National Annual Greenhouse Gas Emissions Report for Malta

2012

Submission under the United Nations Framework Convention on Climate Change

MALTA RESOURCES AUTHORITY

Report prepared by the Climate Change and Policy Unit
Malta Resources Authority
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Preface

This is a revision of Malta's National Inventory Report (NIR) submitted in May 2012 to the United Nations Framework Convention on Climate Change. It contains national greenhouse gas emission estimates for the period 1990-2010, 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 second National Inventory Report (NIR) being submitted under the capacity of an Annex I party.

ES.1.2 Background information on greenhouse gas inventories

This is Malta's National Inventory Report (NIR) being submitted in May 2012. It contains GHG emissions estimates for the period 1990 to 2010, 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 3,035.08Gg CO_2 eq in 2010, an increase of 49.08% compared to 1990.

CO_2 is the largest contributor to national emissions with 88.8% share of total gross emissions in 2010; this is the case throughout the time series. CH_4 is the second highest emitted greenhouse gas representing a share of 8.3%, with lesser shares for the fluorinated gases and N_2O at 3.3% and 1.6% respectively.

Looking at the whole time series (1990-2010) 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 1990-2010 (Gg CO_2 Equivalent).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (Net)	1802.08	1976.46	2081.53	2077.18	2189.76	2154.53	2206.75	2196.83	2200.19	2290.27	2287.36
CO_2 (Gross)	1859.05	2033.43	2138.49	2134.15	2246.73	2211.50	2265.22	2255.30	2258.65	2348.10	2345.20
CH_4	121.30	124.54	130.72	137.66	143.72	150.87	156.58	163.70	169.62	175.02	191.05
N_2O	48.05	48.51	49.75	50.90	52.36	57.33	53.14	53.60	59.38	54.65	59.16
HFCs	7.50	8.91	10.59	12.58	14.95	17.76	21.10	25.07	29.79	35.40	5.52
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
SF_6	0.01	0.01	1.50	1.50	1.50	1.51	1.52	1.52	1.54	1.54	1.54
Total Net Emissions	1978.94	2158.43	2274.08	2279.81	2402.29	2381.99	2439.09	2440.72	2460.52	2556.87	2544.64
Total Gross Emissions	2035.91	2215.40	2331.05	2336.78	2459.25	2438.96	2497.56	2499.18	2518.98	2614.70	2602.47

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change
CO_2 (Net)	2407.04	2426.99	2604.77	2558.52	2644.96	2610.11	2695.98	2654.69	2567.58	2578.93	43.11%
CO_2 (Gross)	2464.87	2484.82	2663.70	2618.61	2703.96	2670.90	2756.77	2715.48	2628.35	2640.51	42.04%
CH_4	190.55	196.22	200.32	210.75	218.10	225.25	234.01	237.16	242.49	247.58	104.10%
N_2O	56.81	56.20	53.46	54.47	54.52	55.97	54.97	51.17	50.03	47.72	-0.68%
HFCs	10.50	19.89	28.35	44.21	48.72	65.06	78.65	88.37	93.74	97.50	1200%
PFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA, NO
SF_6	1.56	1.57	2.16	1.62	1.64	1.65	1.66	1.83	1.57	1.78	15881.30%
Total Net Emissions	2666.46	2700.87	2889.06	2869.56	2967.93	2958.04	3065.27	3033.23	2955.40	2973.50	50.26%
Total Gross Emissions	2724.29	2758.70	2947.98	2929.66	3026.93	3018.84	3126.06	3094.01	3016.18	3035.08	49.08%

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 87.5% of the gross national emissions. Within this sector the energy industries (power plants) account for the majority of the emissions (71.3 %) and this has increased by 38.6% between 1990 and 2010. 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 21.7% of the energy sector emissions, and representing an increase of around 65.2% over the time series covered by this report. The other energy sub sectors together make up the remainder of this sector's emissions.

The waste sector has the second largest share of the total GHG inventory emissions (6.6%), with the largest portion of emissions for the reporting year 2010 resulting from the Solid Waste Disposal on Land category (86.2%), followed by liquid waste (13.4%). The overall trend in this sector for the whole time series is one of continued increase in emissions (+200%).

Agriculture in Malta is estimated to contribute around 2.6% of total national GHG emissions for 2010. Emissions within the Industrial Processes sector account for 3.3% for 2010. 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 2010 it accounted for less than 0.04% of total emissions. The sector has also seen a decrease of 48% over the whole time series.

The Land Use, Land-Use Change and Forestry (LULUCF) sector includes yearly estimates of carbon dioxide emissions and removals by particular vegetation types. In 2010 was 61.58Gg of CO_2 removals were estimated, accounting for a net removal equivalent to 2.0% of the total emissions for 2010.

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	1871.28	2046.37	2152.48	2148.46	2261.26	2224.25	2278.50	2268.52
2. Industrial Processes	7.85	9.50	12.27	14.31	16.97	21.02	24.16	28.34
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	-56.97	-56.97	-56.97	-56.97	-56.97	-56.97	-58.46	-58.46
6. Waste	66.49	71.51	76.85	83.99	91.74	97.38	101.48	106.99
Total (net emissions)	1978.94	2158.43	2274.08	2279.81	2402.29	2381.99	2439.09	2440.72

Source Category	1998	1999	2000	2001	2002	2003	2004	2005
1. Energy	2272.58	2363.18	2360.38	2480.55	2500.62	2680.20	2634.45	2720.23
2. Industrial Processes	32.48	37.34	7.36	12.47	21.82	30.73	46.25	50.79
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	-58.46	-57.83	-57.83	-57.83	-57.83	-58.93	-60.09	-59.00
6. Waste	116.05	120.19	128.78	130.18	135.76	143.57	150.94	160.07
Total (net emissions)	2460.52	2556.87	2544.64	2666.46	2700.87	2889.06	2869.56	2967.93

Source Category	2006	2007	2008	2009	2010
1. Energy	2686.98	2773.43	2732.03	2644.66	2657.16
2. Industrial Processes	67.10	80.61	90.38	95.56	99.52
3. Solvents and Other Product Use	2.03	2.71	2.10	1.60	1.29
4. Agriculture	93.36	95.23	86.45	83.26	77.66
5. LULUCF	-60.79	-60.79	-60.79	-60.78	-61.58
6. Waste	169.36	174.08	183.04	191.09	199.45
Total (net emissions)	2958.04	3065.27	3033.23	2955.40	2973.50

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	6.02	6.36	6.71	7.02	7.25	7.40	7.71	7.93	7.61	7.56	3.14
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
NO_x	9.11	9.22	9.47	9.05	9.58	8.96	9.45	9.26	9.00	9.06
CO	29.01	28.53	28.41	27.88	28.62	28.46	29.67	29.79	30.97	31.60
NMVOC	3.19	3.09	2.85	2.92	3.50	3.66	3.54	3.22	2.92	3.40
SO_2	26.07	25.34	27.53	11.96	12.31	12.38	12.76	11.68	8.27	7.76

Contacts

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Chapter 1 INTRODUCTION

This is a revision of Malta's National Inventory Report (NIR) submitted in May 2012 to the United Nations Framework Convention on Climate Change

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 316km^2. The climate is typically Mediterranean with moist, mild winters and dry, hot summers.

Population size between 1990 and 2010 has grown from 361,908 to 417,608 [4]. Gross Domestic Product (GDP) has increased from €2.44 billion in 1990 [5] to €6.24 billion in 2010 [6]. 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 to date. 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 2010, 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 1990-2010, 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 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 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 (monitoring year 2008). As of 2011 (monitoring year 2009) 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.

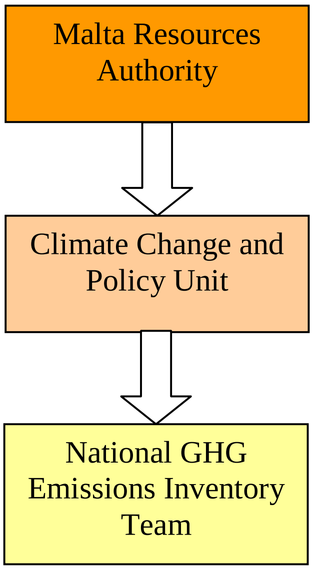

Figure 1-1 Institutional Arrangements for Inventory Preparation in Malta

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.

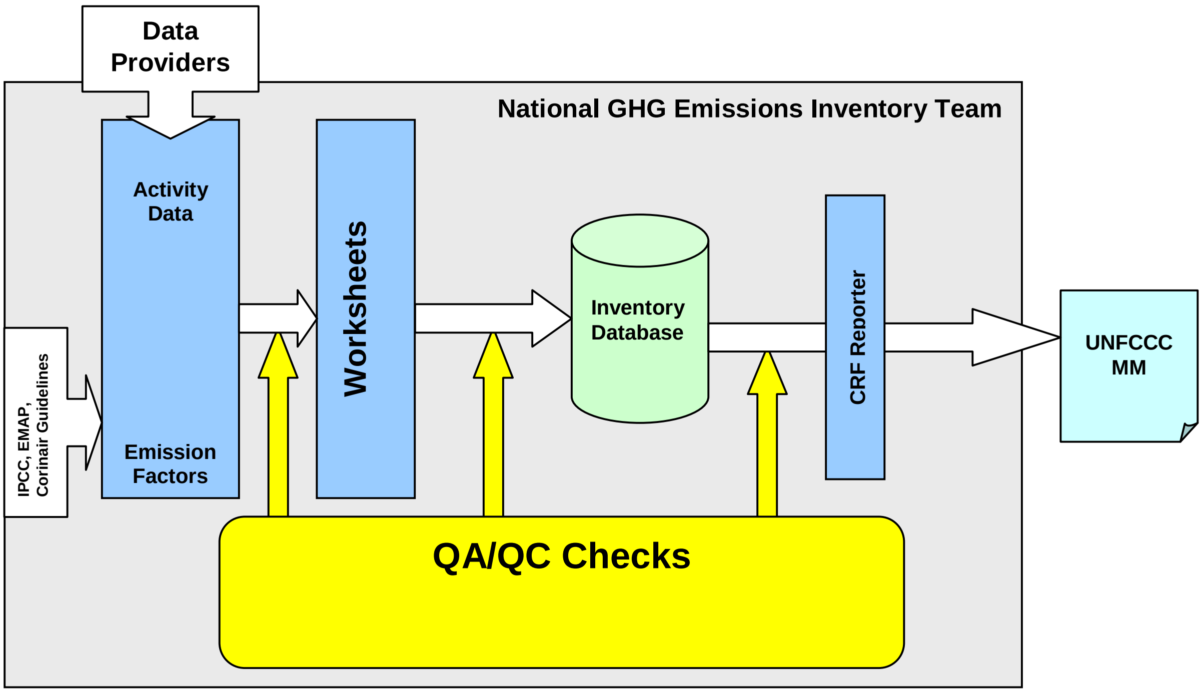

Figure 1-2 Schematic Representation of the National GHG Inventory System

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	Bakers' Cooperative Enemalta Corporation Individual private industrial entities Transport Malta Medicines Authority National Statistics Office Foundation for Medical Services
Solvent and Other Product Use	Malta Federation of Industry National Statistics Office
Agriculture	Malta Environment & Planning Authority Ministry for Resources and Rural Affairs National Statistics Office
Land Use, Land-Use Change and Forestry (LULUCF)	Malta Environment & Planning Authority Ministry for Resources and Rural Affairs
Waste	Individual private industrial entities 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 1990-2010 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:

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 date is received on time. In the meantime other published data which can be found online is collected and stored in relevant database sectioned by sector and by 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.

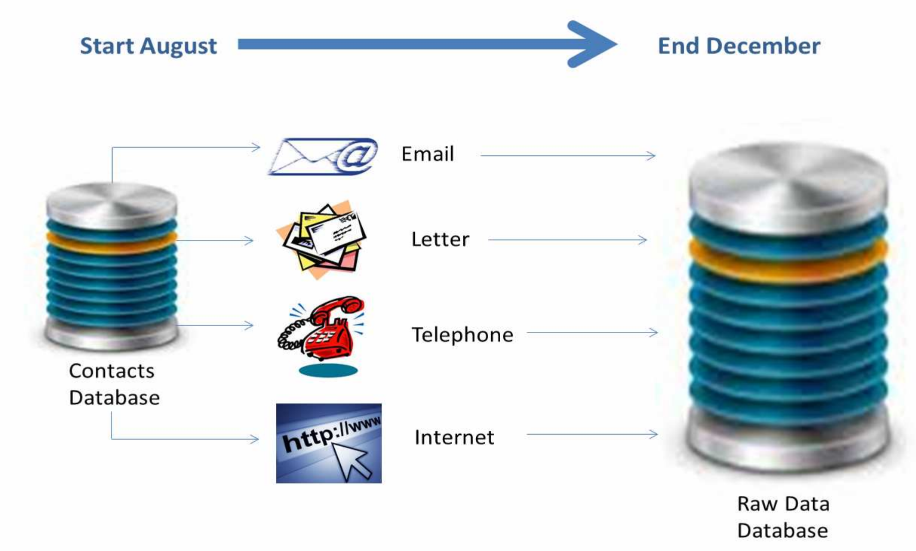

Figure 1-3 Data collection for Malta's greenhouse gas inventory

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.

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.

Data Processing

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

Emission Estimation

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

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.

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.

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.

Report Publication

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

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 1990-2010 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].

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 2010, 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 expected to form 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.

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 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.

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

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 2010, gross GHG emissions increased by 999Gg 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 2010 is of 42%, 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)	1802.08	1976.46	2081.53	2077.18	2189.76	2154.53	2206.75	2196.83	2200.19	2290.27	2287.36
CO_2(Gross)	1859.05	2033.43	2138.49	2134.15	2246.73	2211.50	2265.22	2255.30	2258.65	2348.10	2345.20
CH_4	121.30	124.54	130.72	137.66	143.72	150.87	156.58	163.70	169.62	175.02	191.05
N_2O	48.05	48.51	49.75	50.90	52.36	57.33	53.14	53.60	59.38	54.65	59.16
HFCs	7.50	8.91	10.59	12.58	14.95	17.76	21.10	25.07	29.79	35.40	5.52
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
SF_6	0.01	0.01	1.50	1.50	1.50	1.51	1.52	1.52	1.54	1.54	1.54
Total Net Emissions	1978.94	2158.43	2274.08	2279.81	2402.29	2381.99	2439.09	2440.72	2460.52	2556.87	2544.64
Total Gross Emissions	2035.91	2215.40	2331.05	2336.78	2459.25	2438.96	2497.56	2499.18	2518.98	2614.70	2602.47

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change
CO_2 (Net)	2407.04	2426.99	2604.77	2558.52	2644.96	2610.11	2695.98	2654.69	2567.58	2578.93	43.11%
CO_2(Gross)	2464.87	2484.82	2663.70	2618.61	2703.96	2670.90	2756.77	2715.48	2628.35	2640.51	42.04%
CH_4	190.55	196.22	200.32	210.75	218.10	225.25	234.01	237.16	242.49	247.58	104.10%
N_2O	56.81	56.20	53.46	54.47	54.52	55.97	54.97	51.17	50.03	47.72	-0.68%
HFCs	10.50	19.89	28.35	44.21	48.72	65.06	78.65	88.37	93.74	97.50	1200%
PFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA, NO
SF_6	1.56	1.57	2.16	1.62	1.64	1.65	1.66	1.83	1.57	1.78	15881.30%
Total Net Emissions	2666.46	2700.87	2889.06	2869.56	2967.93	2958.04	3065.27	3033.23	2955.40	2973.50	50.26%
Total Gross Emissions	2724.29	2758.70	2947.98	2929.66	3026.93	3018.84	3126.06	3094.01	3016.18	3035.08	49.08%

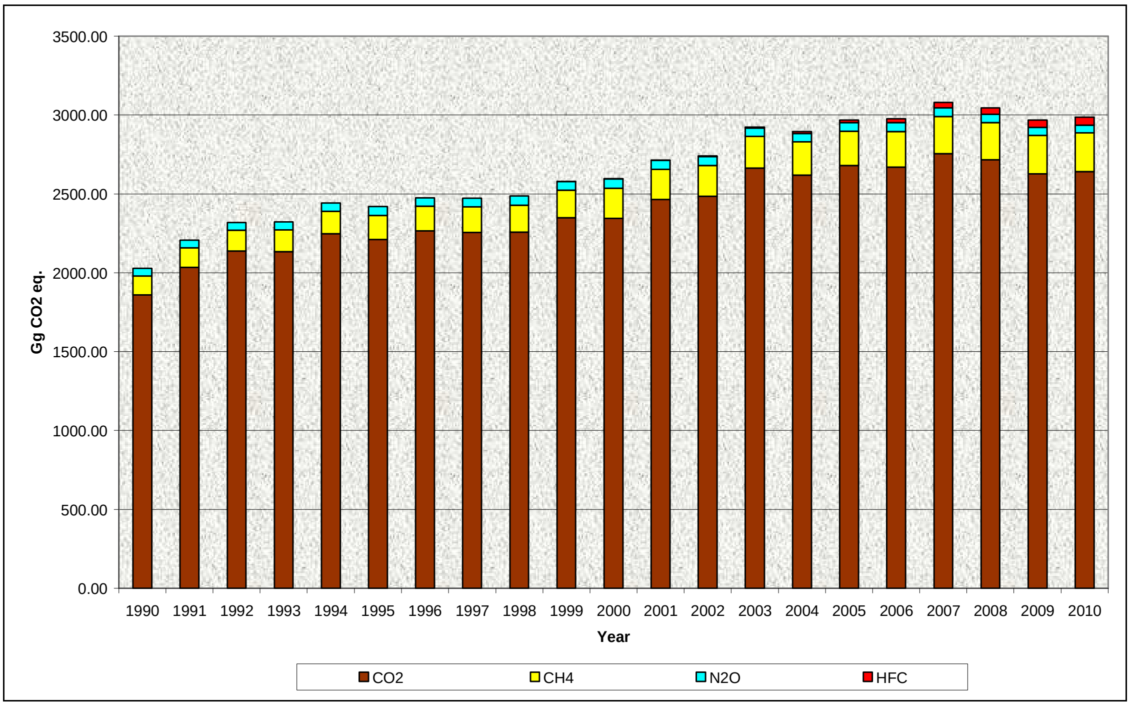

Figure 2-1 Trend in Overall Emissions without LULUCF

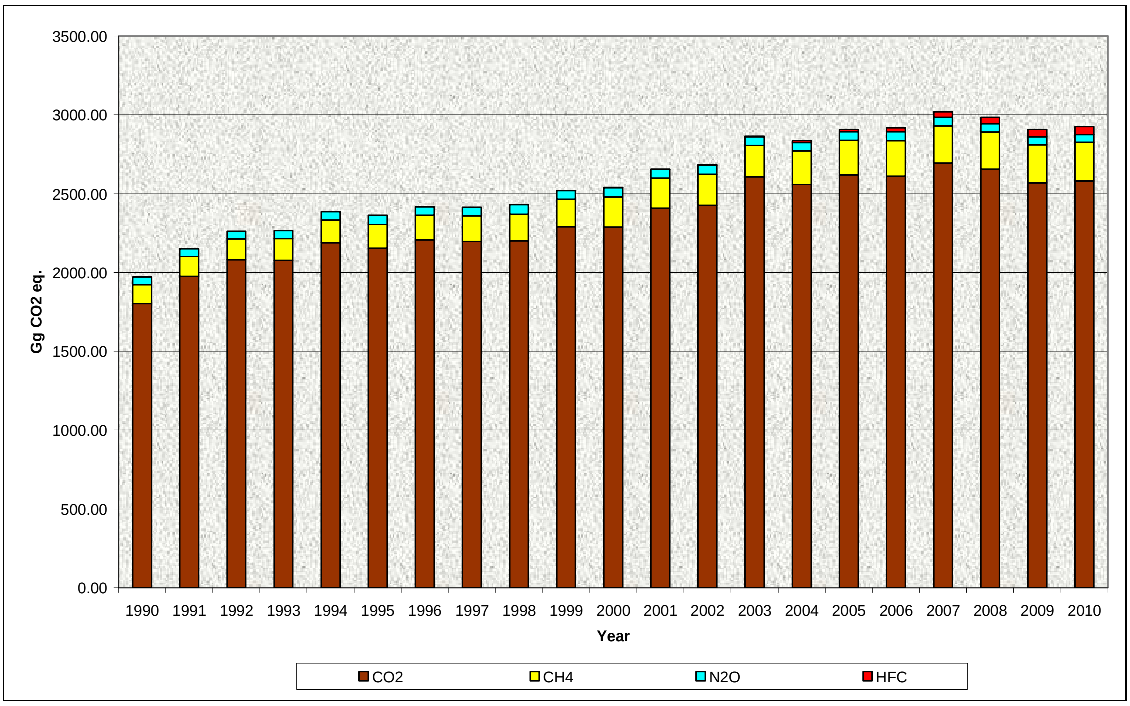

Figure 2-2 Trend in Overall Emissions with LULUCF

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: 27.8% (including LULUCF); an increase of 16.6% is observed from 2000 to 2010. In 2010 there was an increase in emission of 0.6% over 2009. Changes in emissions year-on-year are shown in **Figure 2-3**.

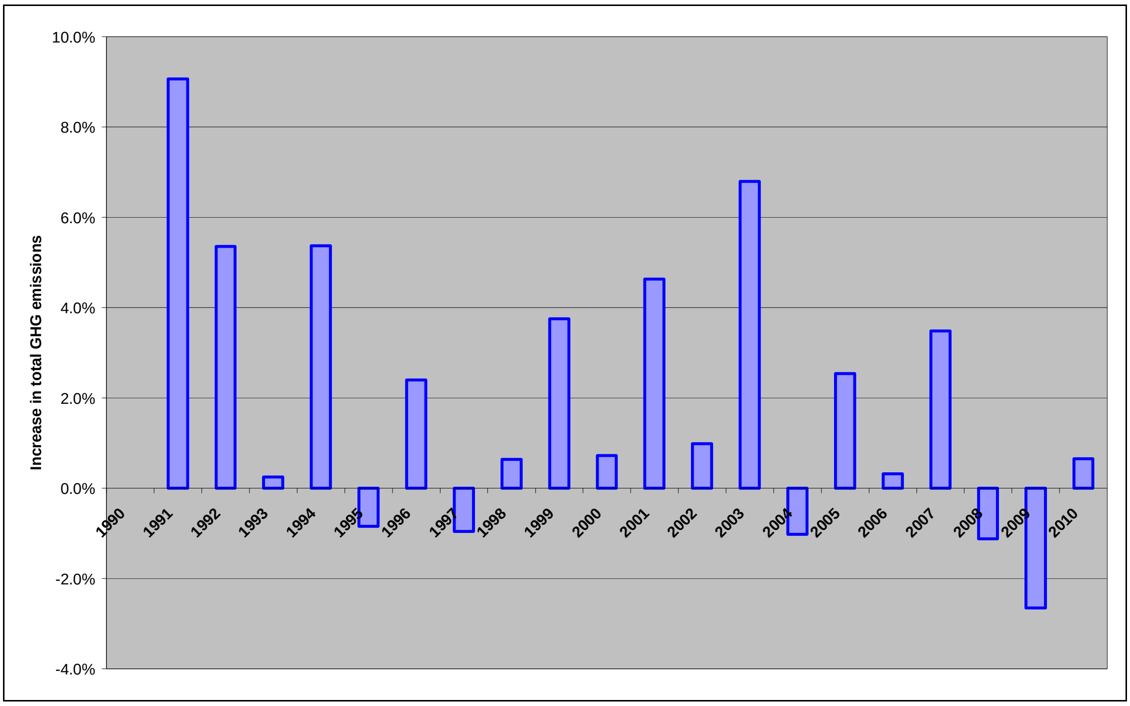

Figure 2-3 Percentage increase or decrease in total emissions for each year over previous year

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 5.6 tonnes per head in 1990 to 7.3 tonnes per head in 2010. However, it may be observed that in the most recent years, the emissions per capita trend has started a downwards trend, reflecting a similar trend in overall emissions.

On the other hand, the overall trend in emissions per unit billion Euro GDP shows a general decrease throughout the whole time series; from 1345Gg in 1990 to 492Gg per billion € in 2010. 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).

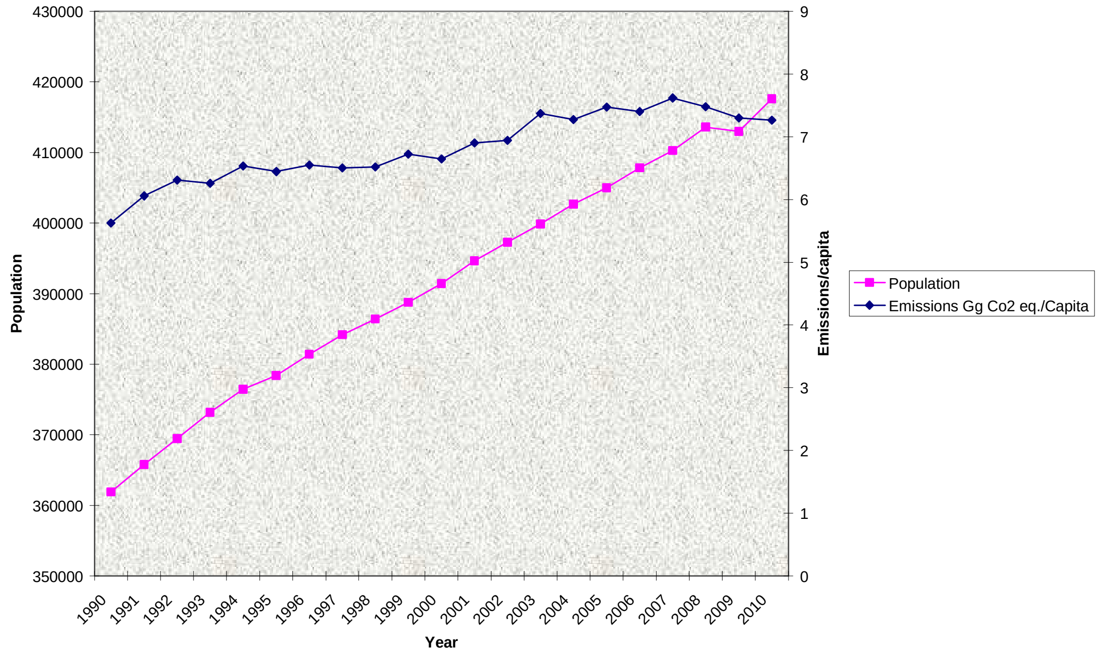

Figure 2-4 Trend in Emissions per Capita

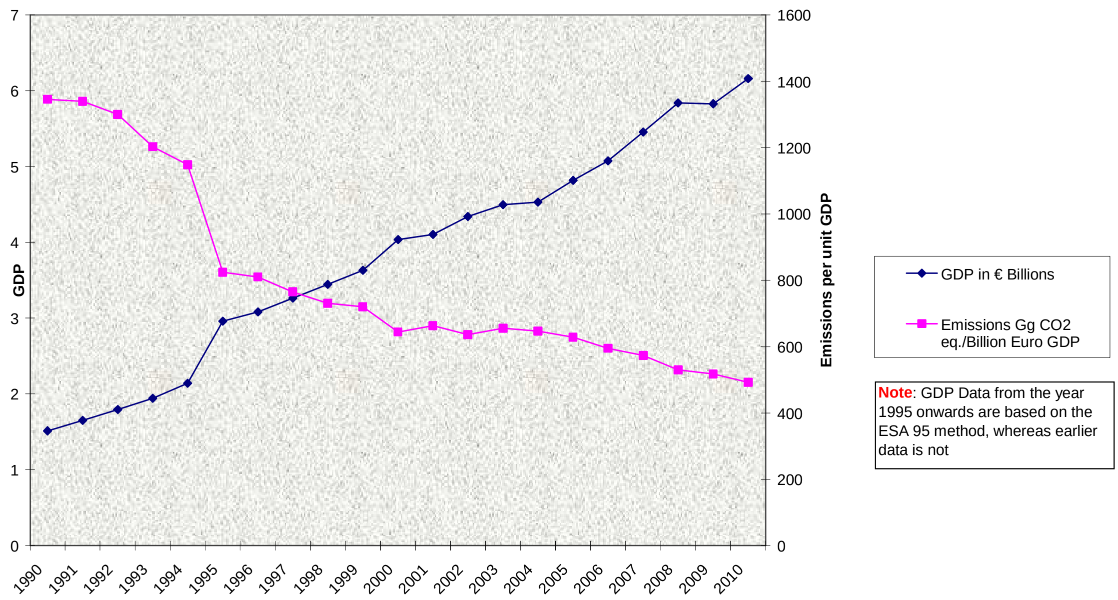

Figure 2-5 Trend in Emissions per unit GDP

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 2010 is presented in **Figure 2-6**. Emissions of this gas account for around 89% 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 42.04% in CO_2 emissions is observed for the period between 1990 and 2010. 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.

