CYPRUS

National Greenhouse Gas Inventory 2020

2020 submission

under the United Nations Convention on Climate Change and the Kyoto Protocol

Department of Environment,

Ministry of Agriculture, Rural Development and Environment

May 2020

Title of Report	**Cyprus National Greenhouse Gas Inventory 2020**
Contact	Nicoletta Kythreotou Theodoulos Mesimeris
Institution	Department of Environment Ministry of Agriculture, Rural Development and Environment
Address	Department of Environment, 1498 Nicosia, Cyprus
Telephone	(+357) 22 408 960
Fax	(+357) 22 774 945
Email	nkythreotou@environment.moa.gov.cy tmesimeris@environment.moa.gov.cy
Version	1.4
Date of Submission	26 May 2020

Contents

List of Tables

List of Figures

EXECUTIVE SUMMARY

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

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

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

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

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

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

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

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

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

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

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

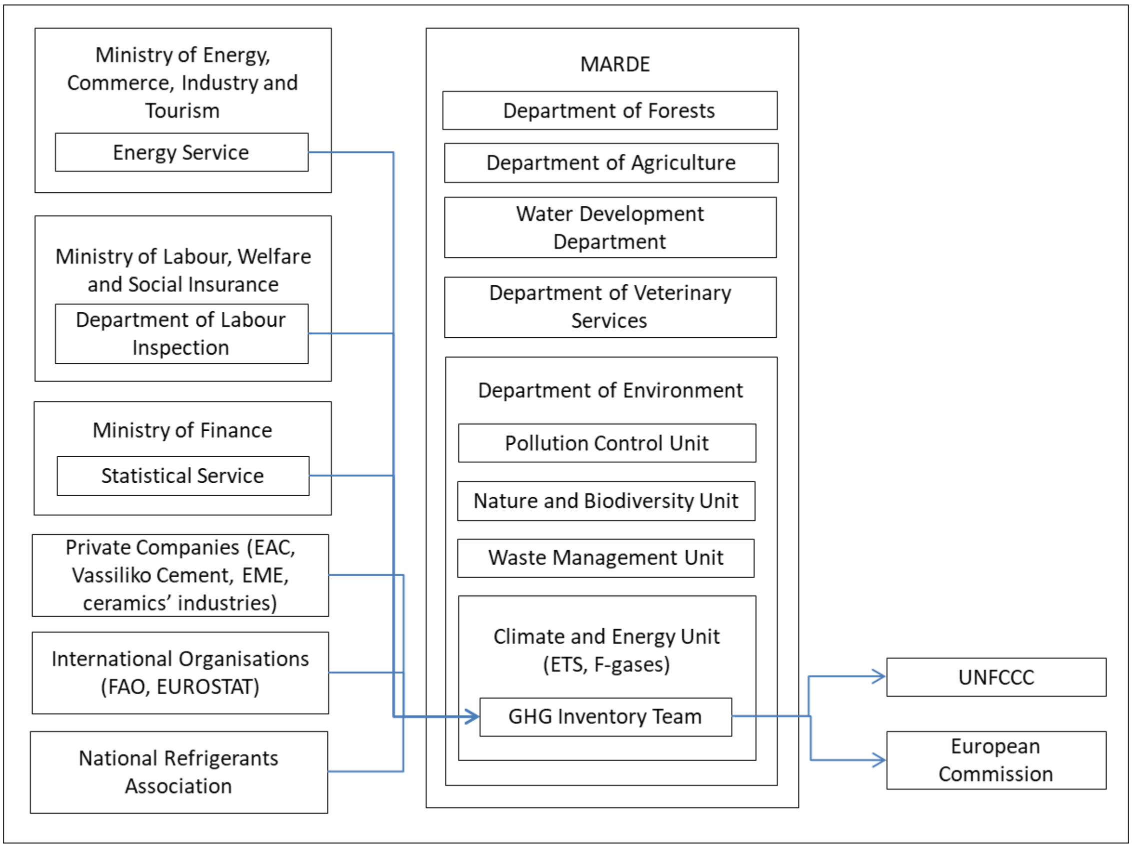

Figure 1. Overview of the organisational structure of the National Inventory System

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

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

GHG emissions trends by gas for the period 1990 - 2018 are presented in Table 1.

