National Greenhouse Gas Emissions Inventory for Malta

2013

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

MALTA RESOURCES AUTHORITY

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Preface

This report is Malta's National Inventory Report (NIR) submitted in April 2013 to the UNFCCC. It contains national greenhouse gas emission estimates for the period 1990-2011, and the descriptions of 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 Malta Resources Authority. The GHG Inventory is compiled according to IPCC 1996 Revised Guidelines [1] and Good Practice Guidance [2] with reference to the new 2006 IPCC Guidelines [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

ES.1.1 Background information on climate change (e.g. as it pertains to the national context)

In 1988, following a proposal by Malta, the United Nations General Assembly addressed climate change for the first time by adopting Resolution 43/53. This recognized that "climate change is a common concern of mankind, since climate is an essential condition which sustains life on earth", and determined that "necessary and timely action should be taken to deal with climate change within a global framework …"

In response to the threat of climate change, the Convention entered into force in 1994 and the Kyoto Protocol was established to strengthen the Convention by committing Annex I Parties to individual, legally-binding targets to limit or reduce their GHG emissions.

The Republic of Malta ratified the United Nations Framework Convention on 17th March 1994 as a non-Annex I country, and the Kyoto Protocol, in the same capacity, on 11th November 2001. It is important to note that owing to it ratification as a non-Annex I country, Malta has no emission limitation or reduction targets for greenhouse gases (GHG) for the first Kyoto Protocol commitment period (2008-2012).

In COP15/MOP5 in Copenhagen, Malta made a request for its inclusion in Annex I to the UNFCCC. This was adopted in 2010 and hence Malta is now included in Annex I but still remains without quantified emissions limit or a reduction target for the first commitment period of the Kyoto protocol.

This is the third National Inventory Report (NIR) being submitted under the capacity of an Annex I party.

ES.1.2 Background information on greenhouse gas inventories

This report is Malta's National Inventory Report (NIR) being submitted in April 2013. It contains GHG emissions estimates for the period 1990 to 2011, and describes the methodology on which the estimates are based. This report and the attached Common Reporting Format (CRF) have been compiled in accordance with UNFCCC reporting guidelines on annual inventories contained in document FCCC/CP/2002/8 and Decision 18/CP8 of the Conference of Parties.

Malta's greenhouse gas inventory is compiled by the National Inventory Systems Team within the Malta Resources Authority. The Climate Change and Policy Unit is responsible for all functions of the inventory system, from data collection from other

entities within different sectors, to data management, through to the preparation and submission of reports.

The inventory covers the six direct greenhouse gases under the Kyoto Protocol. These are as follows:

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

These gases contribute directly to climate change owing to their positive radiative forcing effect. Also reported are four indirect greenhouse gases:

- Nitrogen oxides (reported as NO_2);
- Carbon monoxide;
- Non-Methane Volatile Organic Compounds (NMVOC); and
- Sulphur oxides (reported as SO_2).

Emissions data for direct greenhouse gases, disaggregated by gas is given in Table ES2.1 while emission data for indirect GHGs given in Table ES4.1 Emissions of Indirect Greenhouse Gases in Malta (Gg).

The structure of this report is as follows:

- Chapter 1 of the report provides an introduction and background information on greenhouse gas inventories.
- Chapter 2 provides a summary of the emission trends for aggregated greenhouse gas emissions by source and gas.
- Chapters 3 to 9 discuss each of the main source categories in detail.
- Chapter 10 presents information on recalculations, improvements and a summary of responses to review processes.

The Annexes provide more detailed information regarding specific topics and issues as set out in the Guidelines.

ES.2 Summary of national emission and removal related trends

ES.2.1 GHG Inventory

Table ES2.1 presents Malta's Greenhouse Gas Inventory totals by gas, both including and excluding net emissions from LULUCF. The total GHG gross emissions amounted to 3021.2 Gg CO_2 eq in 2011, an increase of 50.6 % compared to 1990.

CO_2 is the largest contributor to national emissions with 87.2% share of total gross emissions in 2011; this is the case throughout the time series. CH_4 is the second highest emitted greenhouse gas representing a share of 7.4%, with lesser shares for the fluorinated gases and N_2O at 3.6% and 1.7% respectively.

Looking at the whole time series (1990-2011) CO_2, CH_4 and fluorinated gases have been increasing while N_2O has been seen to decrease in the past years.

Table ES2.1 Emissions of GHGs in terms of carbon dioxide equivalent emissions for the period 1990-2011 (Gg CO_2 Equivalent).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (Net)	1,809.0	1,984.5	2,088.9	2,084.9	2,196.3	2,156.5	2,208.7	2,198.7	2,202.1	2,292.2	2,289.3
CO_2 (Gross)	1,865.5	2,041.0	2,145.5	2,141.4	2,252.9	2,213.0	2,265.2	2,255.3	2,258.6	2,348.1	2,345.2
CH_4	91.1	91.4	94.4	98.1	100.9	104.7	107.0	110.4	112.2	113.8	125.0
N_2O	49.9	50.4	51.7	52.8	54.3	59.2	54.9	55.4	61.2	56.5	61.0
HFCs	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	73.9	73.9	73.9	8.3
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	0.0
SF_6	0.0	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Net Emissions	**1,950.0**	**2,126.3**	**2,236.5**	**2,237.3**	**2,353.0**	**2,321.8**	**2,372.1**	**2,439.9**	**2,450.9**	**2,537.9**	**2,485.1**
Total Gross Emissions	**2,006.6**	**2,182.8**	**2,293.0**	**2,293.9**	**2,409.5**	**2,378.4**	**2,428.6**	**2,496.5**	**2,507.4**	**2,593.8**	**2,541.0**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	% Change
CO_2 (Net)	2,408.9	2,428.9	2,606.7	2,560.4	2,647.0	2,612.1	2,698.0	2,656.8	2,569.6	2,580.9	2,603.4	43.92
CO_2 (Gross)	2,464.8	2,484.8	2,663.7	2,618.6	2,704.0	2,671.0	2,756.9	2,715.6	2,628.5	2,640.6	2,663.1	42.75
CH_4	125.5	126.9	126.8	132.8	139.9	148.7	158.8	158.0	167.2	175.4	167.4	83.7
N_2O	58.7	58.2	55.5	56.5	58.5	59.9	59.3	55.7	54.3	51.9	50.4	1.0
HFCs	15.3	28.7	40.1	60.4	64.5	87.5	106.2	116.7	120.3	121.6	132.2	100.0
PFCs	0.0	0.0	0.0	27.9	23.4	23.3	22.8	12.9	7.0	6.6	3.3	100.0
SF_6	1.6	1.6	2.2	1.6	1.6	1.7	1.7	1.8	1.6	1.8	4.8	43,055.2
Total Net Emissions	**2,610.0**	**2,644.3**	**2,831.1**	**2,839.7**	**2,934.9**	**2,933.2**	**3,046.7**	**3,002.0**	**2,920.1**	**2,938.2**	**2,961.5**	**51.9**
Total Gross Emissions	**2,665.9**	**2,700.2**	**2,888.1**	**2,897.8**	2,992.0	**2,992.0**	**3,105.6**	**3,060.8**	**2,979.0**	**2,997.9**	**3,021.2**	**50.6**

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

ES.3.1 GHG Inventory

Energy is the largest contributor of GHG emissions in Malta with a share of 88.8% of the gross national emissions. Within this sector the energy industries (power plants) account for the majority of the emissions (72.3%) and this has increased by 41.2% between 1990 and 2011. This activity also remains the highest contributor overall.

The second highest contributor is transport (which incorporates road transport, national navigation and domestic aviation), this accounts for 21.1% of the energy sector emissions, and representing an increase of around 61.9 % over the time series covered by this report. The other energy sub sectors together make up the remainder of this sector's emissions.

Emissions within the Industrial Processes sector account for 4.7% for 2011. Here one should note that many of the industrial process categories as stipulated by IPCC guidelines do not occur in Malta. The Solvent and Other Product Use sector comprises a very small amount of the total emissions throughout the whole time series; in 2011 it accounted for less than 0.1% of total emissions. The sector has also seen a decrease of 47.3% over the whole time series.

Agriculture in Malta is estimated to contribute around 2.4% of total national GHG emissions for 2011. The Waste sector has the third largest share of the total GHG inventory emissions (4.3%), with the largest portion of emissions for the reporting year 2011 resulting from the Solid Waste Disposal on Land category (86.1%), followed by liquid waste (13.2%). The overall trend in this sector for the whole time series is one of continued increase in emissions (235% increases over 1990).

The Land Use, Land-Use Change and Forestry (LULUCF) sector includes yearly estimates of carbon dioxide emissions and removals by particular vegetation types. In 2011 -59.67 Gg of CO_2 removals were estimated, accounting for a net removal equivalent to 2.0% of the total emissions for 2011.

Table ES3.1 Aggregated emission trends per source category (Gg CO_2 equivalent).

Source Category	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	0.33	0.53	1.65	1.69	1.99	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	87.81	85.53	86.96	87.53	86.80	93.83	90.93	92.85
5. LULUCF	-56.54	-56.54	-56.54	-56.54	-56.54	-56.54	-56.54	-56.54
6. Waste	37.84	39.88	42.08	46.04	50.51	52.81	53.49	55.34
Total (net emissions)	**1,950.02**	**2,126.25**	**2,236.45**	**2,237.32**	**2,352.98**	**2,321.85**	**2,372.09**	**2,439.93**
Source Category	**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	30.61	42.43	90.34	89.92
3. Solvents and Other Product Use	2.48	2.72	3.01	2.33	2.56	2.38	2.37	2.26
4. Agriculture	95.39	91.27	102.95	98.77	97.94	91.10	95.65	93.58
5. LULUCF	-56.54	-55.91	-55.91	-55.91	-55.91	-57.00	-58.17	-57.08
6. Waste	60.25	60.62	64.40	66.84	68.29	71.88	74.86	83.76
Total (net emissions)	**2,450.86**	**2,537.86**	**2,485.12**	**2,610.00**	**2,644.26**	**2,831.14**	**2,839.68**	**2,934.88**
Source Category	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**		
1. Energy	2,689.09	2,775.93	2,734.83	2,647.29	2,659.62	2,681.65		
2. Industrial Processes	112.80	130.90	131.66	129.17	130.24	140.57		
3. Solvents and Other Product Use	2.03	2.71	2.10	1.60	1.29	1.31		
4. Agriculture	93.36	95.23	86.45	83.26	78.04	70.90		
5. LULUCF	-58.87	-58.86	-58.86	-58.87	-59.67	-59.67		
6. Waste	94.76	100.78	105.77	117.64	128.73	126.76		
Total (net emissions)	**2,933.18**	**3,046.69**	**3,001.96**	**2,920.09**	**2,938.24**	**2,961.52**		

ES.4 Other information

Table ES4.1 lists the indirect greenhouse gases for which Malta has made emissions estimates. Nitrogen oxides, carbon monoxide and NMVOCs are included in the inventory because they can produce increases in tropospheric ozone concentrations and this increases radiative forcing. Sulphur oxides are included because they contribute to aerosol formation.

Table ES4.1 Emissions of Indirect Greenhouse Gases in Malta (Gg).

Gas	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

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

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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

In 1988, following a proposal by Malta, the United Nations General Assembly addressed climate change for the first time by adopting Resolution 43/53. This recognized that "climate change is a common concern of mankind, since climate is an essential condition which sustains life on earth", and determined that "necessary and timely action should be taken to deal with climate change within a global framework …"

In response to the threat of climate change, the Convention entered into force in 1994 and the Kyoto Protocol was established to strengthen the Convention by committing Annex I Parties to individual, legally-binding targets to limit or reduce their GHG emissions.

1.1.1.1 Background Information about Malta

The Maltese archipelago is centrally located in the Mediterranean Sea, and is made up of three main islands, Malta, Gozo and Comino, with a number of additional small uninhabited islets which together amount to a total area of 316 km^2. The climate is typically Mediterranean with moist, mild winters and dry, hot summers.

Population size between 1990 and 2011 has grown from 361,908 to 416,055. Gross Domestic Product (GDP) has increased from €1.9 billion in 1990 to €6.4 billion in 2011. The Maltese economy is highly dependent on foreign trade and services. The only abundant natural resource is limestone, mainly utilised in the construction industry. No indigenous fossil fuel sources are available.

1.1.1.2 Malta's Climate Change Obligations

The Republic of Malta ratified the United Nations Framework Convention on 17th March 1994 as a non-Annex I country, and the Kyoto Protocol, in the same capacity, on 11th November 2001. It is important to note that owing to the fact that Malta ratified this protocol as a non-Annex I country, it has no emission limitation or reduction targets for greenhouse gases (GHG) for the first commitment period.

In COP15/MOP5 in Copenhagen, Malta made a request for its inclusion in Annex I to the UNFCCC. This was adopted in 2010 and hence Malta is now included in Annex I but still remains without quantified emissions limitation or a reduction target for the first commitment period of the Kyoto Protocol between 2008-2012.

Malta became a member of the European Union in 2004 and adopted/transposed legislation agreed at European level. Obligations under EU legislation related to the scope of this report include obligations set out in Directive 87/2003/EC which establishes an emissions trading scheme for specific sectors within the Community (EU-ETS). Only emissions of CO_2 from the two power plants fall within the scope of the directive up to the year of this report. Emissions from all other sectors which do not fall under the EU-ETS (except memo items and civil aviation) fall within the scope of the so-called "Effort Sharing Decision" (Decision 406/2009/EC) which establishes annual binding greenhouse gas emission targets for Member States for the period 2013–2020. Malta is bound to limit GHG emissions from the sectors falling within the scope of this decision to a maximum of +5% of 2005 levels by 2020.

1.1.2 Background Information on Greenhouse Gas Inventories

1.1.2.1 Reporting of Malta's Greenhouse Gas Inventory

This 'National Inventory Report' for Malta contains GHG emissions estimates for the period 1990 to 2011, and describes the methodology on which the estimates are based. This report and the attached Common Reporting Format (CRF) have been compiled in accordance with UNFCCC reporting guidelines on annual inventories contained in document FCCC/CP/2002/8 and Decision 18/CP8 of the Conference of Parties.

Malta also reports GHG emissions by sources and removals by sinks in the Common Reporting Format (CRF) tables. The estimates are consistent with the IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories [1] and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories [2].

The main part of the report presents greenhouse gas emissions for the years 1990-2011, and discusses the reasons for the trends and any changes in the estimates due to revisions made since the last inventory. The Annexes provide supplementary detail of the methodology of the estimates, and explain how the Greenhouse Gas Inventory relates to the IPCC Guidelines.

The CRF consists of a series of detailed spreadsheets, with one set for each year. The CRF reports much more detail than the IPCC Sectoral Tables, in that it contains additional tables of activity data as well as updated versions of the IPCC Sectoral Tables.

Malta's greenhouse gas inventory is compiled by the National Emissions Inventory team within the Malta Resources Authority. The Climate Change and Policy Unit is responsible for all functions of the inventory system, from data collection from various entities within different sectors, to data management, through to the preparation and submission of reports.

1.1.2.2 Greenhouse Gases Reported in Malta's Inventory

The inventory covers the six direct greenhouse gases under the Kyoto Protocol. These are as follows:

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

These gases contribute directly to climate change owing to their positive radiative forcing effect. Also reported are four other gases with indirect greenhouse effects:

- Nitrogen oxides (reported as NO_2);
- Carbon monoxide;
- Non-Methane Volatile Organic Compounds (NMVOC); and
- Sulphur oxides (reported as SO_2).

These indirect gases have indirect effects on radiative forcing and are requested by the UNFCCC guidelines.

1.2 Institutional Arrangement for Inventory Preparation

1.2.1 Institutional, legal and procedural arrangements for compiling Malta's inventory

The institutional arrangement for inventory preparation is described in Figure **1-1**. The Malta Environment and Planning Authority (MEPA) was responsible for compiling the national GHG inventory up to 2010. As of 2011 the Malta Resources Authority (MRA) is the authority entrusted with the role of compiling national greenhouse gas emission inventories. The National Emissions Inventory Team within the Climate Change and Policy Unit at MRA has been delegated the main responsibility for managing the inventory compilation system and for preparing the relevant submissions.

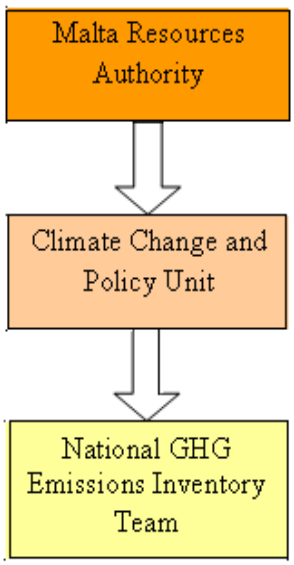

Figure 1-1 Institutional Arrangements for Inventory Preparation in Malta

1.2.1.1 A Brief History of Greenhouse Gas Emission Inventories in Malta

The first national inventory of emissions and removals of GHG was carried out by the University of Malta as part of the Climate Change Project which resulted in the preparation and submission of Malta's First National Communication. This inventory exercise covered a time series from 1990 to 2000.

In 2001 the Malta Environment and Planning Authority (MEPA) was entrusted with the responsibility of compiling national inventories, with a first step towards a comprehensive inventory system being an ad hoc update of the inventory mentioned above, covering the years 2001 to 2003.

Subsequently, a decision was taken to set up a standardised system to cater for all inventory reporting under climate change and air quality obligations, including in particular reporting obligations under UNFCCC and Decision 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. However, a national government decision in early 2010 resulted in the greenhouse gas related functions migrating to MRA with other functions and obligations being retained within MEPA.

Work on developing and consolidating the greenhouse gas emissions and removals inventory system is ongoing, to ensure that Malta has the capacity to meet its reporting obligations in a reliable and timely manner.

1.2.2 Overview of inventory planning

1.2.2.1 The National Inventory System and the Process of Inventory Preparation

The Climate Change and Policy Unit is responsible for all functions of the inventory system, from data collection, through data management, to the preparation and submission of reports.

Figure 1-2 represents a schematic of the main features of the inventory system being developed and also describes the steps that are involved in the inventory preparation. No changes were made to the national inventory system since the GHG inventory submission of March 2010.

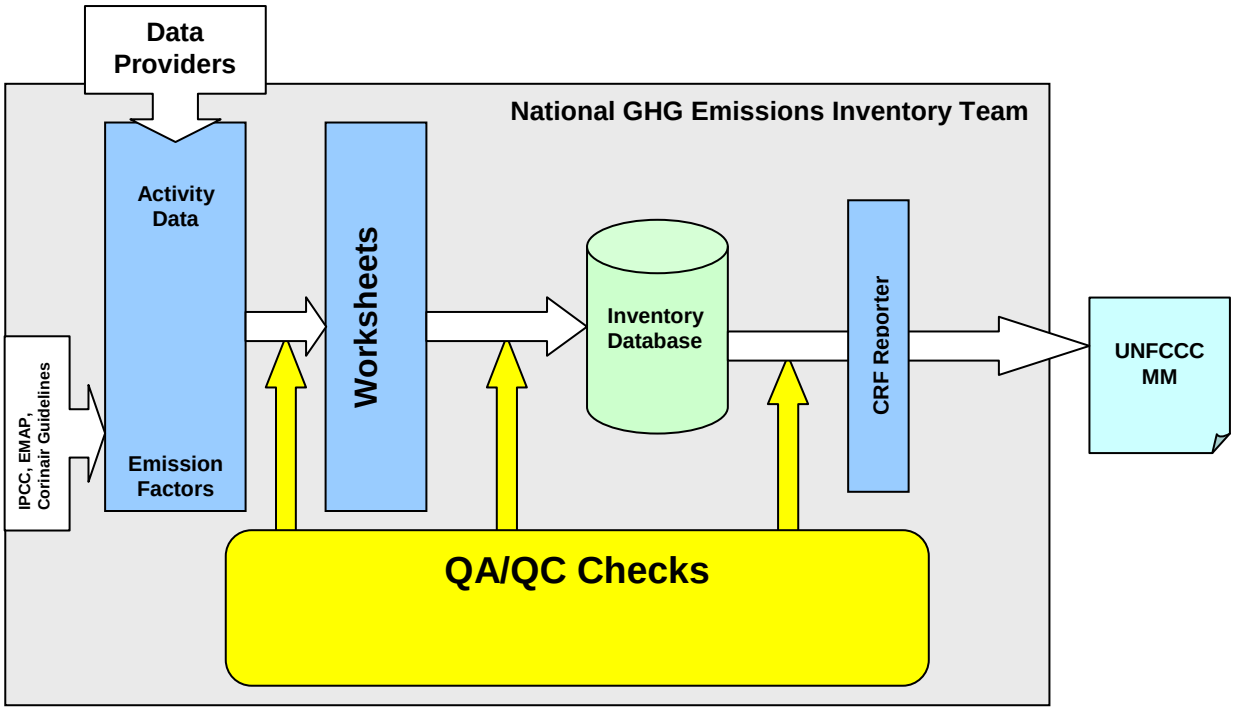

Figure 1-2 Schematic Representation of the National GHG Inventory System

1.2.2.2 Key Data Sources Providers

Activity data used for the preparation of this inventory has been obtained from Malta's past GHG inventory compilations [7, 8], the National Statistics Office, and Government entities (Ministries, departments within Ministries) and other public bodies such as regulatory authorities, from private establishments and published reports. These are listed in Table 1-1.

Table 1-1 Key Data Providers by sector

Sector	Key data providers
Energy	Enemalta Corporation Individual private industrial entities Malta International Airport Malta Maritime Authority Gozo Channel Tug Malta Civil Aviation Directorate Malta Resources Authority Transport Malta National Statistics Office
Industrial Processes	Enemalta Corporation Individual private industrial entities Transport Malta National Statistics Office Foundation for Medical Services
Solvent and Other Product Use	Malta Federation of Industry National Statistics Office
Agriculture	National Statistics Office
Land Use, Land-Use Change and Forestry (LULUCF)	Malta Environment & Planning Authority Ministry for Resources and Rural Affairs
Waste	Malta Environment & Planning Authority Malta Shipyards Ministry of Health WasteServ Malta Ltd Water Services Corporation

1.3 Process of Inventory Preparation

1.3.1 GHG Inventory

Malta's GHG inventory for the period 1990-2011 was compiled in accordance with the IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories [1], IPCC 2006 Guidelines for National Greenhouse Gas Inventories [3] and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories [2].

1.3.2 Data collection, processing and storage

The following is a description of the process which is carried out each year in order to compile the GHG inventory for Malta.

1.3.2.1 Data Collection

The collection of data is the starting point of the GHG inventory compilation. This starts around August when data requests are issued to contacts listed on a database of data providers. The progress of data collection is tracked in the following months up to December and reminders are sent out to ensure that the data is received on time. In the meantime other published data which can be found online is collected and stored in the relevant database according to sector and sub-sector. This task provides the core activity data which is essential to compile the GHG inventory. Figure 1-3 outlines the main elements of the data collection system used for Malta's inventory.

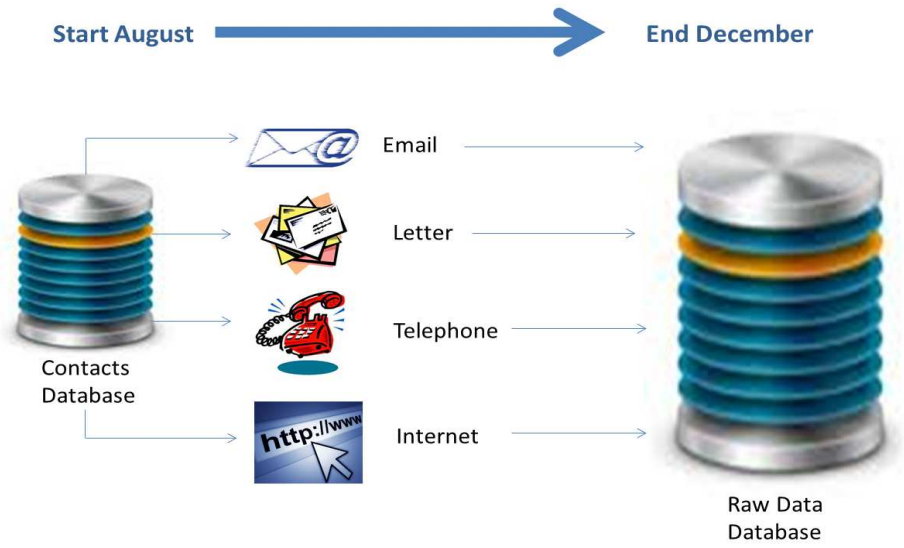

Figure 1-3 Data collection for Malta's greenhouse gas inventory

1.3.2.2 Method Improvement

During the period August to December any improvements to calculation methods which have been identified are carried out. These improvements are either issues identified from the previous inventory submission or are made possible due to new or more comprehensive data being obtained.

1.3.2.3 Data Verification

Activity data received are examined. Inconsistencies are investigated, such as time series discrepancies, or changes in values from the previous to the current inventory year.

1.3.2.4 Data Processing

Data is processed to transform it to the appropriate format to allow calculation of direct and indirect GHG emissions.

1.3.2.5 Emission Estimation

The processed activity data is then used to produce emissions estimates.

1.3.2.6 Emissions Review

The emissions are checked to detect inconsistencies in the estimated emissions (time series variations and year to year changes). Any miscalculation or error is corrected to produce the final emissions estimated for the inventory reporting year.

1.3.2.7 Report Generation

Draft reports are written to satisfy the reporting criteria of the UNFCCC or EU. These include descriptions of methodologies, background data, emissions for the reporting year and any re-calculations from previous years.

1.3.2.8 Report Review

The reports are reviewed internally and by external contributing agencies namely the Ministry responsible for Climate Change MRRA and the EU secretariat. Any changes are then made and the report is finalised.

1.3.2.9 Report Publication

Final reports and data sets are then submitted and published on publicly available web sites.

1.3.2.10 Data archiving

At the end of each inventory cycle, all data, spreadsheets, databases and reports are archived, allowing all data to remain traceable, should it be needed in future years.

1.3.3 Quality Assurance/Quality control (QA/QC) procedures and extensive review of GHG inventory

The inventory team has made its utmost effort to ensure as high a level of quality and reliability as possible and is aware that there is need of a standardised Quality Assurance/Quality Control (QA/QC) system. Details of the plan to establish a standardised Quality Assurance/Quality Control (QA/QC) system within the national inventory system are given in section 1.6.

1.4 Methodologies and Data Sources

1.4.1 GHG Inventory

The methods used to estimate emissions are described in detail in the relevant sections of this report. The methodologies and emission factors used have been principally obtained from the following guidelines:

- Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories [1];

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories [3];
- EMEP/Corinair Emissions Inventory Guidebook – 2006 [9];
- EMEP/Corinair Emissions Inventory Guidebook – 2007 [10];
- EMEP/EEA Air Pollutant Emissions Inventory Guidebook – 2009 [11].

1.5 Description of Key Source Categories

1.5.1 GHG Inventory (including and excluding LULUCF)

An important aspect of inventory preparation is to identify key emission source categories. Key categories are defined as the sources of emissions that have a significant influence on the inventory as a whole, in terms of the absolute level of the emissions, the trend, or both. The key source analysis is prepared according to methods described in the IPCC Good Practice Guidance [2] and is based on Malta's 1990-2011 GHG inventory data. The analysis has been performed using global warming potential (GWP) weighted emissions, which gives totals of emissions for the main greenhouse gases in terms of carbon dioxide equivalents. The GWP values applied are reproduced below in Table **1-2**. The analysis performed represents a Tier 1 analysis and has been completed with and without the LULUCF sector, in accordance with the provisions set out in the Good Practice Guidance [2]. The list of gases in the latter mentioned table is not exclusive and other GWP factors that may have been used are specified in the sector specific text.

Table 1-2 GWP for HFCs, PFCs and SF_6

Chemical	Chemical formula	Global Warming Potential [13]
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310
HFC-32	CH_2F_2	650
HFC-134a	CH_2FCF_3	1 300
HFC-125	C_2HF_5	2 800
HFC-227ea	C_3HF_7	2 900
HFC-143a	$C_2H_3F_3$	3 800
Perfluoropropane	C_3F_8	7 000
Perfluoroethane	C_2F_6	9 200
HFC-23	CHF_3	11 700
Sulphur hexafluoride	SF_6	23 900

For the stationary combustion sector, emissions have been disaggregated according to the fuel type consumed. The LULUCF sector incorporates both sources (positive emissions) and sinks (negative emissions) of CO_2. To avoid confusion in the key source list with

respect to sinks, these have been treated as though they were a source of carbon of equal magnitude, using the absolute value of the sink.

The key source analyses for 1990 and 2011, with and without LULUCF are presented in A1 Annex 1: KEY CATEGORIES.

1.6 QA/QC Procedures

1.6.1 Description of the QA/QC current system

The need for a standardised Quality Assurance/Quality Control (QA/QC) system within the national inventory system is recognised and is acknowledged as being an important aspect to be addressed in the ongoing development of the system in general. Work specifically aimed at developing a QA/QC system is formed part of the national inventory system team's work plan for 2012, to ensure the quality and reliability of the activity data, emission factors and emission estimates, in line with the principles of transparency, accuracy, consistency, comparability and completeness. Quality assurance and quality control methods are continuously being developed.

Efforts were made to ensure as high a level of quality and reliability as possible. A priority task has been to ensure that the best available sources of data are used, especially where these have been verified (for example data on fuel consumption in power generation plants for the most recent years has been derived from verified emission reports that local installations are obliged to submit pursuant to Directive 2003/87/EC[3]).

1.7 General Uncertainty

1.7.1 GHG Inventory

In an inventory process, uncertainty estimates are an essential element. Uncertainty can be described as being a measure of the lack of knowledge of the true value of a variable, and may be defined by a probability density function characterising the range and likelihood of possible values.

Uncertainties are associated with both the activity data and the emission factors, and are therefore reflected in the final results. During this inventory preparation, the necessary uncertainty data have been identified and a Tier 1 uncertainty assessment, as per IPCC Good Practice Guidance [2] Table 6.1 format, has been worked out and is presented in A7 Annex 7: Tier 1 UNCERTAINTY ESTIMATION.

In all the inventory years reported for Malta, the major source of emissions is the Public Electricity and Heat Production (1A1a) category. As indicated earlier, good quality

[3] 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

activity data has been used to calculate the emissions from this category; fuel consumption figures from this sector are of a significantly high level of quality, especially since for the most recent years, the data being used has been verified according to the obligations arising under the EU emissions trading scheme.

1.8 General Assessment on Completeness

1.8.1 General Assessment of Completeness

Completeness means that an inventory covers all sources and sinks, as well as all gases. In this inventory submission Malta is including emissions from all of its known major sources of greenhouse gases emissions and removals. Annex 5 shows sources of GHGs that are not estimated in the Malta GHG inventory, and the reasons for those sources being omitted.

Chapter 2 TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Description and Interpretation of Emission Trends for Aggregated Greenhouse Gas Emissions

2.1.1 Trends in Emissions of Direct Greenhouse Gases

Trends in overall emissions (disaggregated by gas) are shown in Figure 2-1 and Figure 2-2; the 'without LULUCF' and 'with LULUCF' cases respectively. These represent in graphical form the data included in Table 2-1. From 1990 to 2011, gross GHG emissions increased by 1015Gg CO_2 equivalents.

Figure 2-1 represents emissions without subtracting the levels of CO_2 removals. As can be expected, overall emission values shown here are greater than in the 'with LULUCF' representation.

Figure 2-2 'with LULUCF' emissions show net overall emissions after the level of removals ('negative emissions') of CO_2 from the atmosphere as calculated for the LULUCF sector are subtracted from the gross total quantity of emissions ('positive emissions').

An overall increase in emissions over the time series is clear, with some fluctuations in certain instances. The change in gross emissions (as calculated in terms of CO_2 equivalents for CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) between 1990 and 2011 is of 50.6%, a main contributor to this increase being the trend in CO_2 emissions.