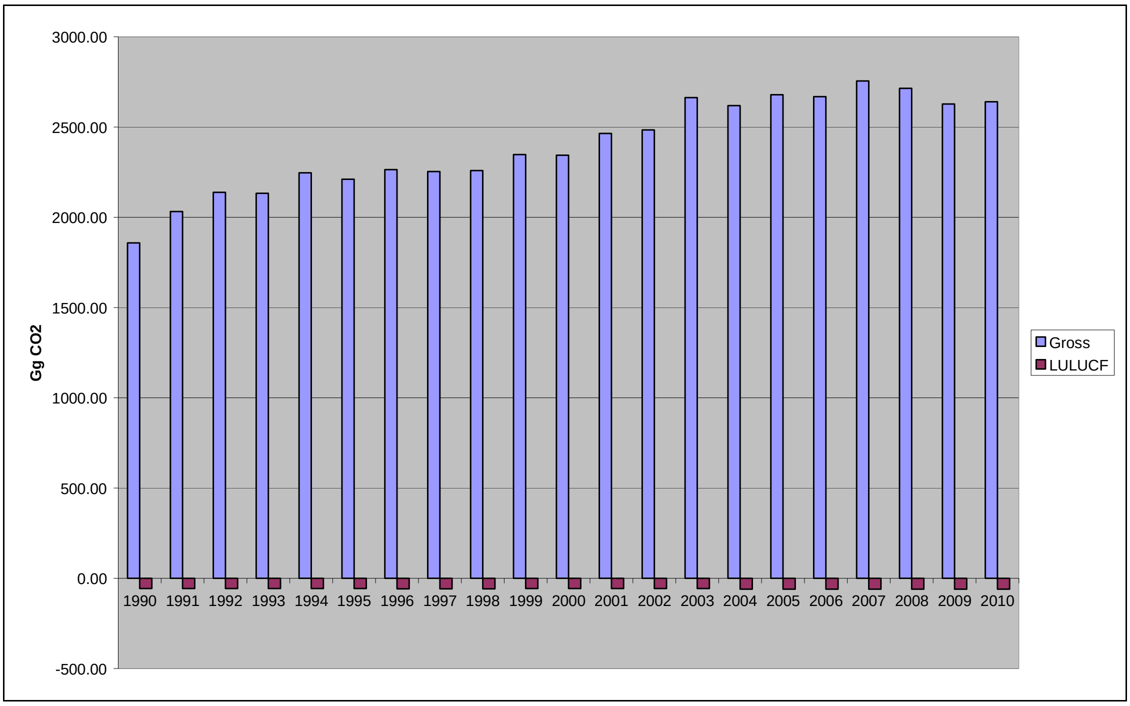

Figure 2-6 Trend in Emissions of CO_2

2.2.2 Methane Emissions

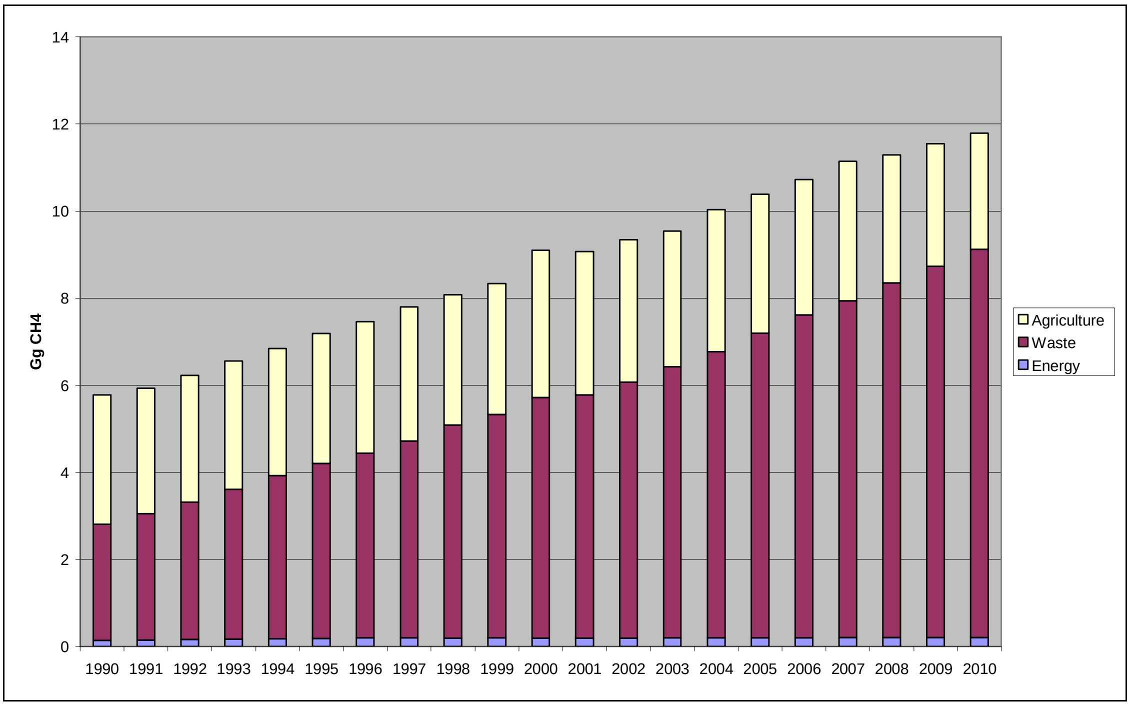

Figure 2-7 Trend in Emissions of CH_4

In 2010, emissions of CH_4 represented a share of 8.2% 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 104%. 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 agricultural sector. The energy sector contributes a very small share, at around 2.85Gg 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 1.6% 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.

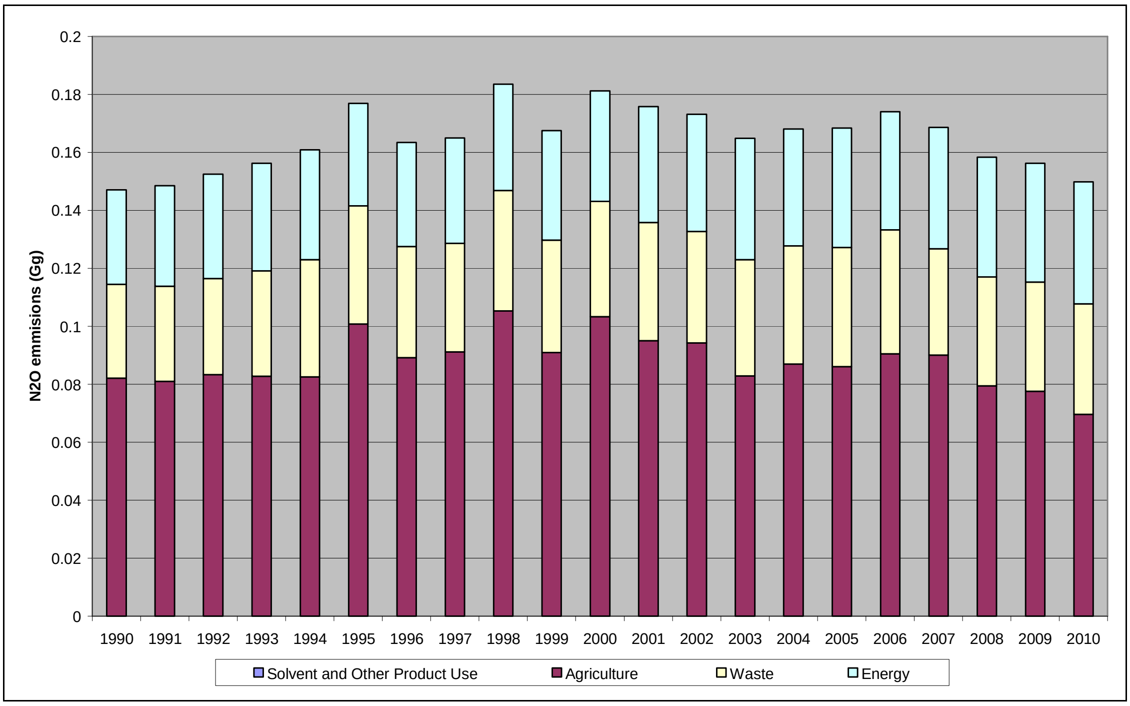

Figure 2-8 Trend in emissions of N_2O

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 an almost zero percent contribution to the total national GHG emissions in 1990, whereas this contribution increases to 3.3% of the total emissions in 2010. HFCs emissions have increased considerably from 1990 to 2010, 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 1.78Gg CO_2 eq. in 2010 has been estimated, resulting mainly from the use of SF_6 in electrical equipment.

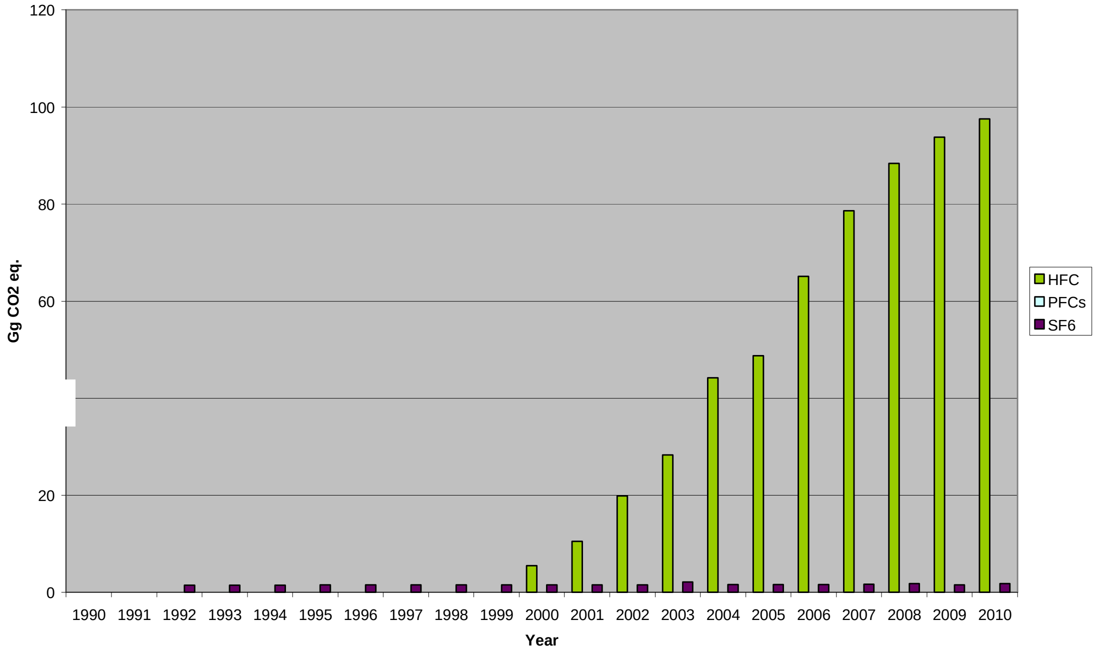

Figure 2-9 Actual Fluorinated Gas emissions in CO_2 Eq

2.3 Description and Interpretation of Emission Trends by Category

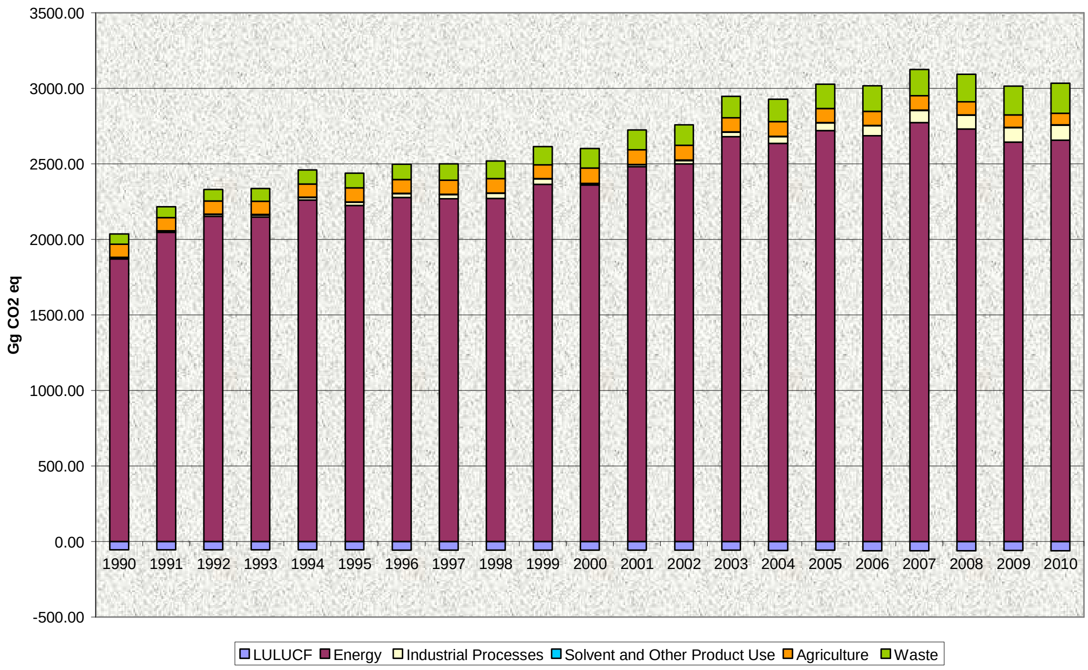

Figure 2-10 Trend in Emissions by Sector

By far the largest contributor to national overall emissions is the energy sector, as clearly shown in **Figure 2-10** with a share in 2010 of 87.5% of gross national emissions. The second highest contributing category is waste, with a share of 6.6% of overall emissions in 2010. Agriculture contributes 2.6% to the total emissions, Industrial Processes a share of 3.3% The Land Use, Land Use Change and Forestry sector accounts for a net removal equivalent to 2.0% of the total emissions for 2010.

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

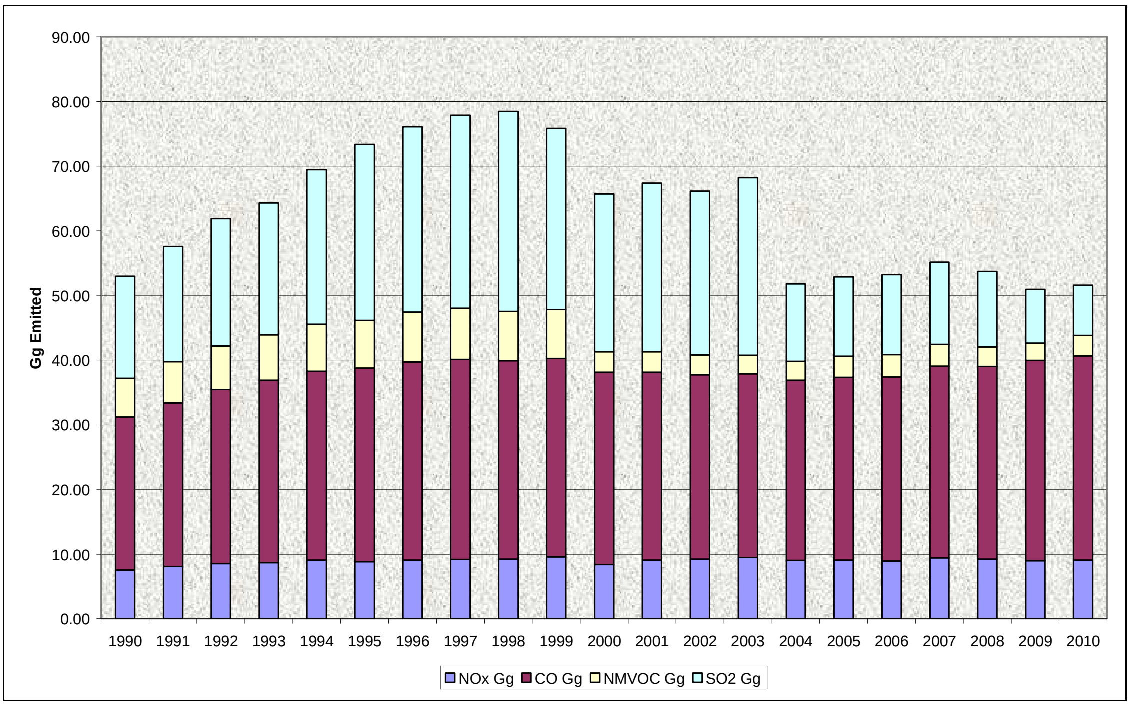

Figure 2-11 Overall Trend in Emissions of Indirect Greenhouse Gases and SO_2

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, as represented in **Figure 2-12** and **Figure 2-13** are very much associated with the trends in the activities that contribute to such emissions (i.e. road transport and power generation respectively).

In the case of CO, which is highly linked with the level of combustion of petrol and diesel fuels in road transport, the trend in emissions closely reflects the trend in consumption of petrol which, of the two fuels, is the major contributor to CO emissions. It is important to note that the emission factor of CO for petrol is 8 times as high as the factor for diesel, thus changes in petrol consumption are more reflected than patterns in diesel consumption in CO emission trends.

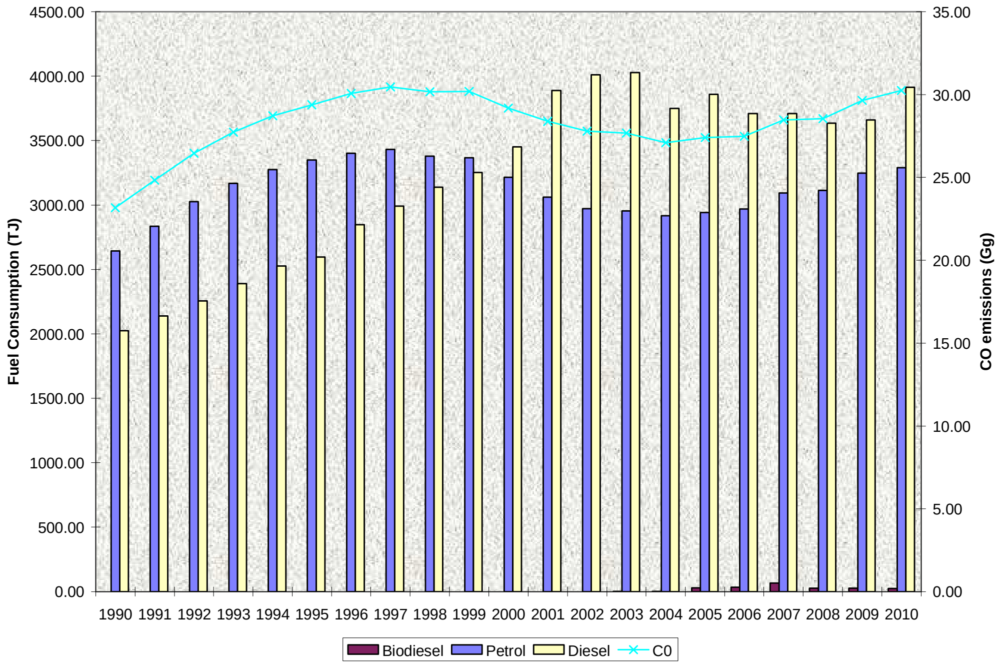

Figure 2-12 CO Emission Trends Compared to Fuel Consumption Trends in Road Transport

The activity that contributes almost all SO_2 emitted locally is fossil fuel combustion in power generation, with only a very minimal contribution from road transport. Therefore it may be expected that the trend in emissions of this gas will be closely linked to fuel consumption patterns in this sector, and any changes in sulphur content. This is in fact borne out in **Figure 2-13** and **Figure 2-14**. There is a strong correlation between SO_2 emissions and the use of residual fuel oil (fuel consumption and sulphur content of fuel) in local power generation, which is very much dependent on this fuel. For the period 1990 to 1998, annual emissions follow the trend in fuel use, which also reflects the trend in power generation. It is important to note that sulphur contents of fuels during this period were very constant. From 1998 onwards, the trend in SO_2 emissions follows the trend in sulphur content of the fuels particularly that of residual fuel oil, which has the highest value for sulphur content and remains the fuel most utilised in local electricity generation.

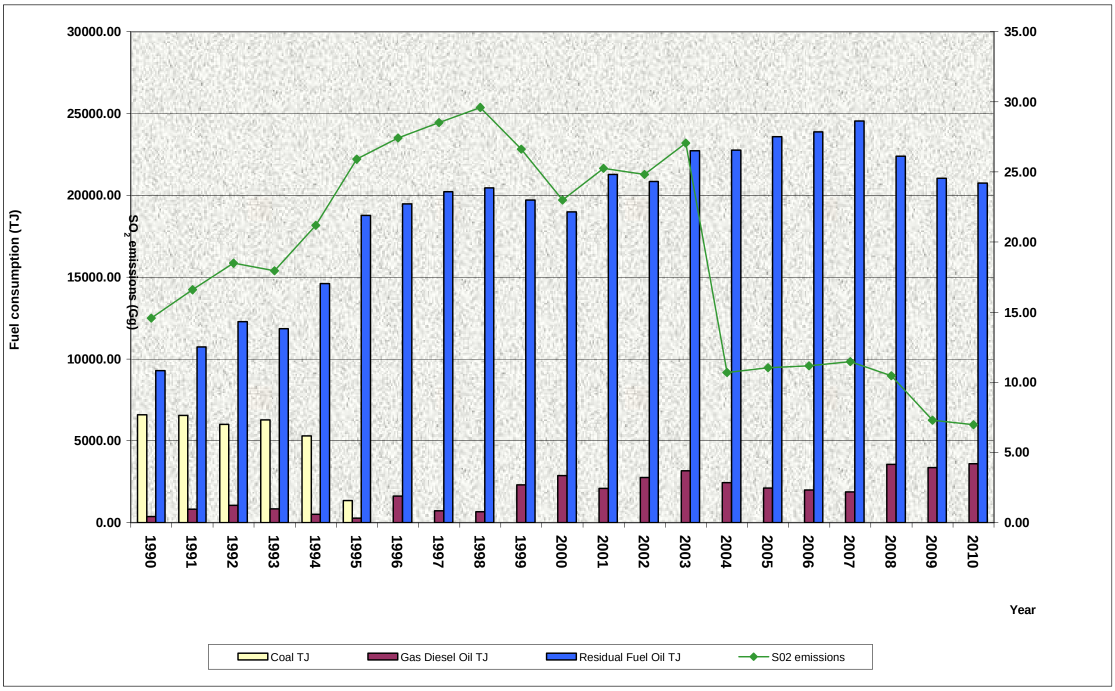

Figure 2-13 SO_2 Emission Trends Compared to Fuel Consumption Trends in Power Generation

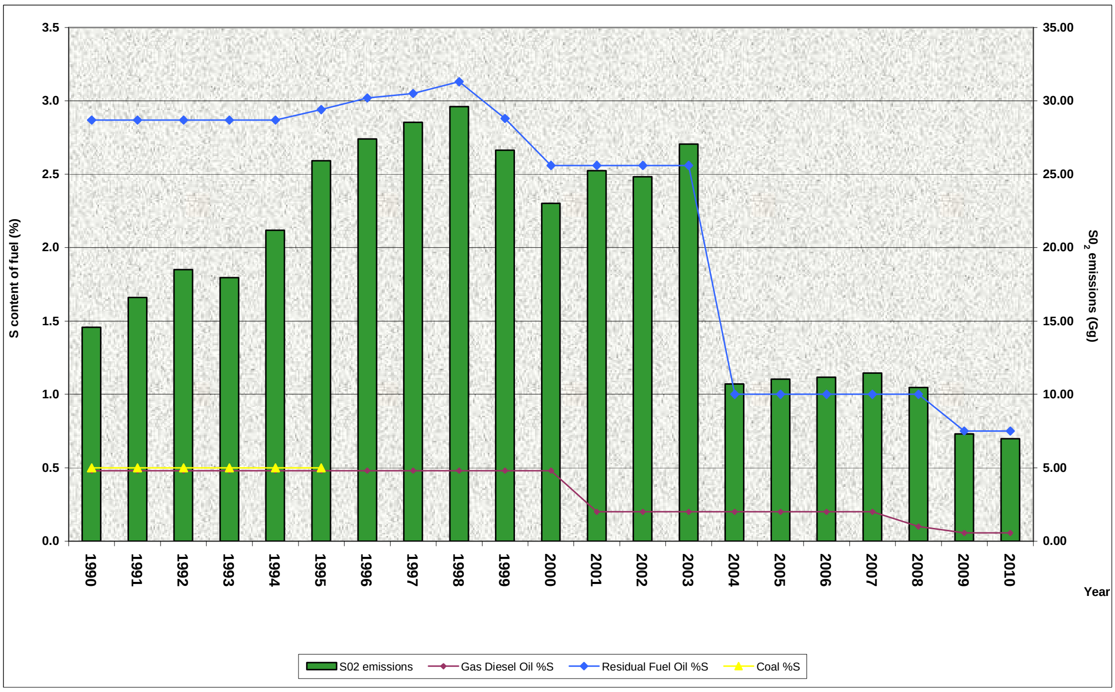

Figure 2-14 SO_2 Emission Trends Compared to Sulphur Content of Fuels Used in Power Generation

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 71.3% of the emissions in the Energy sector as a whole in 2010.. 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 21.7% of this sector's emissions. Transport is thus another major contributor to overall national emissions.