Table 1. GHG emissions trends by gas for the period 1990 – 2018

	1990	1991	1992	1993	1994
CO_2 emissions without LULUCF	4656.89	5146.61	5522.91	5766.97	6011.11
CO_2 emissions with LULUCF	4437.85	4934.35	5304.46	5532.86	5786.88
CH_4 emissions without LULUCF	661.43	673.09	691.22	715.69	728.93
CH_4 emissions with LULUCF	661.49	673.25	691.27	716.10	729.98
N_2O emissions	292.49	293.80	324.33	343.60	337.30

without LULUCF					
N_2O emissions with LULUCF	292.51	293.85	324.35	343.74	337.67
HFCs	79.60	94.13	124.20	118.69	127.49
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.03	0.03	0.03	0.04	0.05
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	5690.44	6207.65	6662.69	6944.99	7204.88
Total (with LULUCF)	5471.47	5995.62	6444.32	6711.42	6982.07
	1995	**1996**	**1997**	**1998**	**1999**
CO_2 emissions without LULUCF	5882.27	6233.23	6321.03	6614.65	6882.47
CO_2 emissions with LULUCF	5642.94	5987.86	6094.10	6428.45	6590.04
CH_4 emissions without LULUCF	750.07	767.00	771.18	772.64	776.03
CH_4 emissions with LULUCF	750.49	767.68	772.17	776.00	776.05
N_2O emissions without LULUCF	379.16	354.32	348.18	372.44	364.08
N_2O emissions with LULUCF	379.30	354.56	348.53	373.61	364.09
HFCs	132.31	135.72	141.53	149.68	164.45
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.06	0.07	0.07	0.07	0.07
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	7143.86	7490.33	7581.99	7909.48	8187.10
Total (with LULUCF)	6905.09	7245.89	7356.39	7727.82	7894.70
	2000	**2001**	**2002**	**2003**	**2004**
CO_2 emissions without LULUCF	7145.88	7021.41	7210.78	7605.55	7840.94
CO_2 emissions with LULUCF	7101.13	6831.38	6934.01	7320.14	7556.49
CH_4 emissions without LULUCF	792.52	824.17	848.41	840.21	835.49
CH_4 emissions with LULUCF	799.72	826.60	848.48	840.52	836.09
N_2O emissions without LULUCF	349.97	381.51	385.89	382.33	343.71
N_2O emissions	352.49	382.35	385.92	382.44	343.92

with LULUCF					
HFCs	169.12	173.87	188.85	195.67	215.15
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.08	0.08	0.08	0.09	0.10
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	8457.56	8401.04	8634.01	9023.85	9235.40
Total (with LULUCF)	8422.54	8214.28	8357.34	8738.86	8951.76
	2005	**2006**	**2007**	**2008**	**2009**
CO_2 emissions without LULUCF	8031.30	8223.17	8538.92	8707.25	8453.80
CO_2 emissions with LULUCF	7727.76	7840.76	8292.49	8289.27	8024.38
CH_4 emissions without LULUCF	818.50	820.19	823.40	821.71	824.02
CH_4 emissions with LULUCF	818.70	820.70	828.26	821.89	824.31
N_2O emissions without LULUCF	316.77	329.73	324.40	312.04	304.37
N_2O emissions with LULUCF	316.84	329.91	326.10	312.10	304.48
HFCs	223.91	227.16	257.13	253.81	266.86
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.12	0.12	0.14	0.15	0.16
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	9390.60	9600.37	9943.99	10094.96	9849.21
Total (with LULUCF)	9087.33	9218.65	9704.11	9677.21	9420.18
	2010	**2011**	**2012**	**2013**	**2014**
CO_2 emissions without LULUCF	8089.01	7759.47	7234.89	6554.36	6934.59
CO_2 emissions with LULUCF	7689.38	7323.53	6812.10	6114.09	6498.37
CH_4 emissions without LULUCF	831.91	837.10	826.52	820.46	820.84
CH_4 emissions with LULUCF	833.04	838.04	827.57	820.83	821.25
N_2O emissions without LULUCF	321.21	308.55	303.41	280.19	275.50
N_2O emissions with LULUCF	321.60	308.88	303.78	280.32	275.64
HFCs	275.84	261.86	266.50	260.75	260.18
PFCs	NO	NO	NO	NO	NO

Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.15	0.16	0.16	0.15	0.15
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	9518.12	9167.14	8631.48	7915.92	8291.26
Total (with LULUCF)	9120.01	8732.47	8210.10	7476.14	7855.59
	2015	**2016**	**2017**	**2018**	**Change 1990-2018**
CO_2 emissions without LULUCF	6960.13	7368.23	7515.69	7332.76	57.46%
CO_2 emissions with LULUCF	6528.04	7302.23	7095.96	6932.54	56.21%
CH_4 emissions without LULUCF	832.43	858.37	875.26	884.55	33.73%
CH_4 emissions with LULUCF	832.57	870.38	875.64	885.29	33.83%
N_2O emissions without LULUCF	283.05	290.40	295.58	297.00	1.54%
N_2O emissions with LULUCF	283.10	294.61	295.71	297.26	1.62%
HFCs	269.72	276.93	287.70	297.14	273.29%
PFCs	NO	NO	NO	NO	0.00%
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	0.00%
SF_6	0.16	0.17	0.17	0.17	541.56%
NF_3	NO	NO	NO	NO	0.00%
Total (without LULUCF)	8345.50	8794.10	8974.40	8811.61	54.85%
Total (with LULUCF)	7913.60	8744.32	8555.18	8412.39	53.75%

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

Energy, with 6479.73 Gg CO2 eq., continues to be the largest contributor to the total national GHG emissions (73.6% compared to the total without LULUCF). 3354 Gg CO2 eq. of these emissions is from the production of electricity, while another 2067 Gg CO2 eq. from transport. Table 2 and Figure 2 present the emissions for the period 1990-2018 by sector.

Table 2 GHG emissions by sector for the period 1990 – 2018

	Energy	**IPPU**	**Agriculture**	**LULUCF**	**Waste**	**Total (incl. LULUCF)**	**Total (excl. LULUCF)**
1990	3972.44	853.25	471.41	-218.97	393.34	5471.47	5690.44
1991	4506.04	828.32	475.42	-212.04	397.88	5995.62	6207.65
1992	4834.78	911.33	509.94	-218.38	406.63	6444.32	6662.69
1993	5012.86	975.58	540.73	-233.56	415.82	6711.42	6944.99
1994	5226.20	1021.15	530.09	-222.81	427.43	6982.07	7204.88
1995	5135.42	992.65	580.26	-238.77	435.53	6905.09	7143.86
1996	5432.24	1055.38	562.35	-244.44	440.35	7245.89	7490.33
1997	5556.95	1027.88	548.51	-225.59	448.65	7356.39	7581.99

	Energy	IPPU	Agriculture	LULUCF	Waste	Total (incl. LULUCF)	Total (excl. LULUCF)
1998	5901.52	989.74	562.80	-181.67	455.42	7727.82	7909.48
1999	6167.13	1011.33	545.60	-292.40	463.03	7894.70	8187.10
2000	6379.92	1053.93	552.17	-35.02	471.54	8422.54	8457.56
2001	6274.51	1044.36	601.53	-186.76	480.64	8214.28	8401.04
2002	6433.70	1092.02	620.83	-276.67	487.46	8357.34	8634.01
2003	6825.81	1105.82	602.56	-284.99	489.66	8738.86	9023.85
2004	6961.73	1197.75	583.21	-283.64	492.70	8951.76	9235.40
2005	7139.56	1218.04	532.83	-303.27	500.16	9087.33	9390.60
2006	7321.72	1231.32	547.99	-381.73	499.33	9218.65	9600.37
2007	7644.82	1258.23	539.87	-239.88	501.06	9704.11	9943.99
2008	7810.88	1259.59	515.55	-417.75	508.94	9677.21	10094.96
2009	7732.01	1094.86	508.93	-429.02	513.41	9420.18	9849.21
2010	7501.87	969.23	531.37	-398.11	515.65	9120.01	9518.12
2011	7202.00	925.44	520.55	-434.67	519.16	8732.47	9167.14
2012	6718.93	885.96	497.06	-421.38	529.52	8210.10	8631.48
2013	5799.49	1113.30	462.29	-439.78	540.84	7476.14	7915.92
2014	5962.75	1329.63	447.69	-435.67	551.20	7855.59	8291.26
2015	6086.00	1243.39	456.87	-431.89	559.24	7913.60	8345.50
2016	6485.44	1262.44	481.13	-49.78	565.09	8744.32	8794.10
2017	6591.98	1316.63	494.24	-419.22	571.54	8555.18	8974.40
2018	6479.73	1255.77	499.40	-399.22	576.71	8412.39	8811.61
Change 1990-2018	63.12%	47.17%	5.94%	82.31%	46.62%	53.75%	54.85%