Table 2-1 Emissions of Greenhouse Gases by Year (in Gg CO_2 equivalents)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (Net)	1,809.0	1,984.5	2,088.9	2,084.9	2,196.3	2,156.5	2,208.7	2,198.7	2,202.1	2,292.2	2,289.3
CO_2 (Gross)	1,865.5	2,041.0	2,145.5	2,141.4	2,252.9	2,213.0	2,265.2	2,255.3	2,258.6	2,348.1	2,345.2
CH_4	91.1	91.4	94.4	98.1	100.9	104.7	107.0	110.4	112.2	113.8	125.0
N_2O	49.9	50.4	51.7	52.8	54.3	59.2	54.9	55.4	61.2	56.5	61.0
HFCs	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	NA,NE, NO	73.9	73.9	73.9	8.3
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	0.0
SF_6	0.0	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Net Emissions	**1,950.0**	**2,126.3**	**2,236.5**	**2,237.3**	**2,353.0**	**2,321.8**	**2,372.1**	**2,439.9**	**2,450.9**	**2,537.9**	**2,485.1**
Total Gross Emissions	**2,006.6**	**2,182.8**	**2,293.0**	**2,293.9**	**2,409.5**	**2,378.4**	**2,428.6**	**2,496.5**	**2,507.4**	**2,593.8**	**2,541.0**

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	% Change
CO_2 (Net)	2,408.9	2,428.9	2,606.7	2,560.4	2,647.0	2,612.1	2,698.0	2,656.8	2,569.6	2,580.9	2,603.4	43.92
CO_2 (Gross)	2,464.8	2,484.8	2,663.7	2,618.6	2,704.0	2,671.0	2,756.9	2,715.6	2,628.5	2,640.6	2,663.1	42.75
CH_4	125.5	126.9	126.8	132.8	139.9	148.7	158.8	158.0	167.2	175.4	167.4	83.7
N_2O	58.7	58.2	55.5	56.5	58.5	59.9	59.3	55.7	54.3	51.9	50.4	1.0
HFCs	15.3	28.7	40.1	60.4	64.5	87.5	106.2	116.7	120.3	121.6	132.2	100.0
PFCs	0.0	0.0	0.0	27.9	23.4	23.3	22.8	12.9	7.0	6.6	3.3	100.0
SF_6	1.6	1.6	2.2	1.6	1.6	1.7	1.7	1.8	1.6	1.8	4.8	43,055.2
Total Net Emissions	**2,610.0**	**2,644.3**	**2,831.1**	**2,839.7**	**2,934.9**	**2,933.2**	**3,046.7**	**3,002.0**	**2,920.1**	**2,938.2**	**2,961.5**	**51.9**
Total Gross Emissions	**2,665.9**	**2,700.2**	**2,888.1**	**2,897.8**	**2,992.0**	**2,992.0**	**3,105.6**	**3,060.8**	**2,979.0**	**2,997.9**	**3,021.2**	**50.6**

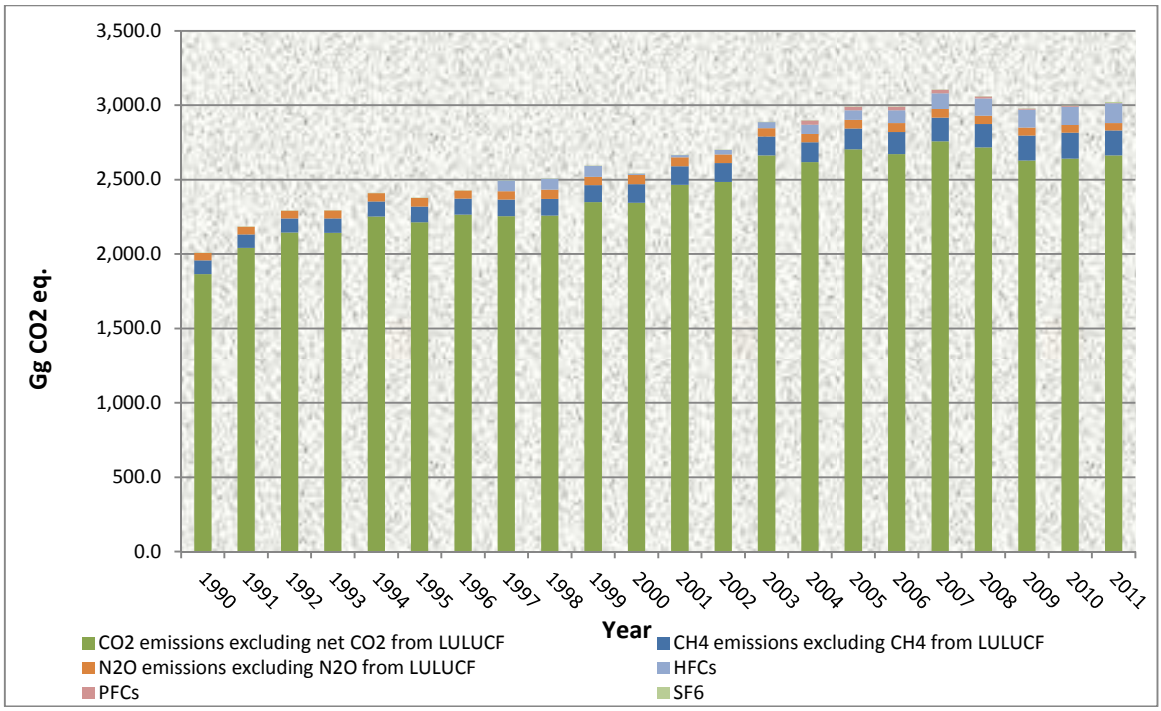

Figure 2-1 Trend in Overall Emissions without LULUCF

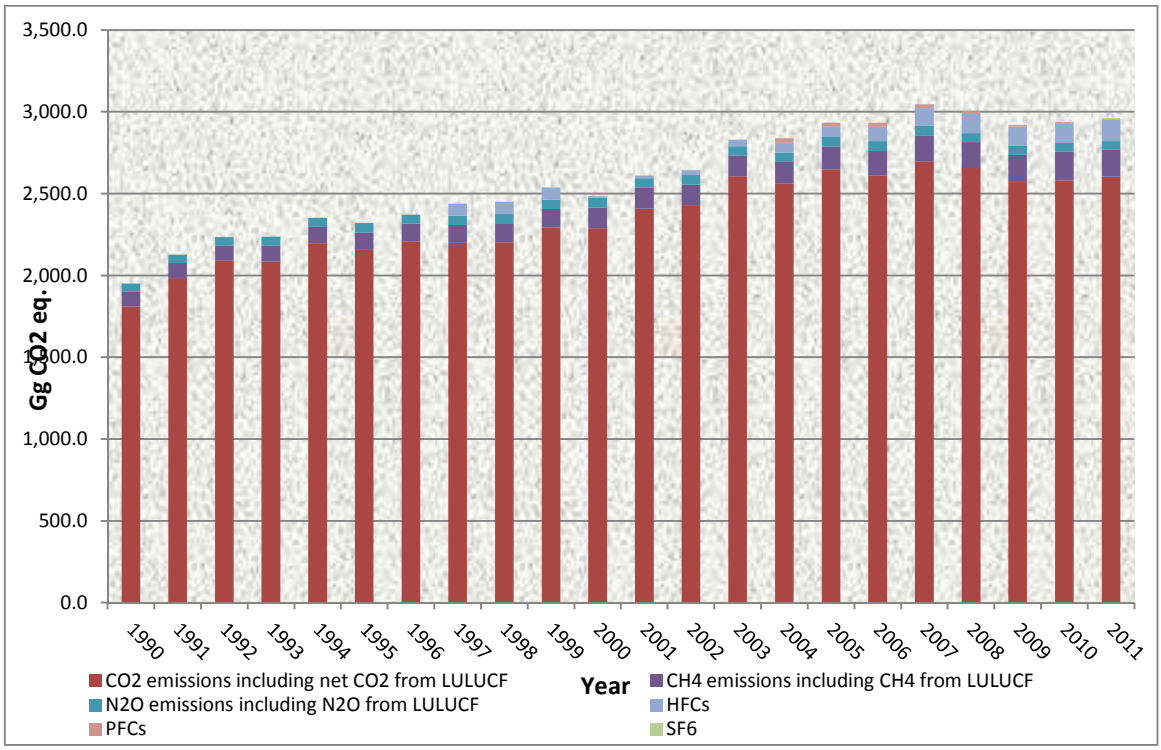

Figure 2-2 Trend in Overall Emissions with LULUCF

Sub-dividing the whole time series shows a change in the rate of increase of overall emissions. The largest increase in emissions is observed from the year 1990 to the year

2000: 27.4% (including LULUCF); an increase of 18.9% is observed from 2000 to 2011. In 2011 there was an increase in emissions of 0.75% over 2010. Changes in emissions year-on-year are shown in Figure 2-3.

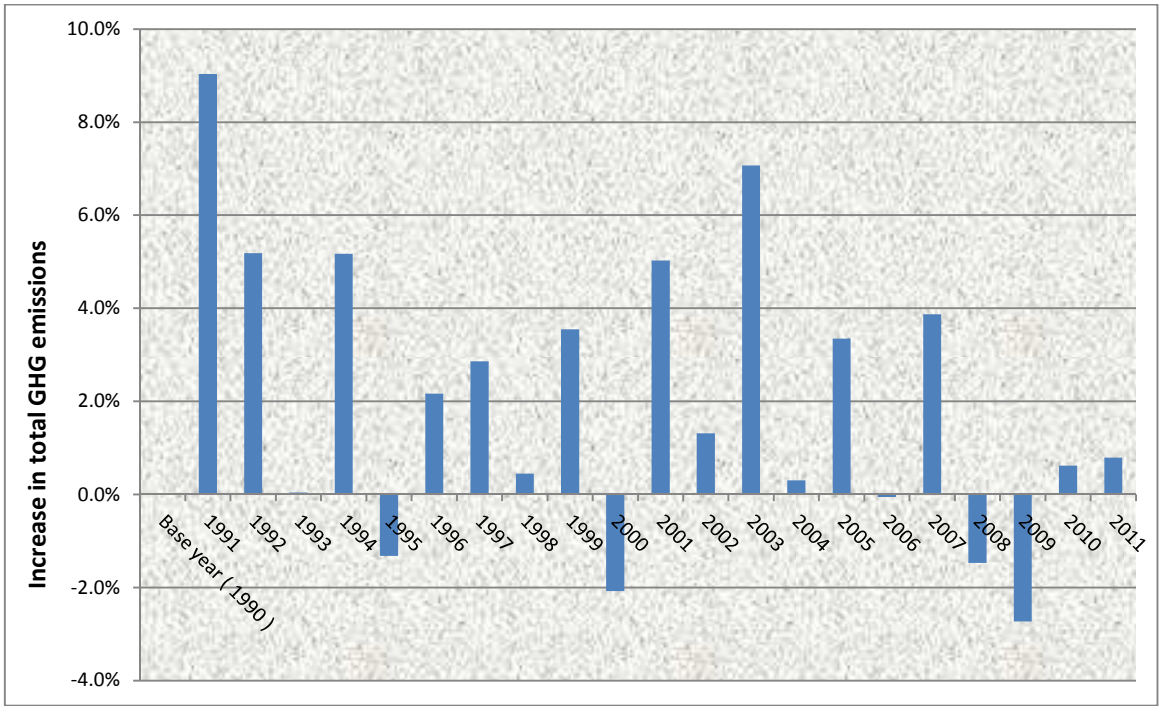

Figure 2-3 Percentage increase or decrease in total emissions for each year over previous year

Figure 2-4 and Figure 2-5 present the trends in emissions intensity, vis-à-vis emissions per capita and emissions per unit GDP respectively. In general, per capita emissions have risen from around 5.3 tonnes per head in 1990 to 7.1 tonnes per head in 2011.

On the other hand, the overall trend in emissions per unit billion Euro GDP shows a general decrease throughout the whole time series; from 1026Gg in 1990 to 460Gg per billion € in 2011. This is seen as a reflection of decoupling of emissions from economic development (as represented by GDP) over the whole time series, though there are significant fluctuations when comparing shorter time ranges (for example 1994-2000 and 2000-2005).

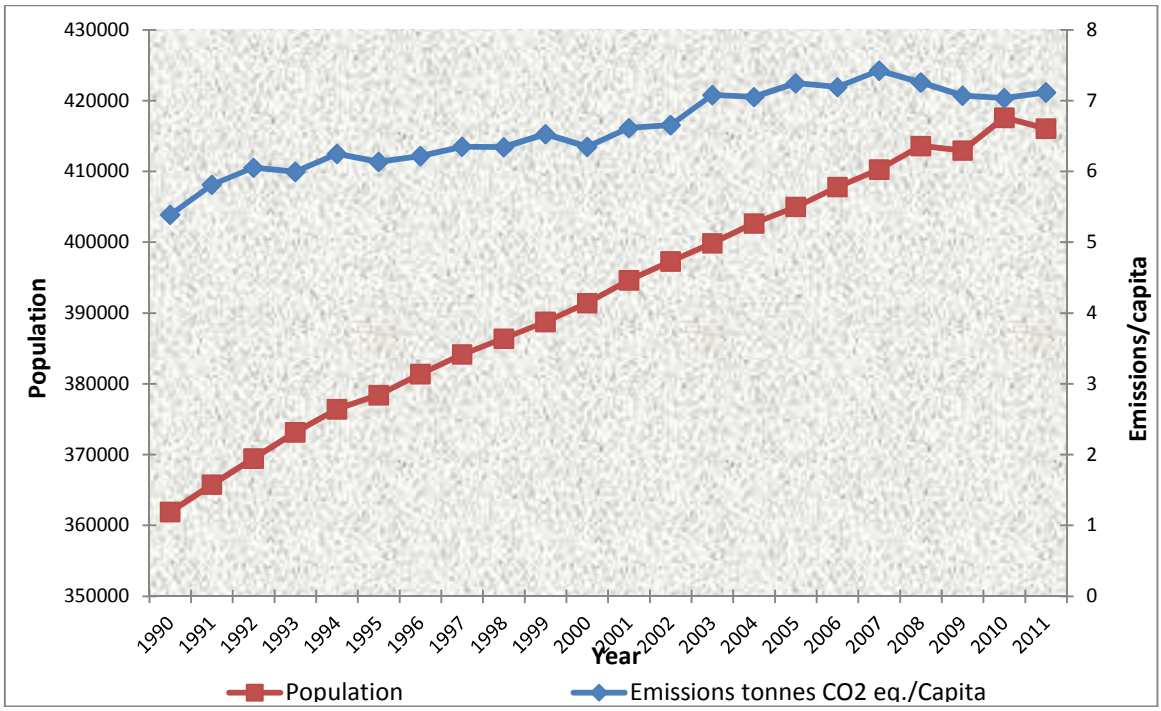

Figure 2-4 Trend in Emissions per Capita

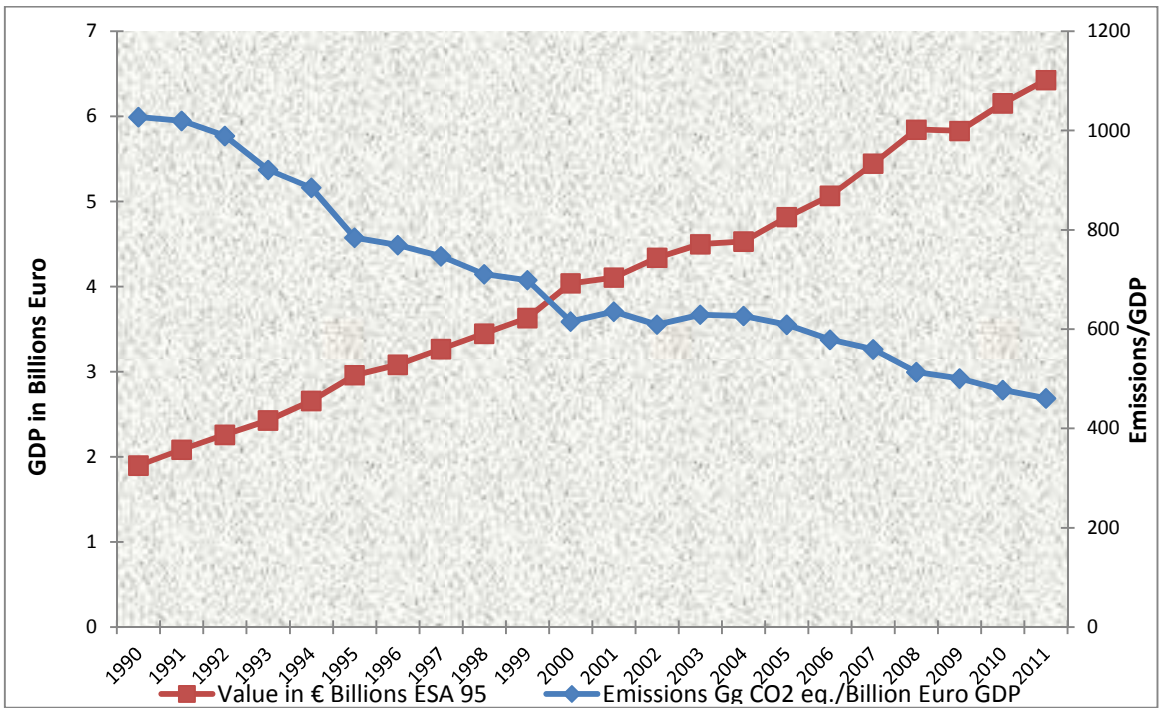

Figure 2-5 Trend in Emissions per unit GDP

2.2 Description and Interpretation of Emission Trends by Gas

2.2.1 Carbon Dioxide Emissions and Removals

The pattern of CO_2 emissions and removals, over the time series 1990 to 2011 is presented in Figure 2-6. Emissions of this gas account for around 87.9% of overall national greenhouse gas emissions (as calculated in terms of CO_2 equivalents for CO_2, CH_4, N_2O, HFCs, PFCs and SF_6). This share has been maintained throughout the period under consideration.

An increase of 44% in CO_2 emissions is observed for the period between 1990 and 2011. Some level of stabilisation and decline can be seen over the most recent five years. The CO_2 removal portion through the LULUCF sector accounts to an average annual figure of around -60Gg.

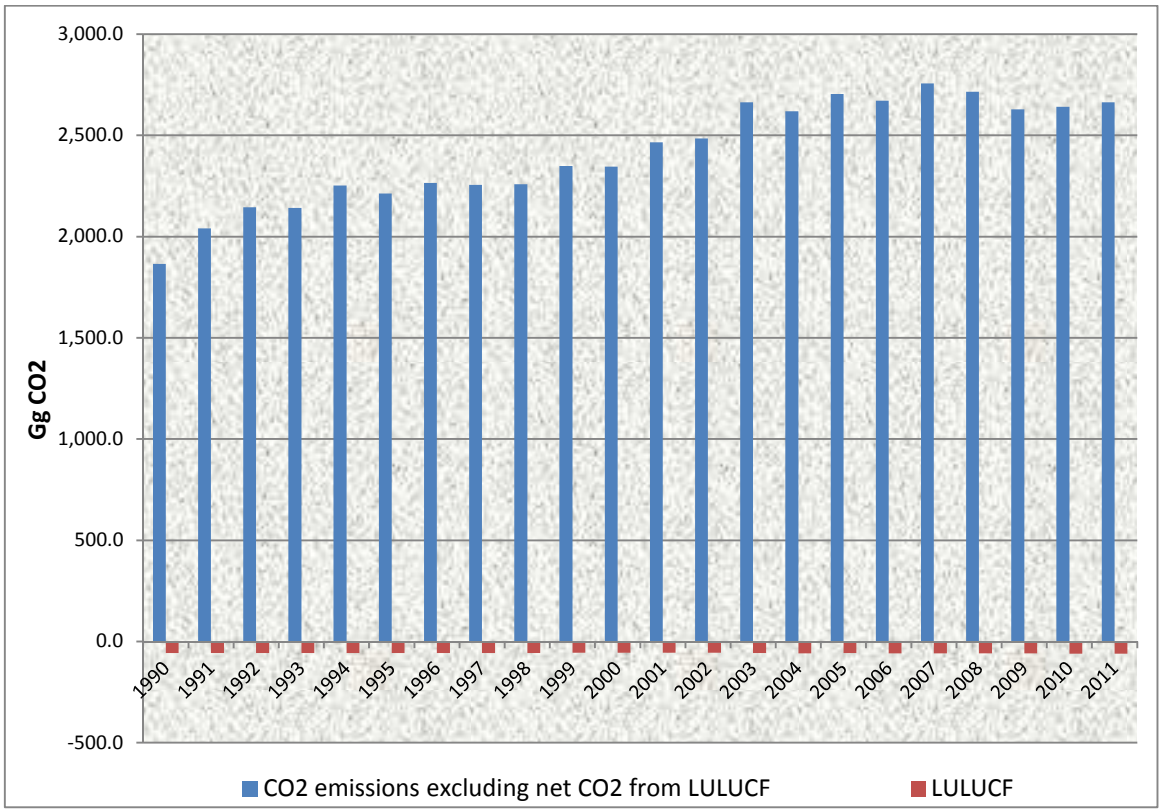

Figure 2-6 Trend in Emissions of CO_2

2.2.2 Methane Emissions

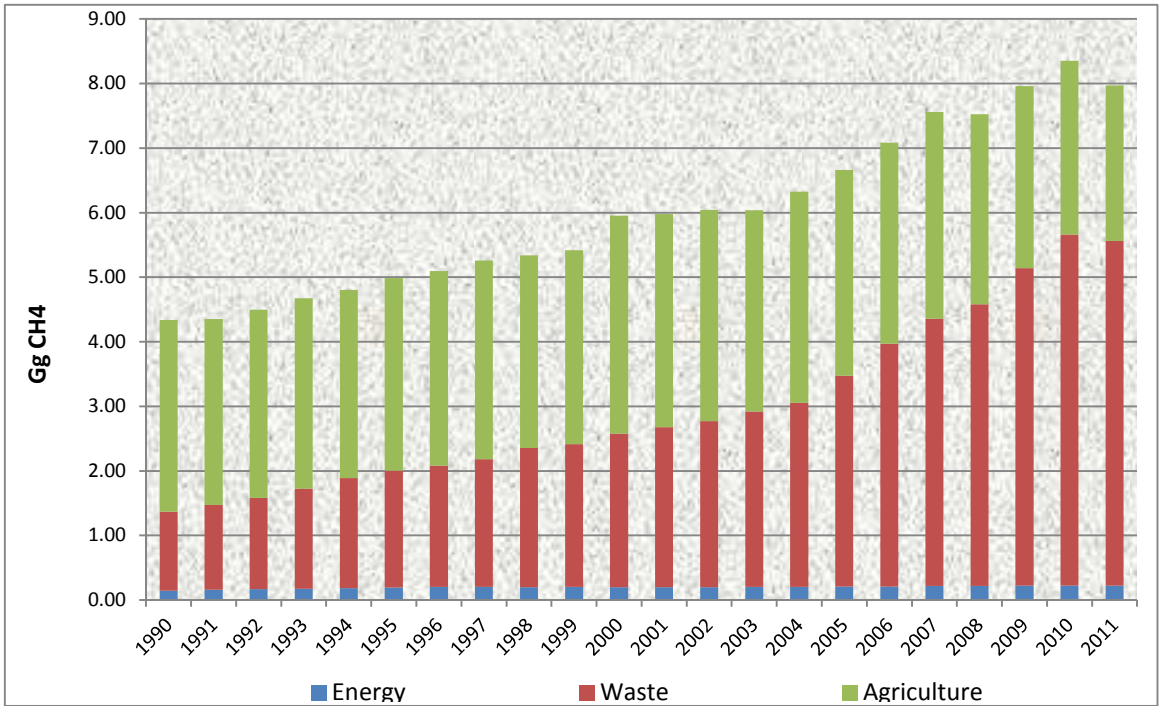

Figure 2-7 Trend in Emissions of CH_4

In 2011, emissions of CH_4 represented a share of 5.7% of overall national emissions, as calculated in terms of CO_2 equivalents for CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. The general increase in emissions of this gas over the time series under consideration is of 83.7%. The trend in emissions of CH_4 is represented in Figure 2-7. As can be observed, CH_4 emissions mainly originate from the Waste sector and to a lesser extent from the Agriculture sector. The Energy sector contributes a very small share of CH_4 annually. Activities typically leading to emissions in the waste sector include solid waste disposal and wastewater handling practices. CH_4 emissions in the agricultural sector are mainly from the enteric fermentation and the manure management categories.

2.2.3 Nitrous Oxide Emissions

Figure 2-8 shows the overall trend in emissions of N_2O from the various contributing sectors. The emission levels for this gas are very small and amount to an average of 2% of the overall GHG emissions, as calculated in terms of CO_2 equivalents for CO_2, CH_4, N_2O, HFCs, PFCs and SF_6.

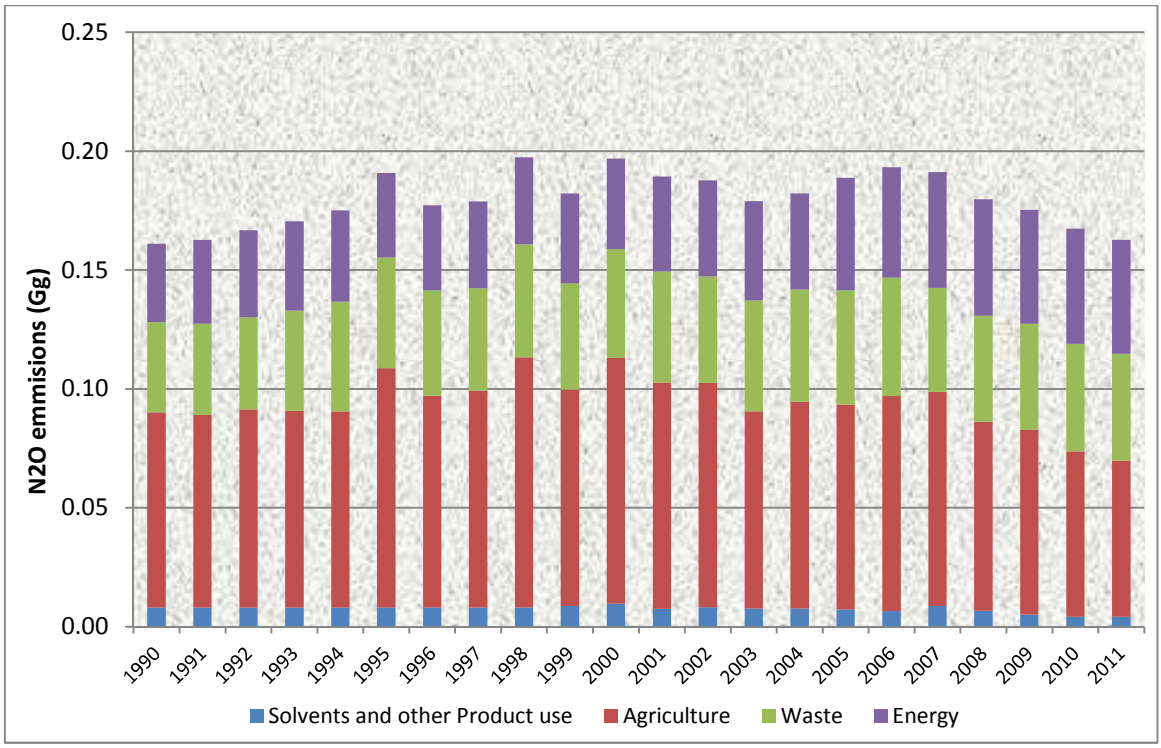

Figure 2-8 Trend in emissions of N_2O

The major source category for N_2O emissions is the Agriculture sector, followed by the contribution from the Waste sector.

2.2.4 Fluorinated Gases Emissions

The fluorinated gases emissions have a zero percent contribution to the total national GHG emissions in 1990, whereas this contribution increases to 4.6% of the total emissions in 2011. HFCs emissions have increased considerably from 1990 to 2011, where the main source is the consumption of refrigerant gases. Increases during this period are due both to the use of these substances as replacements for gases that destroy the ozone layer and to the greater use of refrigeration equipment in industry and elsewhere. From Figure 2-9 the increasing trend in SF_6 emissions is not very evident but in reality, an increase from 0.01Gg CO_2 eq. in 1990 to 4.8Gg CO_2 eq. in 2011 has been estimated, resulting mainly from the use of SF_6 in electrical equipment.

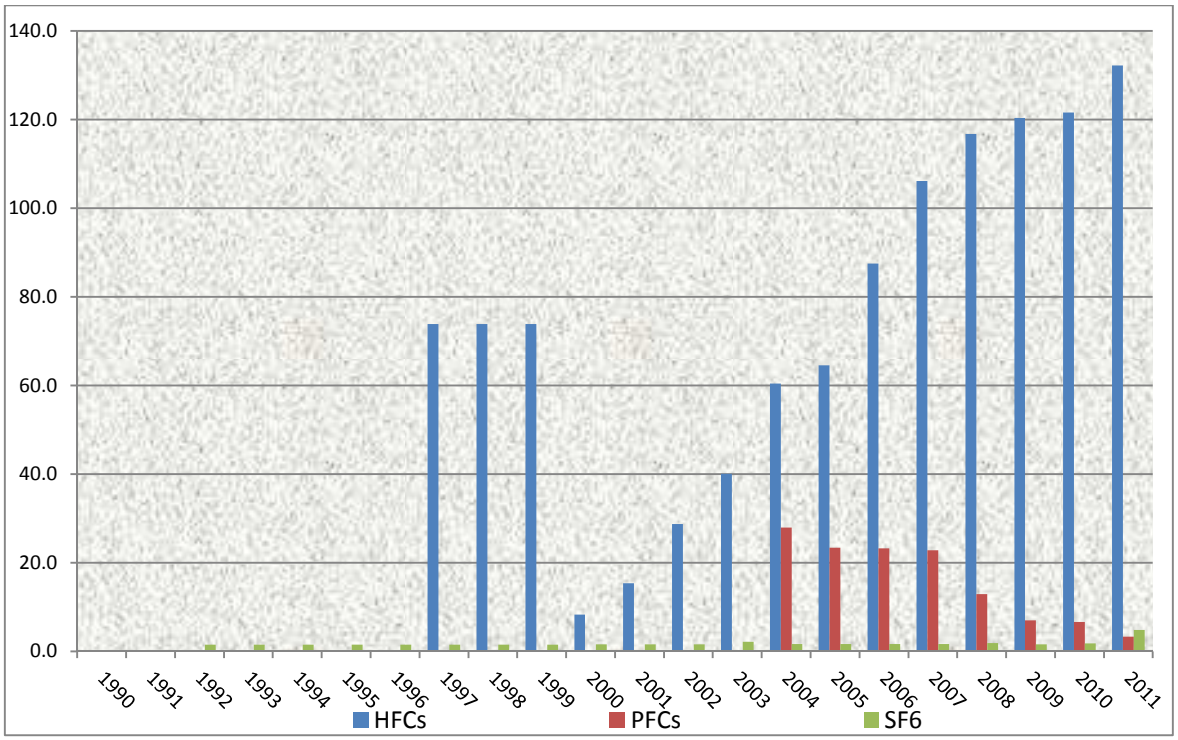

Figure 2-9 Actual Fluorinated Gas emissions in Gg CO_2 Eq

2.3 Description and Interpretation of Emission Trends by Category

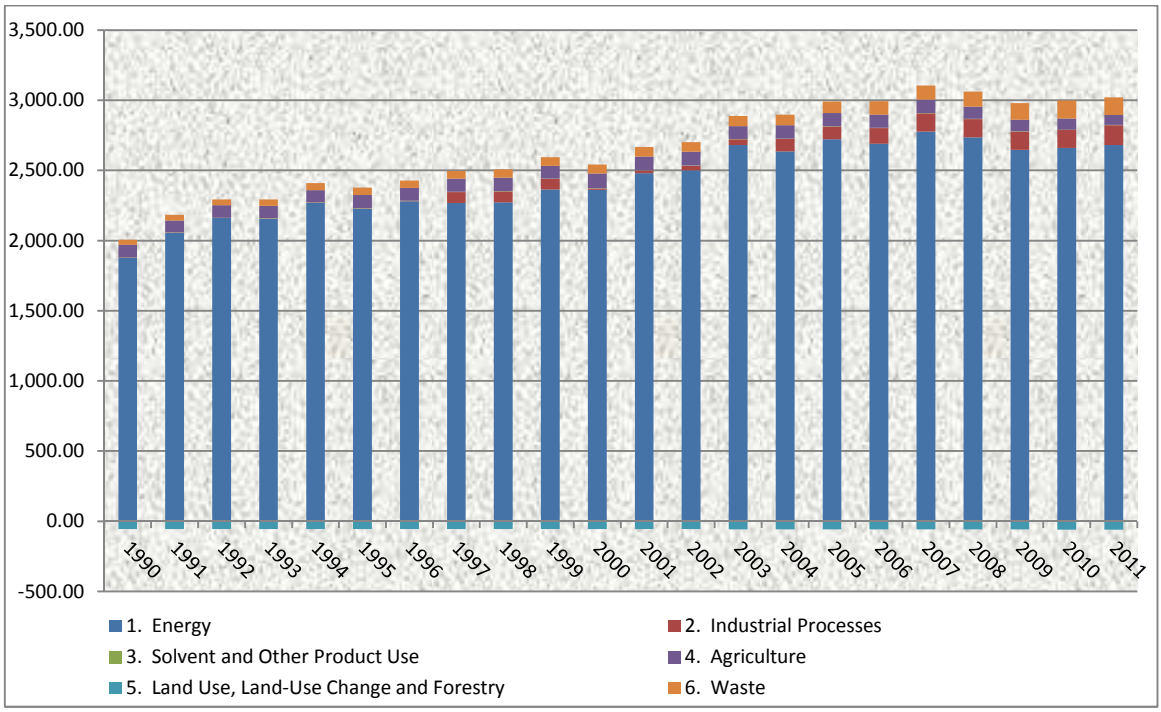

Figure 2-10 Trend in Emissions by Sector

By far the largest contributor to national overall emissions is the energy sector, as clearly shown in Figure 2-10. The second highest contributing category is Industrial processes, with a share of 4.7% of overall emissions in 2011. Waste emits 4.2%, Agriculture contributes 2.3% to the total emissions. The Land Use, Land Use Change and Forestry sector accounts for a net removal equivalent to 2.0% of the total emissions for 2011.