The commercial/institutional (1A4a) account for 3.3 % of energy emissions followed by residential sub sector (1A4b) accounting for 1.5%. The manufacturing industries (1A2) and the agriculture/forestry/fisheries (1A4c) sub-categories account for only 1.7% and 0.4% of the energy emissions.

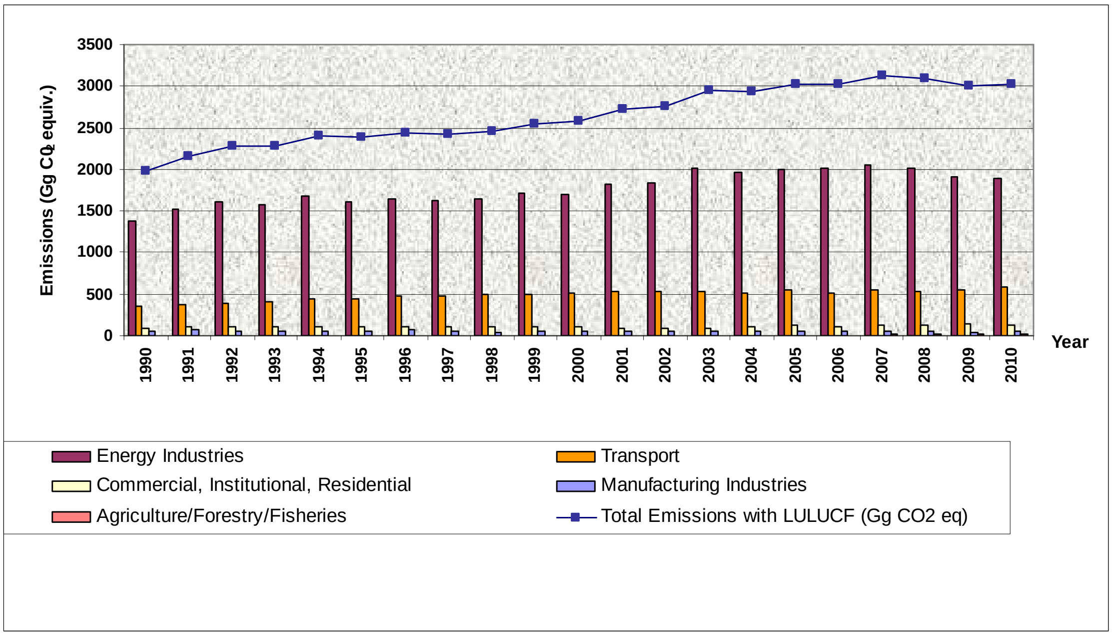

Figure 3-1 Total Emission Trends in the Energy Category

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 6.07% lower than the Sectoral Approach estimate. The reference approach includes data obtained from importers of fuels. The discrepancy between these two approaches is seen to switch from positive to negative over the past years. This could be due to data from importers being reported in one year and being accounted for sectorally in another year.

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)	33.95	2479.40	35.06	2639.74	-3.16	-6.07
Total (5)	***33.95***	***2479.40***	***35.06***	***2639.74***	***-3.16***	***-6.07***

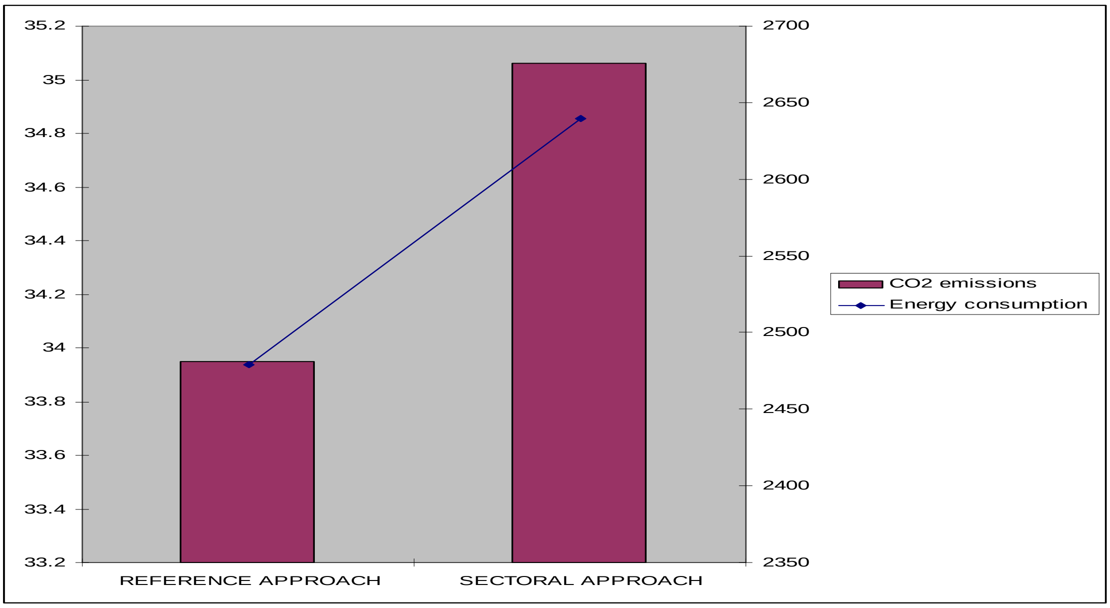

Figure 3-2 Comparison between sectoral and reference approach for CO_2 Emission and Energy Consumption

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 IPCC. Data as of 2001 is taken from statistics of either Port Authorities or Customs. Emissions for international aviation have been estimated based on fuel sales. Statistics where obtained from Suppliers for the period 1993-2010 whereas previous data was obtained from the 1st National communication.

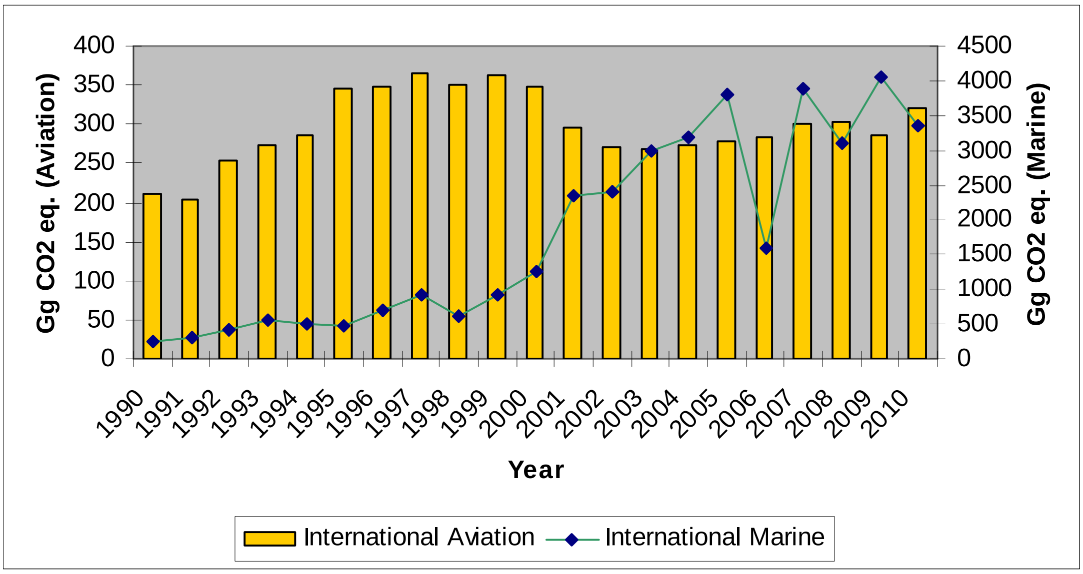

Figure 3-3 International Bunkers (Aviation and Marine) Emissions for 1990 to 2010

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 (1) 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 from MRA from Transport Malta and Customs. Emission factors used are those from 2006 IPCC guidelines (shown inTable 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 2010

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
Heavy Fuel Oil	21.1	3.0	0.6	200.0	15.0	5.0

3.2.2.3 Source Specific Recalculations

3.2.2.3.1 International Navigation

Various recalculations have been done to this sector over the 2011 submission. These recalculations include the inputting of emissions submitted for the 1st National Communication to the IPCC and changes in the emission factors, oxidation factors and calorific values. The changes in the 2012 submission are presented in Table 3-3.

Table 3-3 Recalculations for International Navigation

Year	International Navigation (Gg CO_2 eq.) as reported in the 2011 GHG Inventory	International Navigation (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Percentage change in reported emissions (%)
1990	NE	262.30	-
1991	NE	298.80	-
1992	NE	429.53	-
1993	NE	560.50	-
1994	NE	512.71	-
1995	NE	486.64	-
1996	NE	698.80	-
1997	NE	919.42	-
1998	NE	617.22	-
1999	NE	929.28	-
2000	NE	1247.83	-
2001	2308.79	2356.23	2.05
2002	2361.55	2409.11	2.01
2003	2919.84	2979.84	2.05
2004	3123.96	3187.10	2.02
2005	2109.77	3802.06	80.23
2006	2407.73	1600.89	-33.51
2007	2697.53	3874.61	43.64
2008	2916.01	3102.43	6.39
2009	3612.86	4047.25	12.02
2010		3357.15	-

For thisrReport, data used from 2005 onwards was Customs data as this was the most reliable data available. The drop in consumption in 2006 is also explained by the non-reporting of sales by bunkering operators. These sales and hence emissions are included in the years after when such sales were recorded.. By all probability however even by observing Figure 3.3. the market continued to increase year by year.

3.2.2.3.2 International Aviation

A methodological change was carried out in this submission compared to previous submissions, this due to the fact that the results from the GHG inventory submission were highly discrepant from emissions calculated through in the reference approach thus resulting in relatively high inconsistency between the two. This was due to incomplete coverage of the previously used methodology and the difficulty to obtain comprehensive and complete LTO data. In view that this sector is not a Key category it was decided to revert back to tier 1 approach. Data from 1994 was available for this recalculation through the supplier, thus prior to that was considered as NE.

Table 3-4 illustrates the differences from the previous submission.

Table 3-4 Recalculation international Aviation

Year	International Aviation (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	International Aviation (Gg CO_2 eq.) as reported in the 2011 GHG Inventory	Percentage change in reported emissions (%)
1990	NE	NE	NA
1991	NE	NE	NA
1992	NE	NE	NA
1993	NE	NE	NA
1994	284.9653	NE	NA
1995	345.3253	NE	NA
1996	348.7312	NE	NA
1997	364.1329	NE	NA
1998	349.4858	NE	NA
1999	362.3401	NE	NA
2000	347.1289	NE	NA
2001	294.4897	NE	NA
2002	271.8191	NE	NA
2003	269.1148	37.66471	614.50%
2004	272.9978	33.73193	709.32%
2005	277.7214	44.61166	522.53%
2006	284.0206	45.41487	525.39%
2007	299.4538	48.77946	513.89%
2008	303.1456	48.77946	521.46%
2009	286.8472	37.45804	665.78%
2010	321.2412		

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), which in Malta incorporates two major point sources. These 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 2010, a total of 516.20kt of residual fuel oil (RFO) and 83.03kt of gas oil (GO) were burned at the two power stations.

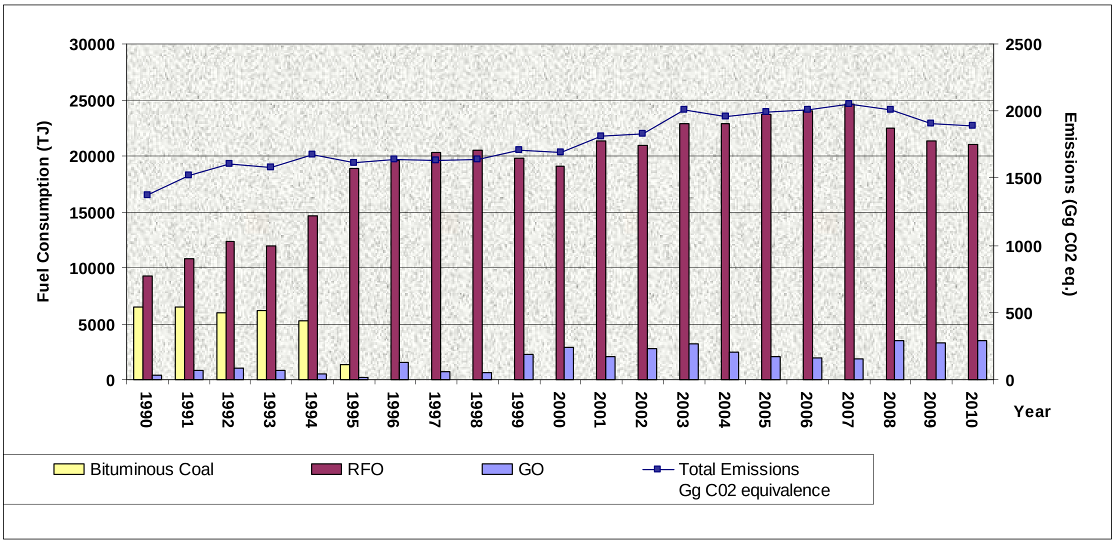

Figure 3-4 Total Emissions Trend Compared with Fuel Consumption for Energy Industries

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 3-6** which compares CO_2 emissions per MWh with electricity generated over the 1990-2010 period.

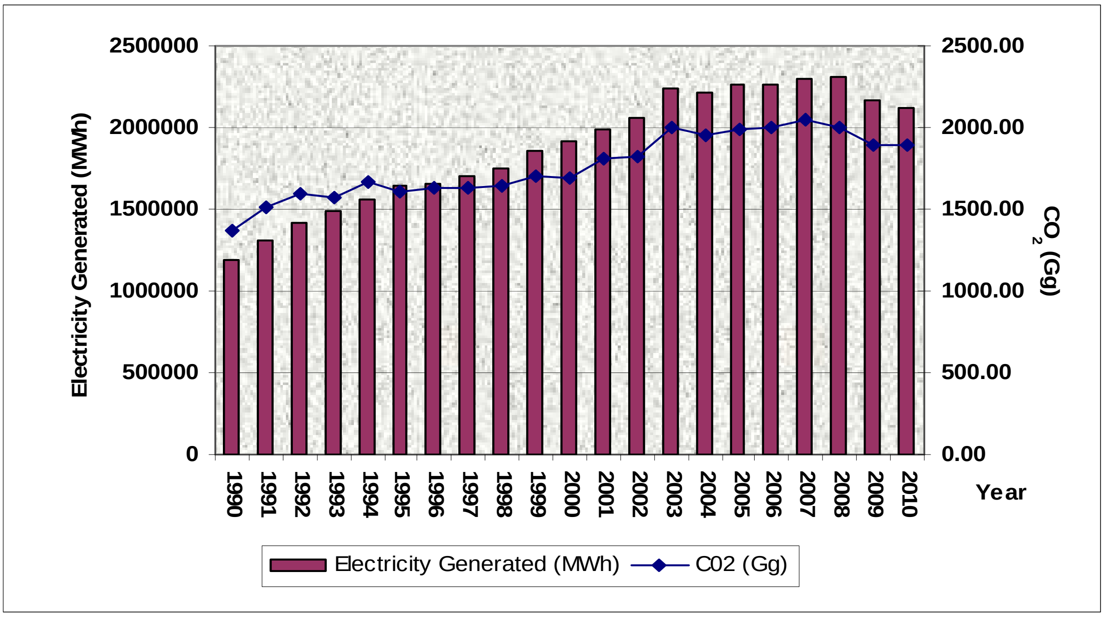

Figure 3-5 Total Energy Industry CO_2 Emissions Trend Compared with Electricity Generated

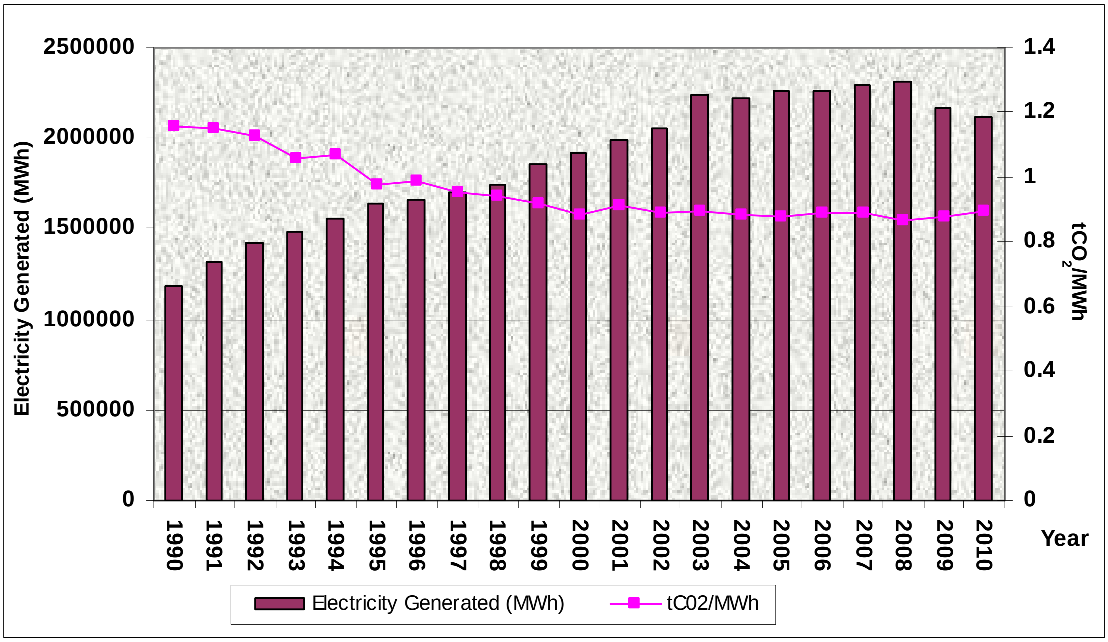

Figure 3-6 Total Energy Industry CO_2 Emissions/MWH Trend Compared with Electricity Generated

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 2010, 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 and 2010 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 3-5 Emission Factors for Power Stations in 2010.

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 3-5 Emission Factors for Power Stations in 2010

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 2010. 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, oxidation factors and the country specific calorific values in the activity data used since the 2011 submission. The changes in the 2012 submission are presented in Table 3.4.

Table 3-6 Recalculation of the Energy Industries Sector

Year	Energy Industries (Gg CO_2 eq.) as reported in the 2011 GHG Inventory	Energy Industries (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Percentage change in reported emissions (%)
1990	1354.96	1373.62	1.38
1991	1497.03	1517.46	1.36
1992	1580.87	1602.51	1.37
1993	1556.42	1577.83	1.37
1994	1651.47	1674.92	1.42
1995	1587.40	1611.16	1.50
1996	1615.10	1638.35	1.44
1997	1606.54	1630.50	1.49
1998	1620.86	1645.10	1.50
1999	1684.95	1708.60	1.40
2000	1670.40	1693.30	1.37
2001	1788.77	1814.22	1.42
2002	1805.27	1830.34	1.39
2003	1979.49	2006.84	1.38
2004	1930.19	1957.47	1.41
2005	1967.67	1995.85	1.43
2006	1982.15	2010.67	1.44
2007	2023.69	2052.96	1.45
2008	1982.80	2009.83	1.36
2009	1863.72	1903.17	2.12
2010		1893.28	

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 and 2010.

In the previous five inventory submissions the fuel combustion of the commercial/institutional sectors was included with this category due to difficulties in segregating data between the various sub-sectors. Recalculations have been performed so that data for 2005-2009 for the Commercial/Institutional and Manufacturing/Construction categories are segregated.

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.

Work is ongoing by the Malta Resources Authority in collaboration with other entities to ensure more accurate and greater reliability of fuel data segregation related to the Manufacturing Industries & Construction and Commercial/Institutional categories.

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 as a result assumptions used in 2004 for the segregation of fuel consumption into their respective categories was applied.

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 2010, the percentage sulphur content was 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 3-7.

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 3-7 Emission Factors for Manufacturing Industry, Construction in 2010

Fuel	C (TC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)
LPG / Propane	17.2	1.0	0.1	150.0	30.0	5.0
Thin Fuel Oil	20.88	3.0	0.6	200.0	10.0	5.0
Kerosene	19.5	3.0	0.6	200.0	10.0	5.0
Automotive Diesel	20.2	3.0	0.6	200.0	10.0	5.0
Gas Oil 0.1% Sulphur	20.2	3.0	0.6	200.0	10.0	5.0

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 3-8.

Table 3-8 Biodiesel Emission Factors for Manufacturing Industry, Construction in 2010

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

Work is ongoing by the Malta Resources Authority in collaboration with other entities to ensure greater reliability of data available for this sector.

3.2.7.2 Source Specific Recalculations

Recalculations have been performed due to changes in the emission factors, oxidation factors, the calorific values, review of importer fuel data and segregation of fuel consumption since the 2011 submission. The automotive diesel consumption of the manufacturing and commercial sectors in 2009 was reported under Transport and has now been segregated and reported under Manufacturing and Construction/Commercial and Institutional categories.

The changes in the 2012 submission are presented inTable 3-9. It is important to note that the high percentage change in emissions from 2005-2009 is due to the fact that the commercial/ institutional sector from 2005 to 2009 is no longer included in this sector.

Table 3-9 Recalculations for the Manufacturing Industries and Construction

Year	Manufacturing Industries and Construction (Gg CO_2 eq.) as reported in the 2011 GHG Inventory	Manufacturing Industries and Construction (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Percentage change in reported emissions (%)
1990	59.568708	59.46356383	-0.176508917
1991	62.767454	62.62608561	-0.225226179
1992	59.314083	59.16384897	-0.253286154
1993	58.507598	58.34854148	-0.271856688
1994	57.788013	57.62301411	-0.285524246
1995	60.340380	60.1572633	-0.303473373
1996	62.858444	62.66514471	-0.307515048
1997	57.653074	57.50777356	-0.252025772
1998	41.340765	41.38558631	0.108419752
1999	54.677738	54.64984233	-0.051017449
2000	57.549594	57.51990493	-0.051588672
2001	49.461789	49.39979172	-0.125343219
2002	46.917514	46.79668987	-0.257524476
2003	48.316247	48.15676068	-0.330089117
2004	59.454048	59.31211915	-0.238720456
2005	123.340803	51.08485506	-58.58235559
2006	83.788957	46.01175367	-45.08613638
2007	106.707748	51.48173331	-51.75445599
2008	101.803570	47.74422522	-53.10161972
2009	66.682122	40.55115228	-39.18736982
2010		46.18690818	

3.2.8 Source Category 1A3 - Transport

3.2.8.1 Source Category Description

This sector is dominated by emissions from road transport (**Figure 3-7**) with CO_2 as the gas that accounts for the bulk of overall GHG emissions from road transport fuel combustion (**Figure 3-8**). 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 2010.

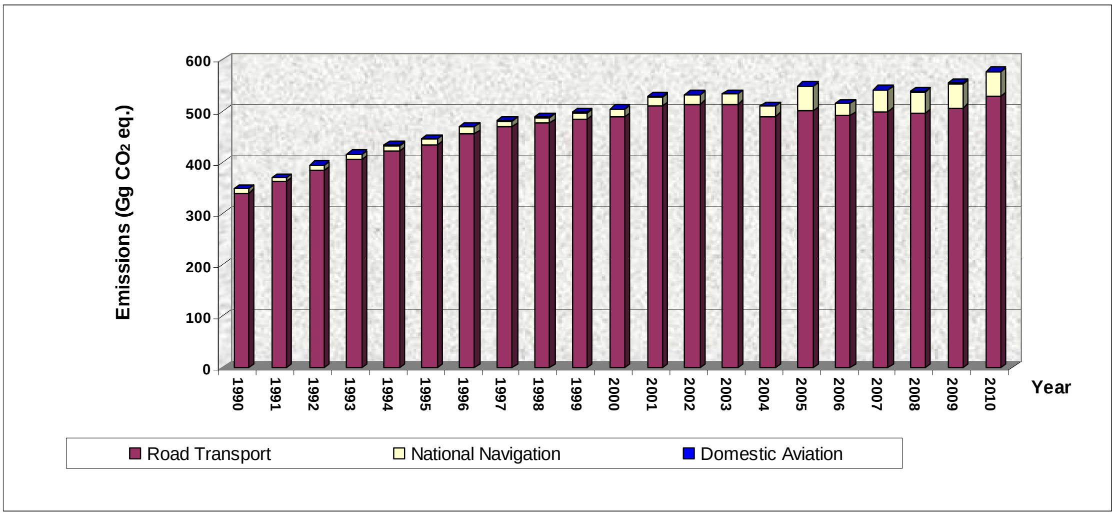

Figure 3-7 Emission Trends in Transport Sector by sub category

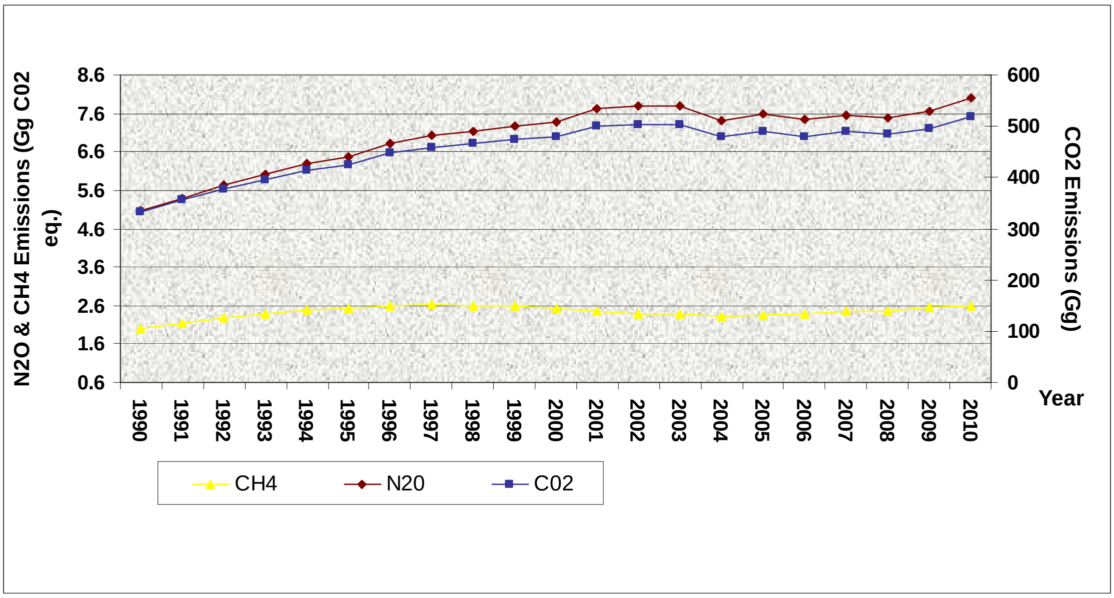

Figure 3-8 Emission Trends in Road Transport by Gas

The most common fuels used in road transport are gasoline (also known as petrol) and diesel, with biodiesel making slow inroads in recent years. 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 is clearly visible from **Figure 3-9**, there is a consistent increase in emissions until 2001, as the number of vehicles in local use, with associated road transport fuel usage, increased rapidly. From 2001 onwards, while vehicle numbers continue to increase, emissions seem to stabilise, possibly a reflection of the changing overall average efficiency of the vehicle fleet; as vehicles are changed, overall efficiency in terms of emissions increases. This enhanced overall efficiency is also reflected by the fact that data of fuel consumption currently available denotes a stable trend for the more recent years.