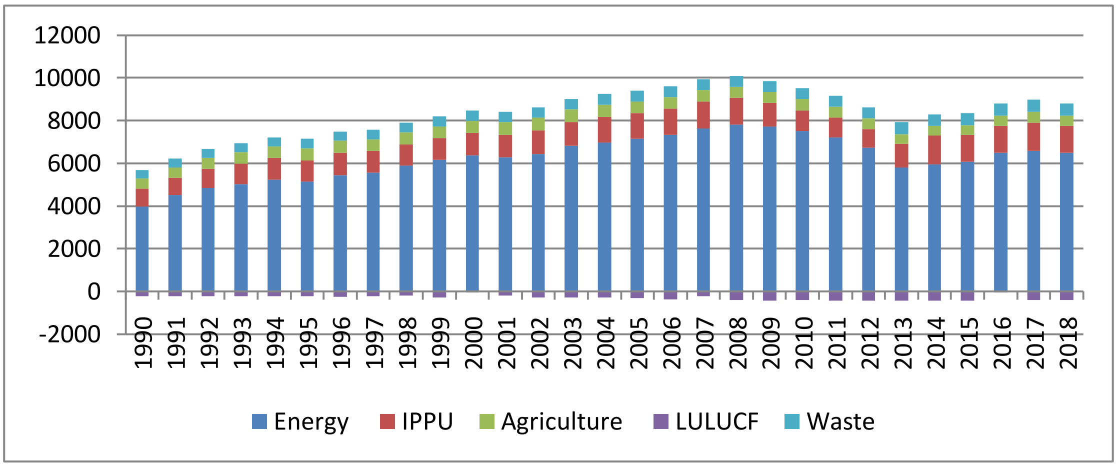

Figure 2 **GHG emissions by sector for the period 1990 – 2018**

ES.4. Other information

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

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

Table 3. **NOx, CO, NMVOCs and SOx emissions 1990-2018 (Gg)**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NOx	16.50	16.87	18.75	18.98	20.24	19.06	19.66	19.93	20.29	20.76

CO	43.40	42.62	41.47	39.63	40.31	38.13	36.97	35.48	33.19	31.90
NMVOCs	17.78	17.54	17.68	17.63	18.15	17.66	17.54	17.74	17.33	17.98
SOx	31.74	33.07	37.90	40.10	42.64	39.64	41.66	43.98	47.29	49.65
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
NOx	22.06	21.39	21.39	21.68	21.26	21.37	21.21	21.42	20.29	20.12
CO	30.54	29.31	28.61	28.90	27.78	26.68	24.84	23.90	22.01	19.78
NMVOCs	18.55	18.71	18.53	20.23	22.29	22.12	20.76	21.04	21.40	19.24
SOx	48.37	45.51	45.95	47.40	40.34	37.88	31.49	29.44	22.44	17.77
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
NOx	18.69	21.54	21.68	16.44	17.44	15.12	14.61	14.52	14.80	
CO	18.59	17.15	15.71	14.64	14.64	14.03	14.36	13.84	12.01	
NMVOCs	20.71	14.78	15.00	13.97	12.59	12.98	13.04	13.26	15.69	
SOx	21.93	20.94	16.24	13.76	16.91	13.02	16.26	16.47	17.71	

Chapter 1.
Introduction

1.1. Background information on GHG inventories and climate change

A greenhouse gas (GHG) is a gas in the atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary natural greenhouse gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone. Hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3) are man-made GHG and are mainly used in a number of industrial activities in replacement of CFCs. Other naturally occurring gases, which do not contribute directly to the greenhouse effect are carbon monoxide (CO), oxides of nitrogen (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO2).