2.4 Description and Interpretation of Emission Trends for Indirect Greenhouse Gases and SO_2

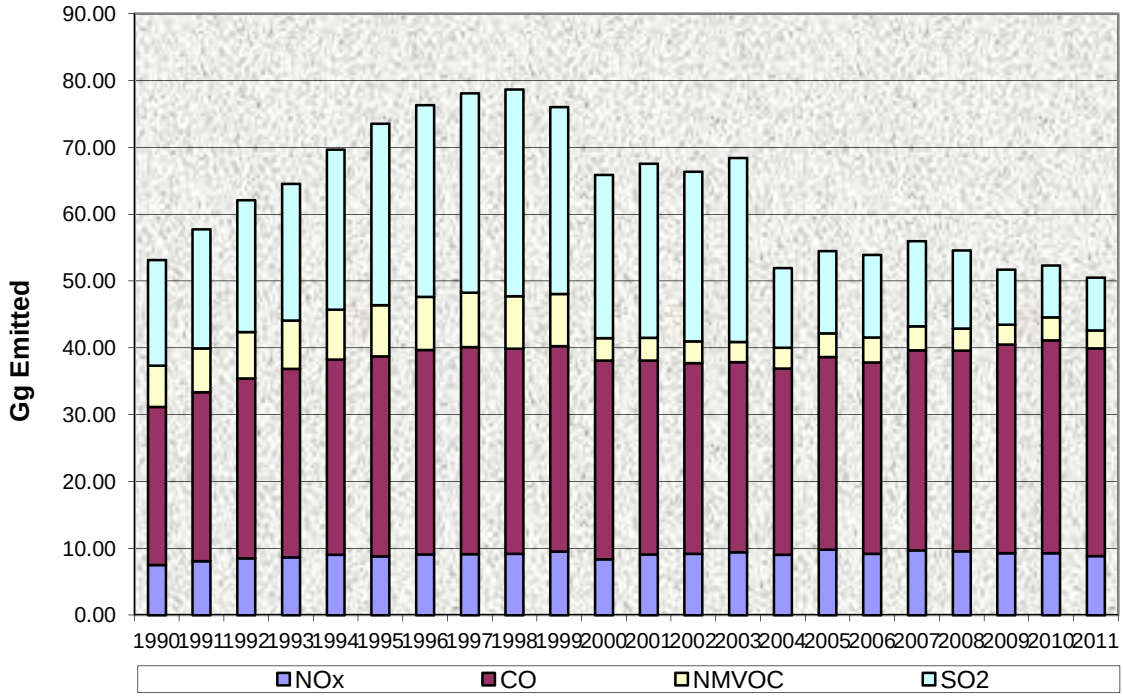

Figure 2-11 Overall Trend in Emissions of Indirect Greenhouse Gases and SO_2

Figure 2-11 represents trends for indirect greenhouse gases (carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC)) and sulphur dioxide (SO_2)).

Among these four gases, CO and SO_2 have the highest share of emissions over the time series. Trends for these two pollutants are very much associated with the trends in the activities that contribute to such emissions (i.e. road transport and power generation respectively).

Chapter 3 ENERGY (CRF Sector 1)

3.1 Overview of Sector

As already illustrated in Section 2.3, the Energy sector is the most significant contributor of greenhouse gas emissions in Malta. Emissions trends for this sector are presented in Figure 3-1.

The sub-category Energy Industries (1A1) accounted for 72.3% of the emissions in the Energy sector as a whole in 2011. This sub-category has the greatest influence on overall energy emission trends, and 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) which accounts for 21.1% of this sector's emissions. Transport is thus another major contributor to overall national emissions.

The manufacturing industries sector (1A2) account for 2.72% and the commercial/institutional (1A4a) account for 1.88 % of energy emissions. The other sub sectors i.e. the residential sub sector (1A4b) and the agriculture/forestry/fisheries (1A4c) account for only 1.82 % and 0.2 % of the energy emissions.

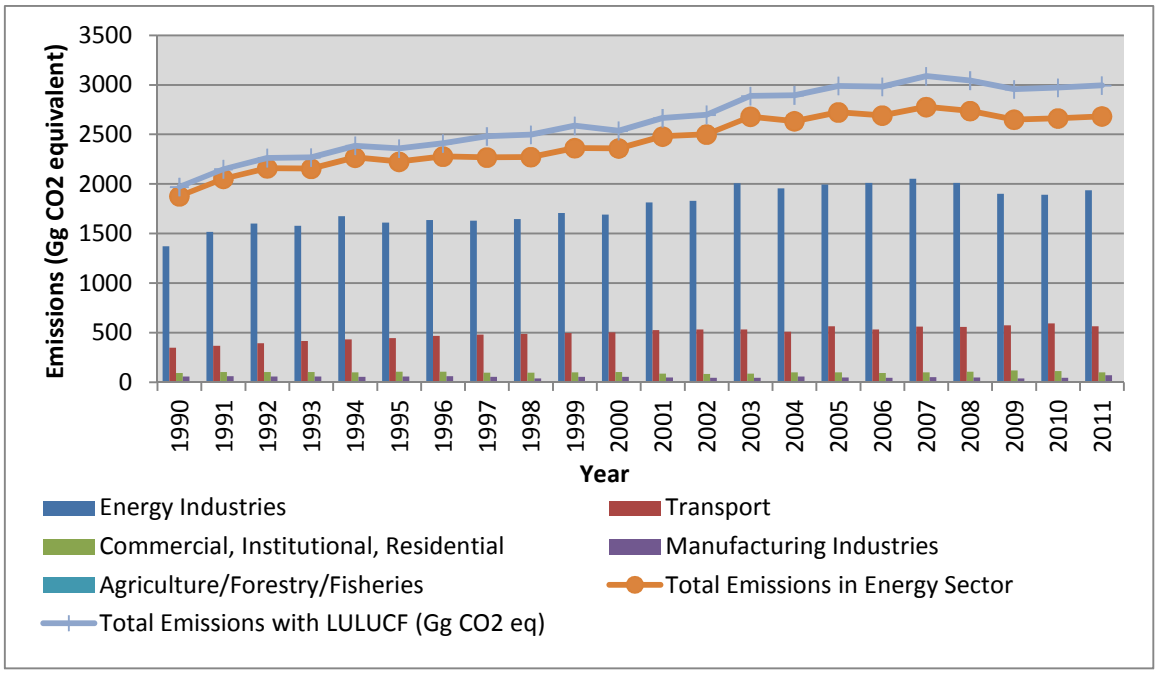

Figure 3-1 Total Emission Trends in the Energy Category

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.

3.2 Fuel Combustion (1A)

3.2.1 Comparison of Sectoral and Reference approaches

The Reference Approach uses a top-down calculation of emissions using the country's energy supply data. All other emissions of pollutants in this chapter were calculated using the Sectoral Approach, this produces estimates using a bottom-up approach with emissions estimated from activity statistics (mostly fuel consumption) in the various economic sectors and processes. The comparison between these two approaches is documented and described in Annex 4.

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 and Figure 3-2 below show the comparison between the Reference Approach and the Sectoral Approach.

Table 3-1 Difference between sectoral and reference approach results

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)	33.93	2557.77	35..34	2662.16	-4.1	-4

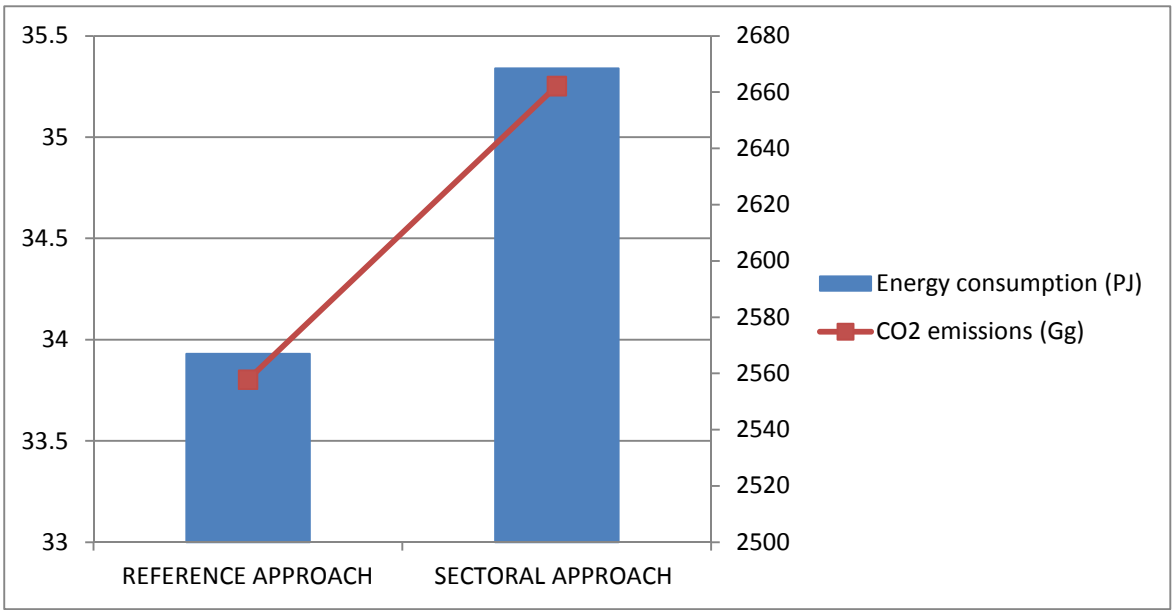

Figure 3-2 Comparison between sectoral and reference approach for CO_2 Emission and Energy Consumption

3.2.1.1 Re-calculations

The inventory submitted in 2011 showed 6.1% lower CO_2 emissions in the reference approach than the sectoral approach. The figure decreased to 3.16% after it transpirted that an incorrect emissions factor had been used for Residual Fuel Oil when calculating Reference Appoach emissions.

3.2.2 International Bunkers (1C)

3.2.2.1 Source category Description

In accordance with agreed guidelines, the inventory for Malta contains estimates for international civil aviation and international marine bunkers. These emissions are recorded as a memo item, and are not included in national totals.

For international marine bunkers emissions reported from 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 2011 some major bunkering operators forwarded specific information which was used inconjunction with data from Port Authorities. Emissions for international aviation have been estimated based on fuel sales. Statistics where obtained from Suppliers for the period 1993-2011 whereas previous data was obtained from the 1st National Communication.

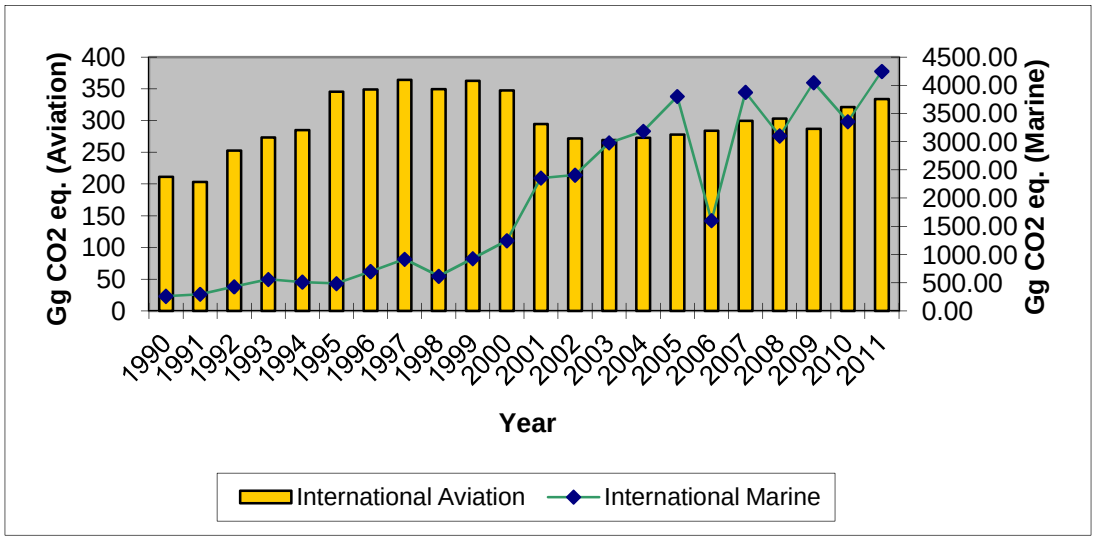

Figure 3-3 International Bunkers (Aviation and Marine) Emissions for 1990 to 2011

3.2.2.2 Methodological Issues

3.2.2.2.1 International Aviation

The method used complies with Tier 1 approach summarised in the 2006 IPCC guidelines and identical to the Revised 1996 Guidelines methodology. The methodology used estimates emissions by multiplying total consumption of fuel (assumed to be equivalent to total sales for international aviation) by a default EF. Data for total fuel sales are obtained through the Malta Resources Authority fuel regulatory function. To date only one supplier is licensed to sell Aviation related fuels. In Malta only Aviation Gasoline and Jet Kerosene A1 are sold for aviation purposes. Further methodological detail is outlined in Section 3.2.8.2.3

3.2.2.2.2 International Navigation

Consumption of gas diesel oil and heavy fuel oil by international marine bunkers is collected by MRA regulatory office from the major bunker operators, Transport Malta (the local Port Authority) and Customs. 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 correlate directly to the type of fuel used, without consideration to the engine type. The sulphur content of the fuels post 2009 was obtained from the results of MRA samples of fuel taken from marine vessels. For the period previous to this an assumption was taken that the sulphur content of marine fuels was similar to that of the same fuel available inland fuel.

Table 3-2 Emission Factors for International Navigation in 2011

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

3.2.2.3 Source Specific Recalculations

3.2.2.3.1 International Navigation

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

3.2.2.3.2 International Aviation

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

3.2.3 Feedstock and non-energy use of Fuels

Feedstock and non-energy use of fuels are not present in Malta.

3.2.4 Capture and storage of CO2 from Flue gases

Currently in Malta, CO_2 emitted from flue gases is not captured and stored.

3.2.5 Country specific issues

Country specific issues have been identified under other headings or as they occur.

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 subcategory Petroleum Refining (1A1b) and Manufacture of Solid Fuels and Other Energy Industries (1A1c) do not occur in Malta. This subcategory

incorporates two major point sources which are two power plants that are currently run on liquid fossil fuels, namely residual fuel oil (RFO) and gas oil (GO). However, it should be noted that until 1995, bituminous coal was also used for electricity generation in one of these plants. During 2011, a total of 540.65kt of residual fuel oil (RFO) and 73.21kt of gas oil (GO) were burned at the two power stations.

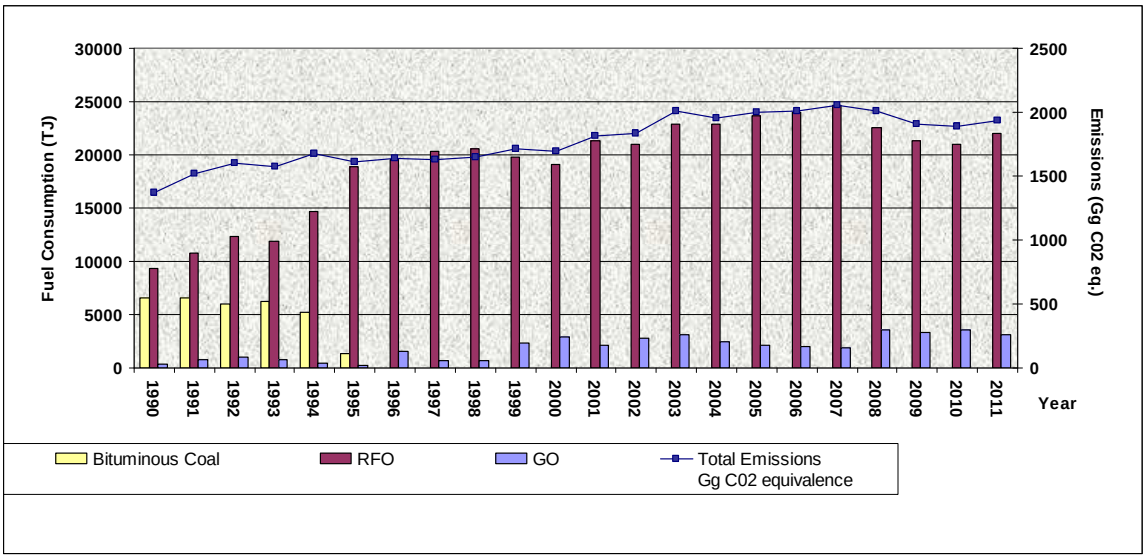

Figure 3-4 Total Emissions Trend Compared with Fuel Consumption for Energy Industries

Emissions remain very much correlated with fuel consumption trends, in particular the trend for utilisation of RFO as depicted in Figure 3-4. However, comparing CO_2 emissions with electricity generated shows that overall, electricity generation efficiency in terms of emissions is improving. This is clearly illustrated in Figure 3-5 which compares CO_2 emissions per MWh with public electricity generated over the 1990-2011 period.

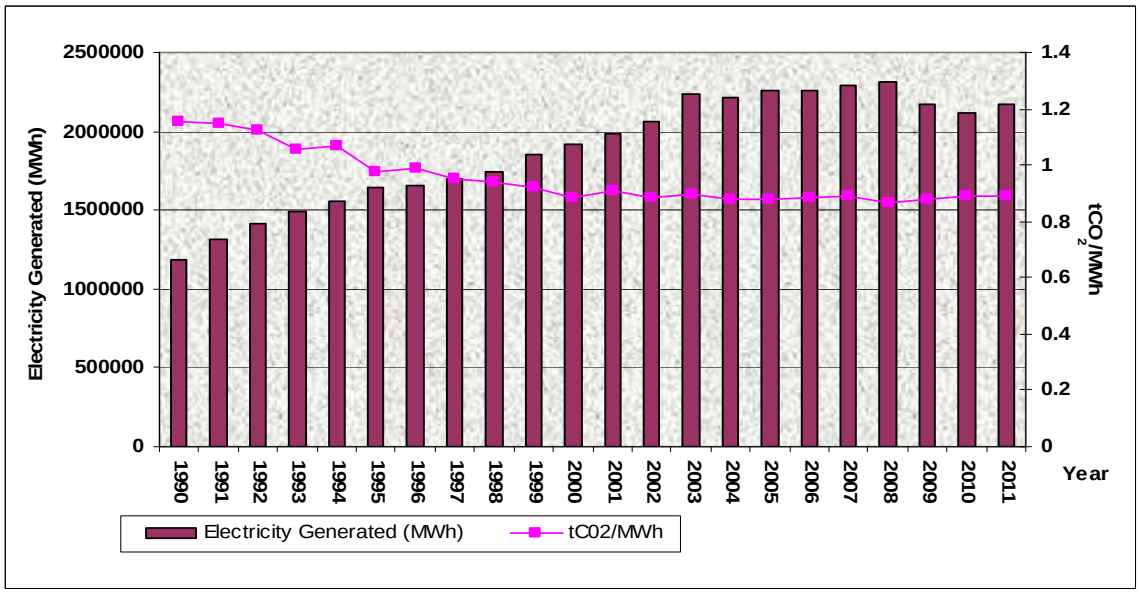

Figure 3-5 Public Energy Industry CO_2 Emissions Trend Compared with Electricity Generated

The period 1990 to 2000 also marks a significant decrease in emissions of CO_2 per MWh generated. From 2000 onwards the "efficiency factor" seems to have stabilised. This could be a reflection of the limitations of the current generating capacity with respect to increasing efficiency coupled with the rather consistent fuel-mix combination employed from 2000 to the present.

3.2.6.2 Methodological Issues

Public Electricity and Heat Production emissions for Malta's inventory have been compiled using fuel combustion data provided by Enemalta Corporation (the operator of the two local power plants). It is important to note that for the years 2005 to 2011, fuel consumption data reported in verified emission reports as submitted by the operator under Directive 2003/87/EC [14] have been used. Directive 2003/87/EC establishes a scheme for greenhouse gas emission allowance trading within the European Community. The Directive requires that emissions reported by operators of stationary installations are verified.

The calculation in the report is made by using a country specific calorific value for each of the two fuels used in each power stations namely the Marsa Power Station and the Delimara Power Station and an oxidation factor of 1 in accordance to the 2006 IPCC Guidelines for National Greenhouse Inventories. For the years 2009, 2010, 2011 the calorific values and oxidation factor used in the verified emission reports have been used for the Residual fuel Oil and the Diesel gas Oil.

The default emission factors for carbon, N_2O and CH_4 and the calorific values provided in the IPCC 2006 guidelines 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 the data provided by the power station operators in Malta. The emission factors are shown in Table 3-3.

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 Energy Industries.

Table 3-3 Emission Factors for Power Stations in 2011

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

Energy industries combustion of liquid fuels is identified as a key emissions activity for 2011. For 1990, combustion of solid fuels for electricity generation is also a key sector.

3.2.6.3 Source Specific Recalculations

Recalculations have been performed due to changes in the emission factors, oxidation factors and the country specific calorific values in the activity data used since the 2012 submission. The changes in the 2013 submission are presented in Table 3-4.

Table 3-4 Recalculation of the Energy Industries Sector

Year	Energy Industries (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Energy Industries (Gg CO_2 eq.) as reported in the 2013 GHG Inventory	Percentage change in reported emissions (%)
1990	1378.45	1372.62	-0.42
1991	1522.25	1517.66	-0.30
1992	1606.90	1602.69	-0.26
1993	1582.41	1578.02	-0.27
1994	1678.79	1675.08	-0.22
1995	1612.14	1611.20	-0.05
1996	1638.35	1638.35	0.00
1997	1630.50	1630.50	0.00
1998	1645.10	1645.10	0.00
1999	1708.60	1708.60	0.00
2000	1693.30	1693.30	0.00
2001	1814.22	1814.22	0.00
2002	1830.34	1830.34	0.00
2003	2006.84	2006.84	0.00
2004	1957.47	1957.47	0.00
2005	1995.85	1995.85	0.00
2006	2010.67	2010.67	0.00
2007	2052.96	2052.96	0.00
2008	2009.83	2009.83	0.00
2009	1903.17	1903.17	0.00
2010	1893.28	1893.28	0.00

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, with smaller amounts of thin fuel oil (TFO), liquefied petroleum gas (LPG), kerosene, and biodiesel (it should be noted that as from 2009, light heating oil usage in local industry was eliminated). Biodiesel is included for 2006, 2007, 2008, 2009, 2010 and 2011.

In the inventory submissions of 2007-2011 the fuel combustion of the commercial/institutional sectors was included with this category due to difficulties in segregating data between the various sub-sectors.

3.2.7.2 Methodological Issues

Fuel data (fuel sold to industry) for the Manufacturing Industries and Construction sector 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 and updated in order to calculate the GHG emissions for Manufacturing Industries and Construction 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. Segregation of data for the years 2005-2009 was based on the sectoral consumption of the year 2010.

For the year 2010 the Malta Resources Authority has obtained data for LPG bulk sales, kerosene, automotive diesel and biodiesel through a bottom up approach. Data for heating gas oil and thin fuel oil was segregated by obtaining end consumer data and assigning each consumer to the respective NACE/ISIC codes.

The segregation of data for the years 2005-2009 was based on the assumption that the ratios of Commercial/Institutional and Manufacturing/Construction fuel consumption in 2005-2009 were similar to that in 2010 with the exception of Light heating oil. The distribution of light heating oil was terminated in the year 2008. In view of this,the segregation of fuel consumption into their respective categories was based on the same assumptions used in 2008.

The activity data for the year 2011 has been obtained directly through the fuel suppliers and distributors. This has resulted in shifts of consumed fuel volumes from one sector to the other in the year 2011.

Work is ongoing by the Malta Resources Authority in collaboration with suppliers, distributors and other entities to ensure more accurate and greater reliability of fuel data

segregation in the Manufacturing Industries & Construction and Commercial/Institutional categories.

Heavy fuel oil has been included in the manufacturing industries and construction sector for the years 2005, 2006, 2007. Review of data has shown that this fuel was produced and burnt during those three years.

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 of the fuels consumed has been obtained from the Malta Resources Authority and the thin fuel oil emission factors and calorific values were calculated according to the weighted average of its constituent fuels (i.e diesel/gas oil and residual fuel oil). The emission factors used are shown in Table 3-5.

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 Manufacturing Industries and Construction. The emissions of biodiesel have been reported under the heading of biomass in the Manufacturing and Construction Sector.

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 Manufacturing Industry, Construction in 2011

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
Thin Fuel Oil	20.88	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 was in accordance to LN 278 of 2007 to convert weight of fuel into energy equivalent. The emission factors used for biodiesel are recorded in table 3.6

Table 3-6 Biodiesel Emission Factors for Manufacturing Industry, Construction in 2011

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

3.2.7.2 Source Specific Recalculations

There were no recalculations in the Manufacturing and Construction Industry Sectors.

3.2.8 Source Category 1A3 - Transport

3.2.8.1 Source Category Description

This sector is dominated by emissions from road transport (Figure 3-6) with CO_2 as the gas that accounts for the bulk of overall GHG emissions from road transport fuel combustion (Figure 3-7). The role of road transport in emissions of indirect GHG is already described in Section 2.4. Road transport is thus identified as a key source, both for 1990 and 2011.

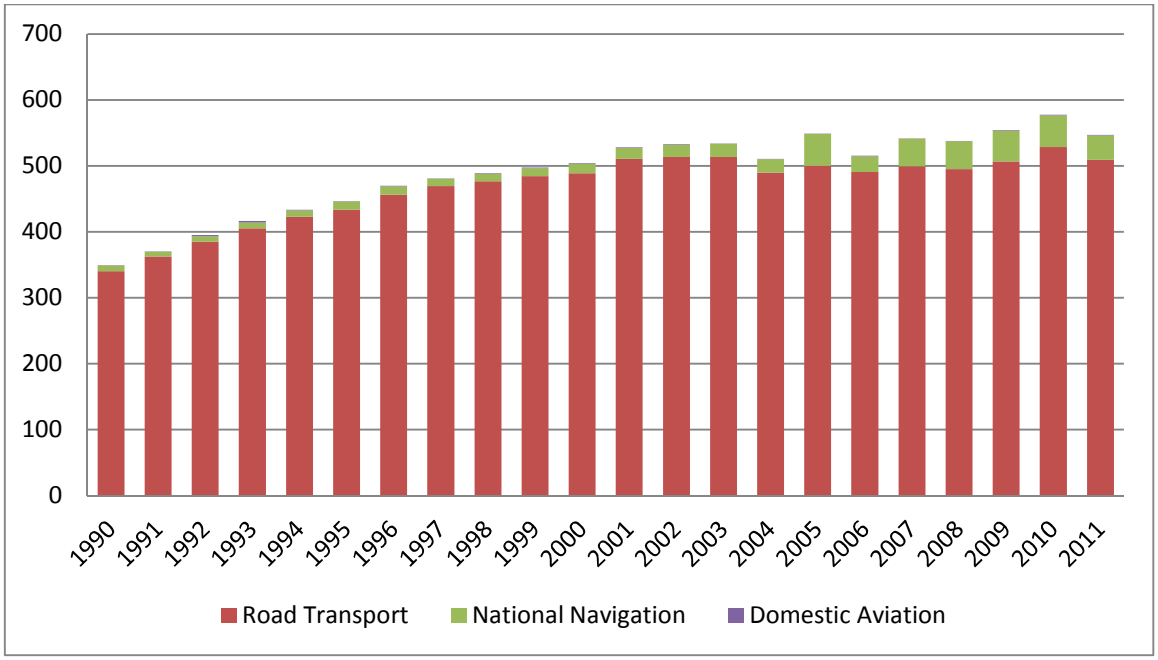

Figure 3-6 Emission Trends in Transport Sector by sub category

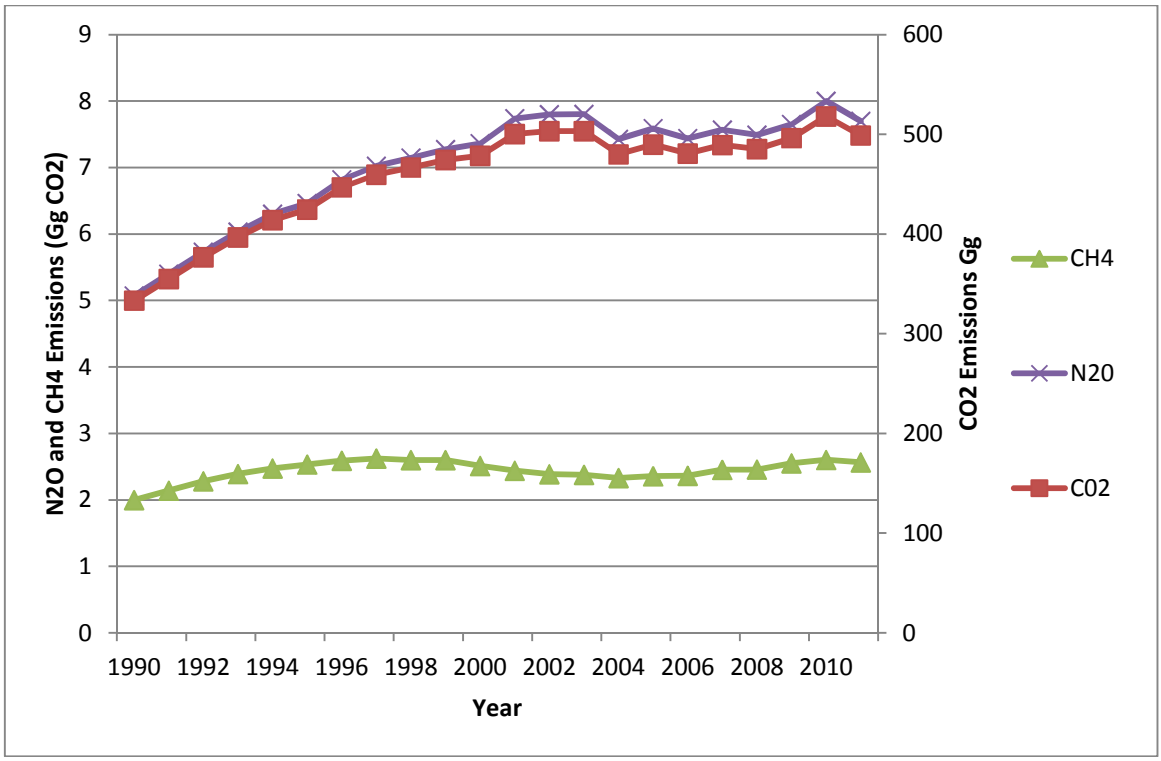

Figure 3-7 Emission Trends in Road Transport by Gas

Diesel is the principal fuel for national navigation and a small portion of petrol is also used. Jet kerosene (Jet A1) and aviation gasoline are used in domestic aviation. 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 puroposes

3.2.8.2 Methodological Issues

3.2.8.2.1 Road Transport

The Tier 1 approach has been used to calculate CO_2, CH_4, N_2O and CO, 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 are listed in Table 3-7.

Table 3-7 Fuel based emission factors for road transport in 2011

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

From 2000 to 2010 emissions of NO_x, SO_2 and NMVOC are calculated using the 2006 EMEP/CORINAIR Guidebook [9], applying a basic Tier 3 methodology. A customised model is used to calculate emissions by vehicle class based on distance travelled per class and g of fuel/km.

The Annual Fuel use by 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. The emission regulations have successively introduced tighter emission control technologies, for example three-way catalysts and better fuel injection and engine management systems. Table 3-10 shows the regulations that have come into force up to 2011 for each vehicle type.

Table 3-8 Estimated Vehicle km data by year

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&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	Grammes 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

Artic 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 and EC Regulation Classes

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

The actual vehicle fleet composition was obtained this year from the National Statistics Office similar to what was done for last year's National Inventory Report. This is an improvement over previous years where estimated fleet composition was used. 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 the number of 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 are 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 Licencing 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
Artic 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

3.2.8.2.2 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 3-12. The default factors for non-CO_2 emissions are similar for all fuels reported i.e. petrol, diesel and residual oil.

The data was collected from the Regulation Unit of the Malta Resources Authority which gathers its information from the the major bunker operators (both owning marine stations and those retailing via road transport vehicles) and also from the Port Authorities. Data

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

Table 3-12 Emission Factors for National Navigation in 2010

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	11.0
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	495

3.2.8.2.3 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 (1990-2011).

Emission factors are based on the EMEP/EEA air pollutant emission inventory guidebook — 2009 [11] 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).

3.2.8.2.4 Railways

This sector does not occur in Malta.

3.2.8.2.5 Other Transport

In previous NIR offroad transport was always included under the Commercial & Institutional sector. However for this submission, data for specific fuel consumption by

major users of diesel for airport ground support equipment and port machinery was forwarded to the MRA. Emissions for this sector are estimated using a Tier 1 approach for estimating CO_2 emissions using default factors and IPCC 1996 [1] default emission factors for CH_4, N_2O and the indirect gases. The emission factors used are shown in table below.

Table 3-13 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

Table 3-14 Recalculation of the Other Transport Sector

Year	Other Transport (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Other Transport (Gg CO_2 eq.) as reported in the 2013 GHG Inventory	Percentage change in reported emissions (%)
2005	0	17.63	100,00
2006	0	16.81	100.00
2007	0	20.28	100.00
2008	0	22.56	100.00
2009	0	20.36	100.00
2010	0	18.79	100.00
2011	0	18.97	100,00

3.2.9 Source Category 1A4 – Other Sectors

3.2.9.1 Source Category Description

This category comprises emissions from fuel combustion in the Residential, Agriculture/Forestry/Fisheries and the Commercial/Institutional sectors for the whole time series.

LPG is used in the commercial, institutional and residential categories. Other liquid fuels, particularly TFO, 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, TFO, Kerosene, Diesel, Gas oil and Heavy Fuel Oil), the residential category is almost wholly dependent on LPG for fossil fuel requirements (Figure 3-8). 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. Activity data for solid biomass for the years 2005-2011 has been included for the residential sector. 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.

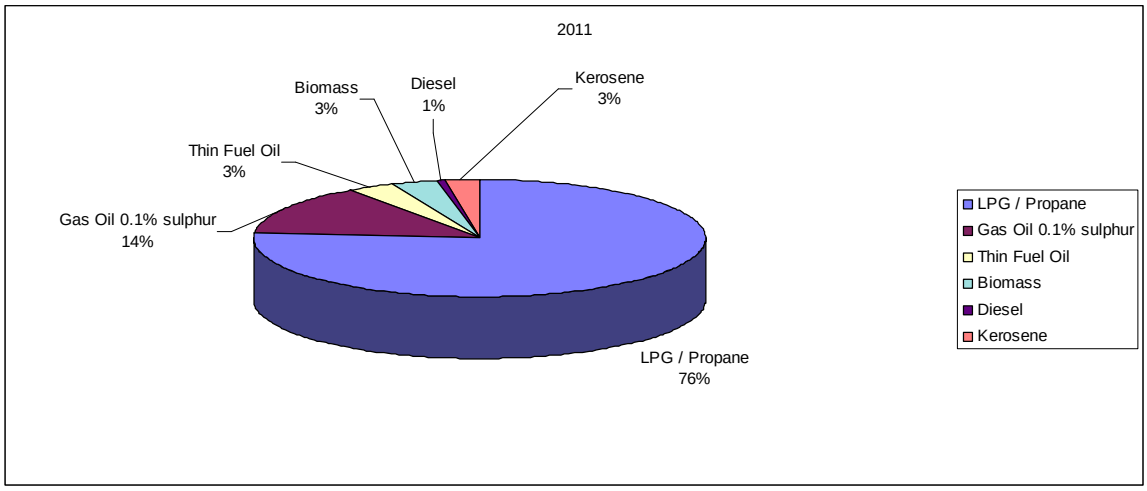

Figure 3-8 Share of Fossil-fuel Consumption in the Residential Sector

For the year 2010 and 2011, 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 eliminated from the Commercial/Institutional sector and has been included under section 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 3-15 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.