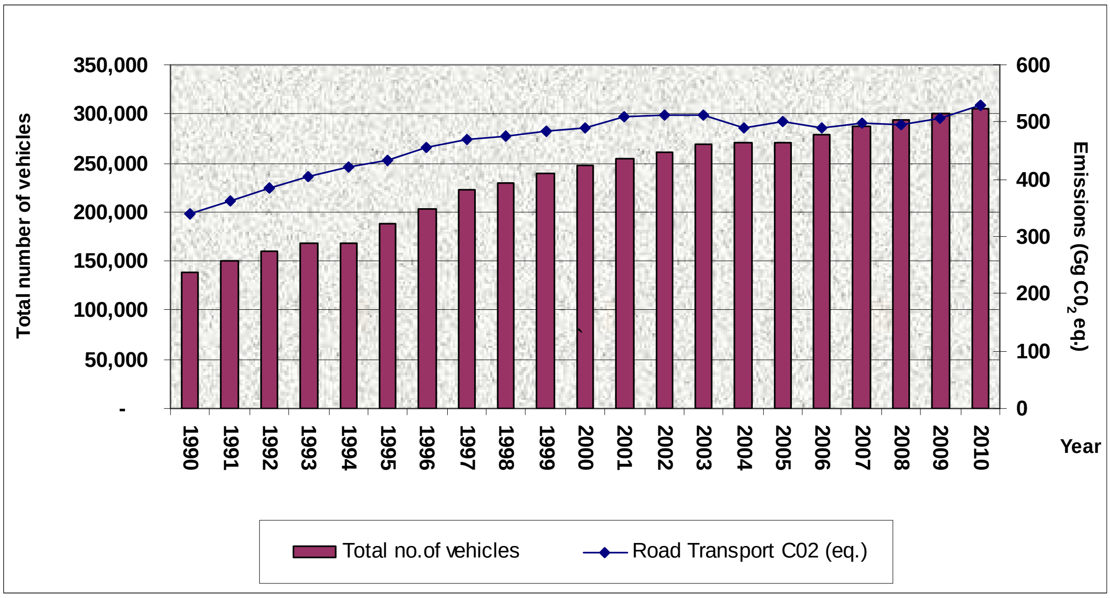

Figure 3-9 Road Transport Emission Trends Compared with Total Number of Vehicles

3.2.8.2 Methodological Issues

3.2.8.2.1 Road Transport

The Tier 1 approach has been used to calculate CO2, CH4, N2O 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 3-10**.

Table 3-10 Fuel based emission factors for road transport in 2010

Fuel	C (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	CO (kg/TJ)
Diesel	74100	3.9	3.9	1000.0
Petrol	69300	33.0	3.2	8000.0

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 3-11) by the grams of fuel/km (Table 3-12) 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 3-13 shows the regulations that have come into force up to 2010 for each vehicle type.

Table 3-11 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 3-12 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
Diesel car	Pre-Euro I	68
	EURO I	66
	EURO II	65
	EURO III	58
	EURO IV	53
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 3-13 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
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. 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 3-14** are then used to estimate NOx 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 supplier (Enemalta) certificates. 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 3-14 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
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
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 3-15. Previously fuel data from diesel use in fishing vessels was gathered from the Ministry for Resources and Rural Affairs (MRRA) and two other local operators to calculate the emissions from national navigation. This year an effort was made to collect data used for national navigation from Customs. The MRA analysed this data and used it to update its oil balance sheet, so that the figures in this Oil balance could be used as opposed to figures collected from operators as was done previously.

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 3-15 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	92.31
Diesel Oil	20.2	5.0	0.6	1500.0	1000.0	200.0	92.31

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 (1990-2010).

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).

3.2.8.3 Source Specific Recalculations

Recalculations have been performed for national navigation emissions. This was due to updating of data for the time series from 2002 to 2009 and change of the oxidation factor from 0.99 to 1. (Table 3-16). Recalculations have also been made for road transport (Table 3-17) since the oxidation factor was changed from 0.99 to 1 as per 2006 guidelines and default emission factors for direct emissions have been updated to 2006 IPPC guidelines. The indirect emissions model was also updated since data not previously available, regarding vehicle numbers split by category and euro class, was provided

Civil aviation sector has been recalculated to include previously excluded emissions such as cruise emissions and due to completeness issues of the LTO data available. A comparative study was carried out comparing the old methodology used for the 2011 submission of the inventory with the new methodology as referenced to Eurostat data based on Energy Consumption. This exercise was done including both national and international aviation. A much larger discrepancy was found between the old methodology and Eurostat data then for the new methodology which indicates a better representation of reality through the new method (Tier 1 IPCC 2006 Guidelines) as compared to the old methodology (Tier 2 IPCC 2006 Guidelines). The changes are summarised in Table 3-18**Error! Reference source not found.** below

Table 3-16 Recalculations for the National Navigation Category

Year	National Navigation (Gg CO_2 eq.) as reported in the 2011 GHG inventory	National Navigation (Gg CO_2 eq.) as reported in the 2012 GHG inventory	Percentage change in reported emissions (%)
1990	8.37	8.45	+ 1.01
1991	6.90	6.97	+ 1.01
1992	8.04	8.13	+ 1.01
1993	8.94	9.03	+ 1.01
1994	9.61	9.70	+ 1.01
1995	12.13	12.26	+ 1.01

1996	12.47	12.60	+ 1.01
1997	10.79	10.90	+ 1.01
1998	10.91	11.02	+ 1.01
1999	12.06	12.18	+ 1.01
2000	14.53	14.68	+ 1.01
2001	16.51	16.68	+ 1.01
2002	23.80	18.33	- 22.99
2003	21.96	19.81	- 9.81
2004	25.41	20.15	- 20.70
2005	23.15	48.41	+ 109.92
2006	23.13	23.94	+ 3.51
2007	25.69	41.58	+ 61.89
2008	26.53	41.82	+ 57.64
2009	31.14	46.94	+ 50.73
2010	-	48.03	-

Table 3-17 Recalculations for the Road Transport Category

Year	Road Transport (Gg CO2 eq.) as reported in the 2011 GHG inventory	Road Transport (Gg CO2 eq.) as reported in the 2012 GHG inventory	Percentage change in reported emissions (%)
1990	335.26	340.33	+ 1.51
1991	357.17	362.57	+ 1.51
1992	379.09	384.81	+ 1.51
1993	399.03	405.05	+ 1.51
1994	416.48	422.78	+ 1.51
1995	427.05	433.51	+ 1.51
1996	449.46	456.28	+ 1.52
1997	462.22	469.24	+ 1.52
1998	469.35	476.49	+ 1.52
1999	476.97	484.24	+ 1.52
2000	481.10	488.46	+ 1.53
2001	502.72	510.45	+ 1.54
2002	505.64	513.43	+ 1.54
2003	505.71	513.50	+ 1.54
2004	482.31	489.73	+ 1.54
2005	456.26	499.75	+ 9.53
2006	494.90	490.54	- 0.88
2007	497.19	499.36	+ 0.44
2008	499.68	495.17	- 0.90
2009	509.62	506.48	- 0.62
2010	-	528.64	-

Table 3-18 Recalculation for the Civil aviation category

Year	National aviation (Gg CO2 eq.) as reported in the 2011 GHG inventory	National aviation (Gg CO2 eq.) as reported in the 2012 GHG inventory	Percentage change in reported emissions (%)
1990	NE	NE	NA
1991	NE	NE	NA
1992	NE	NE	NA
1993	NE	NE	NA
1994	NE	0.7502	+100.00
1995	NE	0.7013	+100.00
1996	NE	0.6351	+100.00
1997	NE	0.8594	+100.00
1998	NE	0.8730	+100.00
1999	NE	0.8340	+100.00
2000	NE	0.8697	+100.00
2001	NE	0.8513	+100.00
2002	NE	0.8103	+100.00
2003	3.5381	0.6067	- 82.85
2004	3.8612	0.6034	- 84.37
2005	2.3121	0.6861	- 70.33
2006	2.0333	0.8257	- 59.39
2007	1.4803	0.7549	- 49.00
2008	1.6091	0.7280	- 54.76
2009	1.5972	0.6244	- 60.91
2010		0.7919	

3.2.9 Source Category 1A4 – Other

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 3-10**). The sub division of fuel usage for the Manufacturing Industries/ Construction and the Commercial/Institutional categories has shown that in 2010 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. Activity data for solid biomass for the years 2005-2010 has been included for the residential sector. This data was not included in previous inventory submissions since information was not available.

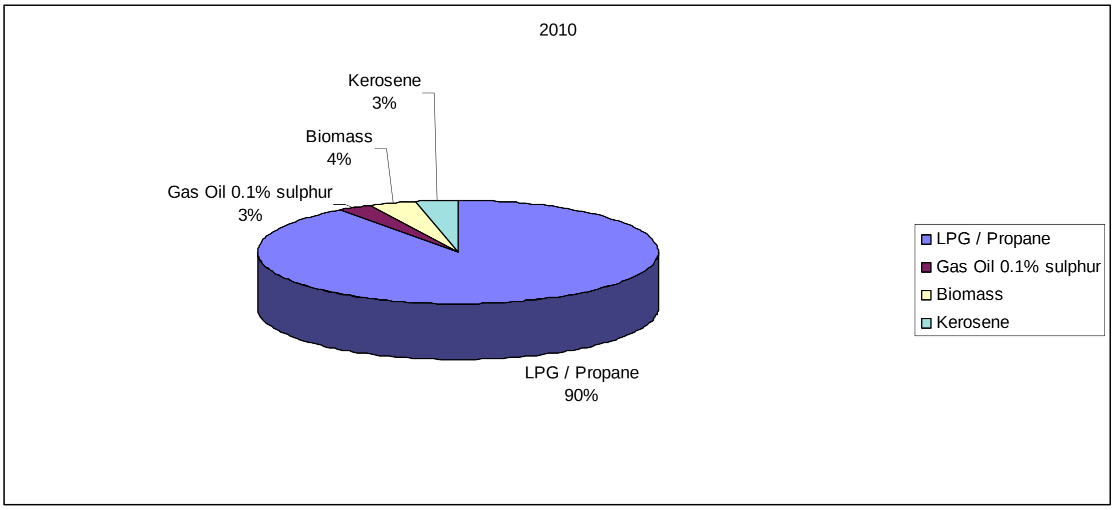

Figure 3-10 Share of Fossil-fuel Consumption in the Residential Sector in 2010

For the year 2010, the fuel mix in the agriculture/forestry/fisheries category has increased to include small quantities of kerosene and gas/diesel oil with its major fuel contributor (automotive diesel). This was a result of the segregation of fuel usage in different categories.

For the year 2009, automotive diesel was reported under the road transport category(1A3b) since segregation of fuel usage was not clear during that year. For the year 2010, fuel consumption data has shown that the Commercial/Institutional sector makes use of automotive diesel primarily at marine harbours.

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.

Table 3-19 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 2010, 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). Activity data for Agriculture/Forestry/Fisheries was obtained through consultations with the Department of Fisheries within the Ministry for Resources and Rural Affairs.

Work is ongoing by the Malta Resources Authority in collaboration with 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 3-19 Emission Factors for Residential and Agriculture/Forestry/Fisheries Sectors in 2010

Fuel	C (TC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	NOx (kg/TJ)	CO (kg/TJ)	NMVOC (kg/TJ)
LPG / Propane	17.2	1.0	0.1	50.0	50.0	5.0
Kerosene	19.5	3.0	0.6	100.0	20.0	5.0
Automotive Diesel	20.2	3.0	0.6	100.0	20.0	5.0
Gasoil 0.1% sulphur	20.2	3.0	0.6	100.0	20.0	5.0
Thin fuel oil	20.88	3.0	0.6	100.0	20.0	5.0

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 sector were due to the updating of emission factors to 2006 IPCC guidelines and the activity data used since the 2011 submission.

The changes reported in the 2012 submission are presented in Table 3-20.

Table 3-20 Recalculations for Residential Category

Year	Residential (Gg CO_2 eq.) as reported in the 2011 GHG Inventory	Residential (Gg CO_2 eq.) as reported in the 2012 GHG Inventory	Percentage change in reported emissions (%)
1990	34.49	34.58	0.269688974
1991	38.75	38.85	0.266932828
1992	40.84	40.95	0.271029121
1993	41.62	41.74	0.270926422
1994	40.40	40.51	0.26774011
1995	40.51	40.62	0.265115317
1996	41.14	41.24	0.262904035
1997	40.37	40.48	0.274721604
1998	39.08	39.21	0.322638207
1999	40.41	40.53	0.30035704
2000	39.81	39.93	0.295303304
2001	38.28	38.39	0.294938052
2002	38.72	38.83	0.283265544
2003	41.28	41.39	0.277071219
2004	42.06	42.18	0.274674506
2005	45.46	46.47	2.232883419
2006	48.75	41.58	-14.70739792
2007	49.07	39.45	-19.59805758
2008	47.06	41.61	-11.59409433
2009	43.88	45.77	4.322233487
2010		40.54	

The changes in the agriculture/forestry/fisheries category were due to changes in the emission factors in accordance to IPCC 2006 guidelines and the activity data used since the 2011 submission. For the years 2002-2009, fisheries diesel oil was reported under the national navigation category. Recalculations have been performed to include this activity data with the agriculture/forestry/fisheries category as requested in the IPCC 2006 guidelines. The changes reported in the 2012 submission are as shown in Table 3-21.

Table 3-21 Recalculations for the Agriculture/Forestry/Fisheries Category

Year	Agriculture/Forestry/Fisheries ($Gg\ CO_2$ eq.) as reported in the 2011 GHG Inventory	Agriculture/Forestry/Fisheries ($Gg\ CO_2$ eq.) as reported in the 2012 GHG Inventory	Percentage change in reported emissions (%)
2002	0.000000	5.665674	-
2003	0.000000	2.357233	-
2004	0.000000	5.469482	-
2005	2.560695	7.141652	178.8951
2006	2.945687	7.597172	157.9083
2007	2.891046	9.144827	216.3155
2008	2.841058	9.159460	222.3961
2009	2.897812	10.861063	274.8023
2010		11.899973	-

The emission factors and calorific values for the activity data in the Commercial/Institutional categories were updated to the values in the IPCC guidelines 2006. This resulted in recalculations of the Commercial/Institutional sector. It is important to note that the changes in emissions from 2005-2009 is due to the fact that the commercial/ institutional sector from 2005 to 2009 is no longer included with the Manufacturing/Construction industries. The changes reported in the 2012 submission are as shown in Table 3-22.

Table 3-22 Recalculations for Commercial/Institutional sector

Year	Commerical/Institutional ($Gg\ CO_2$ eq.) as reported in the 2011 GHG Inventory	Commercial/Institutional ($Gg\ CO_2$ eq.) as reported in the 2012 GHG Inventory	Percentage change in reported emissions (%)
1990	61.944977	61.771893	-0.279415692
1991	65.305800	65.100898	-0.313756839
1992	62.299874	62.095342	-0.328301984
1993	61.943476	61.73403	-0.338124089
1994	61.324841	61.110674	-0.349233795
1995	67.662563	67.420456	-0.357814427
1996	66.982494	66.72661	-0.382016512
1997	59.230558	59.024246	-0.34831977
1998	58.497707	58.498815	0.001893184
1999	62.248042	62.153947	-0.151160518
2000	65.724159	65.629271	-0.144371781
2001	50.684484	50.569197	-0.227460658
2002	46.566621	46.411992	-0.332058786

2003	47.715812	47.528354	-0.392862302
2004	59.732394	59.537225	-0.326738755
2005	IE	70.825076	-
2006	IE	65.798463	-
2007	IE	78.675619	-
2008	IE	85.948995	-
2009	IE	90.216116	-
2010		87.745643	

3.3 Fugitive Emissions from Fuels (1B)

3.3.1 Source Category Description

Malta Being a developed state having no major fuel Refining/Abstraction processes of fuels and 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 $0.022Gg/10^3m^3$ of gasoline sold is considered. The EF is extracted from table 4.2.4 of Volume 2 of the 2006 IPCC guidelines [3].

3.3.3 Source specific Recalculations

This calculation was implemented for the first time this year and was applied retrospectively from 2005. The following table illustrates the new values being submitted.

Table 3-23 Fugitive emissions recalculation

Year	**Fugitive emissions (Gg NMVOCs) as reported in the 2011 GHG Inventory**	**Fugitive emissions (Gg NMVOCs) as reported in the 2012 GHG Inventory**
2005	NE	0.198
2006	NE	0.200
2007	NE	0.208
2008	NE	0.209
2009	NE	0.219
2010	NE	0.221

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 3.3% in the year 2010.

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 2010.

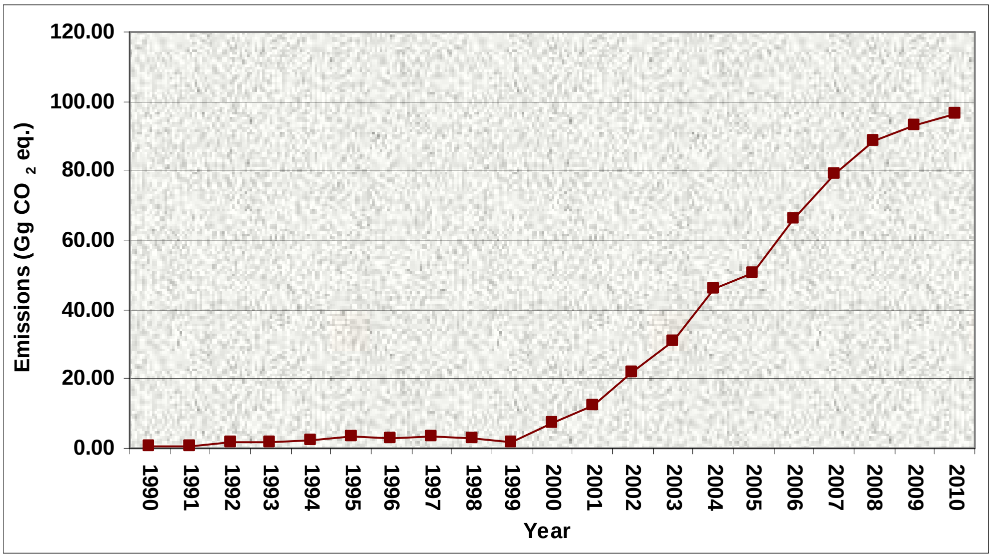

Figure 4-1 Direct GHG Emissions from the Industrial Processes Sector

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.

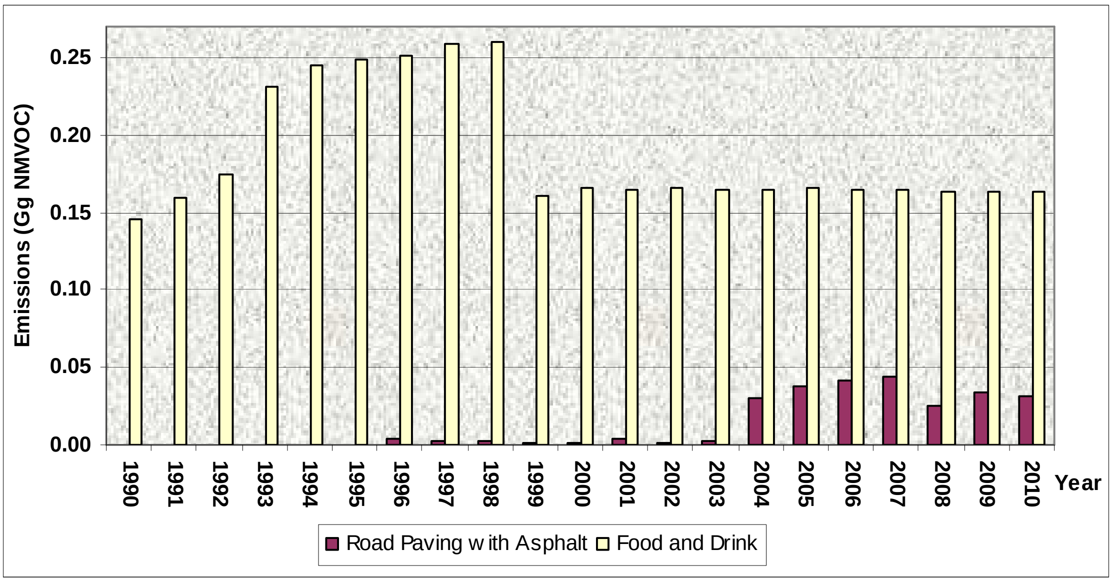

Figure 4-2 Indirect GHG Emissions from the Industrial Processes Sector

4.2 Mineral Industry (2A)

4.2.1 Source Category 2A1 – Cement Production

No relevant activity reported in this sector.

4.2.2 Source Category 2A2 - Lime Production

4.2.2.1 Source Category Description

Lime production 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.

4.2.2.3 Source Specific Recalculations

In previous submissions the emission factor was further multiplied by 0.85 to correct for the efficiency of the process, it is though to be noted that this has been already included in the calculation of the default EF, thus this resulted in incorrect accounting of emissions from the process. Table 4-1 illustrates the differences in emission due to this recalculation.

Table 4-1 Lime production 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	1.250984	1.318	5.34%
1996	1.133504	1.194	5.34%
1997	1.186904	1.250	5.34%
1998	0.60876	0.641	5.34%
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

No relevant activity reported in this sector.

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:

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

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

4.2.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.2.5 Source Category 2A5 – Asphalt roofing

No relevant activity reported in this sector

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 the 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:

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

4.2.6.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.2.7 Source Category 2A7 – Other

No relevant activity reported in this sector.

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

No relevant activity reported in this sector.

4.3.2 Source Category 2B2 – Nitric Acid Production

No relevant activity reported in this sector.

4.3.3 Source Category 2B3 – Adipic acid Production

No relevant activity reported in this sector.

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.

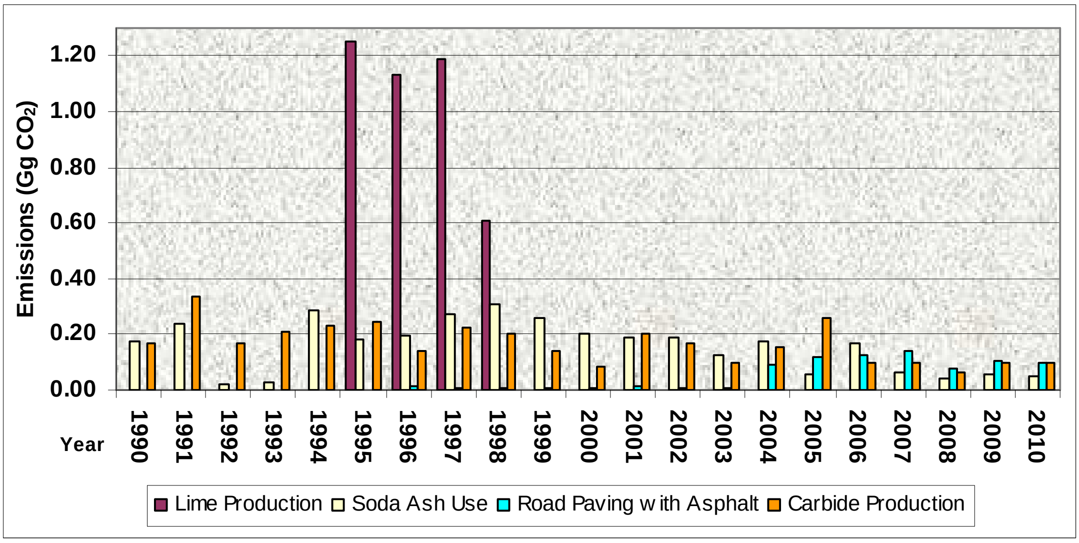

Figure 4-3 Carbon Dioxide Emissions from Lime Production, Soda Ash Use, Road Paving with Asphalt and Carbide Production

4.3.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission

4.3.5 Source Category 2B5 – Other

No relevant activity reported in this sector.

4.4 Metal Production (2C)

No relevant activity reported in this sector.

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

No relevant activity reported in this sector.

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. 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 which is only available in monetary production figures.

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) 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)

No relevant activity reported in this sector

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.

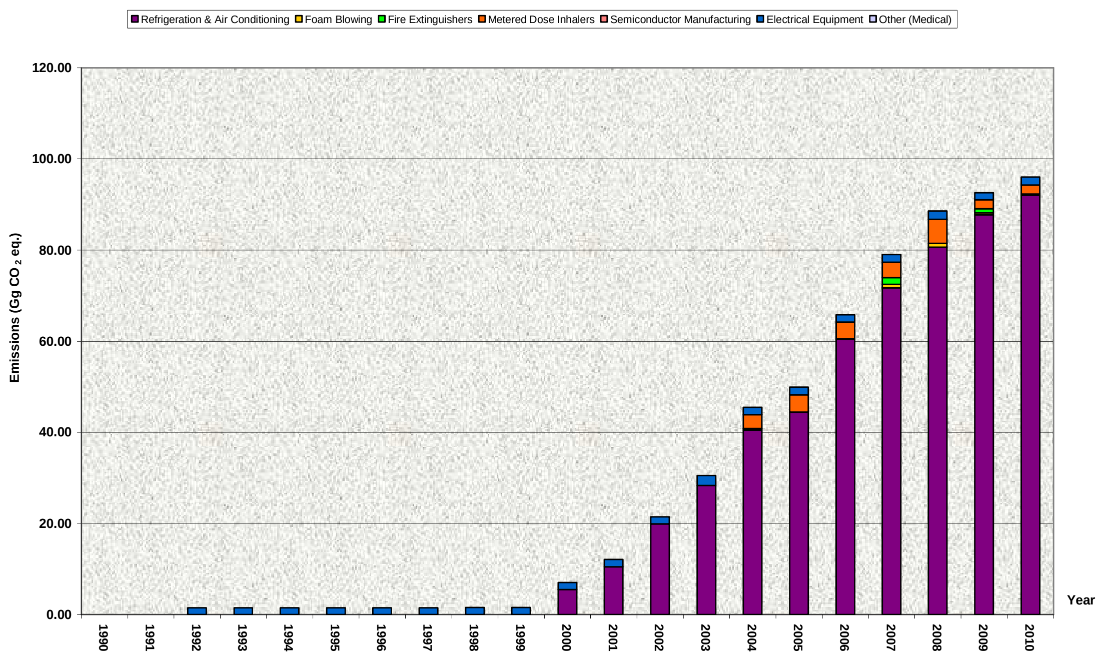

Figure 4-4 depicts graphically the emission trends from the different applications of PFCs, HFCs and SF_6. The annual emissions from each sub-category are shown by the differently coloured bars. Potential emissions of fluorinated gases, as reported from importation data are also shown.

