E-05	3.05E-03	4.32E-03
2F3	Fire Extinguishers	HFCs	0.00	2.26	5	5.00E+00	7.07E+00	2.66E-05	1.15E-03	1.15E-03	5.75E-03	8.13E-03
2F4	Metered Dose Inhalers	HFCs	0.00	3.16	5	5.00E+00	7.07E+00	5.19E-05	1.61E-03	1.61E-03	8.04E-03	1.14E-02
2F7	Semiconductor Manufacture	HFCs	0.00	0.00	5	5.00E+00	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2F7	Semiconductor Manufacture	PFCs	0.00	0.00	5	5.00E+00	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2F9	Other (Medical Applications)	PFCs	0.00	0.00	5	5.00E+00	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2F8	Electrical Equipment	SF6	0.01	0.47	2	1.00E+01	1.02E+01	2.42E-06	2.32E-04	2.40E-04	2.32E-03	6.80E-04
2F9	Other (Medical Applications)	SF6	0.00	0.00	5	5.00E+00	7.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL		**HFCs, PFCs and SF6**	0.01	167.93								

TOTAL UNCERTAINTIES	Overall uncertainty in the Inventory (%)	4.92	Trend uncertainty (%)	7.76

A8 ANNEX 8: SEF TABLES AND RELEVANT DATA

Malta not being an Annex B Party to the UNFCCC and not maintaining a Kyoto registry is not itself involved in transactions of Kyoto units.