Table 3-15 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

Recalculations have been performed in the three categories of residential, agriculture/forestry/fisheries and the commercial/institutional sector.

The changes for the residential and agriculture/forestry/fisheries sectors for the whole time series were due to the updating of emission factors to the online version of 2006 IPCC guidelines.

Recalculations for the commercial/institutional sector for the complete time series were due to the updating of emission factors to the online version of 2006 IPCC guidelines. Recalculations for the years 2005-2011 were also due to shifting of the fuel consumed by

non-road machinery in marine harbours to the section 1A3e of the CRF tables 'other transport'.

The changes reported in the residential sector of the 2013 submission are presented in Table 3-16.

Table 3-16 Recalculations for Residential Category

Year	Residential (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Residential (Gg CO_2 eq.) as reported in the 2013 GHG Inventory	Percentage change in reported emissions (%)
1990	34.58	34.63	0.14
1991	38.85	38.91	0.14
1992	40.95	41.00	0.14
1993	41.74	41.79	0.14
1994	40.51	40.57	0.14
1995	40.62	40.68	0.14
1996	41.24	41.30	0.14
1997	40.48	40.54	0.14
1998	39.21	39.26	0.13
1999	40.53	40.59	0.14
2000	39.93	39.98	0.14
2001	38.39	38.44	0.14
2002	38.83	38.88	0.14
2003	41.39	41.45	0.14
2004	42.18	42.24	0.14
2005	47.58	47.70	0.25
2006	42.85	42.97	0.28
2007	40.61	40.72	0.28
2008	43.27	43.41	0.32
2009	48.62	48.82	0.42
2010	43.64	43.85	0.48

The changes reported in the agriculture/forestry/fisheries sectors in the 2013 submission are as shown in Table 3-17.

Table 3-17 Recalculations for the Agriculture/Forestry/Fisheries Category

Year	Agriculture/Forestry/ Fisheries (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Agriculture/Forestry/Fisheries (Gg CO_2 eq.) as reported in the 2013 GHG Inventory	Percentage change in reported emissions (%)
2002	5.67	5.68	0.20
2003	2.35	2.36	0.20
2004	5.47	5.48	0.20
2005	7.14	7.16	0.20
2006	7.60	7.61	0.20
2007	9.14	9.16	0.20
2008	9.16	9.18	0.20
2009	10.86	10.88	0.20
2010	11.90	11.92	0.20

The changes reported in the Commercial/Institutional sector of the 2013 submission are as shown in Table 3-18.

Table 3-18 Recalculations for Commercial/Institutional sector

Year	Commerical/Institutional (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Commercial/Institutional (Gg CO_2 eq.) as reported in the 2013 GHG Inventory	Percentage change in reported emissions (%)
1990	61.77	61.89	0.19
1991	65.10	65.23	0.19
1992	62.10	62.21	0.19
1993	61.73	61.85	0.19
1994	61.11	61.23	0.19
1995	67.42	67.55	0.19
1996	66.73	66.86	0.19
1997	59.02	59.14	0.19
1998	58.50	58.61	0.19
1999	62.15	62.27	0.19
2000	65.63	65.75	0.19
2001	50.57	50.66	0.19
2002	46.41	46.50	0.19
2003	47.53	47.62	0.19
2004	59.54	59.65	0.19
2005	70.83	55.27	-21.97
2006	65.80	50.96	-22.56
2007	78.68	60.76	-22.77
2008	85.95	66.03	-23.18
2009	90.22	72.26	-19.91
2010	87.75	71.18	-18.88

3.2.1 Source Category 1A4 – Other

This sector does not occur in 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 retain sectors is used and an emission factor of $0.022 Gg/10^3 m^3$ 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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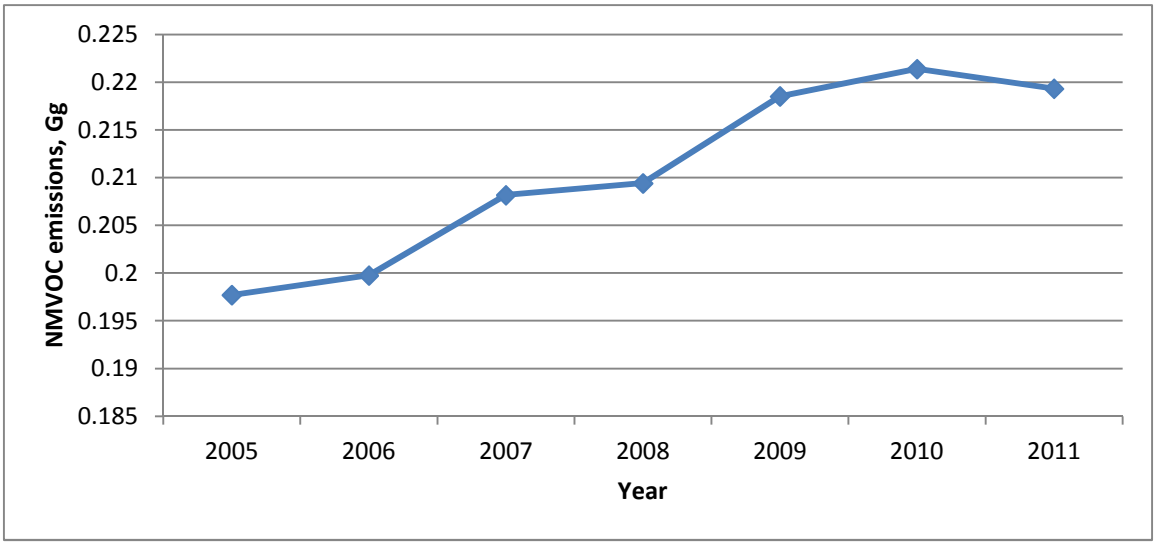

Figure 3-10 Transport Fugitive Emission Trends

3.3.3 Source specific Recalculations

Table 3-19 Fugitive Emissions Recalculation

Year	NMVOC emissions Gg as reported in the 2012 GHG Inventory	NMVOC emissions Gg as reported in the 2013 GHG Inventory	Percentage change in reported emissions (%)
1990	NE	0.117	100
1991	NE	0.190	100
1992	NE	0.202	100
1993	NE	0.212	100
1994	NE	0.219	100
1995	NE	0.224	100
1996	NE	0.228	100
1997	NE	0.230	100
1998	NE	0.227	100
1999	NE	0.226	100
2000	NE	0.216	100
2001	NE	0.205	100
2002	NE	0.199	100
2003	NE	0.198	100
2004	NE	0.195	100
2005	0.198	0.198	0
2006	0.2	0.2	0
2007	0.208	0.208	0
2008	0.209	0.209	0
2009	0.219	0.219	0
2010	0.221	0.221	0.
2011	0.219	0.219	0

As it was recommended from the UNFCCC review for the NIR of 2011, the Authority has included fugitive emissions related to the sales of petrol in the road transport sector for the period 1990 to 2004.

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) 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 4.7% in the year 2011.

The fluorinated gases Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6), because of their high global warming potentials, in terms of carbon dioxide equivalents, contribute to almost 100% of the direct GHG emissions from the industrial processes sector. Figure 4-1 shows the direct GHG emissions increasing trend from 1990 to 2011.

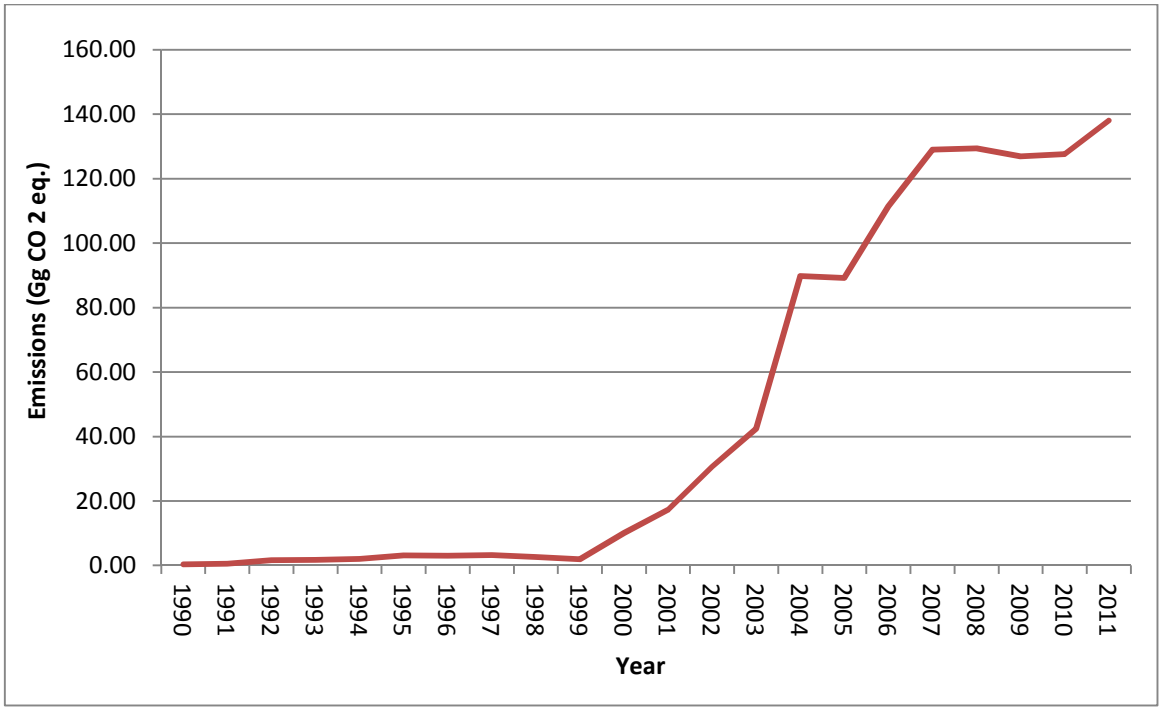

Figure 4-1 Direct GHG Emissions from the Industrial Processes Sector

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 in the years 1995 to 1998 relatively high bread production statistics have been recorded by the National Statistics Office, leading to higher NMVOC emissions for those years only.

From Figure 4-2 one also notes the low contribution of NMVOC emissions in the late 1990s from the road paving with asphalt activities. From 2004 and onwards large scale roads reconstruction projects have started to take place in Malta leading to increased NMVOC emissions from the sub-category Road Paving with Asphalt.

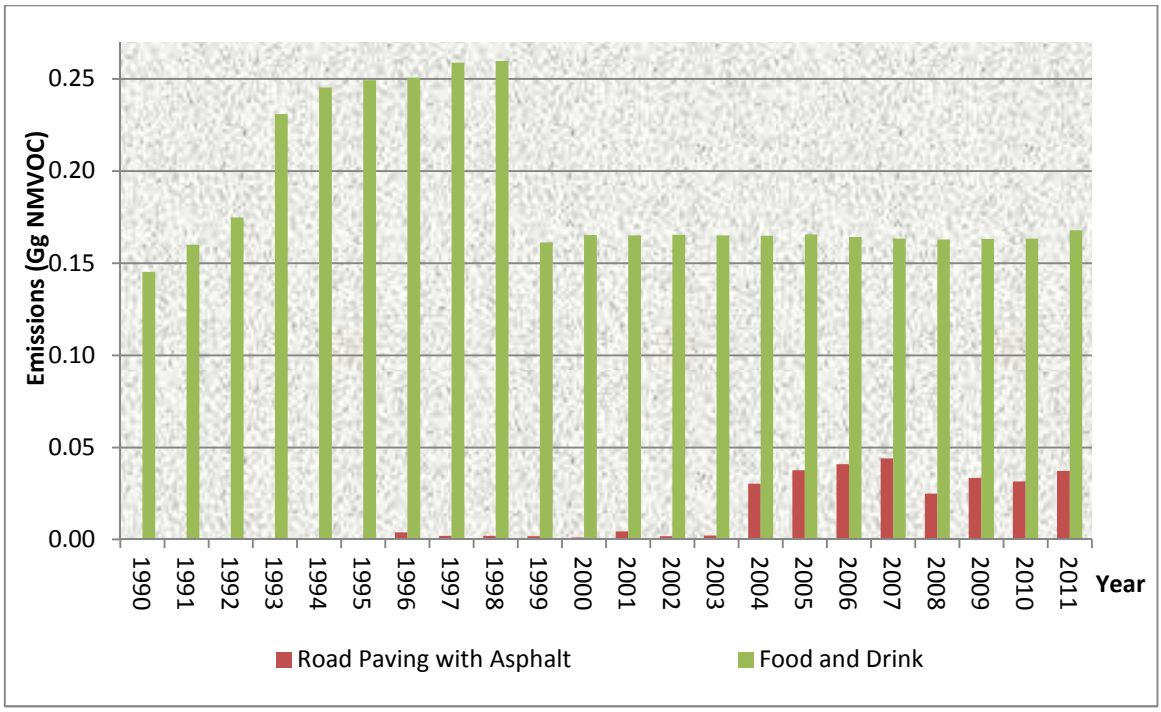

Figure 4-2 Indirect GHG Emissions from the Industrial Processes Sector

4.2 Mineral Industry (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. Nowadays the industry has stopped operating and any lime used in Malta is imported. The activity data

utilised (quantity of lime produced) was compiled by Gauci [7] from data provided by the National Office of Statistics.

In this inventory submission, the CO_2 emissions from this activity during the period 1995-1998 have been reported. For the years 1990 till 1994 no emissions have been reported, since at the time only two lime production plants were operational and hence the quantities of lime produced were confidential data and were not available at the National Statistics Office.

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 for the period 1990-1994 was obtained by back extrapolation of the production figures reported between 1995 and 1997, thus producing an estimate emission from this sector in that period.

4.2.2.3 Source Specific Recalculations

Following comments raised by the ERT in the 2009. the activity data for this sector for the period 1990-1994 was estimated using back extrapolation of the average production 1995-1997, thus giving an average production of 1672t of quicklime produced for each year in that period. This resulted in the variations explained below in Table 4-1.

Table 4-1 Lime production recalculation

	Previous submission	Current submission	Difference
	Gg CO_2eq	Gg CO_2eq	%
1990	NO	1.254	100%
1991	NO	1.254	100%
1992	NO	1.254	100%
1993	NO	1.254	100%
1994	NO	1.254	100%
1995	1.318	1.318	0.00%
1996	1.194	1.194	0.00%
1997	1.250	1.250	0.00%
1998	0.641	0.641	0.00%
1999	NO	NO	NA
2000	NO	NO	NA
2001	NO	NO	NA
2002	NO	NO	NA
2003	NO	NO	NA
2004	NO	NO	NA
2005	NO	NO	NA
2006	NO	NO	NA

2007	NO	NO	NA
2008	NO	NO	NA
2009	NO	NO	NA
2010	NO	NO	NA

4.2.3 Source Category 2A3 – Limestone and Dolomite use

Limestone is a commonly found raw material on the Maltese islands; it is commonly used as a construction material. In the past lime was produced and emissions from this sector are included under 2A2. No other use of limestone is reported. Local limestone may contain traces of Dolomite but is not used in any process. Dolomite like limestone is only used by the construction industry and no process involving heating and/or emission of CO_2 are known.

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 of soda ash imports by year for the period 1990 to 2010 were obtained from the National Statistics Office. It has been assumed that the quantity imported each year was utilised locally during the same year. Furthermore, it has also been assumed that only 95% of the annually imported soda ash has been processed, hence the import figures were multiplied by 0.95.

The following process takes place when soda ash is heated:

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

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].

In the 2009 GHG inventory submission [16], Malta reported only NMVOC emissions from asphalt production and application to road surfaces. Since the following inventory submission, Malta is additionally reporting the estimate of CO_2 emissions from road paving with asphalt, using the methodology provided in the 2009 Portuguese GHG Inventory Report [17]. The Portuguese asphalt methodology assumes that solvents in asphalt products are 100 per cent 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:

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

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 result in GHG emissions 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.

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 2010 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].

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 then 0.30Gg CO_2 emissions in 2010.

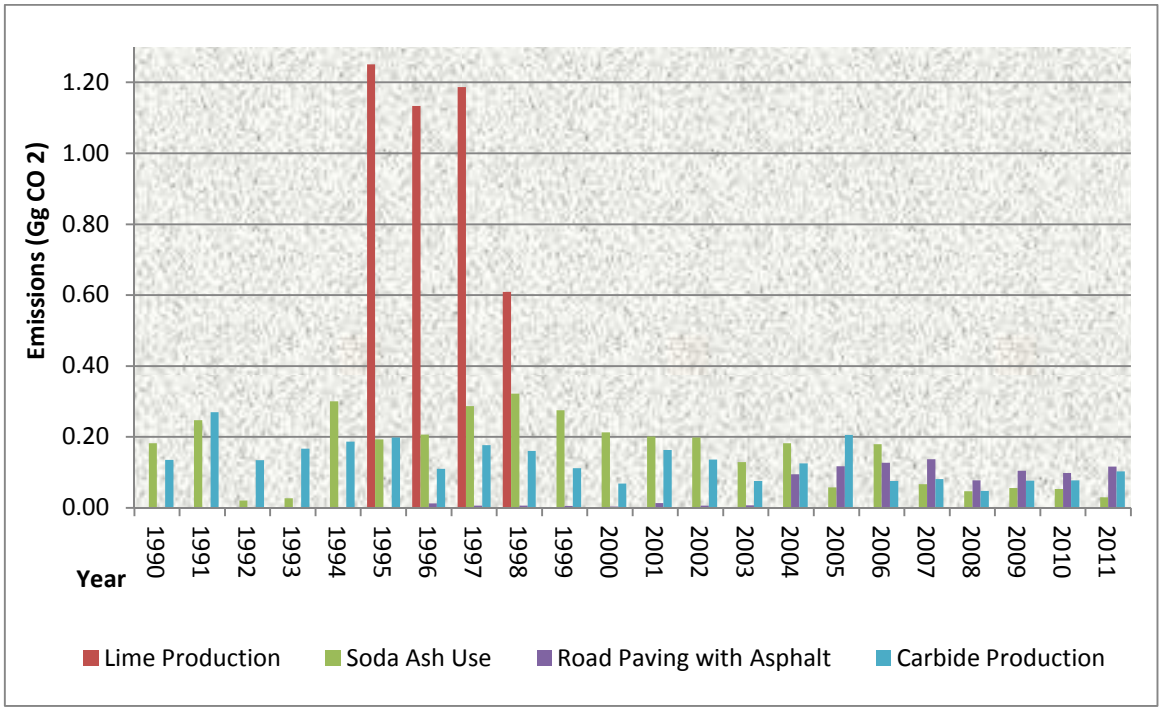

Figure 4-3 Carbon Dioxide Emissions from Lime Production, Soda Ash Use, Road Paving with Asphalt and Carbide Production

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 result in GHG emissions in Malta and has therefore not been included in this inventory process.

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 manufactures of food and drink processes give rise to emissions of NMVOC. Drink includes emissions from the local production of wine and beer. The quantities of wine produced in Malta from the year 2000 and onwards were available from Eurostat [18]. Beer Production also creates emissions of NMVOC. Beer production takes place in Malta, but since there have been only two beer producers in operation, the emissions from beer production are not estimated due to the confidentiality of the activity data up to 2010. In 2011 in agreement with NSO to include data for wine production and beer production and overcome the confidentiality issues an aggregate emission for both production streams will be reported.

Bread production involves a fermentation reaction and ethanol is released. Food includes emissions from the local production of bread. Data on the quantities of bread produced from 1990 till 1998 has been provided by the National Statistics Office in October 2008. However since 1999 it was not possible for the National Statistics Office to quantify the quantities of bread produced in Malta, since only monetary production figures were kept.

4.5.2.2 Methodological Issues

The sub-category Food and Drink (2D2) results in NMVOC emissions.

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.

Through communication with the Maltese Bakers' Cooperative it has been established that in 2006, on average, 7,000 flour sacks per week were used to produce the traditional Maltese loaf. Each sack weighs approximately 50kg and around 100 loaves can be produced from one sack. The figure of 100 loaves per sack was established through a survey of 93 bakeries around Malta during 2007. Each baked loaf weighs around 540 grams. Therefore, it was calculated that approximately 19,656 tonnes of Maltese bread were produced in 2006.

Apart from the traditional Maltese loaf, the Maltese Bread Cooperative Representative mentioned that around 3,500 sacks per week were used to produce soft dough bread in 2006. Since each flour sack weighs around 50kg, it was calculated that annually 9,100 tonnes of soft dough bread was produced in 2006.

In the absence of actual production figures, the figures estimated for Maltese bread and for soft dough bread have also been used for the years 1999 till 2005. Communication with the Bread Cooperative Representative in December 2008 has confirmed that the figures reported for the year 2006 could still be applied. Communication with the cooperative in 2010/11 proved unfruitful thus the values used for 2008 were brought forward to 2010.

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

Perfluorocarbons (PFCs), Hydrofluorocarbons (HFCs) and Sulphur hexafluoride (SF_6) are fluorinated gases of great concern because they have high global warming potentials and long atmospheric residence times. Current application areas of HFCs and PFCs include refrigeration and air conditioning equipment, in foam blowing applications, in fire extinguishers, in metered dose inhalers, in semiconductor manufacture and in other less significant sources, such as in medical applications. A primary use of SF_6 is in gas insulated switch gear and circuit breakers.

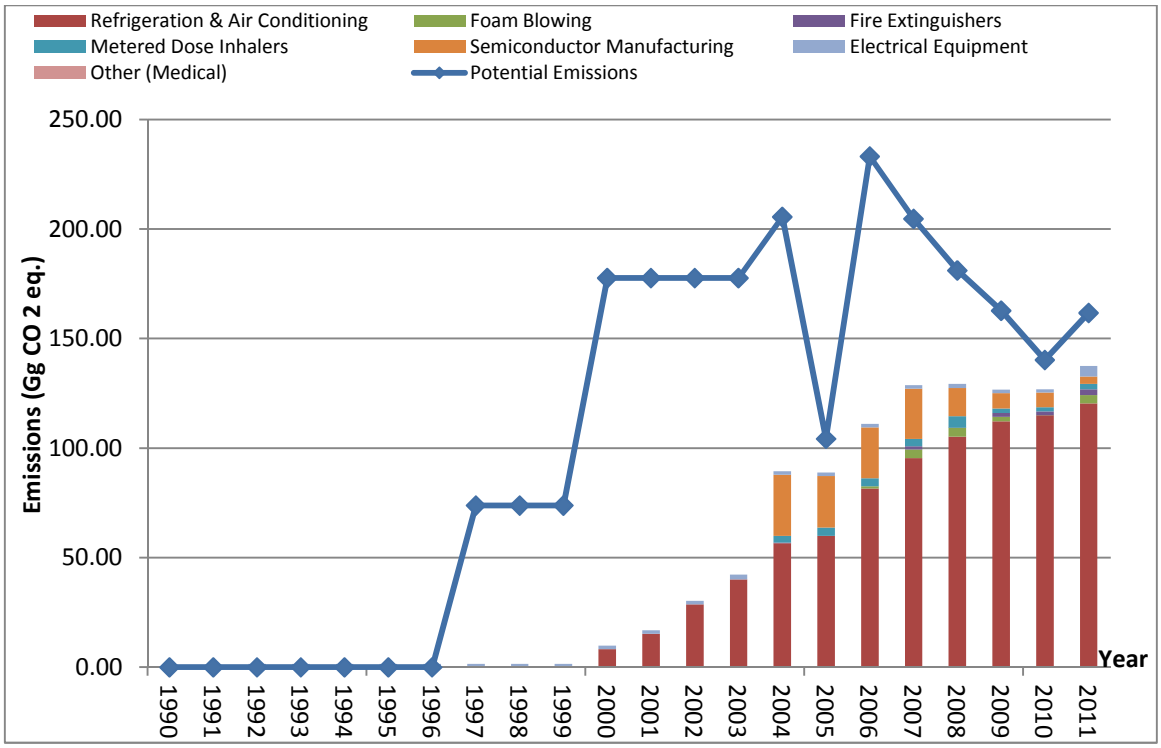

Figure 4-4 Actual Emissions from HFCs, PFCs and SF6 in CO2 Eq

In the present inventory compilation, an effort was made to improve the reported emissions from the consumption of halocarbons and sulphur hexafluoride. A data gathering exercise has 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 have been collected. Information on the processes taking place locally, as well as details on the gases being used was gathered. Such information is presented in Sections 4.7.4, 4.7.5, 4.7.6, 4.7.6.2 and 4.7.10 below.

4.7.2 Source Category 2FP - Potential Fluorinated Gases Emissions – RAC (Refigeration and Airconditioning)

4.7.2.1 Source Category Description

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

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. A questionnaire was sent to the local businesses involved in the importation.. Such businesses were asked to indicate consumption of the fluorinated gases, be they in blends or otherwise. This exercise was now extended to an annual data collection exercise. To confirm completeness of the data collected a list of possible importers is compared through NSO with trade data of importers which import in malta material under CN code 1076 1417 (Mixtures containing perfluorocarbons "PFCs" or hydrofluorocarbons "HFCs", but not containing chlorofluorocarbons "CFCs" or hydrochlorofluorocarbons "HCFCs"). This information is only indicative of coverage and is only used to identify possible gaps in data collection.

4.7.2.3 Source Specific Recalculations

This sector was recalculated to include all potential F-gas emissions, previously including only emissions from the RAC sector. Potential emissions from other sectors are not included.

Table 4-2 Potential Emissions of F-gases Recalulation.

	Previous submission	Current submission	% difference
1990	NO	NO	NA
1991	NO	NO	NA
1992	NO	NO	NA
1993	NO	NO	NA
1994	NO	NO	NA
1995	NO	NO	NA
1996	NO	NO	NA
1997	73.870	73.870	0.0000%
1998	73.870	73.870	0.0000%
1999	73.870	73.870	0.0000%
2000	177.666	177.666	0.0000%
2001	177.666	177.666	0.0000%
2002	177.666	177.666	0.0000%
2003	177.666	177.666	0.0000%
2004	177.666	205.564	15.7021%
2005	80.892	104.286	28.9196%
2006	209.086	233.167	11.5173%
2007	180.083	204.690	13.6641%
2008	164.946	181.108	9.7985%
2009	155.967	162.752	4.3505%
2010	135.341	140.278	3.6476%
2011		161.741	

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 specifically 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.

4.7.3.2 Methodological issues

For the 2013 submission the Tier 1 method from '2006 IPCC Guidelines for National Greenhouse Gas Inventories' is used. The model used utilises past and present import, export and destruction data to calculate the current year emissions and recalculations from previous years.

The model 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.
- 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 weighed 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 importation data is recorded. Importation data has been obtained from importers. These 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.

The resulting current emissions scenario reflects the evolution of the market in Malta, characterised by a rapid growth and boom in various sectors of the Maltese economy namely of the construction industry in industrial, commercial, hospitality and domestic sectors in the years in question.

In 2012 the NEIT entrusted local sector experts to challenge a number of assumptions taken in the modelling used to calculate the RAC sector. In summary this short study entrusted confirmed some assumptions including the lifetime of equipment (15 years) but rejected the assumption of 10% leakage from install base and suggested the use of a 15% rate.

Actual emissions as estimated from the RAC model used are shown in **Figure 4-5** below.

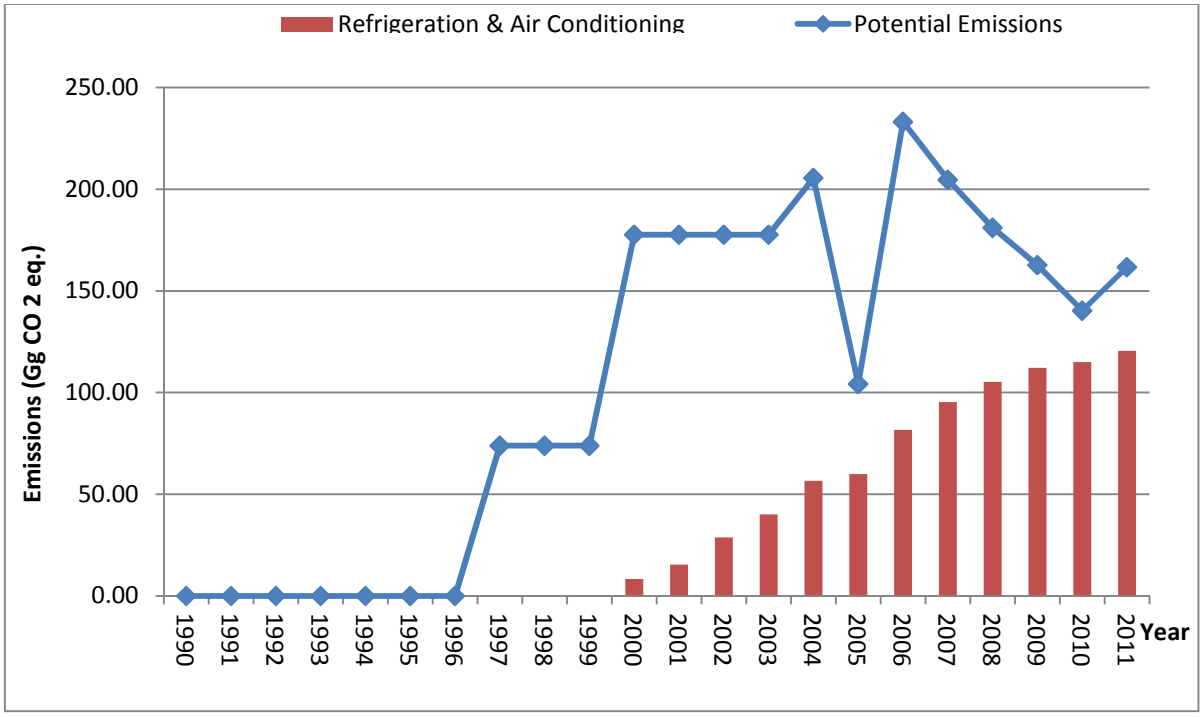

Figure 4-5 Actual RAC emissions

4.7.3.3 Source Specific Recalculations

This sector was modified slightly following the UNFCCC review publication in October 2012, were it was noted that emissions included in the Semiconductor Manufacterring sector were infact to be included within the RAC sector. Additionally following to the short study carried out in 2012 as described above further changes in the final figures have been calculated. Table 4-3 below illustrates this:

Table 4-3 RAC sector Actual emission recalculation

	Previous submission	Current submission	% difference
1990	NO	NO	NA
1991	NO	NO	NA
1992	NO	NO	NA
1993	NO	NO	NA
1994	NO	NO	NA
1995	NO	NO	NA
1996	NO	NO	NA
1997	NO	NO	NA
1998	NO	NO	NA
1999	NO	NO	NA
2000	5.52	8.29	50.0000%
2001	10.50	15.33	46.0526%
2002	19.89	28.70	44.2713%
2003	28.35	40.06	41.3200%
2004	40.52	56.56	39.5909%
2005	44.39	59.96	35.0798%
2006	60.37	81.59	35.1591%
2007	71.69	95.40	33.0624%
2008	80.61	105.22	30.5261%
2009	87.71	112.18	27.8940%
2010	92.01	114.96	24.9382%
2011		120.46	

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 division of foams into open-cell or 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. 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. Open-celled foams are used for applications such as household furniture cushioning, mattresses and moulded products. Closed-cell foams, on the other hand, 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

Foam as already described above can be classified into two, open and closed foam, the main difference being the structure of the finished foam and the possibility of leaking of blowing agent to the atmosphere. This major difference requires a different methodological approach. Whereas open cell foams emit all the blowing agent in a relatively short time, assumed in the year of manufacture, closed cell foams tend to maintain a large fraction of the blowing agent within their structure for a longer period and emitting constantly over a longer period of time.

In this regards emissions from open cell foams can be estimated through sales/imports of gases directed to the use of open cell foam blowing. Locally it was identified that open cell foam manufacturers use a mix of HFC365mfc (93%)/ HFC 227ea (7%) mix, 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 like the one used for open cell foams. For this inventory we started implementing the use of Gamlen based model for locally blown foam and imported foam. The method used is based on the mass of foam blown in a year and assumes that 1% of the mass of the foam is in fact blowing agent. The model also assumes that the lifetime of the product is 15yrs and that a constant 4.5% emission of blowing agent occurs in each year of its lifetime and that the remaining 32.5% of blowing agent is emitted in the year of destruction.

Activity for this sector was collected by contacting all businesses registered with the Malta Resources Authority, a list is of which is publically available at http://www.mra.org.mt, as part of a government run rebate scheme on insulation for households. Each business was asked to provide the consumption in tonnes of foam used for insulation for the time-series in question. A rather limited response was achieved but the main importers of foam possibly (through Expert judgment) covering the vast majority of the market did respond.

4.7.4.3 Source Specific Recalculations

The UNFCCC review identified shortcomings in the previous years submissions and 2010 submission. The NEIT embarked on an internal exescise with the aim to establish a better system for data collection in the sector and align the calculation methodology and EFs used to the IPCC guidelines [3]. The major changes occurred through the implementation of the Gemlen model that accounted for emissions from imported closed cell foam over their lifetime. Better data collection and larger coverage also accounted for an increase of emissions in previous years and thus recalculations in the years in question.