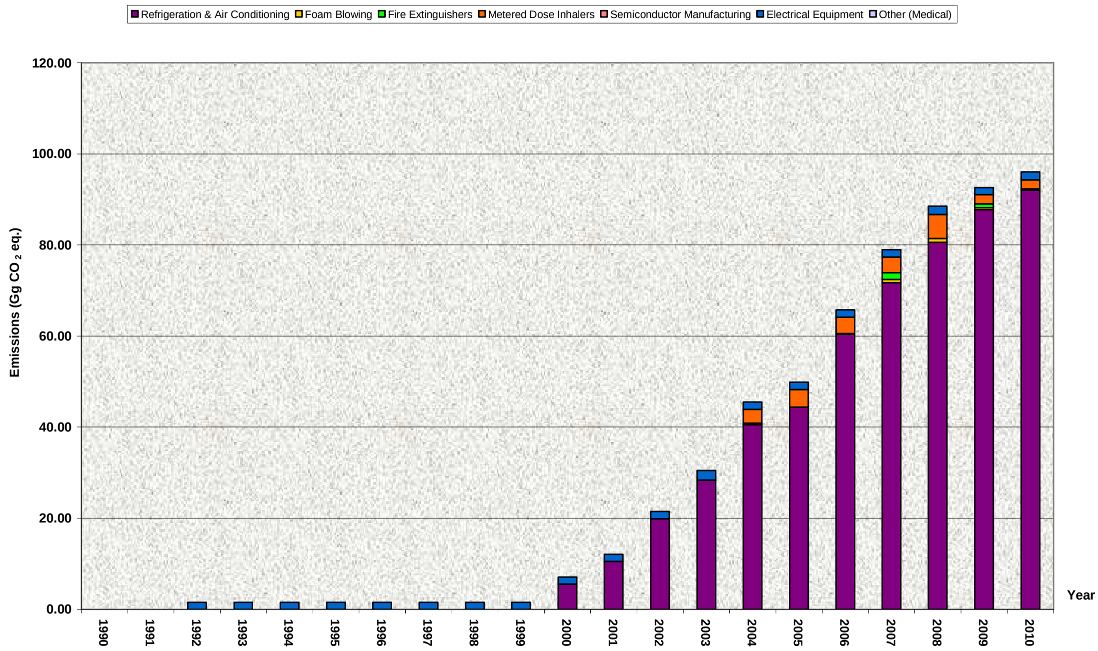

Figure 4-4 Actual Emissions from HFCs, PFCs and SF_6 in CO_2 Equivalents

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

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. The local businesses involved in the importation, were sent a questionnaire. Such businesses were asked to indicate consumption of the fluorinated gases, be they in blends or otherwise.

4.7.2.3 Source Specific Recalculations

Potential emissions in previous submissions were calculated by simple extrapolation of data from 2005-2008 imports. This methodology was kept for data prior to 2005, though since actual import data is available from 2005 onwards, this data was utilised for this submission. In addition the emissions are classified according to gas from the data available.

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 2011 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 10% 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 expert judgement. Moreover, importation figures for each gas from the respective year of introduction till 2004 have been estimated by expert judgement to be equal to the average for the years 2005 to 2010. Furthermore, it is assumed that gases which were not imported between 2005 and 2010 were not imported previously.

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.

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

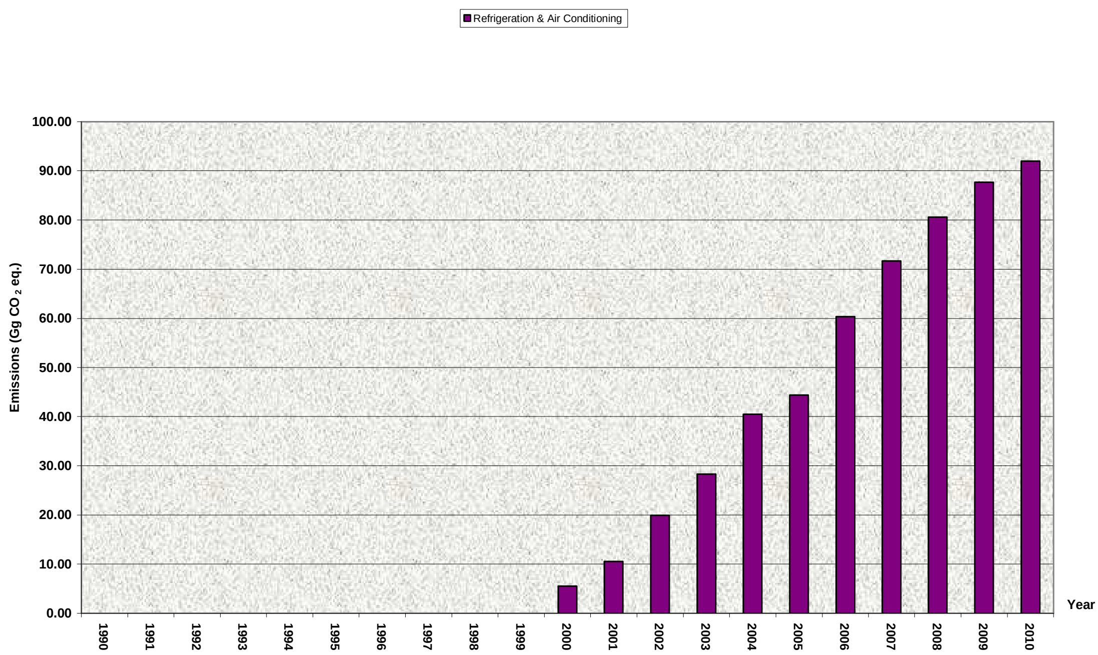

Figure 4-5 Actual RAC emissions

4.7.3.3 Source Specific Recalculations

Data from RAC for all the years was updated and input in the model. The above mentioned assumptions on the period 2000 to 2004 were also included in the current submission, this together with additional data on blends and gases used.

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, 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

Table 4-2 Emissions in CO2 Equivalents from Open-celled and Closed-celled FoamsTable 4-2 includes emissions in CO_2 equivalents for both open-celled and closed-celled foams. Emissions are available only for the most recent years, since it was not possible to estimate the emissions for the previous years.

Table 4-2 Emissions in CO2 Equivalents from Open-celled and Closed-celled Foams

Year	Emissions (Gg CO_2 eq.)	
	Open-Cell	Closed-Cell
2006	0.19	-
2007	0.78	-

2008	0.78	0.05
2009	0.39	0.07
2010	NO	NO

4.7.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.7.5 Source Category 2F3 - Fire Extinguishers

4.7.5.1 Source Category Description

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

4.7.5.2 Methodological issues

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

Due to availability of new updated data for 2009 that was included in the inventory, the following recalculation was done.

Table 4-3 Recalculation of emissions from fire extinguishing agents

Year	Releases to air HFC-227ea (Kg)		% Difference
	2010 Submission	2011 Submission	
2004	122	122	0
2005	0	0	0
2006	0	0	0
2007	501	501	0
2008	5	5	0
2009	297	642	116.17
2010		584	

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 4-4 below.

Table 4-4 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	1.97

4.7.6.1.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

4.7.6.2 Source Category 2F4.2 – Aerosols

No relevant activity reported in this sector.

4.7.7 Source Category 2F5 – Solvents

No relevant activity reported in this sector.

4.7.8 Source Category 2F6 – Other Applications Using ODS Substitutes

No relevant activity reported in this sector.

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.

4.7.9.2 Methodological issues

These entities reported no direct use of PFCs in Malta. One entity reported the installation on its premises since the year 1999 of equipment containing the blend gas R508A. This blend fluorinated gas consists of 39% HFC-23 and 61% PFC-116. The quantity of gas installed in the equipment amounts to 5.44kg. An annual loss rate of 0.2% was applied to cater for potential leakage that may result from operation/maintenance of the banked R508A.

4.7.9.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

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 97% of the total estimated in 2010). 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 the constantly over its lifetime Identified switchgear equipment which no estimates have been provided by the operator, IPCC 2006 default emission factors have been used.

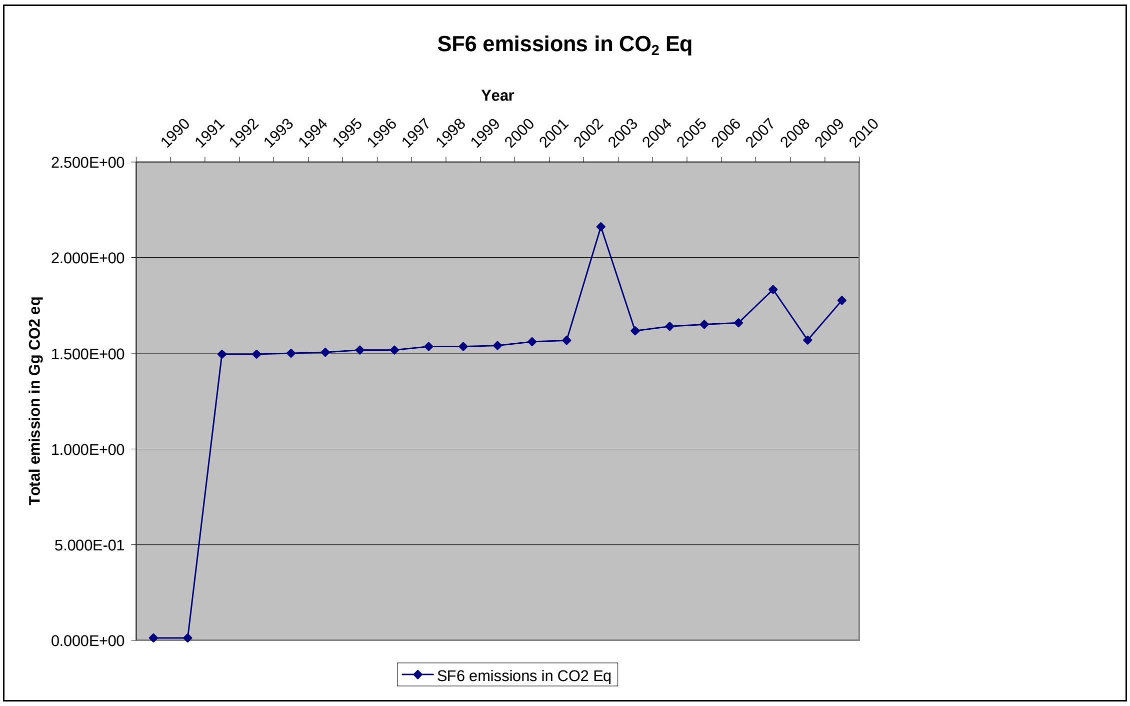

Figure 4-6 SF_6 Emissions in CO_2 Equivalents from Electrical Equipment

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.

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 Source Category 3D1 -Use of N_2O for Anaesthesia

5.2.1 Source Category Description

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

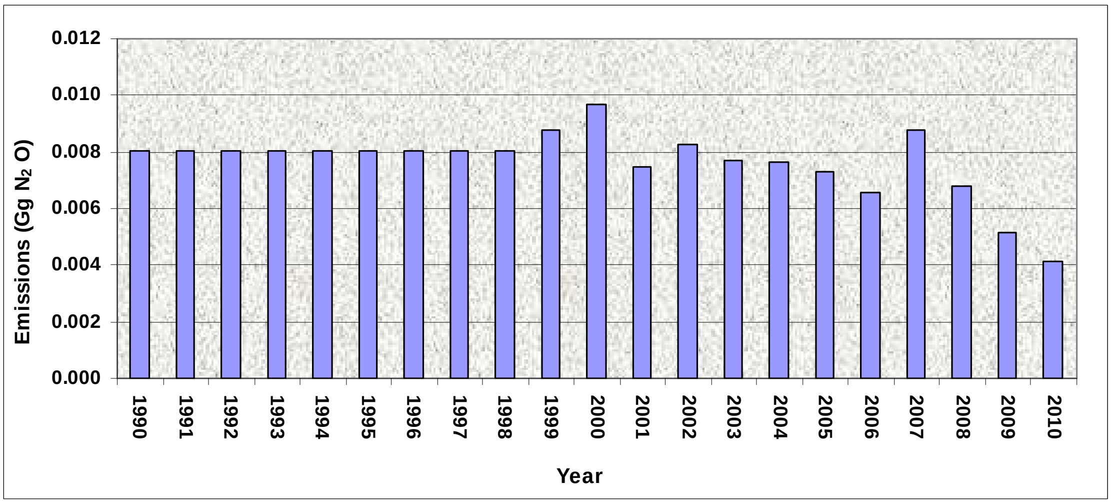

Figure 5-1 Nitrous Oxide Emissions from Anaesthetic Use

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

5.2.2 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.

5.2.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

5.3 Source Category 3D5 - Total Solvent Use

5.3.1 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. .

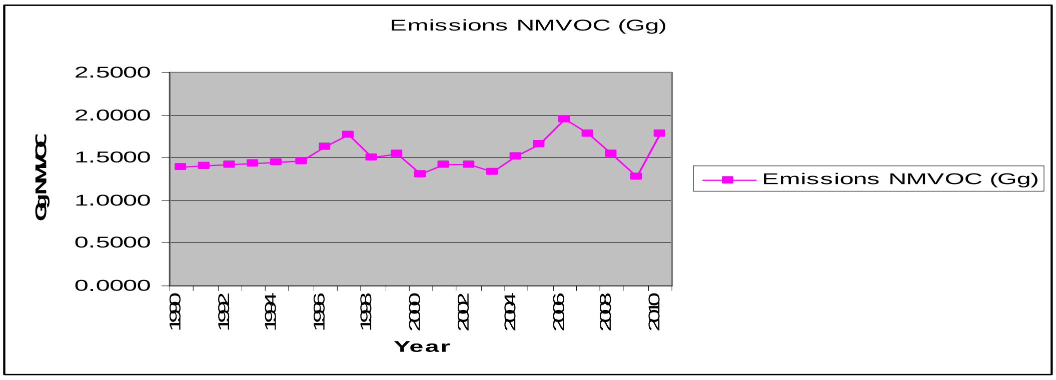

Figure 5-2 NMVOC Emissions from the Use of Solvents and Solvent-containing Products

Figure 5-2 shows a gradual increase in NMVOC emissions over the inventory 1990 to 2009 time series.

5.3.2 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.

5.3.3 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] [57], the Farm Structure Survey [31], the Cattle Survey [52], the Pig Census [53] the Sheep and Goats Survey 2010 [54], Agriculture and Fisheries 2010 [56].

Figure 6-1 below shows the emissions in carbon dioxide equivalents from the Agriculture sector for the years 1990 till 2010.Agriculture sector in Malta contributes around 2.6% of the total national GHG emissions. Greenhouse gas emissions mainly result from enteric fermentation (37.7%) and manure management (40.1%) and to a lesser extent from agricultural soils (22.3%). Total emissions decreased by 5.60 Gg CO_2 from 2009 to 2010.

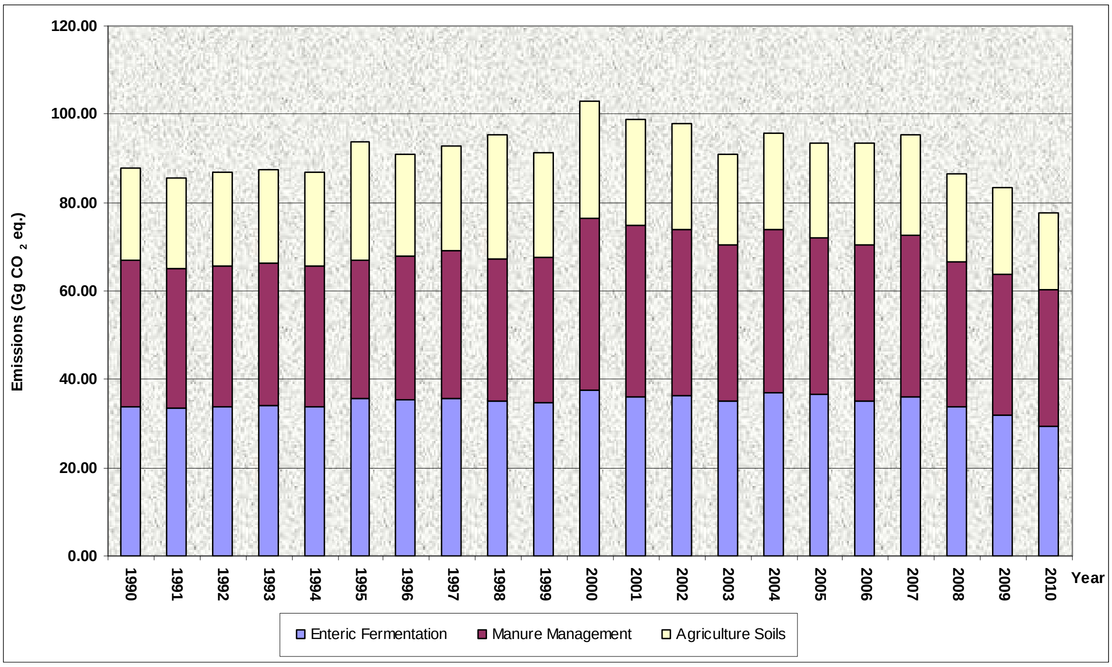

Figure 6-1 Emissions in Carbon dioxide Equivalents from the Agriculture Sector for 1990 to 2010

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 2010, CH_4 emissions from this category were 1.39 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 [22-34; 52-54] 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 inTable 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	853	70583	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, 61.1% 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 [35] 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 [36] from the bovine register, which is maintained by the Department of Veterinary Services. The cattle stock as at December 2010 amounted to 14,954 heads on 341 farms, a decline of 8.1% over 2009 [52]. 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 diary cows has decreased by 569 heads between 2009 and 102010. For other cattle a reduction in headcount is observed between 2009 and 2010 amounting to a decrease of 741 heads.

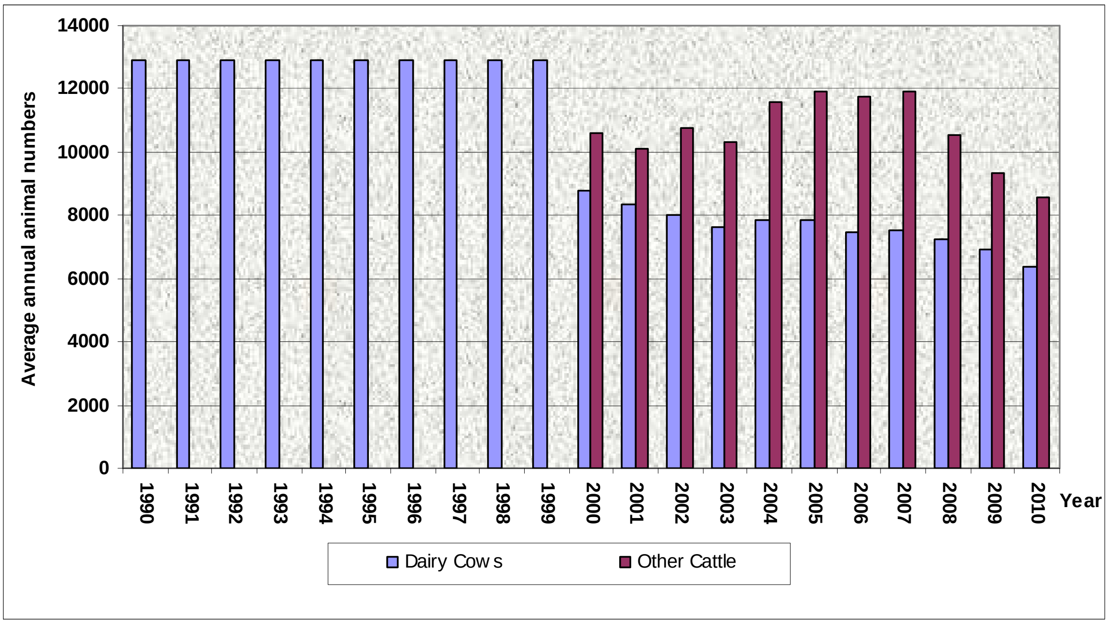

Figure 6-2 Annual average Cattle Figures

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 [37], 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 2010 Agriculture and Fisheries statistics [54] shows that in 2010 there were 1,395 holdings involved in sheep rearing. Just over 75% of these holdings have less than 10 sheep and amount for 29.8% of the sheep population. On the other hand, while only 23.9% of all holdings have more than 10 sheep they account for 70.2% of the sheep stock. The distribution of the goat stock is somewhat similar, where 42.2% of all goats are on holdings having less than 10 goats, which holdings amount to 84.8% of all goat rearing holdings whereas the remaining 57.8% of the goat population is on holdings with 10 goats or more.

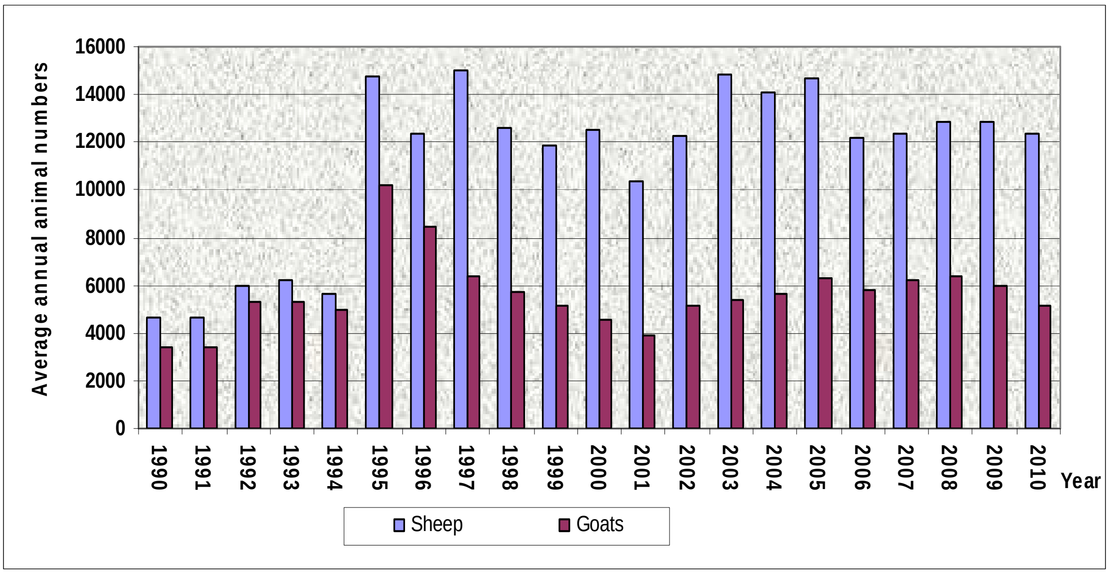

Figure 6-3 Average Annual Sheep and Goats Figures

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 2010, the sheep population amounted to 12,379 heads, an decline of 4.0 % over 92009. As for the goat population, it stood at 5,110 heads, down by 14.6% over the previous years. Figure 6-3 shows 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 2010, the pig stock increased by 7.1% which translates to 4,665 pigs, following a decline of 0.6% in 2009 and a decrease of 14.8% in 2008, that is a decline of 11,389 pigs in 2008 over 2007.

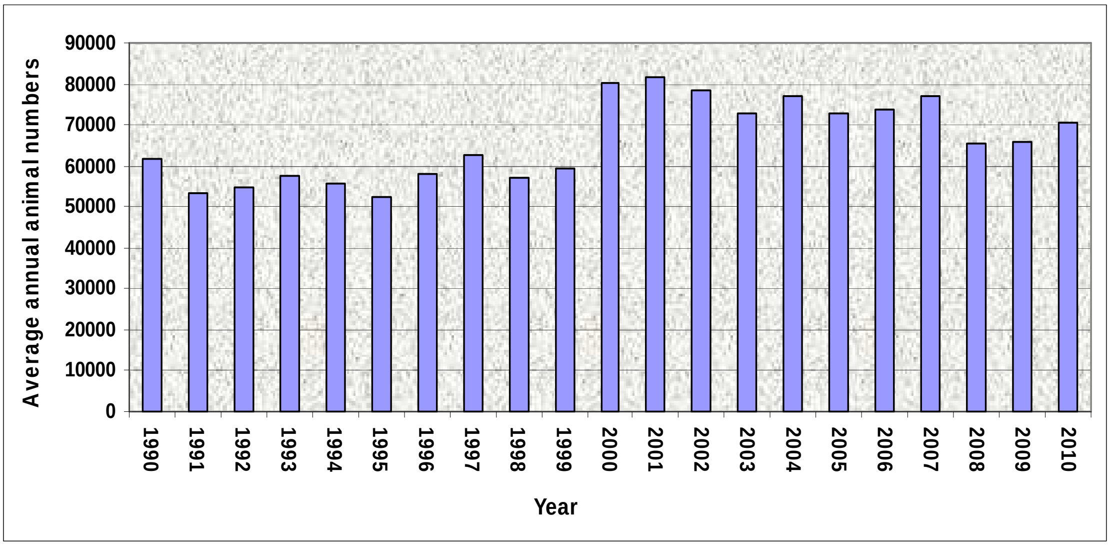

Figure 6-4 Average Annual Swine Figures

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 Statistic 2010 [56], a total of 970,291 animal heads represents a decrease of 20.7% over 2009.

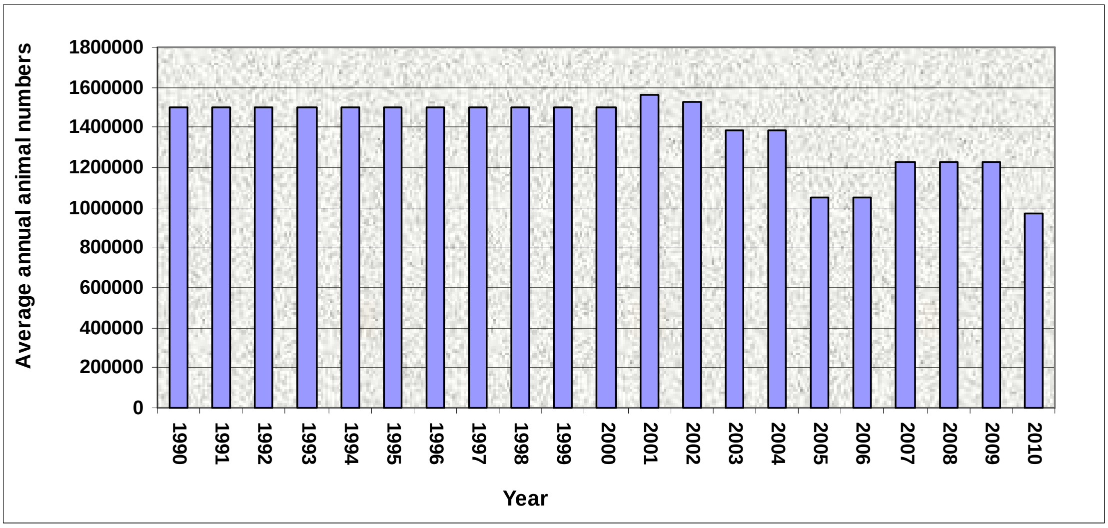

Figure 6-5 Average Annual Poultry Figures

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] and in the 2001 Agriculture Census [25]. Following the year 2001, no other equine population survey has been carried out. The data regarding headcount refer to the number of animals that were present on the farm on the 30th September 2001. The classification of all animal categories was collected strictly according to Eurostat's classification. The latest rabbit numbers are represented in the 2010 Agriculture Census [57].

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]

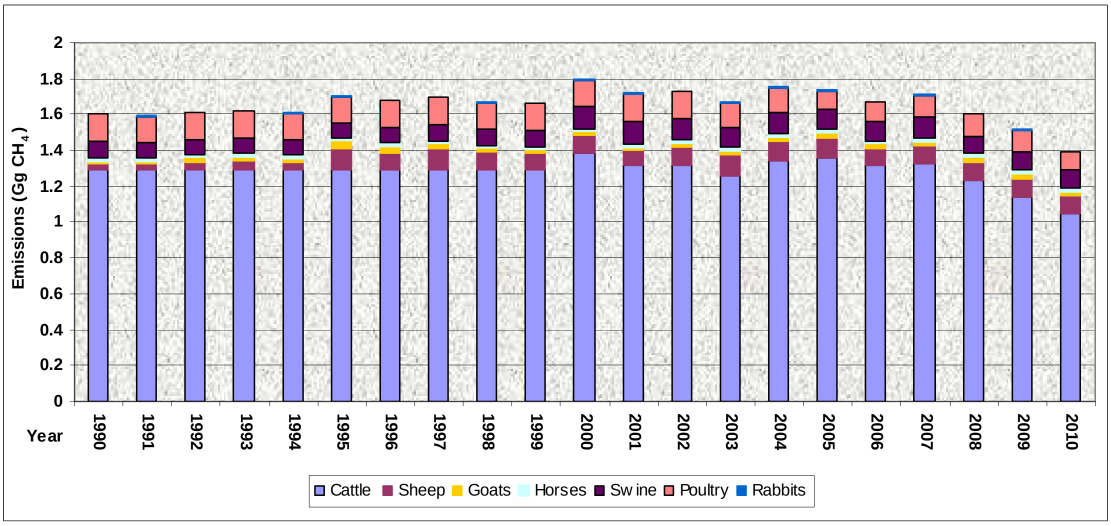

Figure 6-6 Methane Emissions from Enteric Fermentation

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 74% of those emissions, followed by the contribution from poultry, swine and sheep. 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

No recalculations have been carried out from the previous submission.

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.

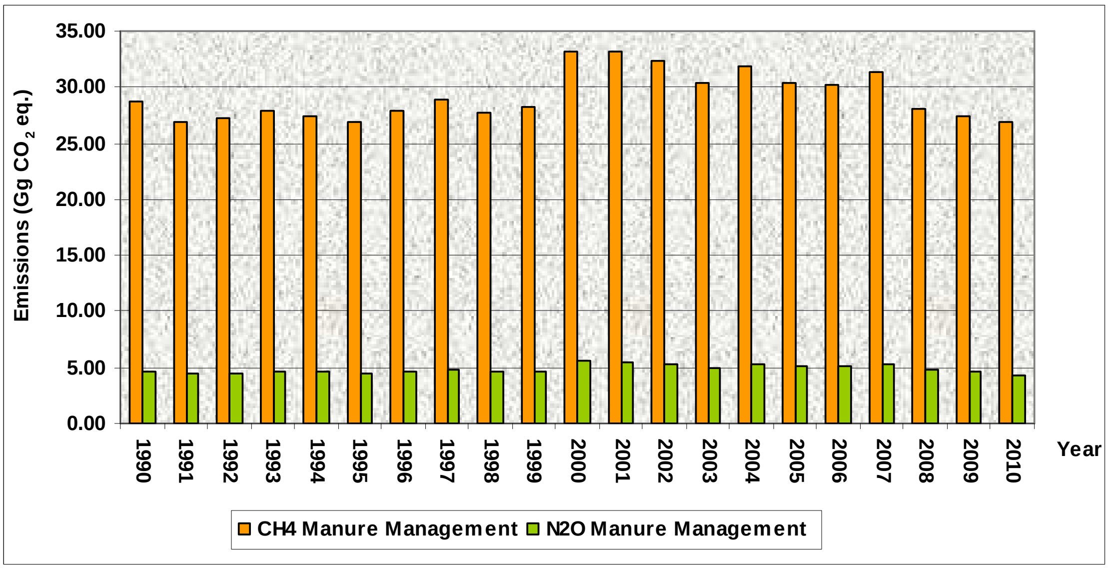

Figure 6-7 Methane and Nitrous Oxide Emissions from Manure Management

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 [38]

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 [39]. 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 [40].

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

No recalculations have been carried out from the previous submission.

6.4 Rice Cultivation (4C)

This source category is not relevant 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 2010. 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.

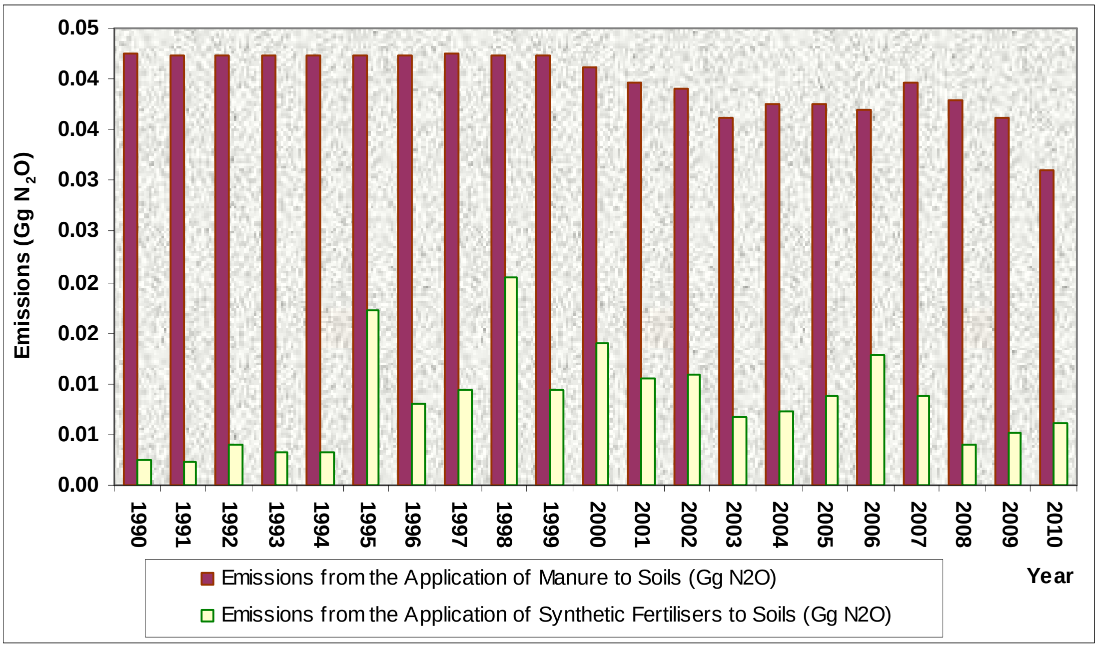

Figure 6-8 Nitrous Oxide Emissions from Agriculture Soils

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 [41] – Nitrogenous Fertiliser Consumption;
- for 1995 to 2010: 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. In the absence of such data it would be required to develop alternative means of deriving the required data.

6.5.2 Source Category 4D3 - Indirect Soil Emissions

6.5.2.1 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 2010 in this category are presented in Figure 6-9.

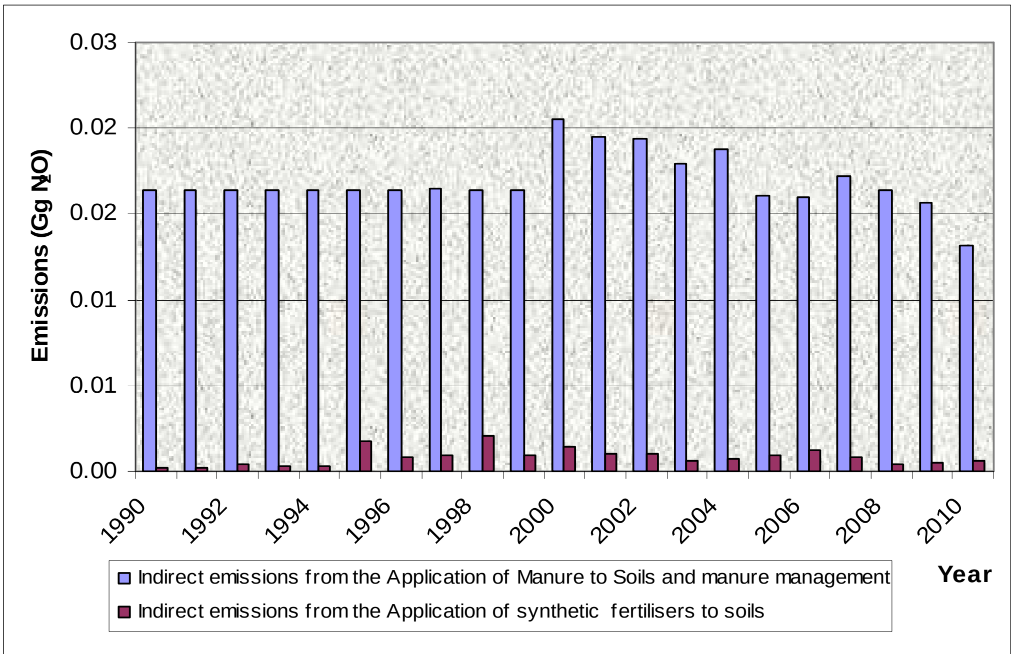

Figure 6-9 Indirect emissions from manure management and agricultural soils

6.5.2.2 Methodological Issues

6.5.2.2.1 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)

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

where

$N_2O_{(ATD)}$-N = annual amount of N_2O-N produced from atmospheric deposition of N volatilised from managed soils, kg N_2O-N yr^{-1}
F_{SN} = annual amount of synthetic fertiliser N applied to soils, kg N yr^{-1}
$Frac_{GASF}$ = fraction of synthetic fertiliser N that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied)$^{-1}$
F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}
F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, 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.

6.5.2.2.2 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.

6.5.2.2.3 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.

6.5.2.3 Source Specific Recalculations

No specific recalculations have been carried out. However errors have been determined in the final presentation of results for the subsectors manure management and manure applied to soils which led to amendments in the final values for indirect emissions from manure applied to soils. These amendments are tabulated in Table 6-6.

Table 6-6 Recalculation for indirect emissions from agriculture

Year	Indirect-Manure Management + soils (Gg CO_2 eq.) as reported in the 2011 inventory	Indirect-Manure Management + soils (Gg CO_2 eq.) as reported in the 2012 inventory	Percentage change in reported emissions (%)
1990	5.10	5.10	0.00
1991	5.07	5.07	0.00
1992	5.05	5.07	0.50
1993	4.88	5.08	4.10
1994	5.08	5.08	0.00
1995	5.07	5.07	0.00
1996	4.88	5.08	4.10
1997	5.07	5.10	0.57
1998	5.08	5.08	0.00
1999	5.08	5.09	0.06
2000	6.38	6.38	0.00
2001	6.44	6.05	-6.03
2002	5.20	6.02	15.94
2003	5.72	5.58	-2.48
2004	5.33	5.81	9.09
2005	5.07	4.99	-1.49
2006	7.61	4.94	-35.05
2007	5.14	5.34	3.82
2008	5.09	5.09	0.00
2009	4.86	4.86	0.00

6.6 Source Category 4E - Prescribed Burning of Savannas

This source is not relevant in the Malta.

6.7 Source Category 4F - Field Burning of Agricultural Residues

No activity data reported.

As was mentioned in section 6.5 investigation is being undertaken to analyse whether data that is appropriate for the estimation of emissions is directly available locally, in consultation with the relevant entities and in the absence of which there is the need to develop alternative means of deriving the required data.

6.8 Source Category 4G - Other

Under this category there are no emissions reported 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 2010 has a net removal of -61.58Gg CO_2 equivalent.

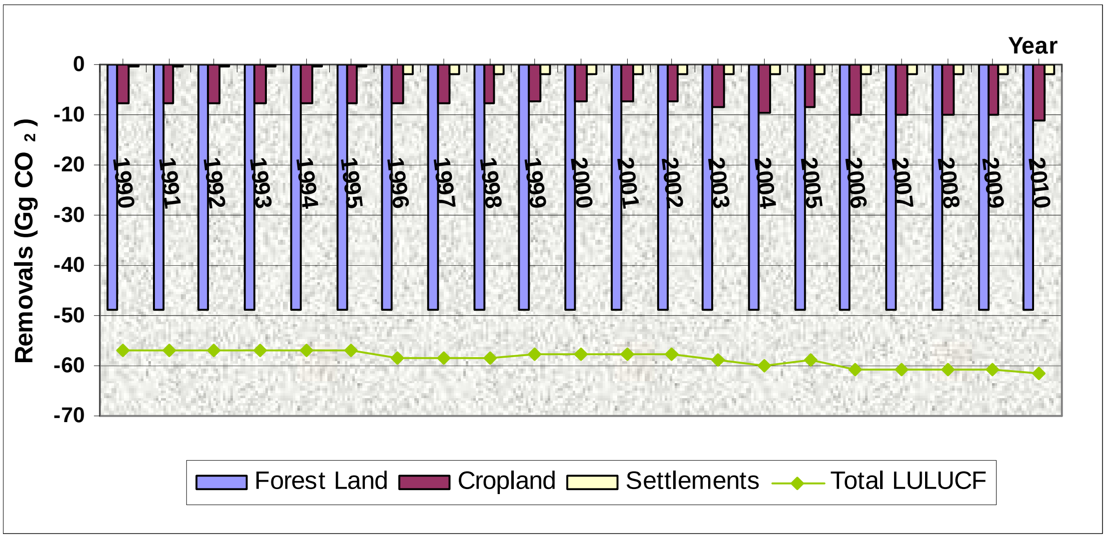

Figure 7-1 LULUCF Carbon Dioxide Removals

Figure 7-1 shows the carbon dioxide removals by vegetation in the LULUCF sector for Malta. A mean figure of -58.6 Gg CO_2 has been estimated to be sequestered annually by Maltese vegetation during the time series 1990 to 2010. Forest land removes 83% of CO_2, followed by 14.4% from Cropland and a very small contribution of 2.5% by vegetation in Settlements.

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). Other land (5F) was also included for the first time in this inventory [42].

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

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 2010, more than 81,180 trees and shrubs have been planted. This year Eco-Gozo project was incorporated. There were 2280 trees and shrubs planted in 2010. The potential carbon removals from such young plantations is 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.

7.2 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 [50]. 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 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).

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 by shrubland was also available from MEPA's Map Server on-line Geographic Information System (GIS). The methodologies as available in the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry have been followed [42].

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 [42]

* 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[51].

7.2.5 Source Specific Recalculations

Data with regards to dead organic matter, litter and mineral soil was not estimated prior to this submission thus all the time series has been estimated with this submission. The fact that Tier 1 was used the result for the three parameters is zero.

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 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 (77.6%);

ii) Kitchen gardens that include small plots of cultivated land (9.6%), 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 (12.8%).

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.

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 [42] has been applied to the activity data.

In this year report, mineral soil was included, the methodology used considers organic stock changes. Tier 1 was considered, changes in dead organic matter and inorganic carbon should be assumed to be zero.

Liming of agricultural soils is not applicable to Malta as our soils content has a large calcium carbonate content. Malta soils are Leptosols, vertisols, calcisols, luvisols, cambisols, regosols and arensols (data derived from the MALSIS database) [55].

The equation used 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 the end of 2011, the National Statistics Office issued a news release on 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 for Other land converted to Cropland was available in the LULUCF Good Practice Guidance.

When there was an increase in the Cropland size area of land it was assumed that the land came from Other Land converted to Cropland. The assumption is based on the fact that the only land use that changed was that of the Cropland. The years that were effected are 2003, 2004, 2006, and 2010. As for the decrease in Cropland area size, it was assumed that it was land converted to Other land.

7.3.3 Source Specific Recalculations

Data with regards to carbon stock changes for mineral soils was not estimated prior to this submission thus all the time series has been estimated with this submission. Through this estimation it resulted that the carbon stock change is zero. Where there was a change it was due to conversion of land. Table 7.2 summarises the data for the calculation of the time series.

Table 7-2 Recalculation for change in carbon stocks in mineral soil from cropland remaining cropland

Year	Previous submission entries for Mineral Soils	2012 Submission values for Mineral Soils (Gg CO_2 eq.)
1990	NE	0
1991	NE	0
1992	NE	0
1993	NE	0
1994	NE	0
1995	NE	0
1996	NE	0
1997	NE	0
1998	NE	0
1999	NE	0
2000	NE	0
2001	NE	0
2002	NE	0
2003	NE	0
2004	NE	0
2005	NE	0
2006	NE	0
2007	NE	0
2008	NE	0
2009	NE	0
2010		0

7.4 Settlements (5E)

7.4.1 Source Category Description

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.

7.4.2 Methodological Issues

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) [42] have been applied to the activity data.

7.4.3 Source Specific Recalculations

No recalculations have been carried out from the previous submission.

7.4.4 Category-Specific Planned Improvements

In this section more data is needed to calculate the change in use of land. Areas of land use change will be compiled from various sources. Also takes account areas of land use change to forest (afforestation) which can result from planting data.

This will provide new information on areas of land use and land use change from 1990 till present. Discussions with the other agencies about analysis of the raw data that would produce information for the inventory are ongoing.

7.5 Other land (5F)

7.5.1 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]

7.5.2 Methodological Issues

The method used was;

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

7.5.3 Source Specific Recalculations

Data with regards to Other land was not estimated prior to this submission thus all the time series has been estimated with this submission. Table 7-3 summarises the data for the calculation of the time series.

Table 7-3 Recalculation for Other land

Year	Previous submission entries for Mineral Soils	2012 Submission
1990	NE	29716.59
1991	NE	29716.59
1992	NE	29716.59
1993	NE	29716.59
1994	NE	29716.59
1995	NE	29716.59
1996	NE	29576.19
1997	NE	29576.19
1998	NE	29576.19
1999	NE	29658.6
2000	NE	29658.6
2001	NE	29658.6
2002	NE	29658.6
2003	NE	29516.3
2004	NE	29364.8
2005	NE	29506.7
2006	NE	29274.7
2007	NE	29274.7
2008	NE	29274.7
2009	NE	29274.7
2010		29170.7

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 2010 are presented. Emission sources include Solid waste disposal (6A), Wastewater handling (6B), Waste incineration (6C) and Compost production (6D).

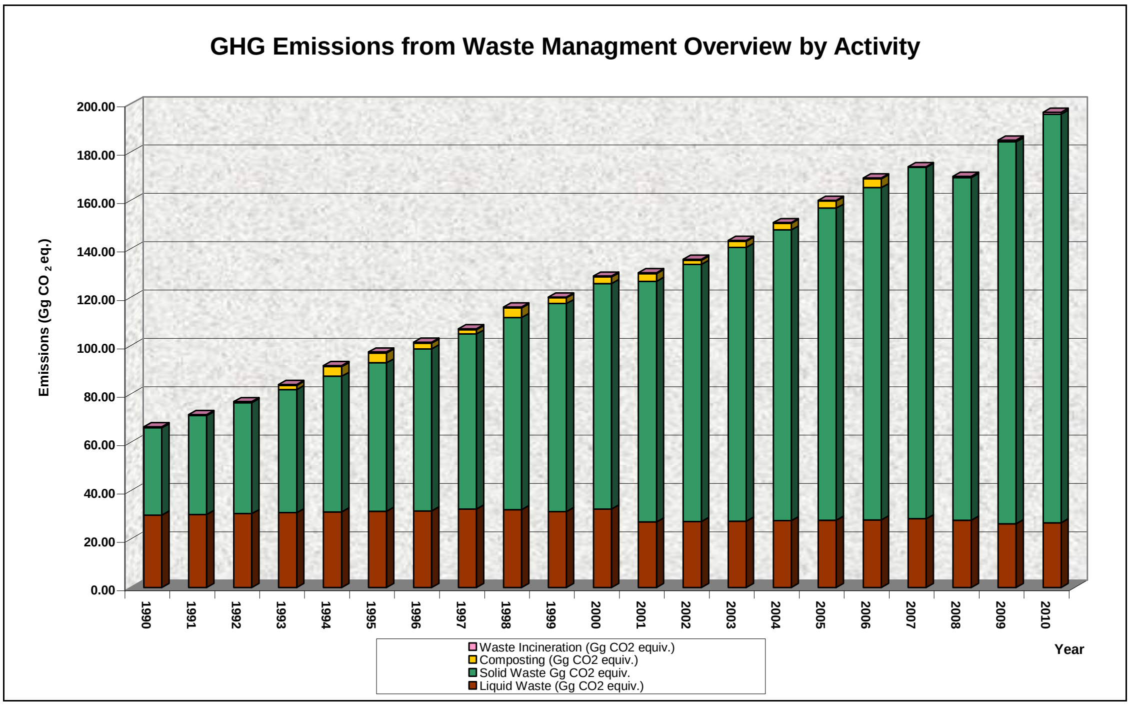

Figure 8-1 Total emissions for waste sector

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 2010. The waste sector contributes 6.6 % to the total GHG inventory emissions. Within this sector, the largest portion of emissions for the reporting year 2010 results from the solid waste category (86.0%), followed by the contribution from liquid waste (13.6%) and much less significant contribution resulting from waste incineration (0.4%). Greenhouse gas emissions have increased by 48.4% from 1990 to the year 2000, with a continuation of this trend between the year 2000 and the latest inventory year, 2010, with an increase of 36.3%.

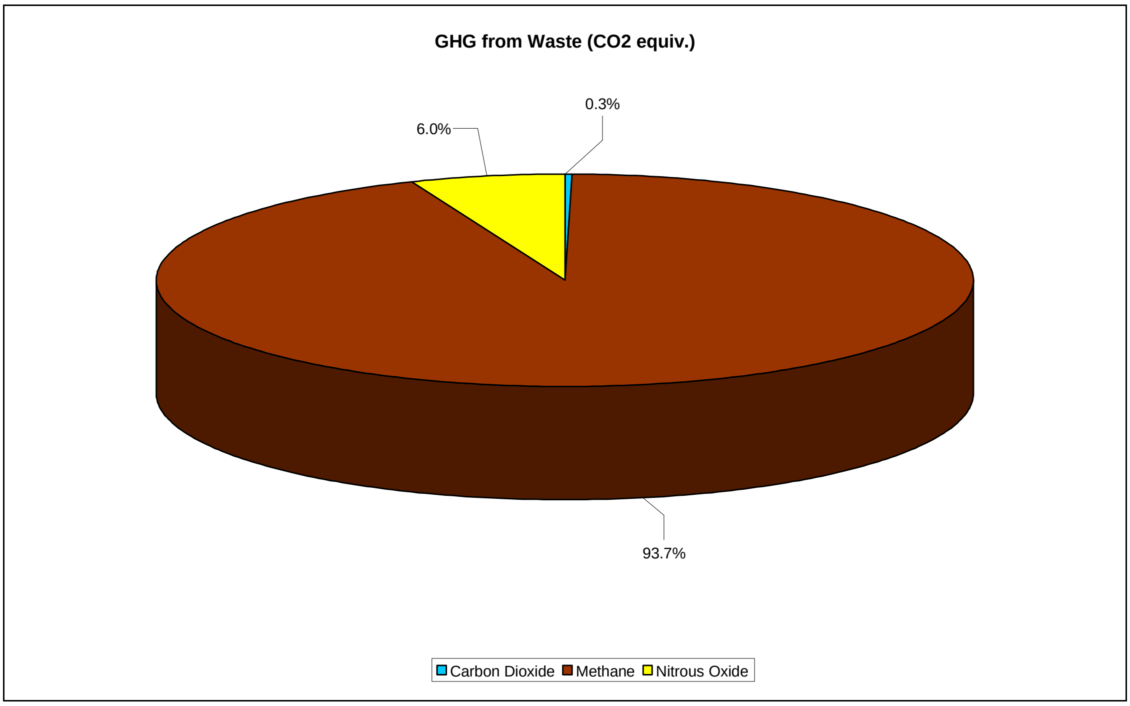

Figure 8-2 GHG from Waste in CO_2 eq.

Figure 8-2 shows the percentage contribution in carbon dioxide equivalents of carbon dioxide, methane and nitrous oxide emissions in the year 2010 from the waste sector. The waste sector largely comprises methane emissions that mainly result from solid waste disposal.

8.2 Solid Waste Disposal on Land (6A)

8.2.1 Source Category Description

Solid waste disposal on land in Solid Waste Disposal sites (SWDSs) leads to CH_4 emissions. From 1990 to 1996, solid waste was deposited into three unmanaged landfills: 'Magħtab' and 'Wied Fulija' in Malta and 'Qortin' in Gozo. In 1997 waste stopped being deposited at Wied Fulija and thereafter, until 2004, all the waste generated between the years 1997 to 2004 was deposited at Magħtab and Qortin. Eventually, from 2004, waste deposition in unmanaged landfills stopped and between the period 2004 and 2006 the waste was deposited at the Ta' Żwejra managed landfill. The Għallis non-hazardous managed landfill has been operational since 2007. Magħtab, Wied Fulija, Qortin, Żwejra and Għallis Landfills are under the responsibility of one company, 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. Methane generated in the

Magħtab landfill is being directed to the RTO. Through ongoing communication with Wasteserv Malta Ltd, the quantities of methane oxidised to carbon dioxide during operation at the RTO 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.