The excersise did not identify any activity, thus emissions prior to 2007, therefore as previously done we shall consider that no emissions occurred in the said period.

Table 4-4 Foam blowing sub sector recalculation

	Previous submission	Current submission	Difference
	Gg CO_2eq	Gg CO_2eq	%
1990	NE	NE	NA
1991	NE	NE	NA
1992	NE	NE	NA
1993	NE	NE	NA
1994	NE	NE	NA
1995	NE	NE	NA
1996	NE	NE	NA
1997	NE	NE	NA
1998	NE	NE	NA
1999	NE	NE	NA
2000	NE	NE	NA
2001	NE	NE	NA
2002	NE	NE	NA
2003	NE	NE	NA
2004	NE	NE	NA
2005	NE	NE	NA
2006	0.19	1.01	416.8966%
2007	0.78	4.03	416.8966%
2008	0.83	4.03	384.9261%
2009	0.44	2.04	362.0229%
2010	NO	0.06	NA
2011		3.81	

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

As a first attempt in this inventory compilation, the local businesses providing fire protection were contacted. Such businesses were asked to indicate the use (if any) of fluorinated gases in fire protection systems. A number of businesses identified the use of

HFC-227ea in such applications. In the short time span of this research project, it was 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, but in a small fraction of the total, HFCs and PFCs may be used as propellants or solvents. During the aerosol use, 100 percent of the chemical is 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 4-5 below. The emissions of HFCs from use is 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 4-5 HFC-134a Emissions in CO2 Equivalents from Use of MDIs

Year	Emissions 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

4.7.6.1.3 Source Specific Recalculations

Following an internal Quality check it was identified that a mistaken summation has occurred in this sector for the year 2010. This resulted in an underestimation for 2010. This occurance has been corrected in this submission. The below illustrates these differences.

Table 4-6 Recalculation for MDI sector, values in tones of HFC 134a

	Previous submission	Current submission	% difference
1990	NO	NO	NA
1991	NO	NO	NA
1992	NO	NO	NA
1993	NO	NO	NA
1994	NO	NO	NA
1995	NO	NO	NA
1996	NO	NO	NA
1997	NO	NO	NA
1998	NO	NO	NA
1999	NO	NO	NA
2000	NO	NO	NA
2001	NO	NO	NA
2002	NO	NO	NA
2003	NO	NO	NA
2004	2.296	2.296	0.00%
2005	2.965	2.965	0.00%
2006	2.751	2.751	0.00%
2007	2.610	2.610	0.00%
2008	4.042	4.042	0.00%
2009	1.549	1.549	0.00%
2010	1.519	1.957	28.88%
2011		2.228	NA

4.7.6.2 Source Category 2F4.2 – Aerosols

This sector does not occur in Malta.

4.7.7 Source Category 2F5 – Solvents

This sector does not occur in Malta.

4.7.8 Source Category 2F6 – Other Applications Using ODS Substitutes

This sector does not occur in Malta.

4.7.9 Source Category 2F7 - Semiconductor Manufacture

4.7.9.1 Source Category Description

PFCs may be used in electronics and precision cleaning applications. Local electronics manufacturers were contacted in 2009 and again in 2010, to identify any potential uses of PFCs at the local plants. The main potential user in the sector is a major electonic manufacturer which through direct communication it was noted that the plant is essentially a backend process plant which is not involved in the deposition or wafer etching, thus the main possible application of F-gas within the sector is as a coolant in testing applications. This product replaced earlier products containing CFCs in 2004 (thus no use of PFCs is identified prior to 2004) and it was also identified that the main user of this product is currently out-phasing the use of PFCs in this process and is introducing alternatives as part of the company's environmental responsibility program.

4.7.9.2 Methodological issues

Iniatally a survey of what processes are carried out in local manufacturing firms related to semiconductor manufacture was conducted. It resulted that the major plants in Malta are as already stated backend process plants, thus there is no known plant that produces the actual silicon wafers and or process actual silicon wafers but the processes used locally. Electronic and semiconductor stakeholders are contacted to provide their consumption of PFC containing heat transfer liquids. The consumption of these heat transfer liquids was assumed to be a replacement of lost heat transfer liquid thus an emission factor of 1 is used. Following the estimation of the PFC in tonnes it is converted to GgCO2 eq by multiplying with a GWP factor. In this case C_8F_{18} is used and, since no default GWP is found in IPCC guidelines, the GWP used (8340) was obtained from peer reviewed literature (Ivy *et al.* 2012)[57].

4.7.9.3 Source Specific Recalculations

Following the publication of the 2010 UNFCCC inventory review report (paras 45, 53 and 55), a through investigation of the sector was launched to identify possible underestimation and emissions which are misallocated under this heading. It was identified that the whole emission allocated under this heading was in reality to be allocated under RAC since the main use of the gas in question was in heat pump based heating process (oven). Other uses of F-gases in the sector are being currently investigated.

The re-allocation of emissions has been carried out and the effects on the sub-sector are described below, no change in the IP sector total has resulted from this recalculation since it is only a re-allocation.

Additionally also following recommendations included in the 2010 UNFCCC inventory review, a specific additional activity in this sector not previously identified was discovered, as described above the use of PFC-containing heat transfer fluids is now included in this sub-sector.

Table 4-7 Recalculation for the Semiconductor manufactering sector

	Previous submission	Current submission	Difference
	Gg CO_2eq	Gg CO_2eq	%
1990	NO	NO	NA
1991	NO	NO	NA
1992	NO	NO	NA
1993	NO	NO	NA
1994	NO	NO	NA
1995	NO	NO	NA
1996	NO	NO	NA
1997	NO	NO	NA
1998	NO	NO	NA
1999	NO	NO	NA
2000	0.00	NO	NA
2001	0.00	NO	NA
2002	0.00	NO	NA
2003	0.00	NO	NA
2004	0.00	27.90	25199802%
2005	0.00	23.39	21131657%
2006	0.00	23.27	21018653%
2007	0.00	22.81	20604305%
2008	0.00	12.93	11676985%
2009	0.00	7.02	6343194%
2010	0.00	6.63	5989114%
2011		3.34	

4.7.10 Source Category 2F8 - Electrical Equipment

4.7.10.1 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 all over the world. SF_6 is also used in medical radiotherapy linear accelerators. While SF_6 possesses a unique combination of properties such as non-toxicity, non-ozone-depletion, non-flammability and very good insulating properties, it has a potent greenhouse effect and despite great research efforts, to date no equivalent alternative gas has been identified.

4.7.10.2 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.

Enemalta Corporation is identified as the main user and emitter of SF_6 gas from switchgear equipment in Malta (emitting around 99% of the total estimated in 2011). 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 government hospitals (Sir Paul Boffa Hospital and Mater Dei Hospital), the Palumbo Malta Shipyards Ltd and a number of private establishments. It is to be noted that due to long life expectancy of such equipment when no changes to the equipment are reported by the operator the equipment is considered to be still in operation under the same conditions thus emitting constantly over its lifetime. Identified switchgear equipment for which no estimates have been provided by the operator, IPCC 2006 default emission factors have been used.

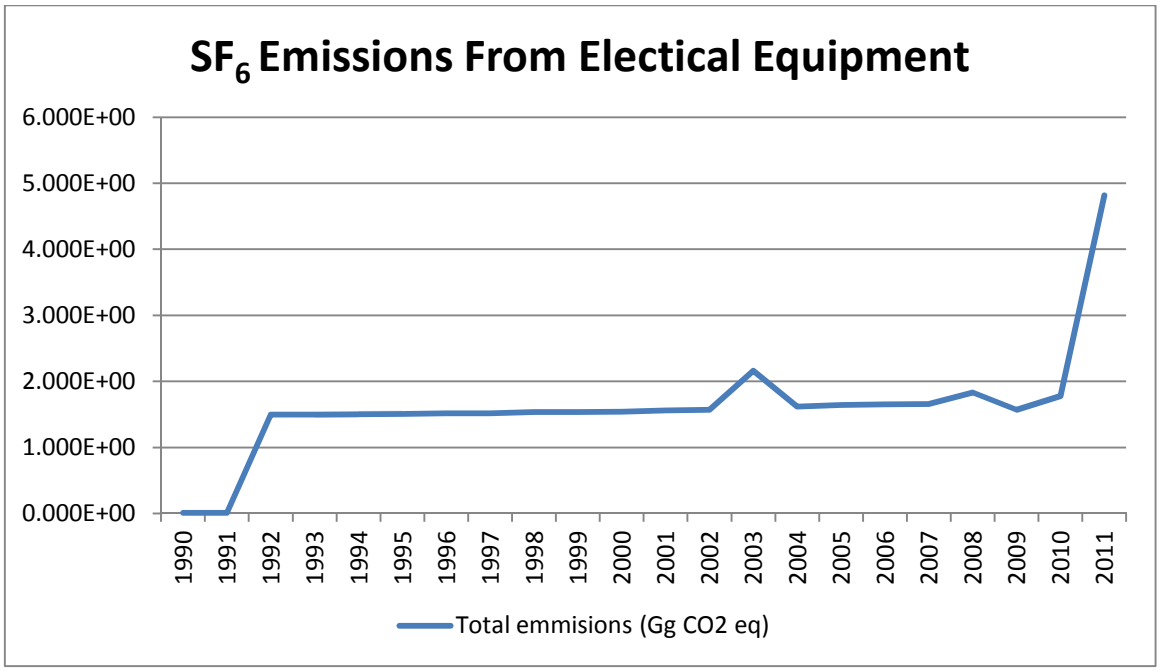

Figure 4-6 SF_6 Emissions in CO_2 Equivalents from Electrical Equipment

Figure 4-6 presents the sulphur hexafluoride emissions in carbon dioxide equivalents over the inventory time series. The emissions in the years 1990 and 1991 are relatively low because only in the electricity distribution network had equipment containing SF_6 been installed. Following the year 1991, new equipment containing SF_6 had been commissioned, as well as extensions to the present equipment took place. Later, around the year 2000, the private industries also started installing SF_6-containing switchgear equipment. An abrupt increase in the reported emissions is observed for the year 2003. Through communication with Malta Shipyards, it has been found that during 2003 an electricity substation was badly damaged during a storm resulting in the switchgear equipment being destroyed and the SF_6 escaping to the air; thus the spike in emissions for 2003. For 2011 an abnormally high level of emission of SF_6 was detected in one of the power stations operated by Enemalta, following communication with the said company it was identified that a leak was identified in one of the swichgears in operation but could not be repaired immediately and the company had no choice but to refill the switchgear continuously until it would have been able to repair the leak.

The trend in emissions during the inventory years is a slowly increasing trend in SF_6 emissions reported, that may be coupled with the increased installation of SF_6-containing equipment over the years. However it must be noted, that the majority of the equipment installed is of the sealed type not requiring regular refilling.

4.7.10.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

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

4.7.11.1 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 not covered separately. Very recently, as part of the data gathering exercise on the usage of fluorinated gases in Malta, it was identified that very small quantities of SF_6 and PFC-218 (perfluoropropane) are being used during hospital operations. Emissions of such gases are being reported for the years 2007 to 2010.

4.7.11.2 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.

4.7.11.3 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 N_2O 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.

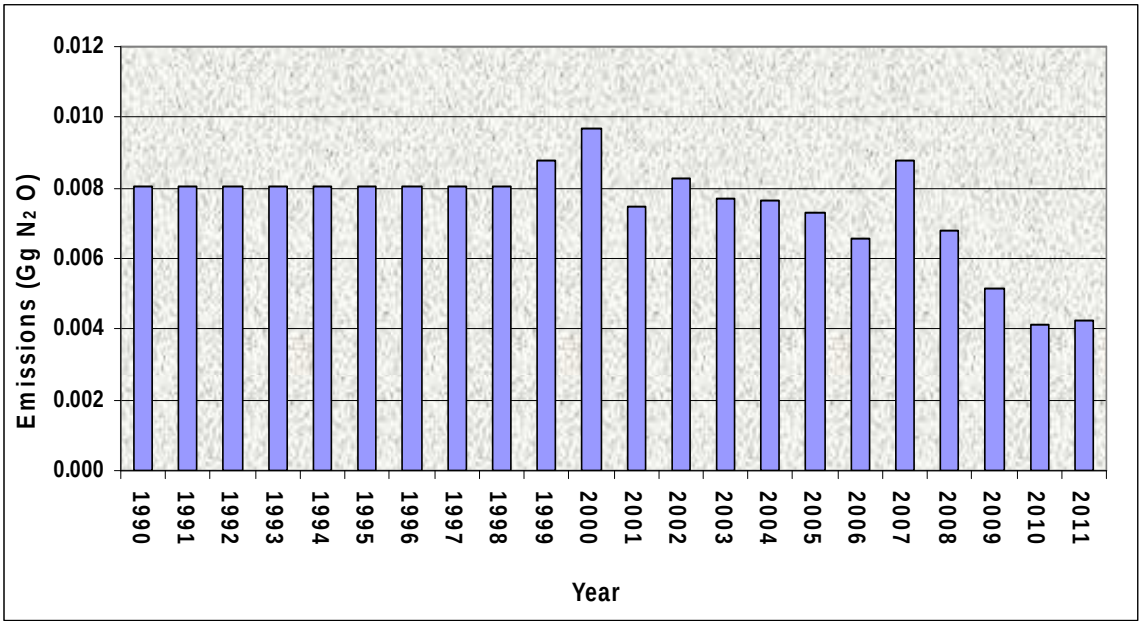

Figure 5-1 Nitrous Oxide Emissions from Anaesthetic Use

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 - N_2O from Fire extinguishers

No relevant activity reported in this sector.

5.5.3 Source Category 3D3 - N_2O from Aerosol cans

No relevant activity reported in this sector.

5.5.4 Source Category 3D4 – Other use of N_2O

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.

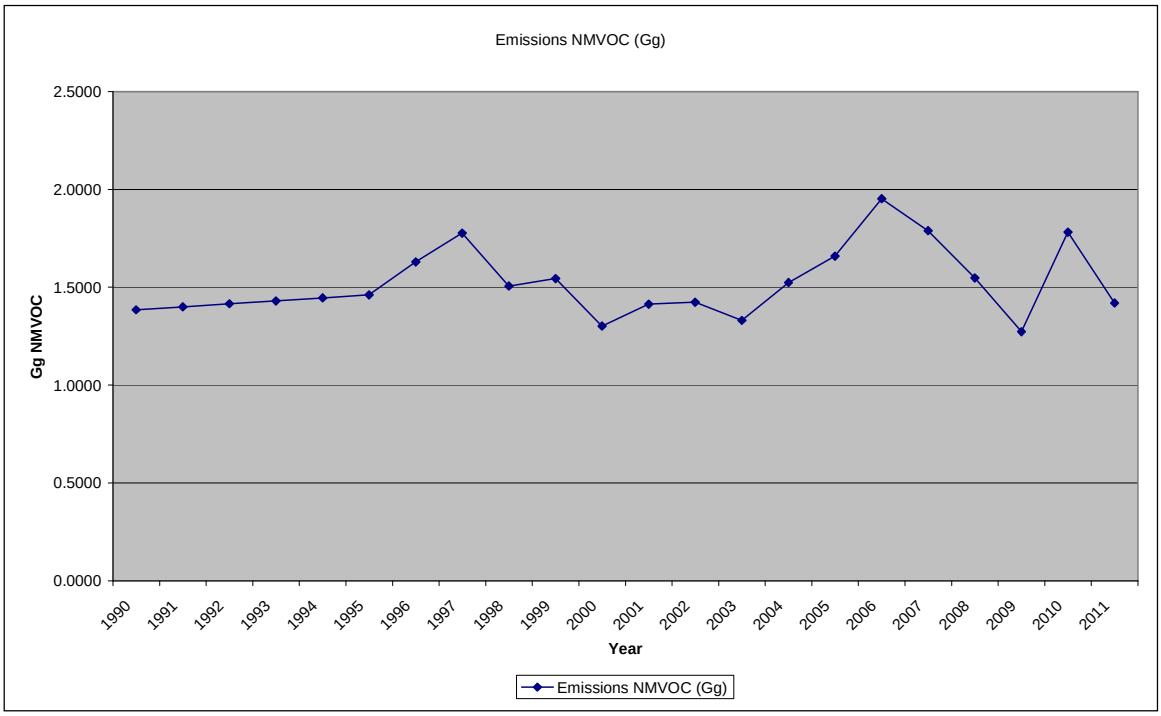

Figure 5-2 NMVOC Emissions from the Use of Solvents and Solvent-containing Products

Figure 5-2 shows a gradual increase in NMVOC emissions over the inventory 1990 to 2011 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 Agriculture sector, as reported under the IPCC is given. Emissions are due to Enteric Fermentation (4A), Manure Management (4B) and Agriculture Soils (4D). Gases estimated and reported are methane (CH_4) and nitrous oxide (N_2O). The source categories Rice Cultivation (4C), Prescribed Burning of Savannas (4E) and Field Burning of Agricultural Residues (4F) do not take place in Malta. Emissions from other sources (4G) have not been estimated. To provide information on the characteristics of the agriculture sector in Malta, figures were taken from the Census of Agriculture [25] [36], the Farm Structure Survey [31], the Cattle Survey [37], the Pig Census [38] the Sheep and Goats Survey [39], Agriculture and Fisheries 2010 [35].

Figure 6-1 below shows the emissions in carbon dioxide equivalents from the Agriculture sector for the years 1990 till 2011. The Agriculture sector in Malta contributes around 2.4% of the total national GHG emissions. Greenhouse gas emissions mainly result from enteric fermentation (40.6%) and manure management (36.0%) and to a lesser extent from agricultural soils (23.4%). Total emissions decreased by 7.14 Gg CO_2 eq. from 2010 to 2011.

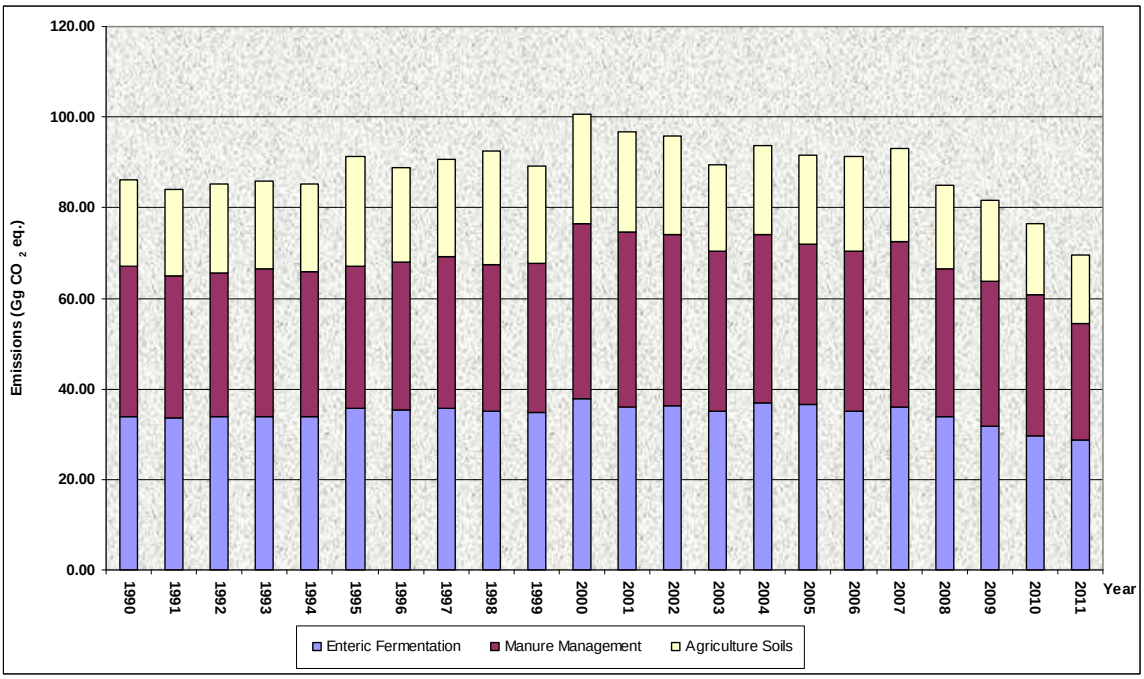

Figure 6-1 Emissions in Carbon dioxide Equivalents from the Agriculture Sector for 1990 to 2011

6.2 Enteric Fermentation (4A)

6.2.1 Source Category Description

Domestic livestock rearing leads to CH_4 emissions from enteric fermentation. CH_4 from enteric fermentation is produced in herbivores as a by-product of the digestive process 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 this inventory process. In Malta, as reported in the National Rural Development Strategy 2007-2013 [21], the two most important livestock rearing sectors are swine and poultry (broiler production) since cows are generally reared for milk, and beef production is a by-product of this activity. In 2011, CH_4 emissions from this category were 1.37 Gg.

6.2.2 Methodological Issues

Annual average animal numbers have been used to calculate methane emissions from enteric fermentation. These figures have been obtained from the past GHG inventory compilation [7]; from the National Statistics Office [22-39] and through consultations with the Department of Agriculture within the Ministry for Resources and Rural Affairs. Methane emissions from enteric fermentation are a major key source. The method used was Tier 1 of the 1996 IPCC guidelines. Livestock categories that were estimated were dairy cows, other cattle, sheep, goats, horses, swine, poultry and rabbits. The activity data is represented in

Table 6-1 below.

Table 6-1 Annual animal numbers

Year	Livestock type and animal numbers							
	Dairy Cows	Other Cattle	Sheep	Goats	Horses	Swine	Poultry	Rabbits
1990	12891	-	4623	3429	944	61607	1500000	29213
1991	12891	-	4623	3429	944	53549	1500000	29213
1992	12891	-	6000	5300	860	54794	1500000	29213
1993	12891	-	6200	5300	840	57748	1500000	29213
1994	12891	-	5600	5000	760	55726	1500000	29213
1995	12891	-	14773	10169	740	52578	1500000	29213
1996	12891	-	12330	8436	700	58027	1500000	29213
1997	12891	-	14980	6407	650	62460	1500000	29213
1998	12891	-	12590	5738	640	56887	1500000	29213
1999	12891	-	11840	5110	600	59229	1500000	29213
2000	8796	10584	12490	4599	600	80074	1500000	29213
2001	8338	10085	10376	3930	853	81841	1565629	55254
2002	8033	10737	12253	5163	853	78303	1529100	55254
2003	7607	10333	14861	5374	853	73067	1381544	55254
2004	7835	11573	14130	5635	853	76853	1381544	55254
2005	7832	11910	14642	6272	853	73025	1052013	55254
2006	7494	11739	12172	5828	853	73683	1052013	55254
2007	7545	11897	12315	6227	853	76900	1224267	55254
2008	7247	10530	12843	6361	853	65511	1224267	55254
2009	6931	9333	12889	5983	853	65918	1224267	55254
2010	6362	8592	12379	5110	1754	70583	970291	10593
2011	6308	8766	11887	4938	1754	46287	970291	10593

6.2.2.1 Activity Data

6.2.2.1.1 Cattle

This category refers to dairy cows that are reared for milk and also includes all other cattle. In Malta, 62.5% of the total cattle stock is found on farms with 100 cattle or more [34]. In the 1990s, only one Agriculture Census was carried out in Malta. Referred to as the 1991 Agriculture Census [22]; this took place in the years 1990 to 1991. In the absence of reliable animal head statistics for the 1990s, the figure of 12,891 dairy cows as recorded in the 1991 Agriculture Census is applied to the years 1990 till 1999.

The first comprehensive cattle census, held by the National Statistics Office took place in June 2000 on all cattle farms, where Eurostat's [40] 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

[41] from the bovine register, which is maintained by the Department of Veterinary Services. The cattle stock as at December 2011 amounted to 15,074 heads on 322 farms, an increase of 0.8% over 2010 [37]. 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. A constant figure of dairy cows is being used for the 1990s, whereas reliable published statistics are available for the year 2000 and onwards. 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 decreased by 54 heads between 2010 and 2011. For other cattle an increase in headcount is observed between 2010 and 2011 amounting to an increase of 174 heads.

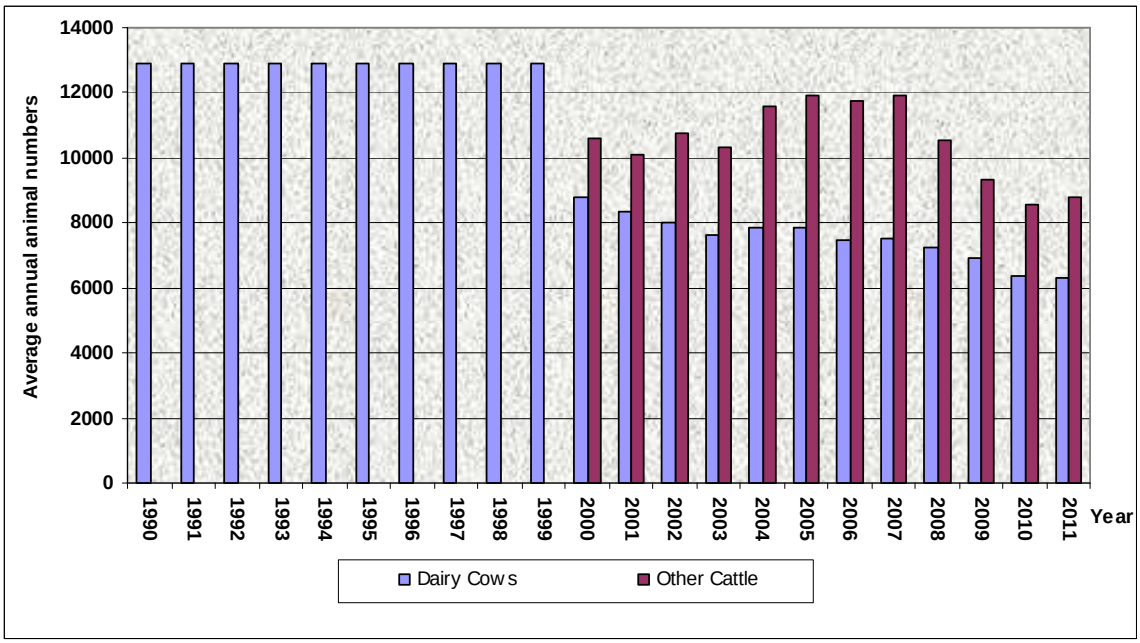

Figure 6-2 Annual average Cattle Figures

6.2.2.1.2 Sheep and Goats

Sheep and goats are mainly reared for the production of the traditional Maltese cheeselet, mainly marketed by the producers themselves. Only a minimal amount of sheep and goats are slaughtered at the civil abattoir. 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 [42], 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 2011 [39] shows that in 2011 there were 1,374 holdings involved in sheep rearing. Just over 77% of these holdings have less than 10 sheep and amount for 31.2% of the sheep population. On the other hand, while

only 22.4% of all holdings have more than 10 sheep they account for 68.8% of the sheep stock. The distribution of the goat stock is somewhat similar, where 43.7% of all goats are on holdings having less than 10 goats, which holdings amount to 86.3% of all goat rearing holdings whereas the remaining 56.3% of the goat population is on holdings with 10 goats or more.

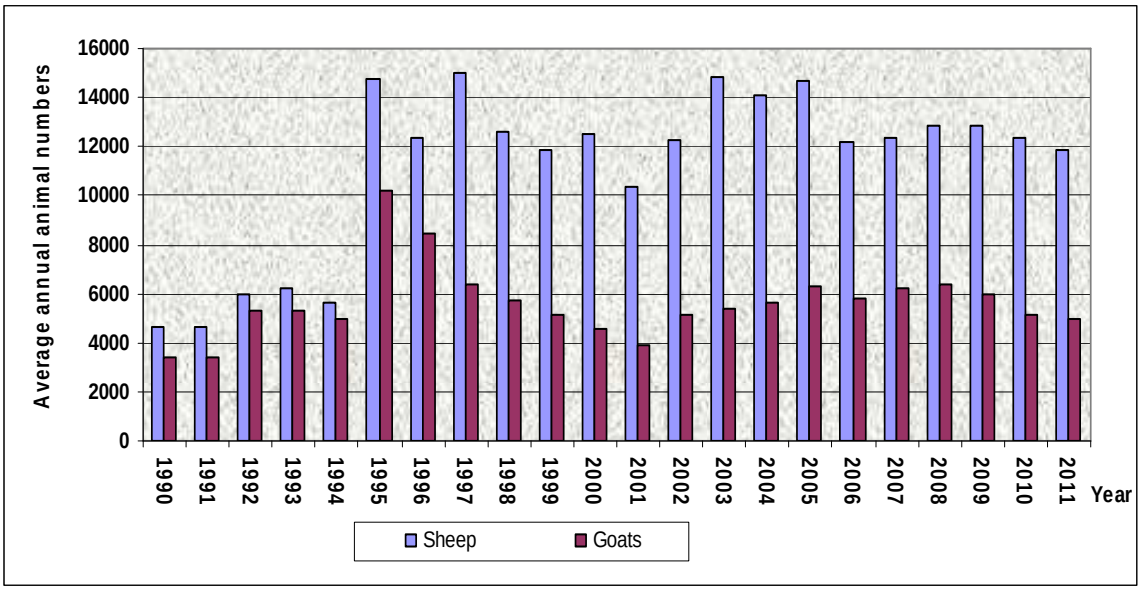

Figure 6-3 Average Annual Sheep and Goats Figures

The annual sheep figures for the early 1990s are relatively low when compared to the figures available for the rest of the time series. For the years 1990 and 1991, for both sheep and goats the figure as reported in the 1991 Agriculture Census is being used. For the rest of the 1990s, the figures as previously reported in Malta's past GHG Inventory [7] are being used, whilst from 2001, the figures as available from the National Statistics Office are being used. In December 2011, the sheep population amounted to 11,887 heads, an decline of 4.0 % over 2010. As for the goat population, it stood at 4,938 heads, down by 3.4% 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.

6.2.2.1.3 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 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 2011, the pig population amounted to 46,287 heads, down by 34.4% which translates to 24,296 pigs.

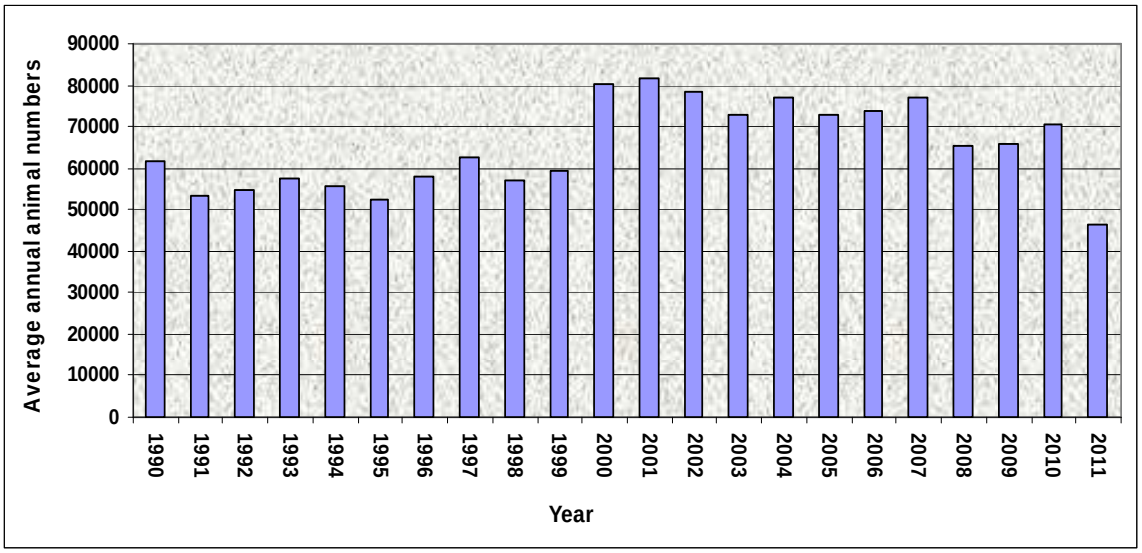

Figure 6-4 Average Annual Swine Figures

6.2.2.1.4 Poultry

The poultry figures include broilers, laying hens and all other poultry. For the years 1990 till 2000, the same mean annual figure of 1,500,000 poultry heads is being reported, since at the time reliable estimates were not available (MRRA, personal communication, November 2008). The contribution of broilers to the poultry industry in Malta is around 54%. The contribution of the laying hens is around 46%, whereas the contribution of the other poultry amounts to less than 1%. 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 [21]. From 2001 until 2003 an annual census was carried out. Following 2003, this was carried out on a biennial basis.

As revealed in the Agriculture and Fisheries Statistics 2010 [35], a total of 970,291 animal heads represents a decrease of 20.7% over 2009.

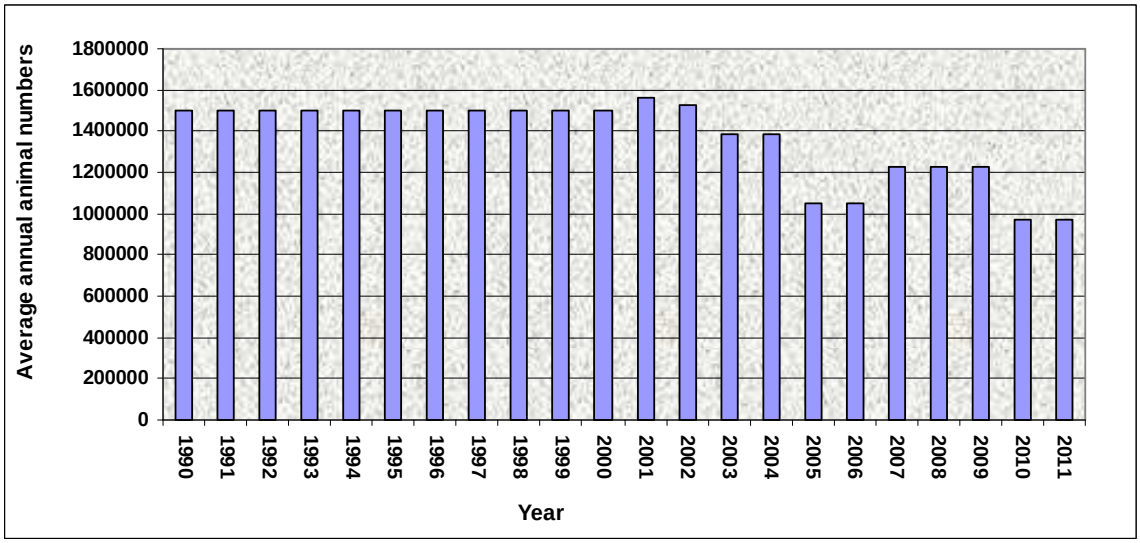

Figure 6-5 Average Annual Poultry Figures

6.2.2.1.5 Rabbits and Horses

Rabbit breeding in Malta is more of a backyard industry, apart from around five major farms. 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 [22], in the 2001 Agriculture Census [25] and in the 2010 Agriculture Census [36]. 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 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 [35].