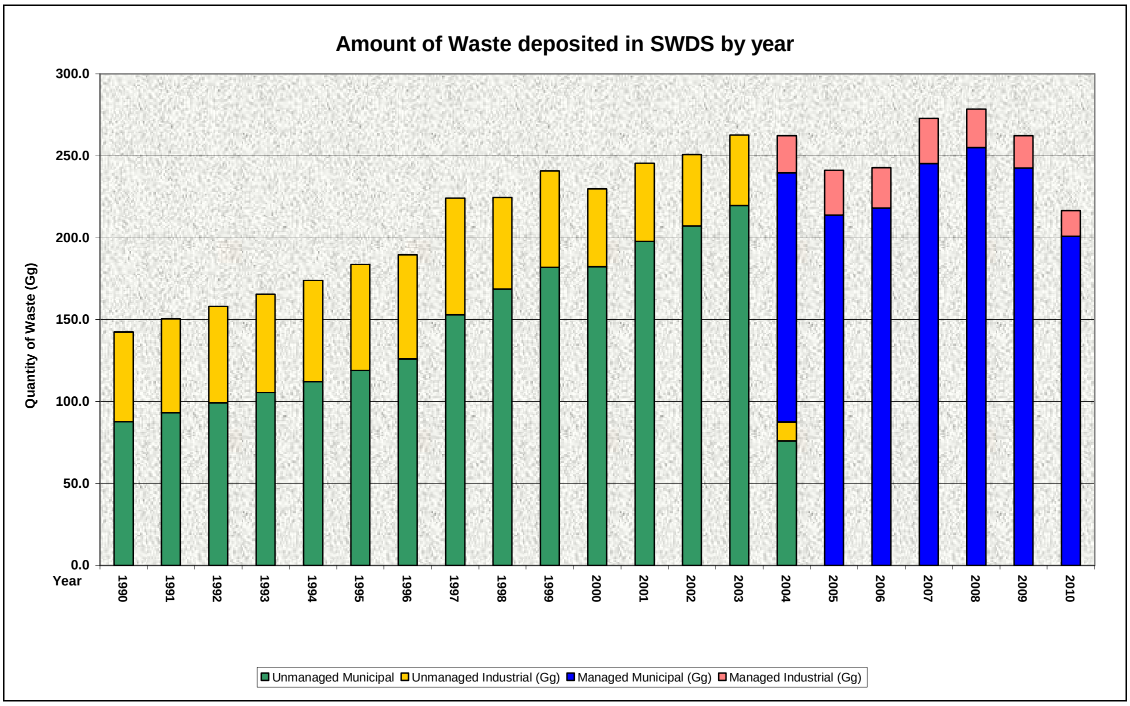

Figure 8-3 Amounts of waste deposited in SWDS by SWDS type

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 for 2009.

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, 1977 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 result 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

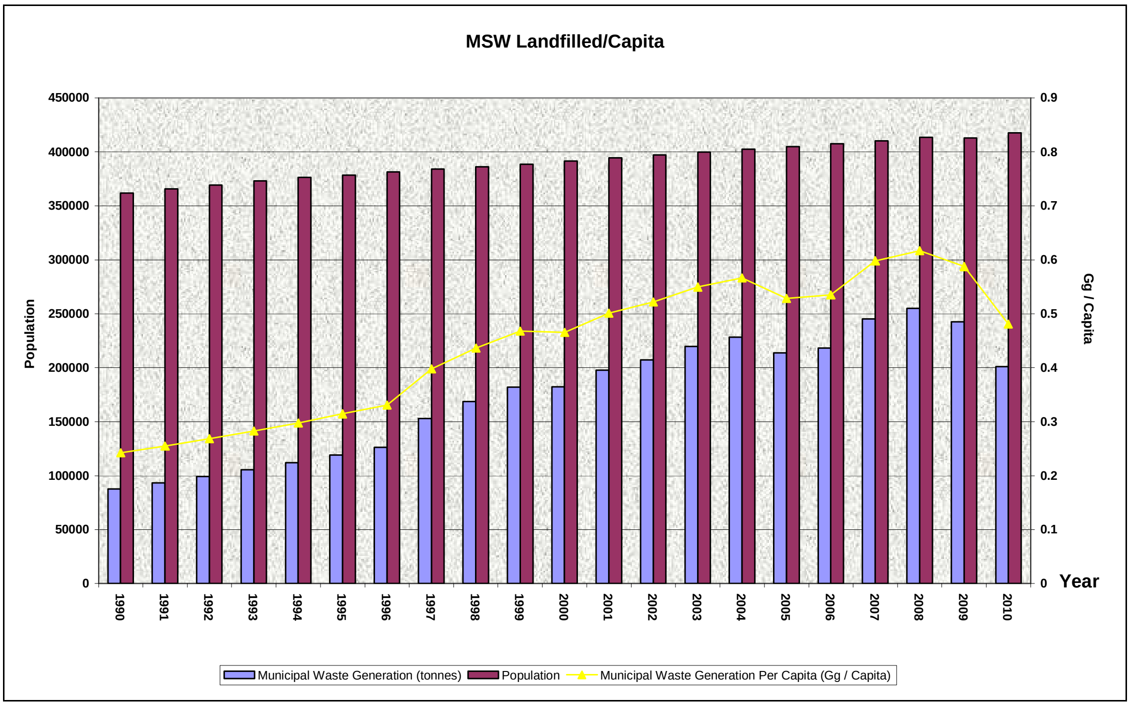

Figure 8-4 Solid waste deposited in SWDSs per capita

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) = 0.6
  - 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) = 0
- % content of paper in industrial waste = 14%
- % content of wood in industrial waste = 5%

Bulk Waste activity data only used for calculation of emissions.

8.2.3 Source Specific Recalculations

In previous Submissions Landfilling of Sewage sludge was considered as part of landfilling of industrial waste, in this submission landfilling of sewage sludge from the year 2009 is being considered separately. Using IPCC default values for degradable organic Carbon (DOC) and Methane Generation Rate Constant (k). Default IPCC values are used for the other k, DOC and MCF values.

Section 3.2.2 of The IPCC 2006 Guidelines [3] it is specified that the FOD model requires 50years of Data to achieve accurate emission estimate, thus the previous submission estimates which covered from 1977 (34 years) were recalculated as described in section 8.2.2 to cover from 1950 (60 years). The sum of these recalculations resulted in the following changes in data reported.
An arithmetic error was identified in the excel model used which affected all years starting 1990, and was corrected in this submission

Table 8-1 Recalculation of emissions from SWDS

Year	Current Submission	Previous Submission	% Difference
	Gg CO_2 eq	Gg CO_2 eq	
1990	36.1	82.31	-56.10%
1991	40.9	89.19	-54.12%
1992	45.9	95.25	-51.86%
1993	50.9	101.47	-49.83%
1994	56.1	107.95	-48.06%
1995	61.4	114.97	-46.61%
1996	66.9	120.03	-44.27%
1997	72.4	126.34	-42.67%
1998	79.3	128.82	-38.41%
1999	86.0	131.30	-34.47%

2000	93.2	134.49	-30.69%
2001	99.6	136.89	-27.26%
2002	106.4	140.00	-24.00%
2003	113.2	143.20	-20.97%
2004	120.2	146.83	-18.13%
2005	129.1	155.31	-16.86%
2006	137.4	163.84	-16.16%
2007	145.3	171.84	-15.42%
2008	141.7	168.80	-16.03%
2009	158.0	185.41	-14.79%
2010	168.9		

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 is presently being upgraded 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.

Emissions from the wastewater category contribute 14.9% 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. For the years 2007, 2008, 2009 and 2010, annual wastewater generation and treatment figures have been provided by the Water Services Corporation. The variations in wastewater production and treatment, as well as the variation in the annual population figures explain the resultant fluctuations in the emissions reported from wastewater in **Figure 8-5**, particularly the stepped variation between 2000 and 2001.

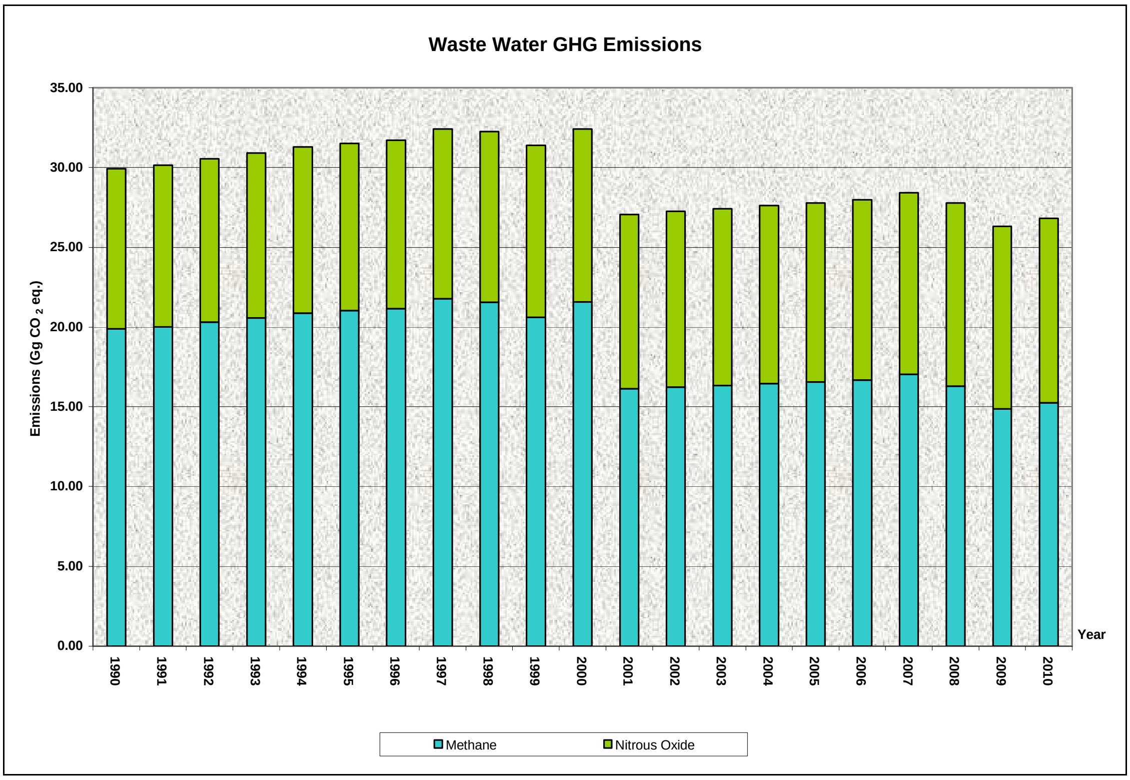

Figure 8-5 Waste water GHG emissions

8.3.2 Methodological Issues

8.3.2.1 Indirect Nitrous Oxide Emissions from Human Sewage

For the reporting period 1990 to 2010, 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 - 35.551 kg/capita/year [43]
Population: Maltese population figures [44]
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 [44]	369 455
Untreated Sewage (m3) [45]	24 787 000
Sant Antnin Sewage Treated (m^3) [45]	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 [44]	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.

Year	Total Population	Total Sewage (m^3)
1990	361908	25835248.11
1991	365781	26111726.99
1992	369455	26374000.00
1993	373161	26638557.37
1994	376433	26872133.12
1995	378404	27012835.38
1996	381405	27227065.46
1997	384176	27424876.71
1998	386397	27583425.53
1999	388759	27752039.80
2000	391415	27941641.63
2001	394641	21868449.05
2002	397296	22015571.96
2003	399867	22158040.13
2004	402668	22313253.42
2005	405006	22442810.24
2006	407810	22598189.76
2007	410290	22735615.31
2008	413609	23687500
2009	412970	24572008
2010	417,608	23758107

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 8.2).

8.3.3 Source Specific Recalculations

Rounded figures for emissions in CRF has been removed. This recalculation affected only CH_4 emission entries in CRF for the whole time series.

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).

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 2009.

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

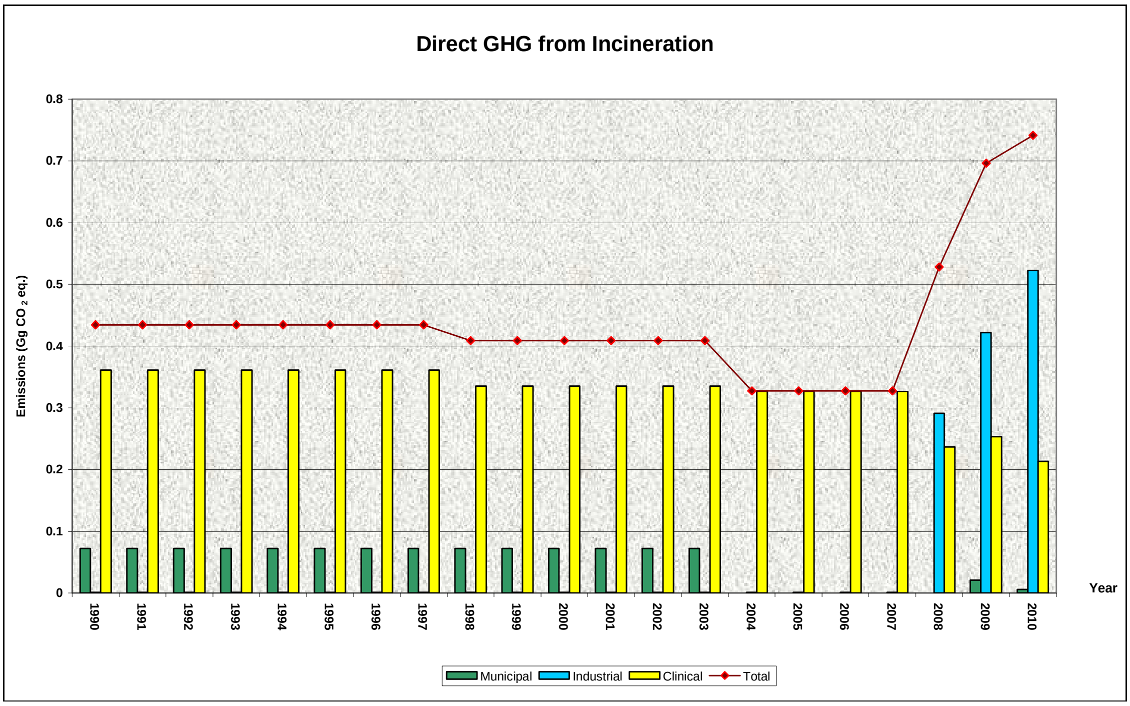

Figure 8-7 Direct GHG emissions from incineration

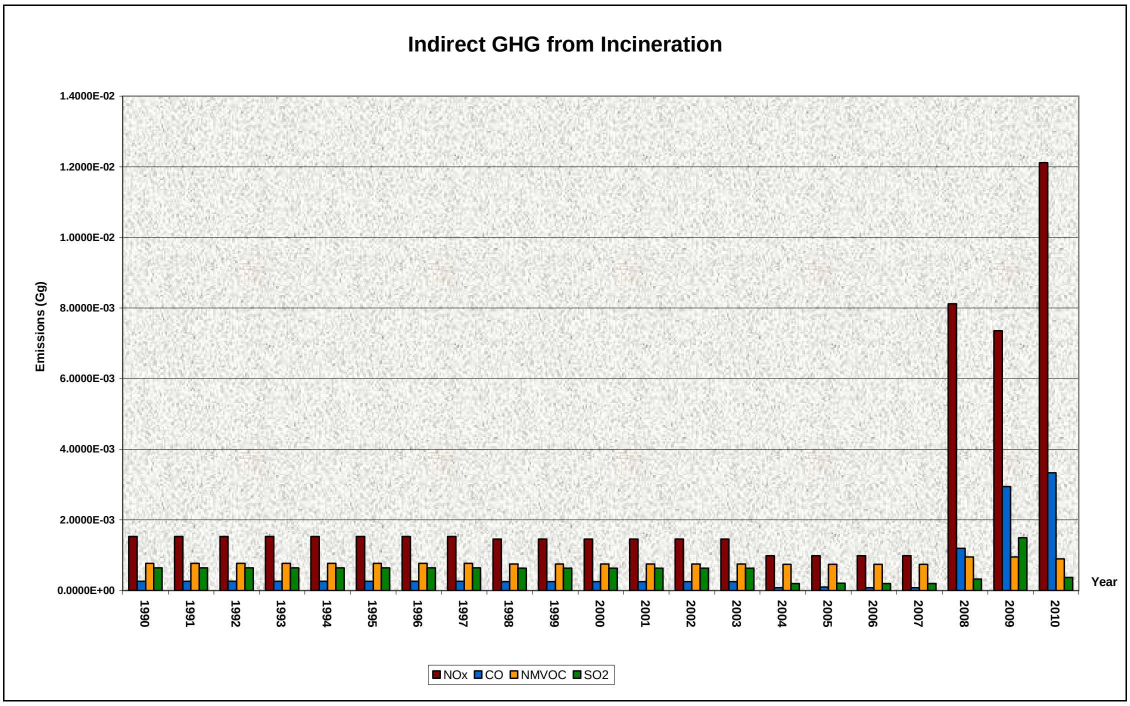

Figure 8-8 Indirect GHG emissions from incineration

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.

CO_2 emissions from municipal waste incineration have been calculated using the default IPCC 2006 method, as presented in **Table 8-2** for the year 1990.

Table 8-2 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). The following **Table 8-3** illustrated the emission factors used.

Table 8-3 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

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 [46]. 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 [45] 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 8-4** for the year 1990.

Table 8-4 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 8-3** 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 8-5** for the year 1990.

Table 8-5 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 8-3** 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

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 [47]. 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.

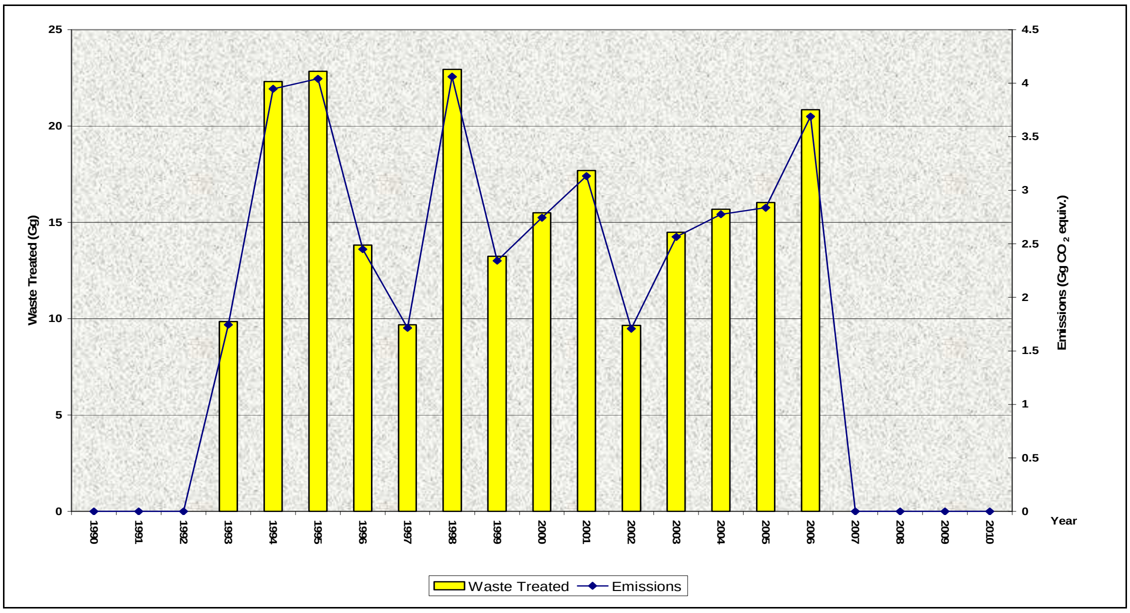

Figure 8-9 Waste treated and emissions from Composting

Figure 8-9 shows the different quantities of waste composted during the period 1990 to 2009. 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 2010 51 toms of CH4 were flared through this process and 0% was used for energy generation.

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 CO2 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 CO2 portion of emissions from these processes can be considered biogenic, other gases (CH4 and N2O) are accounted for in the previous sections of the specific sectors. Figure 8-10 summarises the emission of Biogenic CO2 from 1990.

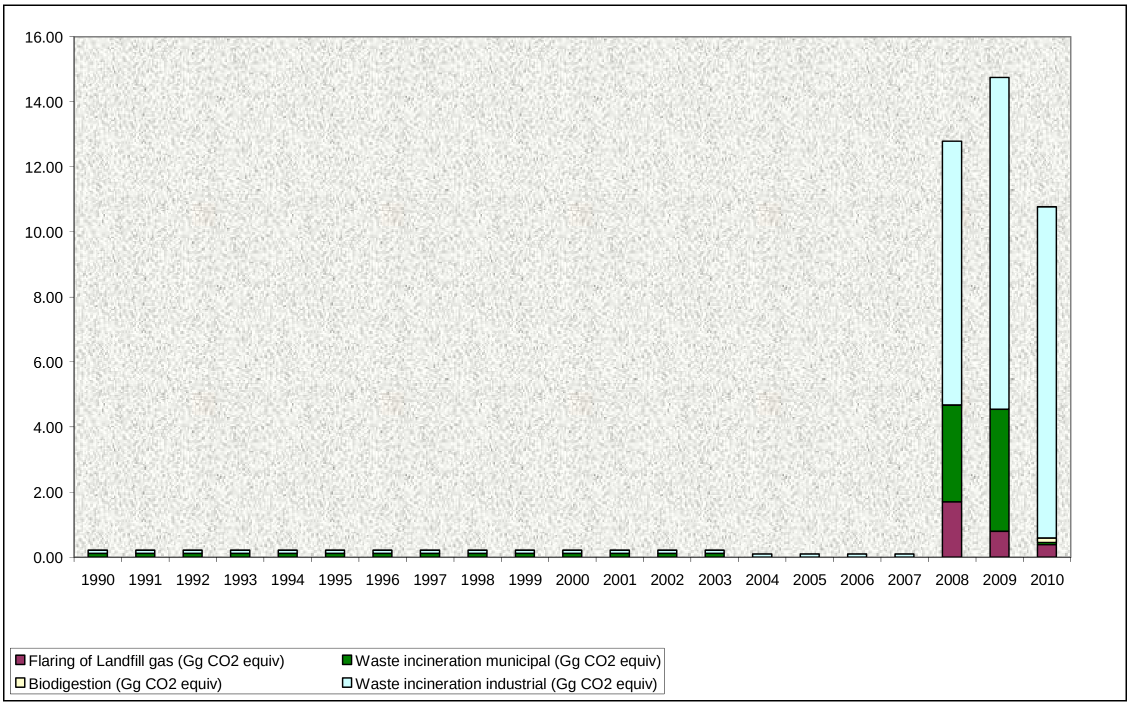

Figure 8-10 CO2 Emissions of biogenic origin from Waste processes

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	√	√	Aviation and navigation sectors have been recalculated using different methodologies, details in NIR page 45
4. Other Sectors			
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products	√	√	CO_2 form Lime production; NIR page 55
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6	√	√	HFC from 2F1; NIR page 62
G. Other			
3. Solvent and Other Product Use			

4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils	√	√	Indirect N_2O emissions from Managed Soils page 73 Indirect N_2O emissions from Manure Management page 73
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			
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land	√	√	CH_4 refer to page 106 of the NIR
B. Waste-water Handling			
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers	√	√	Change in methodology refer to page 28
Aviation	√	√	
Marine	√	√	
Multilateral Operations			
CO_2 Emissions from Biomass			

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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	Current Year Estimate (Gg CO2 eq.) 2010	Base 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	611.44	611.44	0.30	**0.65**
1A3b	Road Transportation	All fuels	CO2	333.26	333.26	0.16	**0.81**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	61.58	0.03	**0.84**
5A1	Forest Land	Land Coverage	CO2	-48.68	-48.68	0.02	**0.86**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	36.13	36.13	0.02	**0.88**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	35.00	0.02	**0.90**
1A4b	Residential	All fuels	CO2	34.55	34.55	0.02	**0.91**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	27.38	0.01	**0.93**
4A1	Cattle	Population Size	CH4	27.07	27.07	0.01	**0.94**
6B	Domestic and Commercial Wastewater	Population Size	CH4	19.73	19.73	0.01	**0.95**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	13.92	0.01	0.96
4B8	Swine	Population Size	CH4	12.94	12.94	0.01	0.96
4B1	Cattle	Population Size	CH4	11.91	11.91	0.01	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	10.03	10.03	0.00	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	2.86	2.86	0.00	0.99
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	2.48	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.48	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	2.21	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.00	2.00	0.00	1.00
4A8	Swine	Population Size	CH4	1.94	1.94	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	1.73	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.65	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	-0.43	-0.43	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	0.17	0.17	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	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
1A4a	Commercial/Institutional	All fuels	CH4	0.05	0.05	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
1A4b	Residential	All fuels	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
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	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
2A6	Road Paving with Asphalt	Product Use	CO2	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	611.44	611.44	0.31	**0.66**
1A3b	Road Transportation	All fuels	CO2	333.26	333.26	0.17	**0.83**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	61.58	0.03	**0.86**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	36.13	36.13	0.02	**0.88**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	35.00	0.02	**0.90**
1A4b	Residential	All fuels	CO2	34.55	34.55	0.02	**0.91**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	27.38	0.01	**0.93**
4A1	Cattle	Population Size	CH4	27.07	27.07	0.01	**0.94**
6B	Domestic and Commercial Wastewater	Population Size	CH4	19.73	19.73	0.01	**0.95**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	13.92	0.01	0.96
4B8	Swine	Population Size	CH4	12.94	12.94	0.01	0.97
4B1	Cattle	Population Size	CH4	11.91	11.91	0.01	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	10.03	10.03	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	2.86	2.86	0.00	0.99
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	2.48	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.48	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	2.21	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.00	2.00	0.00	1.00

4A8	Swine	Population Size	CH4	1.94	1.94	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	1.73	0.00	1.00
4D3.2	Indirect emissions Nitrogen Leaching and run - off	Fertilisers and Manure Applications	N2O	1.65	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	0.17	0.17	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	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
1A4a	Commercial/Institutional	All fuels	CH4	0.05	0.05	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
1A4b	Residential	All fuels	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
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	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
2A6	Road Paving with Asphalt	Product Use	CO2	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: 2010

IPCC Source Categories		Activity	GHG	Current Year Estimate (Gg CO2 eq.) 2010	Base Year Estimate (Gg CO2 eq.) 1990	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	1624.57	710.73	0.53	**0.53**
1A3b	Road Transportation	All fuels	CO2	518.03	333.26	0.17	**0.71**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	262.60	27.38	0.09	**0.79**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	92.33	36.13	0.03	**0.82**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	92.01	0.00	0.03	**0.85**
1A4a	Commercial/Institutional	All fuels	CO2	87.51	61.58	0.03	**0.88**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	79.55	0.00	0.03	**0.91**
1A3d	Navigation	Liquid Fuel	CO2	47.84	8.42	0.02	**0.92**
1A2	Manufacturing Industries and Construction	All fuels	CO2	46.04	35.00	0.02	**0.94**
1A4b	Residential	All fuels	CO2	43.54	34.55	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	19.73	0.01	0.97
4B8	Swine	Population Size	CH4	14.82	12.94	0.00	0.97
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	11.86	0.00	0.00	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.57	10.03	0.00	0.98
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	8.00	5.07	0.00	0.99
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	4.26	5.17	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	3.91	1.73	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.60	2.00	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	0.99
4A3	Sheep	Population Size	CH4	2.08	0.78	0.00	0.99
4A9	Poultry	Population Size	CH4	2.04	3.15	0.00	0.99

4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.00	2.48	0.00	1.00
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	1.97	0.00	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	1.78	0.01	0.00	1.00
2F3	Fire Extinguishers	Consumption Figures	HFCs	1.69	0.00	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	1.32	0.58	0.00	1.00
3D1	Use of N2O for Anaesthesia	Product Use	N2O	1.29	2.48	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.78	0.71	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.66	0.07	0.00	1.00
4A4	Goats	Population Size	CH4	0.54	0.36	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.52	0.37	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	0.22	0.02	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.22	0.03	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.17	0.14	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.12	0.02	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.11	0.08	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.10	0.00	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.10	0.17	0.00	1.00
4B3	Sheep	Population Size	CH4	0.07	0.03	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.07	0.01	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.06	0.05	0.00	1.00
1A4b	Residential	All fuels	N2O	0.06	0.02	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.05	0.17	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.04	0.03	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
1A4b	Residential	All fuels	CH4	0.03	0.01	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.03	0.00	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	0.01	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
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	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	611.44	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	0.00	2.86	0.00	1.00
2F2	Foam Blowing	Consumption Figures	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: 2010