Note that all households who own rabbits and poultry which are not on the farms register and may not have commercial activity, may not have been captured during the census, since it was not considered feasible and practical to cover them during the inventory.

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	Corinair, 2006 [9]
Other Cattle	48	Corinair, 2006 [9]
Sheep	8	Corinair, 2006 [9]
Goats	5	Corinair, 2006 [9]
Horses	18	Corinair, 2006 [9]
Swine	1.5	Corinair, 2006 [9]
Poultry	0.1	IPCC, 1996 [1]
Rabbits	0.08	APAT, 2005 [15]

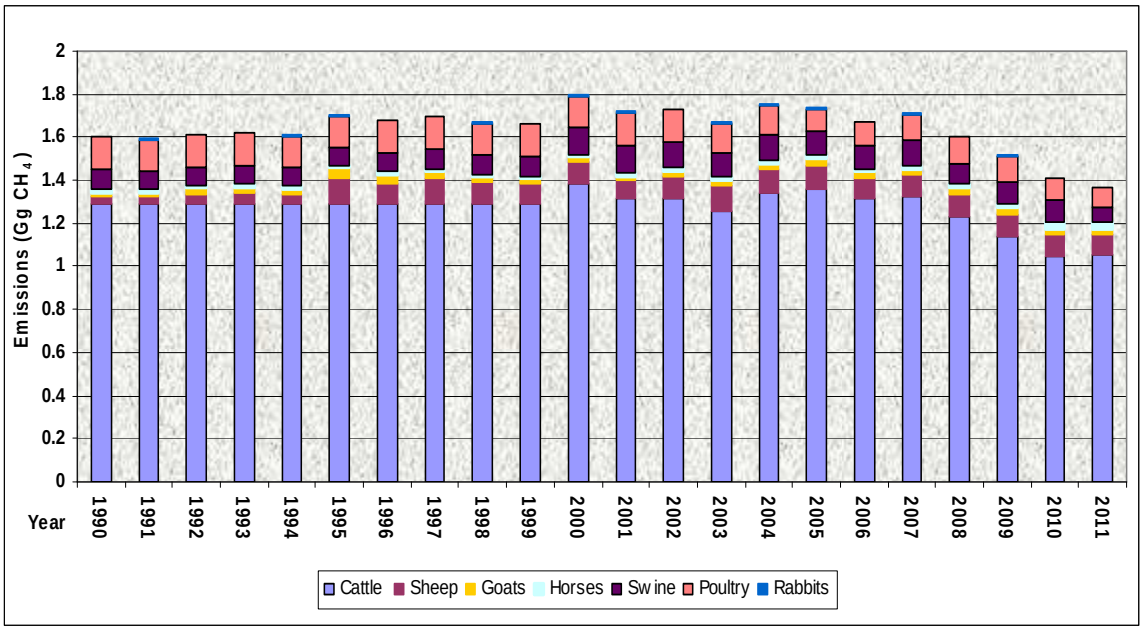

Figure 6-6 Methane Emissions from Enteric Fermentation

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 77% 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.

6.2.3 Specific Recalculations

Animal numbers for horses and rabbits for 2010 have been updated through the publication of the Agricultural Census 2010.

Year	Enteric Fermentation (Gg CO2 eq.) as reported in the 2012 inventory	Enteric Fermentation (Gg CO2 eq.) as reported in the 2013 inventory	Percentage change in reported emissions (%)
2010	29.24	29.58	1.16

6.2.4 Source-specific planned improvements

Emission factors and activity data will be kept under review including the use of more detailed emission factors and activity data to allow estimation of the effect of future mitigation policies.

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.

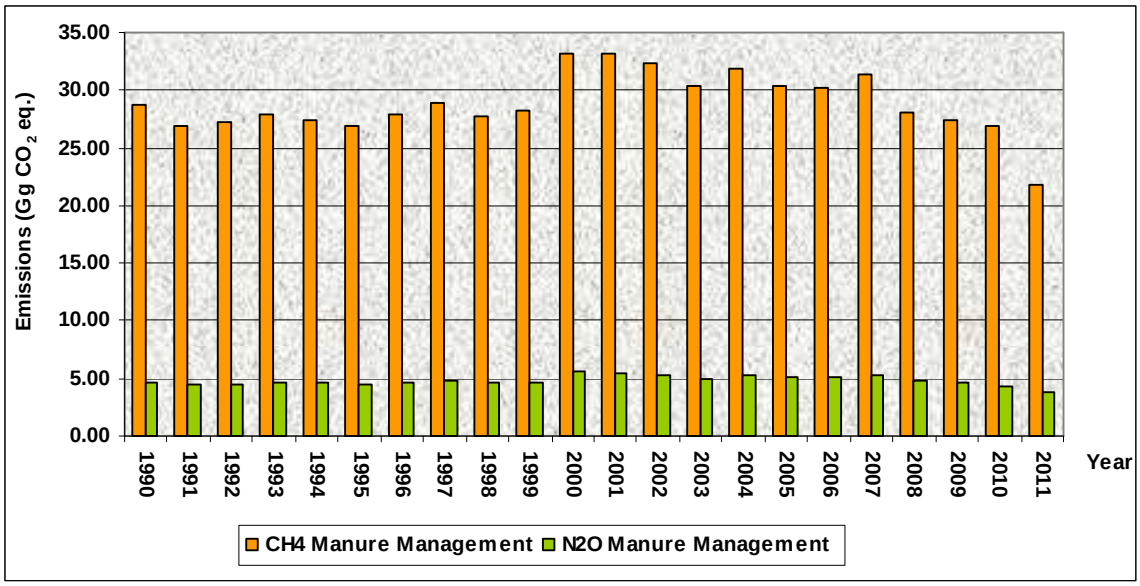

Figure 6-7 Methane and Nitrous Oxide Emissions from Manure Management

6.3.2 Methodological Issues

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	Corinair, 2006 [9]
Other Cattle	20	Corinair, 2006 [9]
Sheep	0.28	Corinair, 2006 [9]
Goats	0.18	Corinair, 2006 [9]
Horses	2.08	Corinair, 2006 [9]
Swine	10	Corinair, 2006 [9]
Poultry	0.117	Corinair, 2006 [9]
Rabbits	0.08	APAT, 2005 [15]

6.3.2.1 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. Table 6-3 includes the methane emission factors used.

6.3.2.2 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 [43]

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 [44]. 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 [45].

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.

6.3.3 Source Specific Recalculations

Animal numbers for horses and rabbits for 2010 have been updated through the publication of the Agricultural Census 2010. This resulted in changes to methane emissions from this sector.

Year	Manure Management (CH4 Gg CO2 eq.) as reported in the 2012 inventory	Manure Management (CH4 Gg CO2 eq.) as reported in the 2013 inventory	Percentage change in reported emissions (%)
2010	26.84	26.90	0.22

6.4 Rice Cultivation (4C)

This source category does not occur in Malta.

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) from the application of synthetic nitrogen fertilisers and manure onto Maltese soils. Figure 6-8 includes the nitrous oxide emissions over the time period 1990 till 2011. 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.

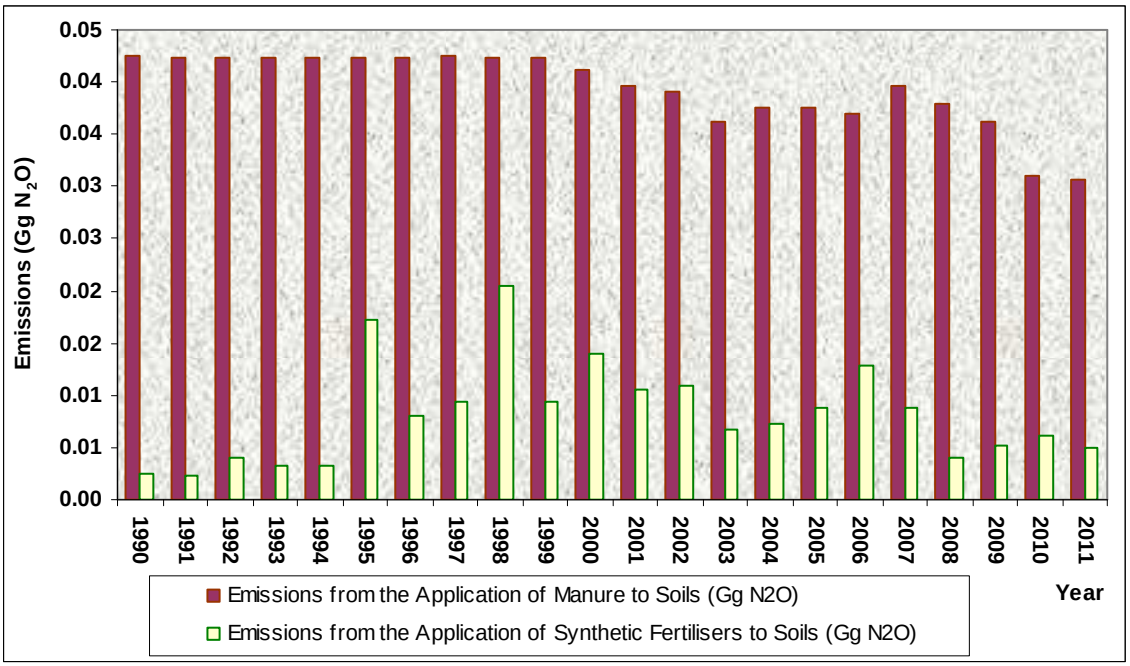

Figure 6-8 Nitrous Oxide Emissions from Agriculture Soils

6.5.1.2 Methodological Issues

In most soils, an increase in available nitrogen enhances nitrification and denitrification rates which then increase the production of N_2O. The following nitrogen sources were included in the methodology for estimating direct N_2O emissions from managed soils:

- Synthetic N fertilisers (F_{SN});
- Organic N applied as fertiliser (animal manure) (F_{ON}).

6.5.1.2.1 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 [46] – Nitrogenous Fertiliser Consumption;
- for 1995 to 2011: Nitrogen fertiliser Import figures, as provided by the National Statistics Office.

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]. The conversion of N_2O-N emissions to N_2O emissions for reporting purposes was performed using the equation:

$$N_2O = N_2O\text{-}N * 44/28$$

6.5.1.2.2 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 6.3.2.2 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 [3] 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. The conversion of N_2O-N emissions to N_2O emissions for reporting purposes was performed using the equation:

$$N_2O = N_2O\text{-}N * 44/28$$

6.5.1.3 Specific Recalculations

No specific recalculations have been carried out.

6.5.1.4 Source Specific Planned Improvements

It is being considered whether the data that is required for the estimation of emissions under source categories N-fixing crops and Crop residues is available locally, in consultation with the relevant entities.

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

This sector 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, runoff, or harvest of crop biomass. Indirect emissions include small contributions from human sewage and volatilised nitrogen, but are derived predominantly from nitrogen lost through leaching and surface runoff (Revised 1996 National Greenhouse Gas Inventories, IPCC Guidelines, 2006).

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 2011 in this category are presented in Figure 6-9.

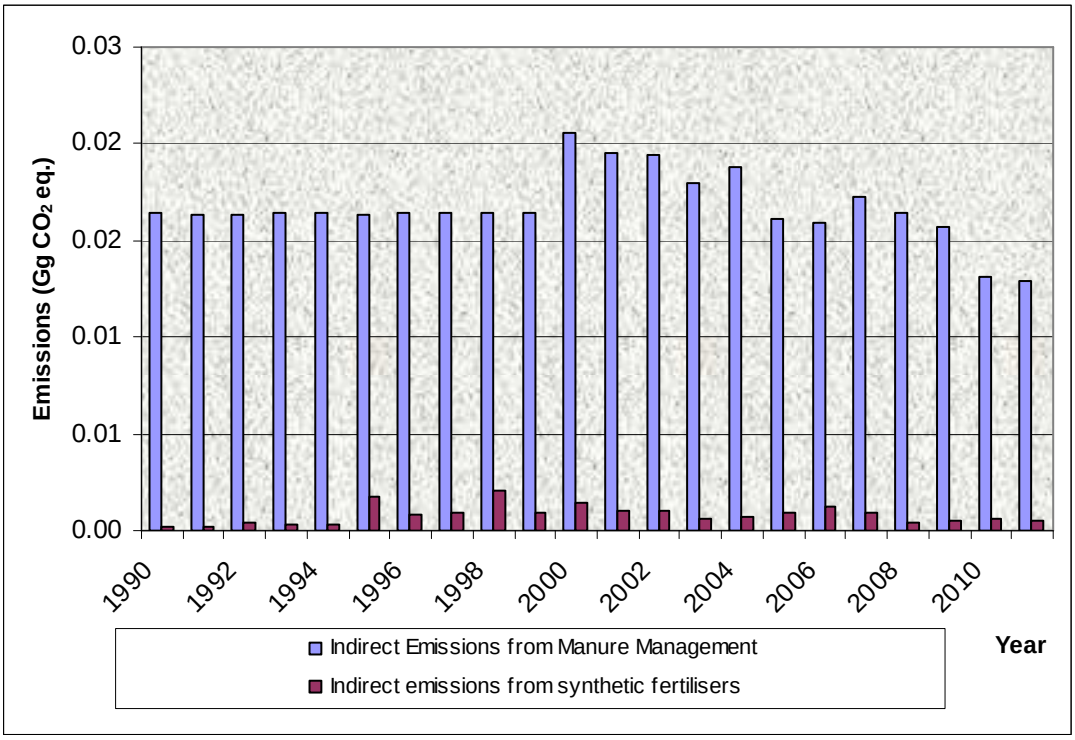

Figure 6-9 Indirect emissions from manure management and agricultural soils

6.5.3.2 Methodological Issues

6.5.3.2.1 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)

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

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, range 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-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 6.3.2.2.

Values for manure applied to soils as estimated in section 6.5.1.2.2. 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.

6.5.3.2.2 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 6.3.2.2. $Frac_{GRASM}$ 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.

6.5.3.2.3 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

No specific recalculations have been carried out.

6.6 Prescribed Burning of Savannas (4E)

This sector does not occur in Malta.

6.7 Field Burning of Agricultural Residues (4F)

This sector does not occur in Malta.

6.8 Other (4G)

This sector does not occur in Malta.

Chapter 7 LULUCF (CRF Sector 5)

7.1 Overview of the Sector

Sector 5 includes carbon stock changes, emissions of GHG (CO_2, CH_4, & N_2O) by sources and removals of CO_2 by sinks from land uses, land use change and forestry activities. The sector in 2011 has a net removal of -59.66Gg CO_2 equivalent.

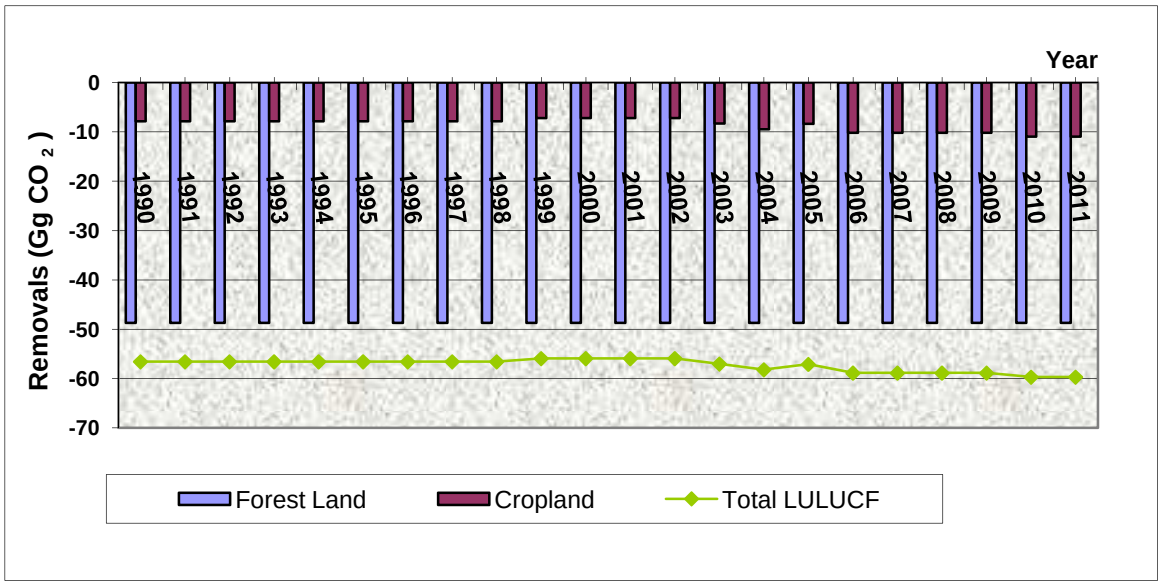

Figure 7-1 LULUCF Carbon Dioxide Removal

Figure 7-1 shows the carbon dioxide removals by vegetation in the LULUCF sector for Malta. A mean figure of -57.25 Gg CO_2 has been estimated to be sequestered annually by Maltese vegetation during the time series 1990 to 2011. Forest land removes 81.60% of CO_2, followed by 18.4% from Cropland. In this year's submission Settlement was not included in the calculation, further details are given in the relevant section.

The Land Use, Land-Use Change and Forestry (LULUCF) sector includes yearly estimates of carbon dioxide emissions and removals by particular vegetation types. Five different types of carbon pools are defined by the IPCC and include Forest Land (5A), Cropland (5B), Grassland (5C), Wetlands (5D) and Settlements (5E).

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). As reported in the National Rural Development Strategy 2007-2013 [21], 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. Therefore, no emissions or removals will be reported for the IPCC source category Grassland (5C). Organic soils are low or non existent in Malta. No long-term data is available to asses whether organic matter in Maltese soils is in fact declining. Baseline data show that 58% of the soils have a soil organic carbon content below the threshold of 2% [58].

In this inventory process, carbon dioxide removals from above ground biomass are being reported for the IPCC source categories Forest Land (5A) and Cropland (5B).

7.2 Forest Land (5A)

7.2.1 Source Category Description

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. It is the major land use sink in the Maltese Islands [54]. No 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. The second stage of the series is the maquis which typically occurs in sheltered areas such as on hillsides and in valleys, and is dominated by a variety of lower trees and large shrubs such as the Olive (*Olea europea*), the Carob (*Ceratonia siliqua*), the Bay laurel (*Laurus nobilis*) and several others [21].

7.2.2 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 landuse and landcover at very high detail, nominally at the 1:1000.

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. CO_2 emissions and removal from forest land remaining forest land have been identified as key category in level and in trend assessment (with LULUCF). In the Maltese context, while CLC information assists with understanding land cover in Malta and montoring 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.

7.2.3 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). The area coverage for shrubland was also available from MEPA's Map Server on-line Geographic Information System (GIS) (a detailed explaination is given in section 7.2.4). The methodologies used as available in the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry have been followed [47].

Table 7-1 summarises the Removal Factors used to estimate the carbon sink from Forest Land in Malta

Table 7-1 Removal Factors used to Estimate Carbon Sink from Forest Land

Factor	Coniferous Wooded Land	Shrubland	Mixed Forest
Volume of growing stock (m^3/ha)		44.8 *	
Above ground biomass default figure (tonnes dry matter / ha / yr)	3.0		4.0
Biomass Expansion Factor (BEF)		1.49 *	
Default carbon fraction of dry matter	0.5	0.5	0.5
Wood Basic Density (tonnes/m^3)		0.63 *	

Removal Factors are default [47]

* Removal Factors as available for Shrubland in the Italian Carbon sink model (personal communication, Italy - Agency for Environmental Protection and Technical Services (APAT), June 2008)

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

Equations 3 and 4 have been used to estimate CO_2 emissions from Shrubland:

(3) Biomass Accumulation (tonnes Carbon) = Size of land (ha) * Volume of growing stock (m3 / ha) * Biomass Expansion Factor * Default carbon fraction of dry matter * Wood basic density (tonnes / m^3)

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

Table 7-1 summarises the Removal Factors used to estimate the carbon sink from Forest Land in Malta. As it was mentioned previously, for this year inventory dead wood, litter and mineral soils for forest area were calculated. For the calculation of the dead wood, 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.

Tier 1 was considered. 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 20yrs. 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.

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

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 [55]. On the other hand the CLC does not provide the data on shrubland as it is not included with forest data. Data collected in CLC for shrubland is collected in one category, sclerophyllous vegetation which includes both the garrigue and the maquis and no percentages for each sub-category are given. Due to this fact data for area coverage by the maquis was taken from another data set which is more accurate. Data for the shrubland was taken from MEPA's Map Server

on-line. The MEPA map server has data on the categories 'woodland trees and shrubs' amounting to 558.36ha and 'maquis' amounting to 264.09ha. From the CLC 1990 and 2006 the area coverage for 'coniferous wooded land' and 'mixed forest' is reported as 209.68ha. By subtracting the CLC 'conferous wooded land' and mixed forest area from the total area as reported in the MEPA's Map Server (822.35ha - 209.68ha = 612.67ha). The resulting 612.67ha will be reported as shrubland for Malta, to include shrubs and macquis vegetation areas.

In forest land remaing forest land biomass burning or controlled burning do not occur in Malta. On the other hand wildfires are not estimated as data is not available so it is reported as NE.

7.2.5 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

7.2.6 Source Specific planned improvements

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 and wildfire data. Moreover will also be included the afforestation projects under otherland converted to forestland. 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 2011, more than 84,180 trees and shrubs have been planted. There were 3000 trees and shrubs planted in 2011. The potential carbon removals from such young plantations are not estimated in this inventory project since the plantations are still in their early development stages and any carbon emissions and/or removals are very difficult to estimate reliably.

7.3 Cropland (5B)

7.3.1 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.

Annual crops are harvested each year, so there is no long-term storage of carbon in biomass. However, 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 1,251.2ha of UAA of which 49.1% was dedicated to vineyards. Fruit and berry plantations, mainly peaches, had a share of 29.7% of total permanent crops, while citrus, olive and nurseries accounted for 8.9%, 11.2% and 1.1% respectively. 1,122.9 ha were utilised for kitchen gardens (including potatoes, vegetables and other). This reflects the high number of small agricultural holders.

A significant feature of Maltese agriculture is that the majority of agricultural holdings in Malta and Gozo are relatively small. It is stated in the Census that 614.1 ha of vineyards were cultivated on 1,258 holdings, of which 70.8 % or 434.6ha, were allocated to the production of grapes for quality wines, while only 76.5 ha were dedicated to table grapes. The majority of vineyards were found in the Northern and Western districts with a total area of 427.9ha, accounting for 69.7 % of the total area under vineyards. 360 holdings had an area dedicated to vineyards of more than 0.5ha each. Together these accounted for 420.4ha, or 68.5% total vineyards.

In this year submission there was no land converted to cropland in year 2011.

7.3.2 Methodological Issues

Cropland includes all annual and perennial crops as well as temporary fallow land; the change in biomass has been estimated only from perennial woody crops, since, for annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year.

The estimates of carbon stocks changes are applied to aboveground biomass only, according to the Good Practice Guidelines (IPCC, 2003), as there is not sufficient information to estimate carbon stocks change in dead organic matter pools. To assess change in carbon in cropland biomass, the Tier 1 based on highly aggregated area estimates for generic perennial woody crops, has been used; therefore default factors of aboveground biomass carbon stock at harvest/maturity cycle, biomass accumulation rate, and biomass carbon loss.

Activity data on perennial crops coverage as available from the 1991 Agriculture Census [22] 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 [23 - 25, 27, 30, 32,57] .

The default Biomass Accumulation Rate (2.1 tonnes carbon/ha/year) for Temperate Climates [47] has been applied to the activity data.

To calculate the dead organic matter and inorganic carbon in Cropland remaining Cropland Tier 1 was applied. Both parameters in Tier 1 are assumed to be zero.

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].

The equation used to calculate carbon stock in mineral soils was;

Annual change in carbon stock in mineral soils= (Soil organic carbon stock in the inventory year, tonnes C ha^{-1}- soil organic carbon stock in the inventory year, tonnes C ha^{-1}) * size of land (ha)/ time period of transition from state. The formula was worked on the whole agricultural land and not on each parcel of land.

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 Other land converted to Cropland in the LULUCF Good Practice Guidance.

7.3.2.1 Other land converted to Cropland

When during the years there was an increase in the Cropland size land area, it is assumed that the conversion came from Other Land converted to Cropland. Only sinks were reported. The assumption was based on the fact that only land from other land is converted to cropland, forestland or settlement. .

7.3.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

7.4 Grassland (5C)

This sector does not occur in Malta.

7.5 Wetlands (5D)

This sector does not occur in Malta.

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. The total area of settlement includes the

green urban areas, continuous urban fabric and the discontinous urban fabric. They all account for 72.2 km^2.

7.6.2 Methodological Issues

In the previous years the area coverage of vegetation in Settlements has been obtained from the Corine Landcover data 1990, 2000 and 2006 as available from the Malta Environment and Planning Authority (MEPA). The default carbon per hectare crown coverage rate (2.9 tonnes carbon/ha crown cover/year) have been applied to the activity data [47]. From the UNFCCC review it was noticed that the calculation that was used in the previous year was not considering the tree crown cover. It was over estimating the Settlement remaining Settlement. To have an estimate for the carbon sink from Settlement remaining Settlement the calculation needs the tree crown cover parameter. The data set used and which is taken from the CORINE landcover 2006, does not have any reference to the tree crown cover in settlement. MEPA was contacted but no data is available on tree crown cover in the Corine Landcover and the calculation cannot be completed. Up till now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the carbon stock changes in living biomass, dead organic matter and soil for this category.

7.6.3 Source Specific Recalculations

Data with regards to carbon sinks for settlement remaining settlement is not available. As it was explained in the previous section the calculation that was used before was not calculating the tree crown cover, it was calculating the green urban areas. Table 7.2 summarises the data for the calculation of the time series from 1990 onwards.

Table 7.2 Recalculations for Settlement remaining Settlement

Year	Previous submission	Current Submission
1990	0.43	NE
1991	0.43	NE
1992	0.43	NE
1993	0.43	NE
1994	0.43	NE
1995	0.43	NE
1996	1.92	NE
1997	1.92	NE
1998	1.92	NE
1999	1.92	NE
2000	1.92	NE
2001	1.92	NE
2002	1.92	NE
2003	1.92	NE
2004	1.92	NE
2005	1.92	NE

2006	1.92	NE
2007	1.92	NE
2008	1.92	NE
2009	1.92	NE
2010	1.92	NE
2011	-	NE

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]

7.7.2 Methodological Issues

The method used was;

Other land = Total Area of the Maltese islands – (Forest land + Cropland + Settlements)

7.7.3 Source Specific Recalculations

Data with regards to Other Land sector was submitted for the first time last year. Table 7.3 shows the recalculation that took place in this sector. There were these recalculations due to the fact that there was a change in the Settlement Sector. As was stated in the sector Settlements, the definition for Settlement (which was taken from the IPCC), included not only the green urban area, but also included the continuous urban fabric and the discontinous urban fabric. Previously, these were included together with Other Land. The change affected the all years.

Table 7-3 Recalculation for Other land

Year	Previous submission	Current Submission
1990	29716.59	22696.19
1991	29716.59	22696.19
1992	29716.59	22696.19
1993	29716.59	22696.19
1994	29716.59	22696.19
1995	29716.59	22696.19
1996	29576.19	22696.19
1997	29576.19	22696.19
1998	29576.19	22696.19
1999	29658.6	22778.6
2000	29658.6	22619.6

2001	29658.6	22619.6
2002	29658.6	22619.6
2003	29516.3	22477.3
2004	29364.8	22325.8
2005	29506.7	22467.7
2006	29274.7	22235.7
2007	29274.7	22235.7
2008	29274.7	22235.7
2009	29274.7	22235.7
2010	29170.7	22131.7
2011	-	22131.7

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 2011 are presented. Emission sources include Solid waste disposal (6A), Wastewater handling (6B), Waste incineration (6C) and Compost production (6D).

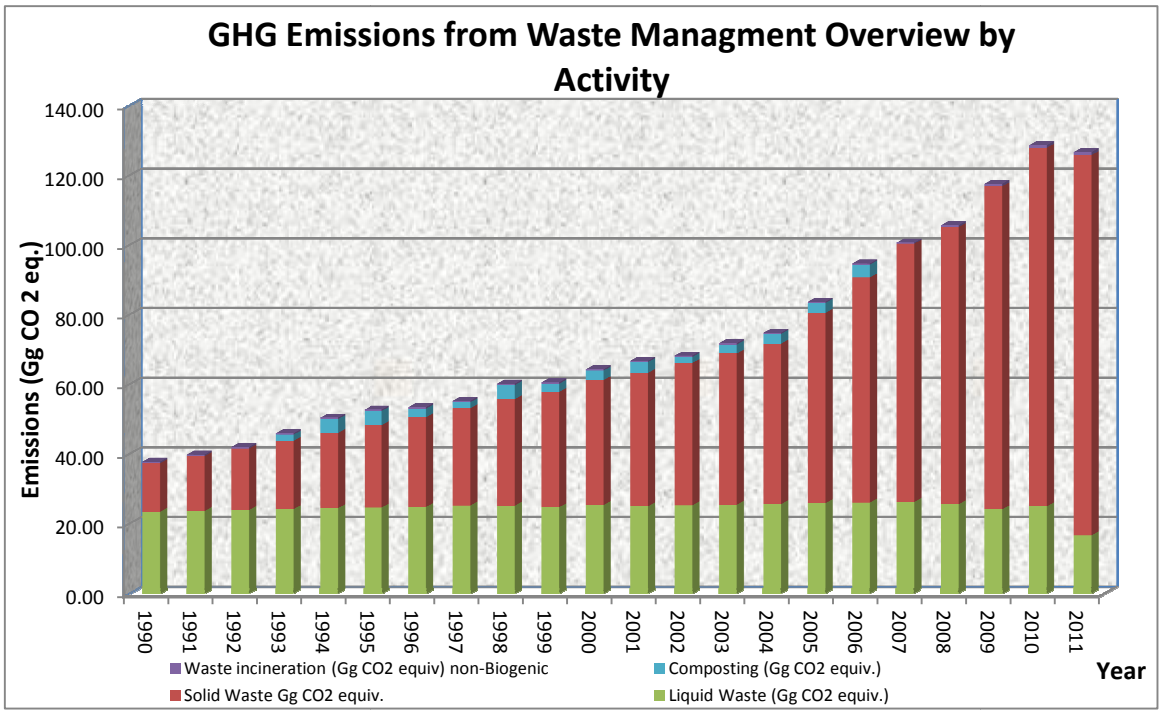

Figure 8-1 Total emissions for waste sector

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 2011. The waste sector contributes 4.2% to the total GHG inventory emissions. Within this sector, the largest portion of emissions for the reporting year 2011 results from the solid waste category (86.12%), followed by the contribution from liquid waste (13.18%) and much less significant contribution resulting from waste incineration (0.70%). Greenhouse gas emissions have increased by 70.2% from 1990 to the year 2000, with a continuation of this trend between the year 2000 and the latest inventory year 2011, with an increase of 96.8%. Trends in the waste sector are expected to remain on the rising side at least until Solid waste disposal on land is reduced to marginal levels or DOC levels in waste being landfilled are further reduced.

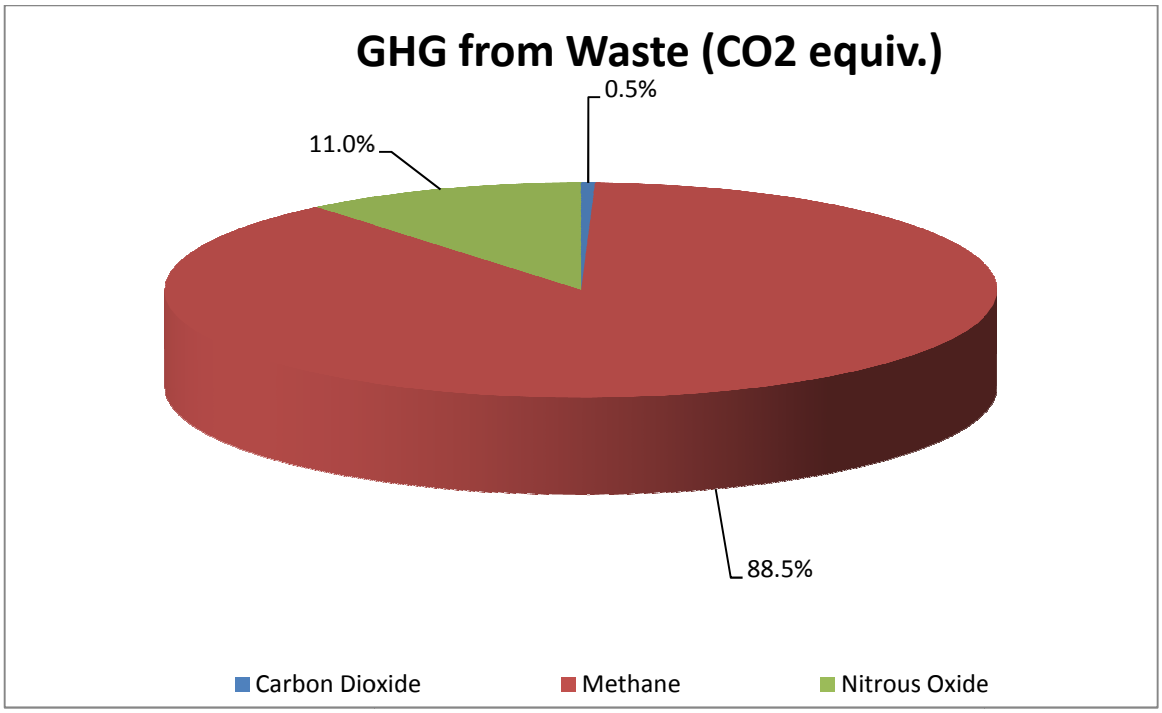

Figure 8-2 GHG from Waste in CO_2 eq.

Figure 8-2 shows the percentage contribution in carbon dioxide equivalents of carbon dioxide, methane and nitrous oxide emissions in the year 2011 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.

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 CH4 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 ladfill 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 prposes. 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. 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.

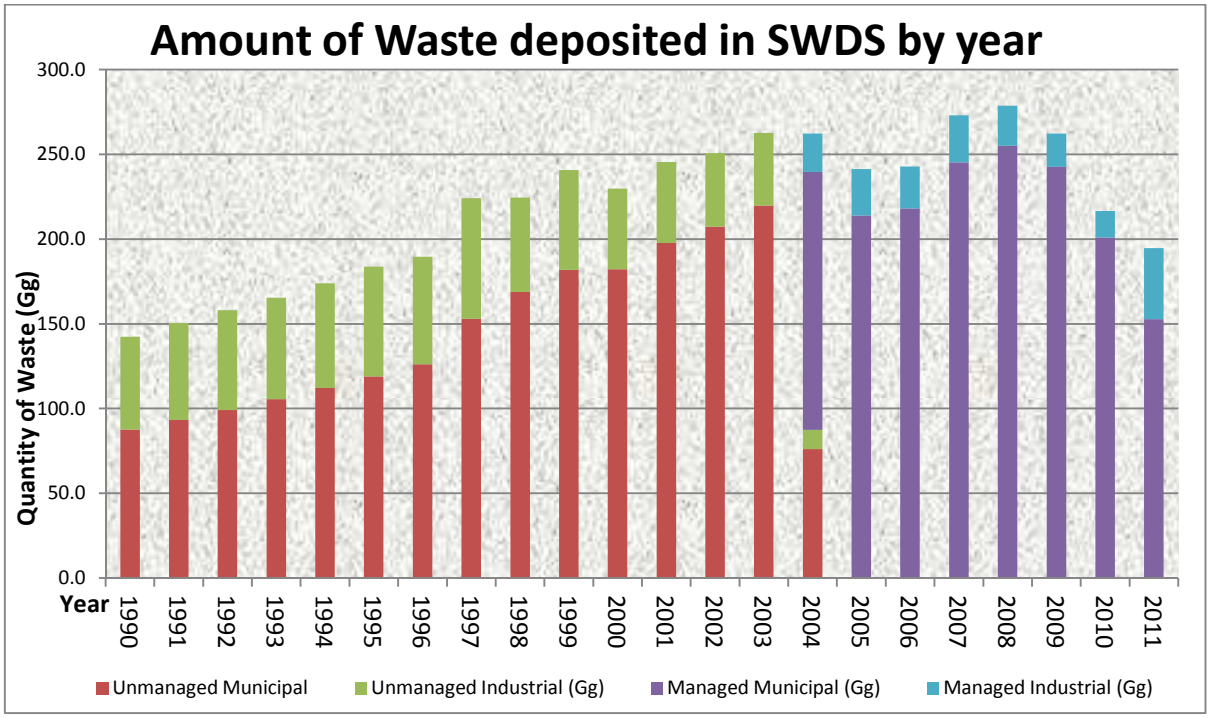

Figure 8-3 Amounts of waste deposited in SWDS by SWDS type

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 8-3 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 8-3 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

The IPCC 2006 [3] Tier 2 First Order Decay (FOD) spreadsheet model has been used to work out methane emissions from the solid waste category. This Tier 2 method uses IPCC 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 the IPCC 2006 [3] 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 [3]. 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.

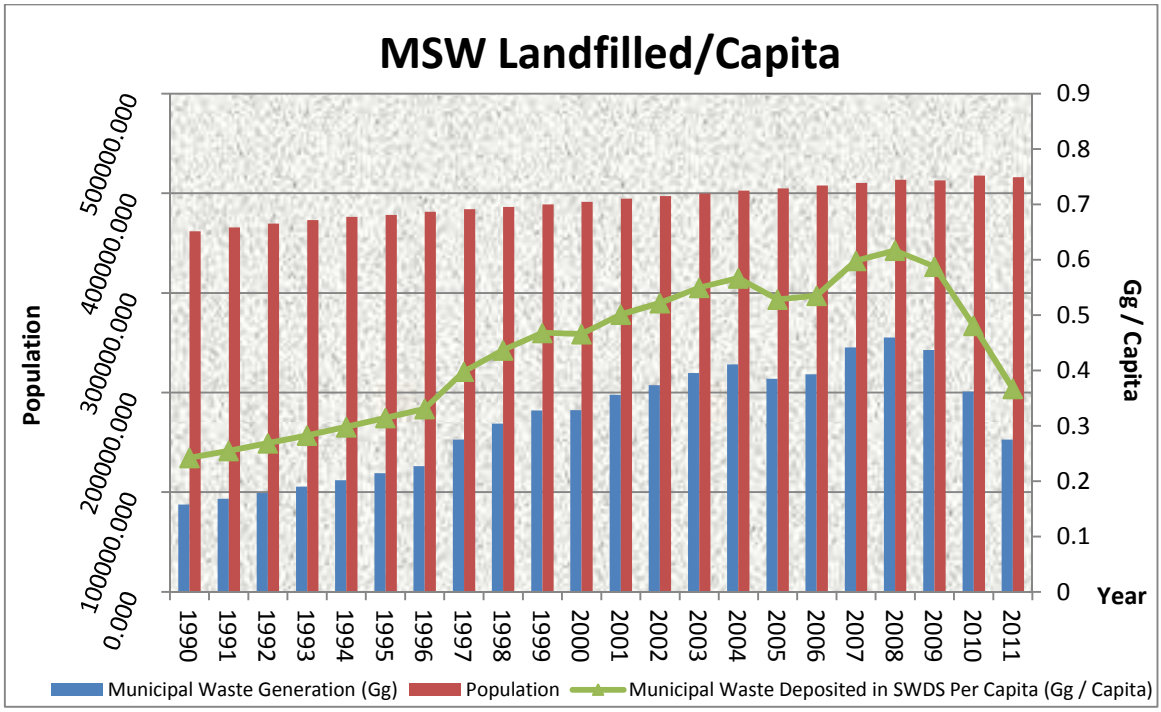

Figure 8-4 Solid waste deposited in SWDSs per capita

The following parameters have been chosen in the IPCC 2006 [3] spreadsheet model:

- Region: Southern Europe
- Climate: Dry Temperate
- Starting Year for Waste Deposition: 1950
- Delay Time for methane emissions to start being generated: 6 months

- % waste going to SWDS – 100%
- Methane Correction Factor (MCF):
  - Unmanaged shallow landfill (1977 – 1987) = 0.4
  - Unmanaged deep landfill (1988 – 2004) = 0.8
  - 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 unmanged waste deposition sites is set to a higher value than that stipulated in the 2006 IPCC 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 Maġtab, which claims that more then 50% of the landfill gas produced is actually treated by the RTO and 90% of the methane treated is actually destroyed.

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 surface gas emissions has been identified. These findings were submitted to Prof. Alfred Vella of the University of Malta, following which an expert judgment was issued by him stating that:

- Oxidation is evidently occurring at the surface of the landfill
- Estimates suggest an oxidation factor of 0.6 would be adequate

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

Municipal waste composition data from waste composition surveys of 2002 and provisional data from 2011[4] used to calculate waste composition. Below Table 8-1 illustrates the results of the two reports mentioned above:

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

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

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 unmanged 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.

Factor	Uncertainty %	
	Managed	Unmanged
DOC	±50%	±50%
DOCf	±30	±30
MCF	±50%	±10
Recovery amount	±10	±10
OX factor	NA	NA
K	±40%	±100%
Total	±87.2%	±116.6%

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

8.2.3 Source Specific Recalculations

Following a shift from bulk waste data to waste composition data use, oxidation factor adjustment, (both imply a major methodological change), the following changes in total emissions from managed and unmanaged SWDSs resulted and are summerised in Table 8-3 and Table 8-4.

Table 8-3 Managed SWDS emissions recalculation

Managed Landfill Gross CH4	Current Submission		Previous submission		% difference
	CH4 Gg	CH4 GgCO2 eq	CH4 Gg	CH4 GgCO2 eq	
1990	0.000	0.000	0.000	0.000	N/A
1991	0.000	0.000	0.000	0.000	N/A
1992	0.000	0.000	0.000	0.000	N/A
1993	0.000	0.000	0.000	0.000	N/A
1994	0.000	0.000	0.000	0.000	N/A
1995	0.000	0.000	0.000	0.000	N/A
1996	0.000	0.000	0.000	0.000	N/A
1997	0.000	0.000	0.000	0.000	N/A
1998	0.000	0.000	0.000	0.000	N/A
1999	0.000	0.000	0.000	0.000	N/A
2000	0.000	0.000	0.000	0.000	N/A
2001	0.000	0.000	0.000	0.000	N/A
2002	0.000	0.000	0.000	0.000	N/A
2003	0.000	0.000	0.000	0.000	N/A
2004	0.000	0.000	0.000	0.000	N/A
2005	0.439	9.221	0.503	10.564	-12.72%
2006	1.020	21.413	1.171	24.595	-12.93%
2007	1.575	33.065	1.812	38.061	-13.13%
2008	2.177	45.709	2.509	52.697	-13.26%
2009	2.762	58.009	3.191	67.007	-13.43%
2010	3.273	68.725	3.788	79.555	-13.61%
2011	3.653	76.716			

Table 8-4 Unmanaged SWDS emissions recalculation

Unmanaged Landfill Gross CH4	Current Submission		Previous submission		% difference
	CH4 Gg	CH4 GgCO2 eq	CH4 Gg	CH4 GgCO2 eq	
1990	0.664	13.943	1.721	36.132	-61.41%
1991	0.752	15.788	1.949	40.923	-61.42%
1992	0.842	17.688	2.184	45.856	-61.43%
1993	0.935	19.633	2.424	50.909	-61.44%
1994	1.029	21.616	2.670	56.067	-61.45%
1995	1.127	23.658	2.923	61.378	-61.46%
1996	1.227	25.775	3.185	66.887	-61.47%
1997	1.329	27.901	3.449	72.428	-61.48%
1998	1.455	30.549	3.778	79.335	-61.49%
1999	1.577	33.107	4.097	86.047	-61.52%
2000	1.707	35.837	4.438	93.208	-61.55%
2001	1.822	38.253	4.741	99.571	-61.58%
2002	1.945	40.842	5.066	106.391	-61.61%
2003	2.067	43.412	5.389	113.173	-61.64%
2004	2.194	46.081	5.725	120.218	-61.67%
2005	2.163	45.432	5.646	118.559	-61.68%
2006	2.058	43.216	5.370	112.777	-61.68%
2007	1.958	41.109	5.108	107.277	-61.68%
2008	1.614	33.904	4.859	102.045	-66.78%
2009	1.655	34.763	4.622	97.068	-64.19%
2010	1.628	34.198	4.397	92.334	-62.96%
2011	1.546	32.456			

The difference is mainly due to the assumed organic fraction in the bulk waste data model which in reality is larger from the actual data on composition obtained and the adjusted oxidation factor used.

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 [3].

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.

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.

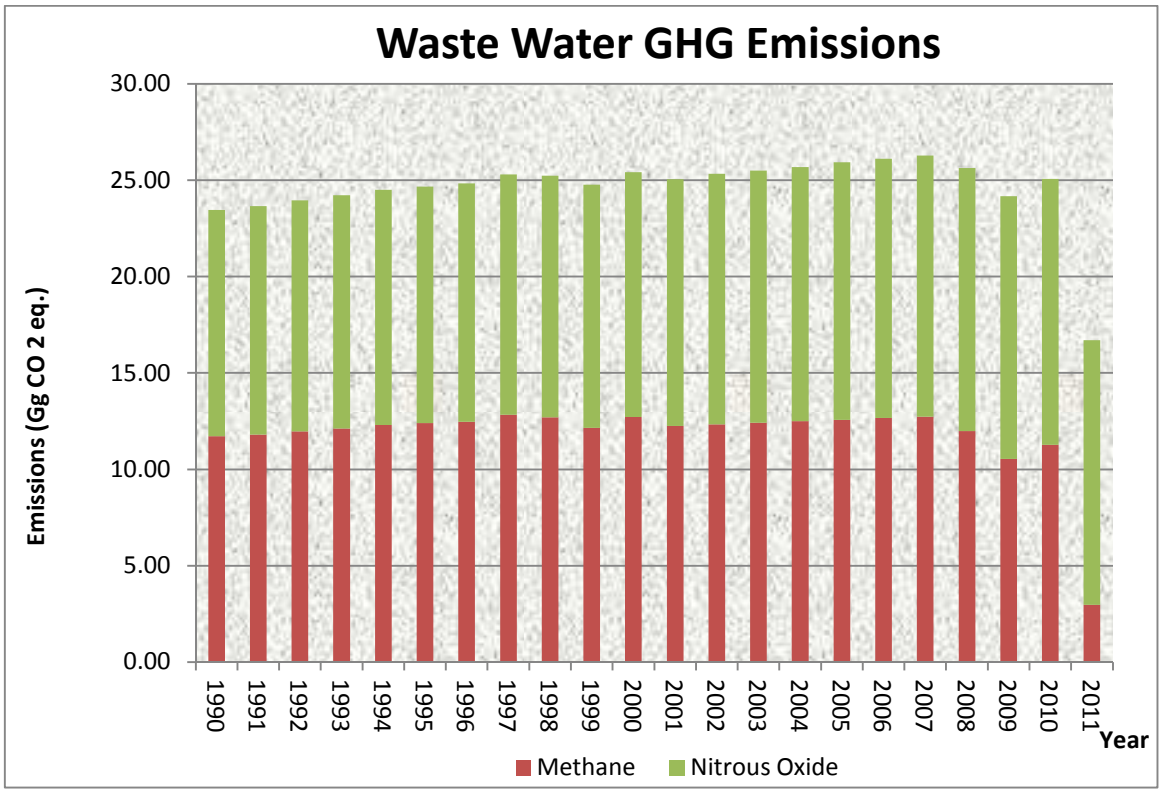

Figure 8-5 Waste water GHG emissions

8.3.2 Methodological Issues

8.3.2.1 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 8-6.

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 x B x C x D) x 44/28 x 10^{-6}
Total					

Figure 8-6 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 [48]
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

8.3.2.2 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.

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 [48]	369 455
Untreated Sewage (m3) [49]	24 787 000
Sant Antnin Sewage Treated (m^3) [49]	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 [48]	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:

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

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

8.3.2.3 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 1.1).

8.3.3 Source Specific Recalculations

Due to the inclusion of FAO data in terms of protein consumption the N_2O emissions were modified from the previous submission. The inclusion of FAO data was suggested by UNFCCC review of the 2010 inventory submission.

Table 8-5 Recalculation of N2O emissions from human sewage

N20 in wastewater	Current Submission		Previous submission		% difference
	N2O Gg	N2O GgCO2 eq	N2O Gg	N2O GgCO2 eq	
1990	0.038	11.737	0.032	10.028	17.04%
1991	0.038	11.863	0.033	10.136	17.04%
1992	0.039	11.982	0.033	10.237	17.04%
1993	0.039	12.102	0.033	10.340	17.04%
1994	0.039	12.208	0.034	10.431	17.04%
1995	0.040	12.272	0.034	10.485	17.04%
1996	0.040	12.370	0.034	10.569	17.04%
1997	0.040	12.460	0.034	10.645	17.04%
1998	0.040	12.532	0.035	10.707	17.04%
1999	0.041	12.608	0.035	10.772	17.04%
2000	0.041	12.694	0.035	10.846	17.04%
2001	0.041	12.799	0.035	10.935	17.04%
2002	0.042	12.998	0.036	11.009	18.07%
2003	0.042	13.082	0.036	11.080	18.07%
2004	0.042	13.174	0.036	11.158	18.07%
2005	0.043	13.366	0.036	11.222	19.10%
2006	0.043	13.458	0.036	11.300	19.10%
2007	0.044	13.540	0.037	11.369	19.10%
2008	0.044	13.650	0.037	11.461	19.10%
2009	0.044	13.628	0.037	11.443	19.10%
2010	0.044	13.781	0.037	11.572	19.10%
2011	0.044	13.730			

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 8-7 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 8-8 includes the indirect emissions from the combustion of municipal, clinical and industrial waste.

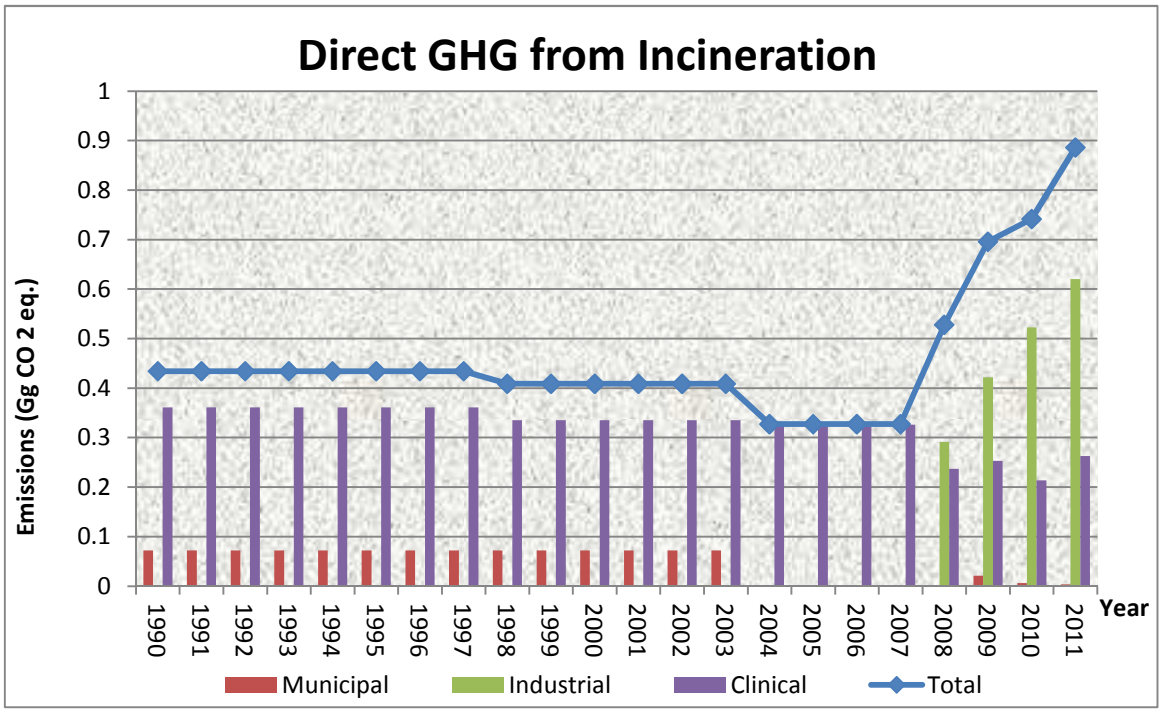

Figure 8-7 Direct GHG emissions from incineration

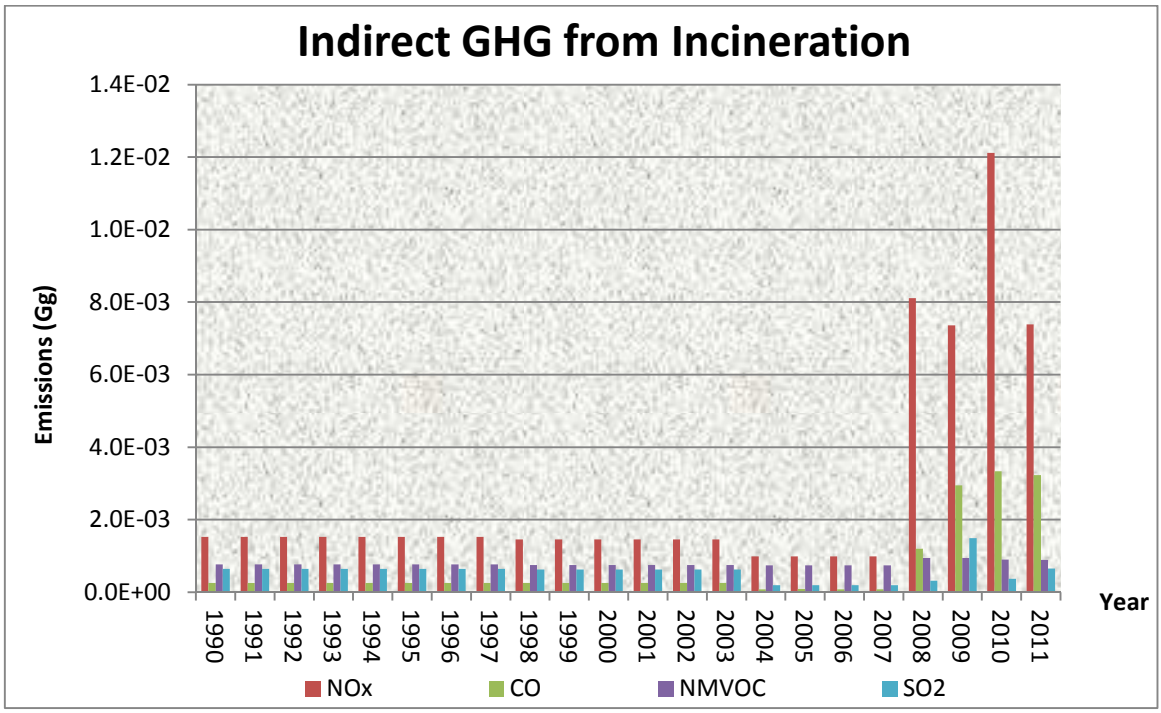

Figure 8-8 Indirect GHG emissions from incineration

8.4.2 Methodological Issues

8.4.2.1 Municipal Waste Incineration

Under this section the following points are to be considered:

- Shipboard kitchen waste reported under Municipal Waste Incineration was previously incinerated at the Malta Shipyards. Shipyard wastes (sediments or paints) were never incinerated.
- Municipal waste incineration is being reported for the years 1990 to 2003, when the incinerator at the Malta Shipyards was operational.
- On average 0.25Gg of waste, 85% of which is considered to be of biogenic origin, used to be incinerated at the shipyards. It is to be noted that the incinerator coped easily with one tonne of waste daily and had no abatement measures fitted.
- For the year 2008, emissions from the incineration of about 0.1tonnes (0.0001Gg) of paper and cardboard, at the Thermal Treatment Facility have been included.
- 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 8-6 for the year 1990.

Table 8-6 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 [3].

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 8-7 illustrated the emission factors used.

Table 8-7 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

8.4.2.2 Clinical Waste Incineration

Two clinical waste incineration facilities existed in the Maltese Islands between 1990 and 2007. During this period, the St Luke's Hospital incinerator provided services for all public and private healthcare institutions on the island of Malta. From a clinical waste survey carried out in 2001 (personal communication, Ministry of Health, 2007) it was found that approximately 1 tonne of clinical waste was produced daily in Malta. In 2006, the St Luke's Hospital incinerator was processing, on average, approximately 910kg of clinical waste per day. No abatement measures were present at the St Luke's Hospital incinerator. The total clinical waste processed by the St Luke's Hospital incinerator in 2006 was estimated at approximately 330 tonnes per year (excluding Gozo).

A second clinical waste incinerator was also operating at the Gozo General Hospital. During the early 1990s, approximately 180kg of contaminated waste per day was incinerated at the Gozo Hospital [50]. 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 [49] 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 8-8 for the year 1990.

Table 8-8 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 8-7 were used.

8.4.2.3 Industrial Waste Incineration

Under this category, incineration of paper waste at a local industrial establishment is reported for the inventory years 1990 to 2007, 99% of which is considered as waste of biogenic origin. As indicated by the operator of this facility, the incinerator was more than three decades old and was of a self-burning configuration, that is, no other fuel was used during the burning process. During the years 1990 to 2007, about 0.066Gg of paper waste 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 8-9 for the year 1990.

Table 8-9 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 [3].

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 8-7 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 [51]. 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.

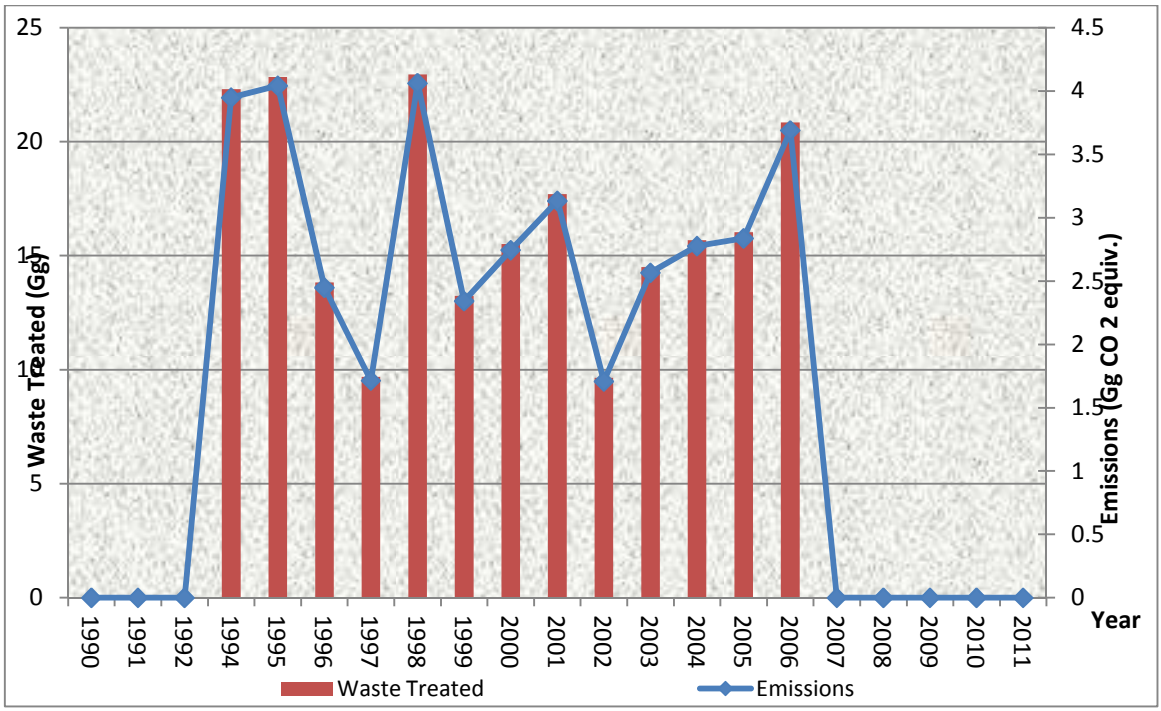

Figure 8-9 Waste treated and emissions from Composting

Figure 8-9 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 (Wasetserv 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 2011 249 toms 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.

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 8.4.

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 8-10 summarises the emission of Biogenic CO_2 from 1990.

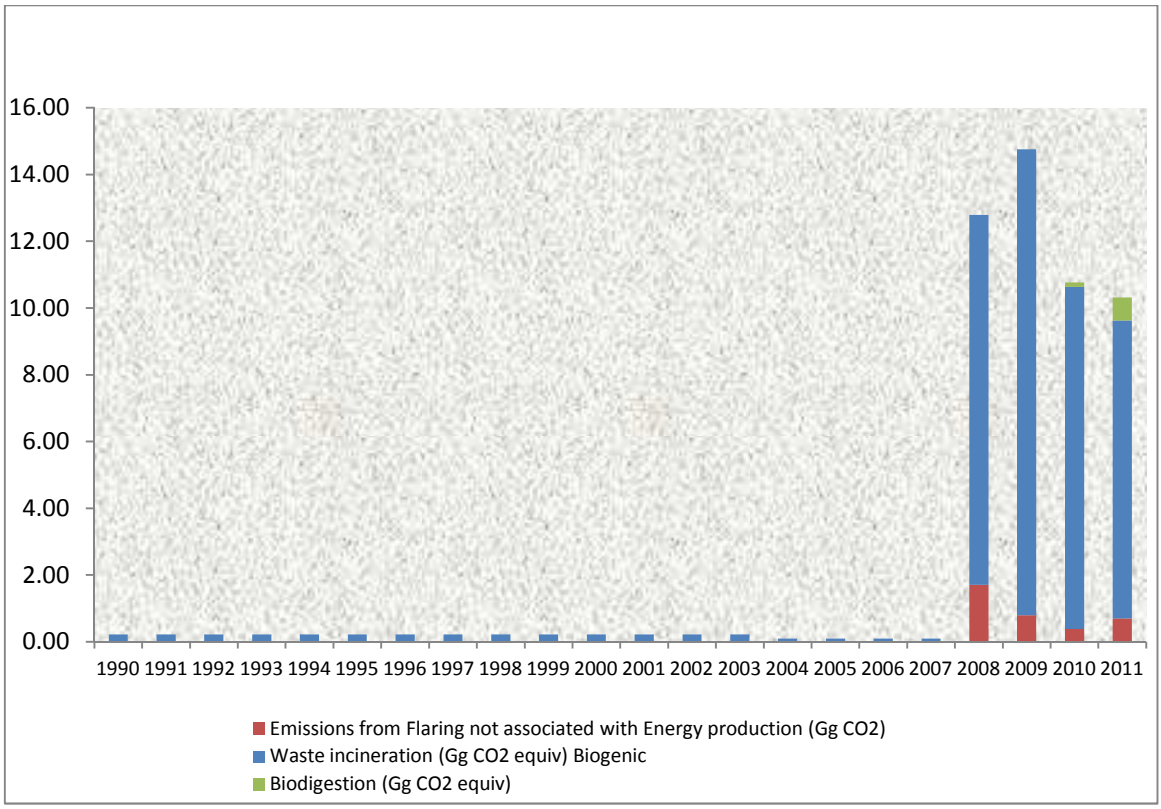

Figure 8-10 CO2 Emissions of biogenic origin from Waste processes

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

8.5.3.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

Chapter 9 OTHER (CRF SECTOR 7)

At present, no greenhouse gas emissions are calculated for Malta which cannot be allocated to one of the existing source categories as described in the previous chapters.

Chapter 10 RECALCULATIONS & 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 methododological 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			
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	√	√	HFC from 2F2 and PFCs from 2F7; NIR page 62 and 67
G. Other			
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils			

E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land			
B. Cropland			
C. Grassland			
D. Wetlands			
E. Settlements	√	√	Settlement was not calculated because there was an overestimation of the tree crown cover (page 102)
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land	√	√	CH_4 refer to page 111 of the NIR
B. Waste-water Handling	√	√	Protein consumption data source changed. Please refer to page 116
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			

Chapter 11 KP-LULUCF

No relevant data to be reported since Malta is not included in annex B of the Kyoto propocol

Chapter 12 Information on accounting of Kyoto Units

No relevant data to be reported since Malta is not included in annex B of the Kyoto propocol.

Chapter 13 Information on changes in national systems

Relevant changes to Registry systems described in Chapter 14, otherwise no relevant changes to report,

Chapter 14 Information on changes in national registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities

to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

(a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;

(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of Malta have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	Malta Resources Authority Millennia Complex 2nd Floor Triq Aldo Moro Marsa MRS 9065 Malta EU Tel: +356 21220619 Fax: +356 22955200 Email: MRA-ClimateChange@office.mra.org.mt

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • **Readiness questionnaire** • **Application logging** • **Change management procedure** • **Disaster recovery** • **Manual Intervention** • **Operational Plan** • **Roles and responsibilities** • **Security Plan** • **Time Validation Plan** • **Version change Management** The documents above are provided as an appendix to this document. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June 2012.**
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012,
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission..

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	The new internet address of the Malta registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/malta/index.xhtml
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations	N/A

Chapter 15 Information on minimization of adverse impacts in accordance with Article3, paragraph 14

No relevant data to be reported since Malta is not included in annex B of the Kyoto propocol.

Chapter 16 Other information

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A1 Annex 1: KEY CATEGORIES

Key sources are source categories which are highlighted in the national inventory, because their emissions have a significant influence on total emissions of direct greenhouse gases.

In Table A1-0-1 and Table A1-0-3 below, only emissions from sources have been evaluated, and storages in sinks have not been considered. In Table A1-0-2 and

Table **A1-0-4** below, emissions storage in sinks have been included, without any consideration for whether the emissions are positive or negative. Key contributors to trend were also identified with and without LULUCF in Table A1-0-5 and Table A1-0-6.

A Tier 1 level approach has been adopted in the key categories calculation. Those source categories responsible for 95% of the total national emissions (as CO_2 equivalent emissions) have been identified as key categories.