IPCC Source Categories		Activity	GHG	Base Year Estimate (Gg CO2 eq.) 1990	Current Year Estimate (Gg CO2 eq.) 2010	Level Assessment	Cumulative Total
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	1624.57	0.52	**0.52**
1A3b	Road Transportation	All fuels	CO2	333.26	518.03	0.17	**0.69**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	262.60	0.08	**0.78**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	36.13	92.33	0.03	**0.81**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	92.01	0.03	**0.84**
1A4a	Commercial/Institutional	All fuels	CO2	61.58	87.51	0.03	**0.86**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	79.55	0.03	**0.89**
5A1	Forest Land	Land Coverage	CO2	-48.68	-48.68	0.02	**0.91**
1A3d	Navigation	Liquid Fuel	CO2	8.42	47.84	0.02	**0.92**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	46.04	0.01	**0.94**
1A4b	Residential	All fuels	CO2	34.55	43.54	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	19.73	16.38	0.01	0.96
4B8	Swine	Population Size	CH4	12.94	14.82	0.00	0.97
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	11.86	0.00	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	10.03	11.57	0.00	0.97
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	11.51	0.00	0.98
5B1	Cropland	Land Coverage	CO2	-7.86	-10.98	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	8.00	0.00	0.99
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	5.17	4.26	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	3.91	0.00	0.99
1A3b	Road Transportation	All fuels	CH4	2.00	2.60	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	0.99

4A3	Sheep	Population Size	CH4	0.78	2.08	0.00	0.99
4A9	Poultry	Population Size	CH4	3.15	2.04	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.00	0.00	0.99
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	1.97	0.00	1.00
5E1	Settlements	Land Coverage	CO2	-0.43	-1.92	0.00	1.00
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	1.78	0.00	1.00
2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	1.69	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	1.32	0.00	1.00
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	1.29	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	0.78	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.07	0.66	0.00	1.00
4A4	Goats	Population Size	CH4	0.36	0.54	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.52	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	0.22	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.03	0.22	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.14	0.17	0.00	1.00
1A3d	Navigation	Liquid Fuel	N2O	0.02	0.12	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.08	0.11	0.00	1.00
2A6	Road Paving with Asphalt	Product Use	CO2	0.00	0.10	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.17	0.10	0.00	1.00
4B3	Sheep	Population Size	CH4	0.03	0.07	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.01	0.07	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.05	0.06	0.00	1.00
1A4b	Residential	All fuels	N2O	0.02	0.06	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.17	0.05	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.03	0.04	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
1A4b	Residential	All fuels	CH4	0.01	0.03	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.00	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	0.01	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
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	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	611.44	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	2.86	0.00	0.00	1.00
2F2	Foam Blowing	Consumption Figures	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
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.) 2010	Trend Assesment	Cumulative trend assesment
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	710.73	1624.57	0.46	**0.46**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	27.38	262.60	0.19	**0.65**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	0.00	92.01	0.08	**0.73**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	0.00	79.55	0.07	**0.80**
6A2	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	36.13	92.33	0.03	**0.83**
1A3d	Navigation	Liquid Fuel	CO2	8.42	47.84	0.03	**0.86**
5A1	Forest Land	Land Coverage	CO2	-48.68	-48.68	0.02	**0.88**
4A1	Cattle	Population Size	CH4	27.07	22.02	0.02	**0.90**
6B	Domestic and Commercial Wastewater	Population Size	CH4	19.73	16.38	0.01	**0.91**
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	0.00	11.86	0.01	**0.92**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	13.92	11.51	0.01	**0.93**
1A4b	Residential	All fuels	CO2	34.55	43.54	0.01	**0.94**
4B1	Cattle	Population Size	CH4	11.91	9.49	0.01	**0.95**
1A2	Manufacturing Industries and Construction	All fuels	CO2	35.00	46.04	0.01	0.95
1A4a	Commercial/Institutional	All fuels	CO2	61.58	87.51	0.01	0.96
1A3b	Road Transportation	All fuels	CO2	333.26	518.03	0.00	0.97
4B8	Swine	Population Size	CH4	12.94	14.82	0.00	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	10.03	11.57	0.00	0.97
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	5.17	4.26	0.00	0.98
4B9	Poultry	Population Size	CH4	3.69	2.38	0.00	0.98
4A9	Poultry	Population Size	CH4	3.15	2.04	0.00	0.98
3D1	Use of N2O for Anaesthesia	Product Use	N2O	2.48	1.29	0.00	0.98
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	0.00	1.97	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.48	2.00	0.00	0.99
2F8	Electrical Equipment	Emissions per Equipment	SF6	0.01	1.78	0.00	0.99

2F3	Fire Extinguishers	Consumption Figures	HFCs	0.00	1.69	0.00	0.99
5E1	Settlements	Land Coverage	CO2	-0.43	-1.92	0.00	0.99
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	1.73	3.91	0.00	0.99
4B12	Liquid Systems	Manure Generation	N2O	2.21	2.29	0.00	0.99
5B1	Cropland	Land Coverage	CO2	-7.86	-10.98	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
4A3	Sheep	Population Size	CH4	0.78	2.08	0.00	1.00
4A8	Swine	Population Size	CH4	1.94	2.22	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.07	0.66	0.00	1.00
1A3b	Road Transportation	All fuels	CH4	2.00	2.60	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	0.58	1.32	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.71	0.78	0.00	1.00
4A6	Horses	Population Size	CH4	0.36	0.32	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.17	0.05	0.00	1.00
1A3b	Road Transportation	All fuels	N2O	5.07	8.00	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.02	0.22	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.03	0.22	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.17	0.10	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	0.12	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	CH4	0.01	0.07	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.14	0.17	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.37	0.52	0.00	1.00
4B3	Sheep	Population Size	CH4	0.03	0.07	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.00	0.03	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
1A4b	Residential	All fuels	N2O	0.02	0.06	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.08	0.11	0.00	1.00
4A4	Goats	Population Size	CH4	0.36	0.54	0.00	1.00

1A4a	Commercial/Institutional	All fuels	CH4	0.05	0.06	0.00	1.00
1A4b	Residential	All fuels	CH4	0.01	0.03	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.00	0.01	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	CH4	0.03	0.04	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
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	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	611.44	0.00	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	2.86	0.00	0.00	1.00
2F2	Foam Blowing	Consumption Figures	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
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.) 2010	Base Year Estimate (Gg CO2 eq.) 1990	Trend Assessment	Cumulative Trend Assessment
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CO2	1624.57	710.73	0.48	**0.48**
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CO2	262.60	27.38	0.19	**0.67**
2F1	Refrigeration & Air Conditioning Equipment	Consumption Figures	HFCs	92.01	0.00	0.08	**0.75**
6A1	Managed Waste Disposal on Land	Solid Waste Disposal on Land	CH4	79.55	0.00	0.07	**0.82**
4D3.1	UnManaged Waste Disposal on Land	Solid Waste Disposal on Land	CH4	92.33	36.13	0.03	**0.85**
1A3d	Navigation	Liquid Fuel	CO2	47.84	8.42	0.03	**0.88**
4A1	Cattle	Population Size	CH4	22.02	27.07	0.02	**0.90**
6B	Domestic and Commercial Wastewater	Population Size	CH4	16.38	19.73	0.01	**0.91**
1A4c	Agriculture/Forestry/Fisheries	All fuels	CO2	11.86	0.00	0.01	**0.92**
1A3b	Road Transportation	All fuels	CO2	518.03	333.26	0.01	**0.93**
4D1	Direct Soil Emissions	Fertilisers and Manure Applications	N2O	11.51	13.92	0.01	**0.94**
1A4b	Residential	All fuels	CO2	43.54	34.55	0.01	**0.95**
4B1	Cattle	Population Size	CH4	9.49	11.91	0.01	0.96
1A2	Manufacturing Industries and Construction	All fuels	CO2	46.04	35.00	0.01	0.96
1A4a	Commercial/Institutional	All fuels	CO2	87.51	61.58	0.01	0.97
4B8	Swine	Population Size	CH4	14.82	12.94	0.00	0.97
6B	Domestic and Commercial Wastewater	Population Size	N2O	11.57	10.03	0.00	0.98
4D3.1	Indirect emissions Atmospheric Deposition	Fertilisers and Manure Applications	N2O	4.26	5.17	0.00	0.98
4B9	Poultry	Population Size	CH4	2.38	3.69	0.00	0.98
4A9	Poultry	Population Size	CH4	2.04	3.15	0.00	0.98
3D1	Use of N2O for Anaesthesia	Product Use	N2O	1.29	2.48	0.00	0.99
2F4	Metered Dose Inhalers	Consumption Figures	HFCs	1.97	0.00	0.00	0.99
4B13	Solid Storage and Dry Lot	Manure Generation	N2O	2.00	2.48	0.00	0.99
2F8	Electrical Equipment	Emissions per Equipment	SF6	1.78	0.01	0.00	0.99
2F3	Fire Extinguishers	Consumption Figures	HFCs	1.69	0.00	0.00	0.99

1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	N2O	3.91	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
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	N2O	0.66	0.07	0.00	1.00
1A3b	Road Transportation	All fuels	CH4	2.60	2.00	0.00	1.00
1A1a	Energy Industries - Residual Fuel Oil	Liquid Fuel	CH4	1.32	0.58	0.00	1.00
1A3a	Civil Aviation	Liquid Fuel	CO2	0.78	0.71	0.00	1.00
1A3b	Road Transportation	All fuels	N2O	8.00	5.07	0.00	1.00
4A6	Horses	Population Size	CH4	0.32	0.36	0.00	1.00
2A4	Soda Ash Use	Product Use	CO2	0.05	0.17	0.00	1.00
1A1a	Energy Industries - Gas/Diesel Oil	Liquid Fuel	CH4	0.22	0.02	0.00	1.00
6C	Waste Incineration	Waste Burning	N2O	0.22	0.03	0.00	1.00
2B4	Carbide Production	Production Figures	CO2	0.10	0.17	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	0.12	0.02	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
6C	Waste Incineration	Waste Burning	CH4	0.00	0.03	0.00	1.00
1A3d	Navigation	Liquid Fuel	CH4	0.07	0.01	0.00	1.00
1A4a	Commercial/Institutional	All fuels	N2O	0.17	0.14	0.00	1.00
6C	Waste Incineration	Waste Burning	CO2	0.52	0.37	0.00	1.00
4B3	Sheep	Population Size	CH4	0.07	0.03	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	N2O	0.03	0.00	0.00	1.00
4B6	Horses	Population Size	CH4	0.04	0.04	0.00	1.00
1A4b	Residential	All fuels	N2O	0.06	0.02	0.00	1.00
1A2	Manufacturing Industries and Construction	All fuels	N2O	0.11	0.08	0.00	1.00
1A4a	Commercial/Institutional	All fuels	CH4	0.06	0.05	0.00	1.00
1A4b	Residential	All fuels	CH4	0.03	0.01	0.00	1.00
4A4	Goats	Population Size	CH4	0.54	0.36	0.00	1.00
1A4c	Agriculture/Forestry/Fisheries	All fuels	CH4	0.01	0.00	0.00	1.00

1A2	Manufacturing Industries and Construction	All fuels	CH4	0.04	0.03	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
2F7	Semiconductor Manufacture	Emissions per Equipment	PFCs	0.00	0.00	0.00	1.00
2F7	Semiconductor Manufacture	Emissions per Equipment	HFCs	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	611.44	0.00	1.00
1A1a	Energy Industries - Other Bituminous Coal	Solid Fuel	N2O	0.00	2.86	0.00	1.00
2F2	Foam Blowing	Consumption Figures	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 2010 Submission 2012

Sources and sinks not estimated (NE)[1]			
GHG	**Sector[2]**	**Source/sink category [2]**	**Explanation**
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	No factor available in the GPG
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
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.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
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.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
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	1 Energy	1.AA.4.C 1.AA.4.C Agriculture/Forestry/Fisheries	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	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Data unavailable
N2O	1 Energy	1.AA.4.C 1.AA.4.C Agriculture/Forestry/Fisheries	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
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 2012

Sources and sinks not estimated (NE)[1]			
GHG	**Sector[2]**	**Source/sink category [2]**	**Explanation**
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
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.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
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.E.1 5.E.1 Settlements remaining Settlements	Data unavailable
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Data unavailable
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	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.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
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	n/a
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			Base Year emissions 1990	Year t emissions 2010	Activty Data Uncertainty	Emission Factor Uncertainty	Combined Uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gas	CO2 eq. (Gg)	CO2 eq. (Gg)	%	%	%	%	%	%	%	%	%
1A1a	Energy Industries - Gas/Diesel Oil	CO2	27.38	262.60	1	3	3.16E+00	7.79E-02	1.14E-01	1.36E-01	3.42E-01	1.92E-01	1.54E-01
1A1a	Energy Industries - Residual Fuel Oil	CO2	710.73	1624.57	1	3	3.16E+00	2.98E+00	2.74E-01	8.39E-01	8.21E-01	1.19E+00	2.08E+00
1A1a	Energy Industries - bituminous coal	CO2	611.44	0.00	1	3	3.16E+00	0.00E+00	-4.84E-01	0.00E+00	-1.45E+00	0.00E+00	2.11E+00
1A2	Manufacturing Industries and Construction	CO2	35.00	46.04	5	12	1.30E+01	4.05E-02	-4.01E-03	2.38E-02	-4.82E-02	1.68E-01	3.06E-02
1A3a	Civil Aviation	CO2	0.71	0.78	8	30	3.10E+01	6.67E-05	-1.59E-04	4.04E-04	-4.77E-03	4.57E-03	4.37E-05
1A3b	Road Transportation	CO2	333.26	518.03	5	15	1.58E+01	7.58E+00	2.96E-03	2.68E-01	4.44E-02	1.89E+00	3.58E+00
1A3d	Navigation	CO2	8.42	47.84	5	30	3.04E+01	2.39E-01	1.80E-02	2.47E-02	5.41E-01	1.75E-01	3.23E-01
1A4a	Commercial/Institutional	CO2	61.58	87.51	5	12	1.30E+01	1.46E-01	-3.69E-03	4.52E-02	-4.43E-02	3.20E-01	1.04E-01
1A4b	Residential	CO2	34.55	43.54	5	12	1.30E+01	3.62E-02	-4.94E-03	2.25E-02	-5.93E-02	1.59E-01	2.88E-02
1A4c	Agriculture/Forestry/Fisheries	CO2	0.00	11.86	5	12	1.30E+01	2.68E-03	6.13E-03	6.13E-03	7.35E-02	4.33E-02	7.28E-03
2A4	Soda Ash Use	CO2	0.17	0.05	15	15	2.12E+01	1.30E-07	-1.11E-04	2.62E-05	-1.67E-03	5.55E-04	3.08E-06
2A6	Road Paving with Asphalt	CO2	0.00	0.10	15	15	2.12E+01	4.89E-07	5.07E-05	5.07E-05	7.60E-04	1.08E-03	1.73E-06
2B4	Carbide Production	CO2	0.17	0.10	15	15	2.12E+01	4.71E-07	-8.43E-05	4.97E-05	-1.26E-03	1.05E-03	2.71E-06
5A1	Forest Land Remaining Forest Land	CO2	-48.68	-48.68	18	50	5.31E+01	7.56E-01	1.35E-02	-2.51E-02	6.76E-01	-6.40E-01	8.66E-01

5B1	Cropland Remaining Cropland	CO2	-7.86	-10.98	5	50	5.02E+01	3.44E-02	5.66E-04	-5.67E-03	2.83E-02	-4.01E-02	2.41E-03
5E1	Settlements Remaining Settlements	CO2	-0.43	-1.92	18	50	5.31E+01	1.18E-03	-6.52E-04	-9.94E-04	-3.26E-02	-2.53E-02	1.70E-03
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	0.52	15	50	5.22E+01	8.32E-05	-2.53E-05	2.69E-04	-1.27E-03	5.70E-03	3.41E-05
TOTAL		**CO2**	**1766.82**	**2581.96**				**3.45E+00**					

1A1a	Energy Industries - Gas/Diesel Oil	CH4	0.02	0.22	1	3	3.16E+00	5.63E-08	9.67E-05	1.15E-04	2.90E-04	1.63E-04	1.11E-07
1A1a	Energy Industries - Residual Fuel Oil	CH4	0.58	1.32	1	3	3.16E+00	1.98E-06	2.19E-04	6.83E-04	6.57E-04	9.66E-04	1.37E-06
1A1a	Energy Industries - bituminous coal	CH4	0.14	0.00	1	3	3.16E+00	0.00E+00	-1.10E-04	0.00E+00	-3.30E-04	0.00E+00	1.09E-07
1A2	Manufacturing Industries and Construction	CH4	0.03	0.04	5	12	1.30E+01	2.72E-08	-3.38E-06	1.95E-05	-4.05E-05	1.38E-04	2.07E-08
1A3a	Civil Aviation	CH4	0.00	0.00	8	30	3.10E+01	1.46E-12	-2.42E-08	5.98E-08	-7.26E-07	6.77E-07	9.85E-13
1A3b	Road Transportation	CH4	2.00	2.60	5	15	1.58E+01	1.91E-04	-2.43E-04	1.34E-03	-3.64E-03	9.51E-03	1.04E-04
1A3d	Navigation	CH4	0.01	0.07	5	30	3.04E+01	4.81E-07	2.56E-05	3.51E-05	7.68E-04	2.48E-04	6.51E-07
1A4a	Commercial/Institutional	CH4	0.05	0.06	5	12	1.30E+01	7.20E-08	-7.49E-06	3.17E-05	-8.99E-05	2.24E-04	5.84E-08
1A4b	Residential	CH4	0.01	0.03	5	12	1.30E+01	1.95E-08	6.27E-06	1.65E-05	7.52E-05	1.17E-04	1.93E-08
1A4c	Agriculture/Forestry/Fisheries	CH4	0.00	0.01	5	12	1.30E+01	1.94E-09	5.21E-06	5.21E-06	6.25E-05	3.69E-05	5.27E-09
4A1	Cattle	CH4	27.07	22.02	5	15	1.58E+01	1.37E-02	-1.01E-02	1.14E-02	-1.52E-01	8.04E-02	2.95E-02
4A3	Sheep	CH4	0.78	2.08	5	15	1.58E+01	1.22E-04	4.58E-04	1.07E-03	6.86E-03	7.60E-03	1.05E-04
4A4	Goats	CH4	0.36	0.54	5	15	1.58E+01	8.13E-06	-8.74E-06	2.77E-04	-1.31E-04	1.96E-03	3.86E-06
4A6	Horses	CH4	0.36	0.32	5	15	1.58E+01	2.93E-06	-1.17E-04	1.67E-04	-1.75E-03	1.18E-03	4.46E-06
4A8	Swine	CH4	1.94	2.22	5	15	1.58E+01	1.40E-04	-3.92E-04	1.15E-03	-5.89E-03	8.12E-03	1.01E-04
4A9	Poultry	CH4	3.15	2.04	5	15	1.58E+01	1.17E-04	-1.45E-03	1.05E-03	-2.17E-02	7.44E-03	5.28E-04
4A10	Rabbits	CH4	0.05	0.02	5	15	1.58E+01	8.94E-09	-2.98E-05	9.19E-06	-4.47E-04	6.50E-05	2.04E-07
4B1	Cattle	CH4	11.91	9.49	5	15	1.58E+01	2.54E-03	-4.56E-03	4.90E-03	-6.84E-02	3.47E-02	5.87E-03
4B3	Sheep	CH4	0.03	0.07	5	15	1.58E+01	1.50E-07	1.60E-05	3.76E-05	2.40E-04	2.66E-04	1.28E-07
4B4	Goats	CH4	0.01	0.02	5	15	1.58E+01	1.05E-08	-3.15E-07	9.98E-06	-4.72E-06	7.06E-05	5.00E-09
4B6	Horses	CH4	0.04	0.04	5	15	1.58E+01	3.92E-08	-1.35E-05	1.92E-05	-2.02E-04	1.36E-04	5.95E-08

4B8	Swine	CH4	12.94	14.82	5	15	1.58E+01	6.20E-03	-2.62E-03	7.66E-03	-3.92E-02	5.41E-02	4.47E-03
4B9	Poultry	CH4	3.69	2.38	5	15	1.58E+01	1.60E-04	-1.70E-03	1.23E-03	-2.54E-02	8.71E-03	7.22E-04
4B10	Rabbits	CH4	0.05	0.02	5	15	1.58E+01	8.94E-09	-2.98E-05	9.19E-06	-4.47E-04	6.50E-05	2.04E-07
6A1	Managed Waste Disposal on Land	CH4	0.00	79.55	5	10	1.12E+01	8.93E-02	4.11E-02	4.11E-02	4.11E-01	2.91E-01	2.53E-01
6A2	UnManaged Waste Disposal on Land	CH4	0.00	92.33	5	10	1.12E+01	1.20E-01	4.77E-02	4.77E-02	4.77E-01	3.37E-01	3.41E-01
6B	Domestic and Commercial Wastewater	CH4	36.13	16.38	5	70	7.02E+01	1.49E-01	-2.02E-02	8.46E-03	-1.42E+00	5.98E-02	2.01E+00
6C	Waste Incineration	CH4	19.73	0.00	15	15	2.12E+01	4.57E-14	-1.57E-02	1.55E-08	-2.35E-01	3.29E-07	5.52E-02
TOTAL		**CH4**	**121.08**	**248.71**				**6.18E-01**					

1A1a	Energy Industries - Gas/Diesel Oil	N2O	0.07	0.66	1	3	3.16E+00	4.91E-07	2.85E-04	3.41E-04	8.56E-04	4.82E-04	9.66E-07
1A1a	Energy Industries - Residual Fuel Oil	N2O	1.73	3.91	1	3	3.16E+00	1.72E-05	6.47E-04	2.02E-03	1.94E-03	2.85E-03	1.19E-05
1A1a	Energy Industries - bituminous coal	N2O	2.86	0.00	1	3	3.16E+00	0.00E+00	-2.27E-03	0.00E+00	-6.82E-03	0.00E+00	4.65E-05
1A2	Manufacturing Industries and Construction	N2O	0.08	0.11	5	12	1.30E+01	2.31E-07	-9.94E-06	5.69E-05	-1.19E-04	4.02E-04	1.76E-07
1A3a	Civil Aviation	N2O	0.01	0.01	8	30	3.10E+01	5.09E-09	-1.43E-06	3.53E-06	-4.29E-05	4.00E-05	3.43E-09
1A3b	Road Transportation	N2O	5.07	8.00	5	15	1.58E+01	1.81E-03	1.06E-04	4.13E-03	1.59E-03	2.92E-02	8.56E-04
1A3d	Navigation	N2O	0.02	0.12	5	30	3.04E+01	1.51E-06	4.53E-05	6.21E-05	1.36E-03	4.39E-04	2.04E-06
1A4a	Commercial/Institutional	N2O	0.14	0.17	5	12	1.30E+01	5.48E-07	-2.56E-05	8.76E-05	-3.07E-04	6.19E-04	4.78E-07
1A4b	Residential	N2O	0.02	0.06	5	12	1.30E+01	6.64E-08	1.26E-05	3.05E-05	1.52E-04	2.15E-04	6.95E-08
1A4c	Agriculture/Forestry/Fisheries	N2O	0.00	0.03	5	12	1.30E+01	1.69E-08	1.54E-05	1.54E-05	1.85E-04	1.09E-04	4.59E-08
3D1	Use of N2O for Anaesthesia	N2O	2.48	1.29	2	2	2.83E+00	1.50E-06	-1.31E-03	6.66E-04	-2.61E-03	1.88E-03	1.04E-05
4B12	Liquid Systems	N2O	2.21	2.29	5	15	1.58E+01	1.49E-04	-5.70E-04	1.19E-03	-8.55E-03	8.38E-03	1.43E-04
4B13	Solid Storage and Dry Lot	N2O	2.48	2.00	5	15	1.58E+01	1.13E-04	-9.34E-04	1.04E-03	-1.40E-02	7.32E-03	2.50E-04
4D1	Direct Soil Emissions	N2O	13.92	11.51	5	15	1.58E+01	3.74E-03	-5.11E-03	5.95E-03	-7.67E-02	4.20E-02	7.64E-03
4D3.1	Indirect emissions Atmospheric Deposition	N2O	5.17	4.26	5	15	1.58E+01	5.13E-04	-1.90E-03	2.20E-03	-2.86E-02	1.56E-02	1.06E-03

4D3.2	Indirect emissions Nitrogen Leaching and run - off	N2O	1.65	1.51	5	15	1.58E+01	6.41E-05	-5.34E-04	7.78E-04	-8.00E-03	5.50E-03	9.44E-05
6B	Domestic and Commercial Wastewater	N2O	0.00	11.57	5	70	7.02E+01	7.45E-02	5.98E-03	5.98E-03	4.18E-01	4.23E-02	1.77E-01
6C	Waste Incineration	N2O	10.03	0.22	15	15	2.12E+01	2.50E-06	-7.85E-03	1.15E-04	-1.18E-01	2.43E-03	1.39E-02
TOTAL		**N2O**	**47.96**	**47.72**				**2.84E-01**					

2F1	Refrigeration & Air Conditioning Equipment	HFCs	0.00	92.01	50	50	7.07E+01	4.78E+00	4.75E-02	4.75E-02	2.38E+00	3.36E+00	1.69E+01
2F2	Foam Blowing	HFCs	0.00	0.00	40	40	5.66E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2F3	Fire Extinguishers	HFCs	0.00	1.69	5	5	7.07E+00	1.62E-05	8.75E-04	8.75E-04	4.37E-03	6.19E-03	5.74E-05
2F4	Metered Dose Inhalers	HFCs	0.00	1.97	5	5	7.07E+00	2.20E-05	1.02E-03	1.02E-03	5.10E-03	7.21E-03	7.80E-05
2F7	Semiconductor Manufacture	HFCs	0.00	0.00	5	5	7.07E+00	1.02E-16	2.19E-09	2.19E-09	1.10E-08	1.55E-08	3.60E-16
2F7	Semiconductor Manufacture	PFCs	0.00	0.00	5	5	7.07E+00	2.49E-16	3.43E-09	3.43E-09	1.71E-08	2.42E-08	8.82E-16
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	1.78	2	10	1.02E+01	3.71E-05	9.09E-04	9.18E-04	9.09E-03	2.60E-03	8.93E-05
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**	**97.45**				**2.19E+00**					

TOTAL EMISSIONS		**1935.86**	**2975.84**				**29.14**
TOTAL UNCERTAINTIES			Overall uncertainty in the Inventory (%)	4.14		Trend uncertainty (%)	5.40

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.