Table A1-0-1 Tier 1 Level Assessment with LULUCF: 1990

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	0.35	**0.35**
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	CO2	617.92	617.92	0.30	**0.66**
1A3b	Road Transportation	All fuels	CO2	333.26	333.26	0.16	**0.82**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	61.58	0.03	**0.85**
5A1	Forest Land	Land Coverage	CO2	-48.68	-48.68	0.02	**0.87**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	35.00	0.02	**0.89**
1A4b	Residential	All fuels	CO2	34.55	34.55	0.02	**0.91**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	27.38	0.01	**0.92**
4A1	Cattle	Population Size	CH4	27.07	27.07	0.01	**0.93**
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
4B1	Cattle	Population Size	CH4	11.91	11.91	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
5B1	Cropland	Land Coverage	CO2	-7.86	-7.86	0.00	0.98
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	5.17	5.17	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	0.99
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	1.65	1.65	0.00	1.00
4A3	Sheep	Population Size	CH4	0.78	0.78	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
5E1	Settlements	Land Coverage	CO2	0.00	0.00	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.37	0.00	1.00
4A4	Goats	Population Size	CH4	0.36	0.36	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.36	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
4B3	Sheep	Population Size	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
4B4	Goats	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
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
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 Tier 1 Level Assessment without LULUCF: 1990

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	0.31	**0.67**
1A3b	Road Transportation	All fuels	CO2	333.26	333.26	0.17	**0.84**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	61.58	0.03	**0.87**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	35.00	0.02	**0.89**
1A4b	Residential	All fuels	CO2	34.55	34.55	0.02	**0.91**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	27.38	0.01	**0.92**
4A1	Cattle	Population Size	CH4	27.07	27.07	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
4B1	Cattle	Population Size	CH4	11.91	11.91	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	0.98
1A3d	Navigation	Liquid Fuel	CO2	8.42	8.42	0.00	0.98
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	5.17	5.17	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	0.99
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	1.65	1.65	0.00	1.00
4A3	Sheep	Population Size	CH4	0.78	0.78	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
4A4	Goats	Population Size	CH4	0.36	0.36	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.36	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
4B3	Sheep	Population Size	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
4B4	Goats	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
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 Tier 1 Level Assessment without LULUCF: 2011

IPCC Source Categories		Activity	GHG	Current Year Estimate (Gg CO2 eq.) 2011	Base Year Estimate (Gg CO2 eq.) 1990	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	1793.25	710.73	0.58	**0.58**
1A3b	Road Transportation	All fuels	CO2	498.90	333.26	0.16	**0.74**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	232.88	27.38	0.07	**0.81**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	97.91	0.00	0.03	**0.84**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	79.55	0.00	0.03	**0.87**
1A2	Manufacturing Industries and Construction	All fuels	CO2	72.10	35.00	0.02	**0.89**
1A4a	Commercial/Institutional	All fuels	CO2	66.66	61.58	0.02	**0.91**
1A4b	Residential	All fuels	CO2	51.67	34.55	0.02	**0.93**
1A3d	Navigation	Liquid Fuel	CO2	35.33	8.42	0.01	**0.94**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	32.46	13.94	0.01	**0.95**
4A1	Cattle	Population Size	CH4	22.02	27.07	0.01	0.96
6B	Domestic and Commercial Wastewater	Population Size	CH4	16.38	11.73	0.01	0.96
4B8	Swine	Population Size	CH4	14.82	12.94	0.00	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.57	11.74	0.00	0.97
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	11.51	13.92	0.00	0.98
4B1	Cattle	Population Size	CH4	9.49	11.91	0.00	0.98
1A3b	Road Transportation	All fuels	N2O	7.70	5.07	0.00	0.98
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	5.39	0.00	0.00	0.98
2F8	Electrical Equipment	Emissions per Equipment	SF6	4.81	0.01	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	4.31	1.73	0.00	0.99
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	4.26	5.17	0.00	0.99
2F2	Foam Blowing	Consumption Figures	HFCs	4.23	0.00	0.00	0.99
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	3.34	0.00	0.00	0.99
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	2.90	0.00	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.57	2.00	0.00	0.99
2F3	Fire Extinguishers	Consumption Figures	HFCs	2.51	0.00	0.00	0.99

4B9	Poultry	Population Size	CH4	2.38	3.69	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.29	2.21	0.00	0.99
4A8	Swine	Population Size	CH4	2.22	1.94	0.00	1.00
4A3	Sheep	Population Size	CH4	2.08	0.78	0.00	1.00
4A9	Poultry	Population Size	CH4	2.04	3.15	0.00	1.00
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.00	2.48	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.51	1.65	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	1.46	0.58	0.00	1.00
3D1	Use of N2O for Anaesthesia	Product Use	N2O	1.31	2.48	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.69	0.37	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.67	0.71	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	0.54	0.36	0.00	1.00
4A6	Horses	Population Size	CH4	0.32	0.36	0.00	1.00
1A4b	Residential	All fuels	CH4	0.25	0.06	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.20	0.03	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.20	0.02	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
2B4	Carbide Production	Production Figures	CO2	0.13	0.17	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.12	0.14	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.10	0.00	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.09	0.02	0.00	1.00
1A4b	Residential	All fuels	N2O	0.08	0.02	0.00	1.00
4B3	Sheep	Population Size	CH4	0.07	0.03	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.06	0.03	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.05	0.01	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.03	0.18	0.00	1.00
4B4	Goats	Population Size	CH4	0.02	0.01	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.02	0.05	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.02	0.05	0.00	1.00

1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.02	0.00	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.01	0.00	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	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
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

Table A1-0-4 Tier 1 Level Assessment with LULUCF: 2011

IPCC Source Categories		Activity	GHG	Base Year Estimate (Gg CO2 eq.) 1990	Current Year Estimate (Gg CO2 eq.) 2011	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	1,793.25	0.57	**0.57**
1A3b	Road Transportation	All fuels	CO2	333.26	498.90	0.16	**0.72**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	232.88	0.07	**0.80**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	97.91	0.03	**0.83**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	79.55	0.03	**0.85**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	72.10	0.02	**0.88**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	66.66	0.02	**0.90**
1A4b	Residential	All fuels	CO2	34.55	51.67	0.02	**0.91**
5A1	Forest Land	Land Coverage	CO2	-48.68	-48.68	0.02	**0.93**
1A3d	Navigation	Liquid Fuel	CO2	8.42	35.33	0.01	**0.94**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	13.94	32.46	0.01	**0.95**
4A1	Cattle	Population Size	CH4	27.07	22.02	0.01	0.96
6B	Domestic and Commercial Wastewater	Population Size	CH4	11.73	16.38	0.01	0.96
4B8	Swine	Population Size	CH4	12.94	14.82	0.00	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.74	11.57	0.00	0.97
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	11.51	0.00	0.97
5B1	Cropland	Land Coverage	CO2	-7.86	-10.18	0.00	0.98
4B1	Cattle	Population Size	CH4	11.91	9.49	0.00	0.98
1A3b	Road Transportation	All fuels	N2O	5.07	7.70	0.00	0.98
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	5.39	0.00	0.98
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	4.81	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	4.31	0.00	0.99
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	5.17	4.26	0.00	0.99
2F2	Foam Blowing	Consumption Figures	HFCs	0.00	4.23	0.00	0.99
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	3.34	0.00	0.99
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	2.90	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.00	2.57	0.00	0.99

2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	2.51	0.00	0.99
4B9	Poultry	Population Size	CH4	3.69	2.38	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	2.29	0.00	0.99
4A8	Swine	Population Size	CH4	1.94	2.22	0.00	1.00
4A3	Sheep	Population Size	CH4	0.78	2.08	0.00	1.00
4A9	Poultry	Population Size	CH4	3.15	2.04	0.00	1.00
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.00	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.65	1.51	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	0.58	1.46	0.00	1.00
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	1.31	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.69	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	0.67	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	0.36	0.54	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.32	0.00	1.00
1A4b	Residential	All fuels	CH4	0.06	0.25	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.03	0.20	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.02	0.20	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
2B4	Carbide Production	Production Figures	CO2	0.17	0.13	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.14	0.12	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.00	0.10	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.02	0.09	0.00	1.00
1A4b	Residential	All fuels	N2O	0.02	0.08	0.00	1.00
4B3	Sheep	Population Size	CH4	0.03	0.07	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.03	0.06	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.01	0.05	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.18	0.03	0.00	1.00
4B4	Goats	Population Size	CH4	0.01	0.02	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.05	0.02	0.00	1.00

4B10	Rabbits	Population Size	CH4	0.05	0.02	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.00	0.02	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.00	0.01	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	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
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

Table A1-0-5 Trend assessment with LULUCF

IPCC Source Categories		Activity	GHG	Base Year Estimate (Gg CO2 eq.) 1990	Current Year Estimate (Gg CO2 eq.) 2011	Trend Assesment	Cumulative trend assesment
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	1,793.25	0.52	**0.52**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	232.88	0.15	**0.66**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	97.91	0.08	**0.74**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	79.55	0.06	**0.80**
1A3b	Road Transportation	All fuels	CO2	333.26	498.90	0.03	**0.83**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	66.66	0.02	**0.85**
5A1	Forest Land	Land Coverage	CO2	-48.68	-48.68	0.02	**0.88**
1A3d	Navigation	Liquid Fuel	CO2	8.42	35.33	0.02	**0.89**
4A1	Cattle	Population Size	CH4	27.07	22.02	0.02	**0.91**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	72.10	0.01	**0.92**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	11.51	0.01	**0.93**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	13.94	32.46	0.01	**0.94**
4B1	Cattle	Population Size	CH4	11.91	9.49	0.01	**0.95**
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.74	11.57	0.01	**0.95**
4B8	Swine	Population Size	CH4	12.94	14.82	0.00	0.96
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	5.39	0.00	0.96
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	4.81	0.00	0.96
2F2	Foam Blowing	Consumption Figures	HFCs	0.00	4.23	0.00	0.97
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	5.17	4.26	0.00	0.97
4B9	Poultry	Population Size	CH4	3.69	2.38	0.00	0.97
1A4b	Residential	All fuels	CO2	34.55	51.67	0.00	0.98
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	3.34	0.00	0.98
4A9	Poultry	Population Size	CH4	3.15	2.04	0.00	0.98
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	2.90	0.00	0.98
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	1.31	0.00	0.98
2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	2.51	0.00	0.99
5B1	Cropland	Land Coverage	CO2	-7.86	-10.18	0.00	0.99
6B	Domestic and Commercial Wastewater	Population Size	CH4	11.73	16.38	0.00	0.99

4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.00	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	4.31	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	2.29	0.00	0.99
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.65	1.51	0.00	1.00
4A8	Swine	Population Size	CH4	1.94	2.22	0.00	1.00
4A3	Sheep	Population Size	CH4	0.78	2.08	0.00	1.00
1A3b	Road Transportation	All fuels	CH4	2.00	2.57	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	0.58	1.46	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.07	0.58	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	0.67	0.00	1.00
1A3b	Road Transportation	All fuels	N2O	5.07	7.70	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.18	0.03	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.32	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.02	0.20	0.00	1.00
1A4b	Residential	All fuels	CH4	0.06	0.25	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.03	0.20	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.17	0.13	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
2A6	Road Paving with Asphalt	Product Use	CO2	0.00	0.10	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.69	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.05	0.02	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.05	0.02	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.03	0.00	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.02	0.09	0.00	1.00
1A4b	Residential	All fuels	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
4A4	Goats	Population Size	CH4	0.36	0.54	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.01	0.05	0.00	1.00
4B3	Sheep	Population Size	CH4	0.03	0.07	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.00	0.02	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	0.01	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
4B4	Goats	Population Size	CH4	0.01	0.02	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
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

Table A1-0-6 Trend assessment without LULUCF

IPCC Source Categories		Activity	GHG	Current Year Estimate (Gg CO2 eq.) 2011	Base Year Estimate (Gg CO2 eq.) 1990	Trend Assessment	Cumulative Trend Assessment
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	1793.25	710.73	0.54	**0.54**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	232.88	27.38	0.15	**0.69**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	97.91	0.00	0.08	**0.77**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	79.55	0.00	0.06	**0.83**
1A4a	Commercial/Institutional	All fuels	CO2	66.66	61.58	0.02	**0.86**
1A3b	Road Transportation	All fuels	CO2	498.90	333.26	0.02	**0.88**
1A3d	Navigation	Liquid Fuel	CO2	35.33	8.42	0.02	**0.90**
4A1	Cattle	Population Size	CH4	22.02	27.07	0.02	**0.91**
1A2	Manufacturing Industries and Construction	All fuels	CO2	72.10	35.00	0.01	**0.93**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	11.51	13.92	0.01	**0.94**
4D3.1	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	32.46	13.94	0.01	**0.94**
4B1	Cattle	Population Size	CH4	9.49	11.91	0.01	**0.95**
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.57	11.74	0.01	0.96
4B8	Swine	Population Size	CH4	14.82	12.94	0.00	0.96
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	5.39	0.00	0.00	0.97
2F8	Electrical Equipment	Emissions per Equipment	SF6	4.81	0.01	0.00	0.97
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	4.26	5.17	0.00	0.97
4B9	Poultry	Population Size	CH4	2.38	3.69	0.00	0.98
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	3.34	0.00	0.00	0.98
4A9	Poultry	Population Size	CH4	2.04	3.15	0.00	0.98
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	2.90	0.00	0.00	0.98
1A4b	Residential	All fuels	CO2	51.67	34.55	0.00	0.98
3D1	Use of N2O for Anaesthesia	Product Use	N2O	1.31	2.48	0.00	0.99
2F3	Fire Extinguishers	Consumption Figures	HFCs	2.51	0.00	0.00	0.99
6B	Domestic and Commercial Wastewater	Population Size	CH4	16.38	11.73	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.00	2.48	0.00	0.99

1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	4.31	1.73	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.29	2.21	0.00	0.99
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.51	1.65	0.00	1.00
4A3	Sheep	Population Size	CH4	2.08	0.78	0.00	1.00
4A8	Swine	Population Size	CH4	2.22	1.94	0.00	1.00
1A3b	Road Transportation	All fuels	CH4	2.57	2.00	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	1.46	0.58	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.58	0.07	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.67	0.71	0.00	1.00
1A3b	Road Transportation	All fuels	N2O	7.70	5.07	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.03	0.18	0.00	1.00
4A6	Horses	Population Size	CH4	0.32	0.36	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.20	0.02	0.00	1.00
1A4b	Residential	All fuels	CH4	0.25	0.06	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.20	0.03	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.13	0.17	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
6C	Waste Incineration	Waste Burning	CO2	0.69	0.37	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.10	0.00	0.00	1.00
4A10	Rabbits	Population Size	CH4	0.02	0.05	0.00	1.00
4B10	Rabbits	Population Size	CH4	0.02	0.05	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.09	0.02	0.00	1.00
6C	Waste Incineration	Waste Burning	CH4	0.00	0.03	0.00	1.00
1A4b	Residential	All fuels	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
4A4	Goats	Population Size	CH4	0.54	0.36	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.05	0.01	0.00	1.00
4B3	Sheep	Population Size	CH4	0.07	0.03	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.02	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	0.01	0.00	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	N2O	0.01	0.01	0.00	1.00
4B4	Goats	Population Size	CH4	0.02	0.01	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	4.23	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	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

A2 Annex 2: DETAILED DISCUSSION OF METHODOLOGY AND DATA FOR ESTIMATING CO_2 EMISSIONS FROM FOSSIL FUEL COMBUSTION

Methodology for estimating CO_2 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 CO_2.

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.

A4 Annex 4: COMPARISON OF CO_2 REFERENCE AND SECTORAL APPROACHES

This annex presents information about the Reference Approach calculations, and its comparison with the Sectoral Approach.

A4.1 ESTIMATION OF CO_2 FROM THE REFERENCE APPROACH

Malta's greenhouse gas inventory uses the bottom-up (sectoral) approach based on the combustion of fuels in different sectors and estimates of non-combustion emissions from other known sectors to generate detailed sectoral emissions inventories of the pollutants.

Furthermore, estimates of carbon dioxide emissions using the Reference Approach are also calculated. This is a top down inventory calculated from national oil statistics on imports and stock changes. The assumption taken in this approach is that carbon is transferred from the fuel to CO_2.

This approach was been calculated for the first time in the 2011 submission of the National Inventory. Data on fuel import/export for the year 2009 was collected from the competent Authority (MRA) as mass of fuel by fuel type. The data provided is converted to energy and emission values using IPCC 1996 default methodology and conversion factors (including Emission factors) are used to calculate the CO_2 emissions. Table A4-0-1 illustrates the emission factors and conversion factors used.

Table A4-0-1 Emission factors and conversion factors used in the Reference Approach

Fuel	Energy conversion factor (TJ/Gg)	C content conversion factor (tC/TJ)	% of Carbon oxidised	C to CO_2 conversion factor
Gasoline (petrol)	44.80	18.9	1	3.6667
Diesel/Gasoil	43.33	20.2	1	3.6667
Jet Kerosene (Jet A1)	44.59	19.5	1	3.6667
Kerosene	44.75	19.6	1	3.6667
Heavy fuel oil	40.19	21.1	1	3.6667
LPG/Propane	47.31	17.2	1	3.6667

This exercise is mainly used to have a second estimate of the emissions from fuel consumption.

A5 Annex 5 Assessment of Completeness

Table A5-0-1 Sources and sinks not estimated (NE) Year 2011 Submission 2013

Sources and sinks not estimated (NE)[1]			
GHG	**Sector[2]**	**Source/sink category [2]**	**Explanation**
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
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	Data unavailable
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Details in NIR
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Details in NIR
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	data unavailable.
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	Do not have data and Malta will improve to get the data for the next submission
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	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 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 2013

Sources and sinks not estimated (NE)[1]			
GHG	**Sector[2]**	**Source/sink category [2]**	**Explanation**
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
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	Data unavailable
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Details in NIR
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	data is unavailable
CH4	1 Energy	1.B.2.A.5 Distribution of oil products	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.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	2 Industrial Processes	2.A.2 Lime Production	Data unavailable
CO2	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Do not have data and Malta will to improve to get the data for the next submission
CO2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	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)

The only two installations situated in the territory of Malta falling within the scope of the EU ETS Directive remain the two power electricity generation plants which also account for all emissions under CRF sub-category 1A1a.

Allocation of allowances to these two installations for the first two phases of the scheme (2005-2007; 2008-2012) were notified to, and duly approved by, 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 directly allocated amongst the two installations and 2.288 million allowances were set aside as a new entrants' reserve. No allowances from the new entrants' reserve were subsequently allocated.

Allowances allocated and emissions reported (for which allowances were surrendered) for all the years of the first phase of the EU ETS are presented in Table A4-1.

Table A6-0-1 Annual quantity of allowances allocated to the two installations and reported emissions for the EU ETS trading 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 Phase II amounted to a total of 10.715 million allowances, completely allocated to the two installations. Annual allocations and the emissions reported during this phase are presented in Table A4-2. It is pertinent to note that in 2010, emissions covered by the EU ETS amounted to approximately 66% of total net national greenhouse gas emissions.

Table A6-0-2 Annual quantity of allowances allocated to the two installations and reported emissions for the EU ETS trading 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	1.936
2012	2.159	n/a

A6.2 Use of project credits from Kyoto Protocol Mechanisms

To-date, there has not been any use of credits from the Kyoto Protocol mechanisms (CDM; JI) for compliance reasons in Malta, either by the Maltese Government (no emission accounting commitments to-date) or by local operators within the scope of the EU ETS Directive. In the latter case however, the possibility to use such credits remains, within the constraints set by the Directive and the applicable National Allocation Plan.

In line with its status as Annex I party until 2009, Malta was eligible to host CDM projects that result in the reduction of emissions of greenhouse gases. No such projects were however realized. Subsequent to its change in status to that of Annex I, with, however, the lack of a quantified emission limitation or reduction commitment, it is understood that Malta is not eligible to participate in either CDM or JI projects, until such time as the current conditions of such change in status are changed (i.e. until Malta takes on a quantified emission limitation or reduction commitment).

A7 Annex 7: Tier 1 UNCERTAINTY ESTIMATION

Table A7-0-1 Tier 1 Uncertainty Estimate

A		B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source Category		Gas	Base Year emissions 1990	Year t emissions 2011	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
			CO2 eq. (Gg)	CO2 eq. (Gg)	%	%	%	%	%	%	%	%	%
1A1a	Energy Industries - Gas/Diesel Oil	CO2	27.38	232.88	1	3	3.16E+00	5.83E-02	9.83E-02	1.21E-01	2.95E-01	1.71E-01	1.16E-01
1A1a	Energy Industries - Residual Fuel Oil	CO2	710.73	1793.25	1	3	3.16E+00	3.46E+00	3.46E-01	9.30E-01	1.04E+00	1.31E+00	2.80E+00
1A1a	Energy Industries - bituminous coal	CO2	617.92	0.00	1	3	3.16E+00	0.00E+00	-5.05E-01	0.00E+00	-1.51E+00	0.00E+00	2.30E+00
1A2	Manufacturing Industries and Construction	CO2	35.00	72.10	5	12	1.30E+01	9.44E-02	8.67E-03	3.74E-02	1.04E-01	2.64E-01	8.07E-02
1A3a	Civil Aviation	CO2	0.71	0.67	8	30	3.10E+01	4.69E-05	-2.33E-04	3.49E-04	-6.98E-03	3.95E-03	6.43E-05
1A3b	Road Transportation	CO2	333.26	498.90	5	15	1.58E+01	6.69E+00	-1.46E-02	2.59E-01	-2.18E-01	1.83E+00	3.39E+00
1A3d	Navigation	CO2	8.42	35.33	5	30	3.04E+01	1.24E-01	1.14E-02	1.83E-02	3.42E-01	1.30E-01	1.34E-01
1A4a	Commercial/Institutional	CO2	61.58	66.66	5	12	1.30E+01	8.07E-02	-1.59E-02	3.46E-02	-1.91E-01	2.44E-01	9.62E-02
1A4b	Residential	CO2	34.55	51.67	5	12	1.30E+01	4.85E-02	-1.54E-03	2.68E-02	-1.85E-02	1.89E-01	3.62E-02
1A4c	Agriculture/Forestry/Fisheries	CO2	0.00	5.39	5	12	1.30E+01	5.28E-04	2.79E-03	2.79E-03	3.35E-02	1.98E-02	1.52E-03
2A4	Soda Ash Use	CO2	0.18	0.03	15	15	2.12E+01	4.16E-08	-1.34E-04	1.52E-05	-2.01E-03	3.23E-04	4.14E-06
2A6	Road Paving with Asphalt	CO2	0.00	0.10	15	15	2.12E+01	4.66E-07	5.06E-05	5.09E-05	7.59E-04	1.08E-03	1.74E-06
2B4	Carbide Production	CO2	0.17	0.13	15	15	2.12E+01	8.03E-07	-7.16E-05	6.68E-05	-1.07E-03	1.42E-03	3.16E-06
5A1	Forest Land Remaining Forest Land	CO2	-48.68	-48.68	18	50	5.31E+01	7.19E-01	1.47E-02	-2.52E-02	7.34E-01	-6.42E-01	9.51E-01
5B1	Cropland Remaining Cropland	CO2	-7.86	-10.18	5	50	5.02E+01	2.81E-02	1.17E-03	-5.28E-03	5.83E-02	-3.73E-02	4.80E-03

5E1	Settlements Remaining Settlements	CO2	0.00	0.00	18	50	5.31E+01	0.00E+00	-3.53E-04	0.00E+00	-1.76E-02	0.00E+00	3.11E-04
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	-3.03E-04	0.00E+00	-1.52E-02	0.00E+00	2.30E-04
TOTAL		**CO2**	**1774.16**	**2698.25**				**3.36E+00**					

1A1a	Energy Industries - Gas/Diesel Oil	CH4	0.02	0.20	1	3	3.16E+00	4.22E-08	8.34E-05	1.03E-04	2.50E-04	1.45E-04	8.37E-08
1A1a	Energy Industries - Residual Fuel Oil	CH4	0.58	1.46	1	3	3.16E+00	2.29E-06	2.78E-04	7.57E-04	8.33E-04	1.07E-03	1.84E-06
1A1a	Energy Industries - bituminous coal	CH4	0.14	0.00	1	3	3.16E+00	0.00E+00	-1.12E-04	0.00E+00	-3.37E-04	0.00E+00	1.14E-07
1A2	Manufacturing Industries and Construction	CH4	0.03	0.06	5	12	1.30E+01	6.43E-08	7.22E-06	3.08E-05	8.67E-05	2.18E-04	5.51E-08
1A3a	Civil Aviation	CH4	0.00	0.00	8	30	3.10E+01	1.02E-12	-3.52E-08	5.15E-08	-1.06E-06	5.83E-07	1.46E-12
1A3b	Road Transportation	CH4	2.00	2.57	5	15	1.58E+01	1.77E-04	-3.09E-04	1.33E-03	-4.63E-03	9.40E-03	1.10E-04
1A3d	Navigation	CH4	0.01	0.05	5	30	3.04E+01	2.50E-07	1.62E-05	2.60E-05	4.86E-04	1.84E-04	2.70E-07
1A4a	Commercial/Institutional	CH4	0.17	0.16	5	12	1.30E+01	4.59E-07	-5.57E-05	8.24E-05	-6.68E-04	5.83E-04	7.86E-07
1A4b	Residential	CH4	0.06	0.25	5	12	1.30E+01	1.17E-06	8.15E-05	1.31E-04	9.78E-04	9.29E-04	1.82E-06
1A4c	Agriculture/Forestry/Fisheries	CH4	0.00	0.02	5	12	1.30E+01	4.22E-09	7.90E-06	7.90E-06	9.49E-05	5.59E-05	1.21E-08
4A1	Cattle	CH4	27.07	22.02	5	15	1.58E+01	1.30E-02	-1.08E-02	1.14E-02	-1.62E-01	8.07E-02	3.26E-02
4A3	Sheep	CH4	0.78	2.08	5	15	1.58E+01	1.16E-04	4.41E-04	1.08E-03	6.62E-03	7.62E-03	1.02E-04
4A4	Goats	CH4	0.36	0.54	5	15	1.58E+01	7.73E-06	-1.70E-05	2.78E-04	-2.55E-04	1.97E-03	3.93E-06
4A6	Horses	CH4	0.36	0.32	5	15	1.58E+01	2.79E-06	-1.25E-04	1.67E-04	-1.88E-03	1.18E-03	4.93E-06
4A8	Swine	CH4	1.94	2.22	5	15	1.58E+01	1.33E-04	-4.38E-04	1.15E-03	-6.58E-03	8.15E-03	1.10E-04
4A9	Poultry	CH4	3.15	2.04	5	15	1.58E+01	1.12E-04	-1.53E-03	1.06E-03	-2.29E-02	7.47E-03	5.80E-04
4A10	Rabbits	CH4	0.05	0.02	5	15	1.58E+01	8.51E-09	-3.10E-05	9.23E-06	-4.65E-04	6.52E-05	2.21E-07
4B1	Cattle	CH4	11.91	9.49	5	15	1.58E+01	2.42E-03	-4.85E-03	4.92E-03	-7.27E-02	3.48E-02	6.50E-03
4B3	Sheep	CH4	0.03	0.07	5	15	1.58E+01	1.42E-07	1.54E-05	3.77E-05	2.32E-04	2.67E-04	1.25E-07
4B4	Goats	CH4	0.01	0.02	5	15	1.58E+01	1.00E-08	-6.13E-07	1.00E-05	-9.20E-06	7.08E-05	5.10E-09
4B6	Horses	CH4	0.04	0.04	5	15	1.58E+01	3.73E-08	-1.45E-05	1.93E-05	-2.17E-04	1.37E-04	6.59E-08
4B8	Swine	CH4	12.94	14.82	5	15	1.58E+01	5.90E-03	-2.92E-03	7.68E-03	-4.38E-02	5.43E-02	4.87E-03
4B9	Poultry	CH4	3.69	2.38	5	15	1.58E+01	1.53E-04	-1.79E-03	1.24E-03	-2.68E-02	8.74E-03	7.94E-04

4B10	Rabbits	CH4	0.05	0.02	5	15	1.58E+01	8.51E-09	-3.10E-05	9.23E-06	-4.65E-04	6.52E-05	2.21E-07
6A1	Managed Waste Disposal on Land	CH4	0.00	79.55	10	87	8.78E+01	5.24E+00	4.12E-02	4.12E-02	3.60E+00	5.83E-01	1.33E+01
6A2	UnManaged Waste Disposal on Land	CH4	13.94	32.46	10	117	1.17E+02	1.55E+00	5.39E-03	1.68E-02	6.29E-01	2.38E-01	4.52E-01
6B	Domestic and Commercial Wastewater	CH4	13.94	16.38	5	70	7.02E+01	1.42E-01	-2.94E-03	8.49E-03	-2.06E-01	6.00E-02	4.59E-02
6C	Waste Incineration	CH4	11.73	0.00	15	15	2.12E+01	3.55E-14	-9.61E-03	1.40E-08	-1.44E-01	2.98E-07	2.08E-02
TOTAL		**CH4**	**104.99**	**189.23**				**2.64E+00**					

1A1a	Energy Industries - Gas/Diesel Oil	N2O	0.07	0.58	1	3	3.16E+00	3.67E-07	2.46E-04	3.03E-04	7.39E-04	4.29E-04	7.29E-07
1A1a	Energy Industries - Residual Fuel Oil	N2O	1.73	4.31	1	3	3.16E+00	2.00E-05	8.20E-04	2.23E-03	2.46E-03	3.16E-03	1.60E-05
1A1a	Energy Industries - bituminous coal	N2O	3.04	0.00	1	3	3.16E+00	0.00E+00	-2.49E-03	0.00E+00	-7.47E-03	0.00E+00	5.58E-05
1A2	Manufacturing Industries and Construction	N2O	0.08	0.17	5	12	1.30E+01	5.52E-07	2.14E-05	9.04E-05	2.57E-04	6.39E-04	4.75E-07
1A3a	Civil Aviation	N2O	0.01	0.01	8	30	3.10E+01	3.57E-09	-2.08E-06	3.04E-06	-6.24E-05	3.44E-05	5.08E-09
1A3b	Road Transportation	N2O	5.07	7.70	5	15	1.58E+01	1.59E-03	-1.67E-04	3.99E-03	-2.50E-03	2.82E-02	8.02E-04
1A3d	Navigation	N2O	0.02	0.09	5	30	3.04E+01	7.83E-07	2.87E-05	4.60E-05	8.60E-04	3.25E-04	8.46E-07
1A4a	Commercial/Institutional	N2O	0.14	0.12	5	12	1.30E+01	2.47E-07	-5.63E-05	6.05E-05	-6.76E-04	4.28E-04	6.39E-07
1A4b	Residential	N2O	0.02	0.08	5	12	1.30E+01	1.12E-07	2.24E-05	4.08E-05	2.68E-04	2.88E-04	1.55E-07
1A4c	Agriculture/Forestry/Fisheries	N2O	0.00	0.01	5	12	1.30E+01	3.31E-09	7.00E-06	7.00E-06	8.40E-05	4.95E-05	9.51E-09
3D1	Use of N2O for Anaesthesia	N2O	2.48	1.31	2	2	2.83E+00	1.47E-06	-1.36E-03	6.79E-04	-2.72E-03	1.92E-03	1.11E-05
4B12	Liquid Systems	N2O	2.21	2.29	5	15	1.58E+01	1.41E-04	-6.22E-04	1.19E-03	-9.34E-03	8.41E-03	1.58E-04
4B13	Solid Storage and Dry Lot	N2O	2.48	2.00	5	15	1.58E+01	1.08E-04	-9.94E-04	1.04E-03	-1.49E-02	7.35E-03	2.76E-04
4D1	Direct Soil Emissions	N2O	13.92	11.51	5	15	1.58E+01	3.56E-03	-5.45E-03	5.97E-03	-8.17E-02	4.22E-02	8.46E-03
4D3.1	Indirect emissions Atmospheric Deposition	N2O	5.17	4.26	5	15	1.58E+01	4.88E-04	-2.03E-03	2.21E-03	-3.04E-02	1.56E-02	1.17E-03
4D3.2	Indirect emissions Nitrogen Leaching and run - off	N2O	1.65	1.51	5	15	1.58E+01	6.10E-05	-5.73E-04	7.81E-04	-8.60E-03	5.52E-03	1.05E-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	11.57	15	15	2.12E+01	6.47E-03	-3.62E-03	6.00E-03	-5.44E-02	1.27E-01	1.91E-02
TOTAL		**N2O**	**49.84**	**47.53**				**1.12E-01**					

2F1	Refrigeration & Air Conditioning Equipment	HFCs	0.00	97.91	50	50	7.07E+01	5.15E+00	5.08E-02	5.08E-02	2.54E+00	3.59E+00	1.93E+01
2F2	Foam Blowing	HFCs	0.00	4.23	40	40	5.66E+01	6.16E-03	2.19E-03	2.19E-03	8.78E-02	1.24E-01	2.31E-02
2F3	Fire Extinguishers	HFCs	0.00	2.51	5	5	7.07E+00	3.38E-05	1.30E-03	1.30E-03	6.51E-03	9.20E-03	1.27E-04
2F4	Metered Dose Inhalers	HFCs	0.00	2.90	5	5	7.07E+00	4.51E-05	1.50E-03	1.50E-03	7.51E-03	1.06E-02	1.69E-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	3.34	5	5	7.07E+00	5.98E-05	1.73E-03	1.73E-03	8.65E-03	1.22E-02	2.24E-04
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	4.81	2	10	1.02E+01	2.58E-04	2.48E-03	2.49E-03	2.48E-02	7.05E-03	6.66E-04
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**	**115.70**				**2.27E+00**					

TOTAL EMISSIONS		**1929.01**	**3050.71**			**43.13**
TOTAL UNCERTAINTIES			Overall uncertainty in the Inventory (%)	4.84	Trend uncertainty (%)	6.57

A8 ANNEX 8: SEF TABLES AND RELEVANT DATA

Malta not being an Annex B country and not operating a Kyoto registry, does not generate trade or surrender Kyoto units thus it is not considered relevant for Malta to compile SEF tables.