Human activities since the beginning of the Industrial Revolution have produced an increase in the atmospheric concentration of carbon dioxide. This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle. Anthropogenic carbon dioxide (CO2) emissions (i.e., emissions produced by human activities) come predominately from combustion of fossil fuels and deforestation.

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

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

In accordance with Articles 4 and 12 of the Convention and the relevant decisions of the Conference of the Parties (COP), Annex I Parties to the Convention submit to the secretariat national greenhouse gas inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol. These inventories are subject to an annual technical review process.

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

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

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

1.1.1. Background information on climate change

International framework

United Nations Framework Convention on Climate Change[2]

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

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

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

Kyoto Protocol[3]

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

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

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

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

The Doha Amendment[4]

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

---

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

Pursuant to Article 21, paragraph 7 and Article 20, paragraph 4, the amendment is subject to acceptance by Parties to the Kyoto Protocol. In accordance with Article 20, paragraph 4, the amendment will enter into force for those Parties having accepted it on the ninetieth day after the date of receipt by the Depositary of an instrument of acceptance by at least three fourths of the Parties to the Kyoto Protocol. A total of 144 instruments of acceptance are required for the entry into force of the amendment.

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

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

The Paris Agreement[5]

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

The key features of the Paris Agreement are as follows:

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

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

addressing needs linked to adaptation and loss and damage associated with adverse effects of climate change. To promote individual and collective action on adaptation, the Paris Agreement establishes for the first time a global goal with the aim to enhance capacity, climate resilience and reduce climate vulnerability. Internationally, it encourages greater cooperation among Parties to share scientific knowledge on adaptation as well as information on practices and policies.

Climate change and Cyprus

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

1.1.2. Background information on greenhouse gas inventories

International framework

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

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

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

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

Cyprus

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

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

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

[6] Available at http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf

[7] Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/

1.2. A description of the national inventory arrangements

According to decision 24/CP.19, each Annex I Party should implement and maintain national inventory arrangements for the estimation of anthropogenic GHG emissions by sources and removals by sinks. The national inventory arrangements include all institutional, legal and procedural arrangements made within an Annex I Party for estimating anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

National inventory arrangements should be designed and operated:

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

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

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

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

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

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

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

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

1.2.1. Institutional, legal and procedural arrangements

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

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

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

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

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

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

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

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

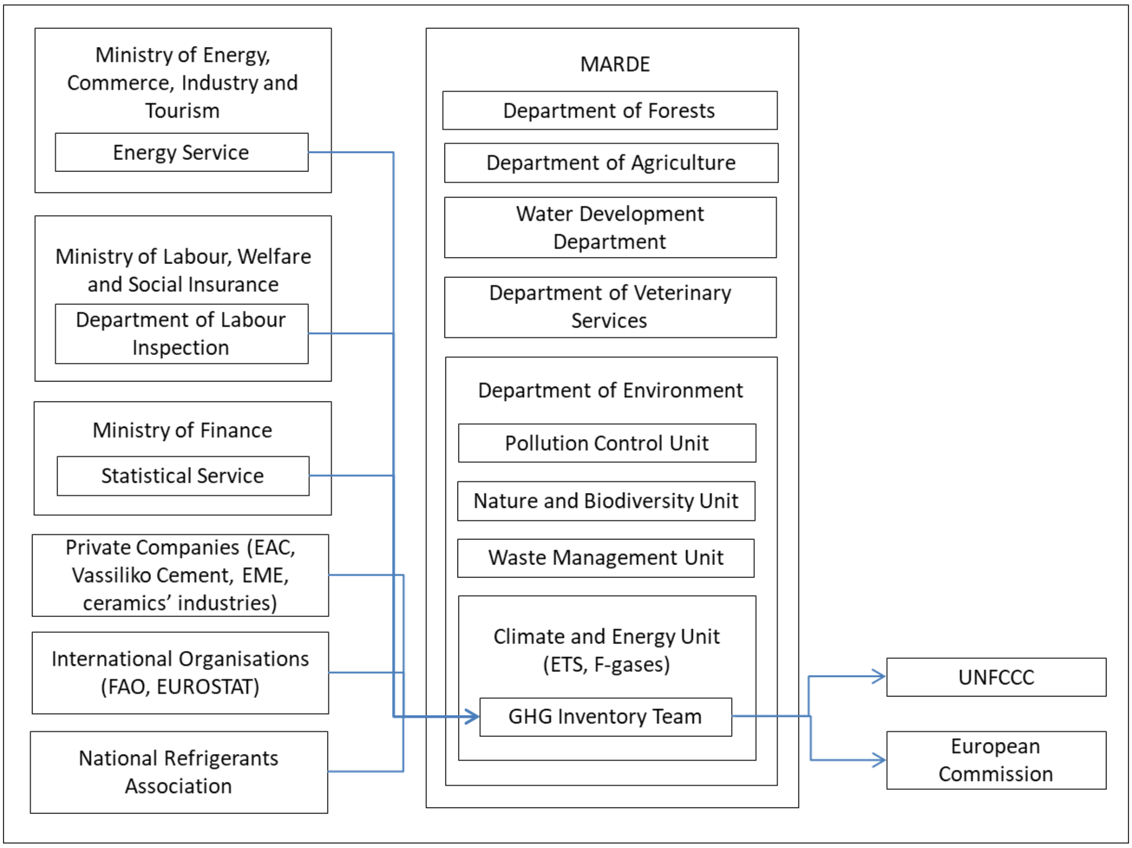

Figure 1.1. Overview of the organisational structure of the National Inventory System

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

1.2.1.1. Roles and responsibilities for inventory preparation

Department of Environment

The DoE, has the overall responsibility, as the national entity, for the national GHG inventory. Among its responsibilities are the following:

- The co-ordination of all ministries and other institutions involved, as well as any relevant public or private organization. In this context, it oversees the operation of the National System and decides on the necessary arrangements to ensure compliance with relevant decisions of the COP and the COP/CMP.
- The official consideration and approval of the inventory prior to its submission.
- The response to any issues raised by the inventory review process under Article 8 of the Kyoto Protocol[10],
- The timely submission of the GHG inventory to the European Commission and to the UNFCCC Secretariat.
- The keeping of the Centralised Inventory File, which is delivered to the inventory team which has the technical responsibility for the inventory planning, preparation and management at the

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

beginning of each inventory cycle. The Centralised Inventory File is kept at the premises of the DoE.

- The administration of the National Registry. Cyprus cooperates with the Member States of the European Union and with the supplementary transaction log and the registry of the European Community by maintaining the national registries in a consolidated system.
- The supervision and implementation of Quality Assurance/Quality Control Plan (QA/QC)

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

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

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

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

(b) Ms. Melina Menelaou (LULUCF, KP-LULUCF)
Technician, Department of Environment, Ministry of Agriculture, Rural Development and Environment, Offices' address: 20-22 28th Oktovriou Ave., Engomi, 2414, Nicosia, Cyprus, Postal address: Department of Environment, 1498 Nicosia, Cyprus, Tel. +357 22 408 959, Email. mmenelaou@environment.moa.gov.cy
BA Biological Sciences - emphasis in Ecology, Master's degree in Public Administration

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

(d) Ms. Florence Dubart
Technical Research Specialist for Greenhouse Gases and Air Pollutants Inventory, the Cyprus Institute, address. 20, Konstantinou Kavafi Street, 2121, Nicosia, Cyprus, Tel. +357 22 397 558

Email. f.dubart@cyi.ac.cy
BSc Mathematics, BSc Earth Sciences, MSc Petroleum Geology

Government Ministries/ Government agencies

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

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

Contact points for data collection

Data from the annual ETS submissions from installations participating is the EU-ETS scheme has been obtained since 2006 from the ETS team, which is also part of the Climate Action Unit of the Department of Environment (contact point Ms. Chrystalla Papastavrou, tel. no. +357 22 408962, cpapastavrou@environment.moa.gov.cy). Apart from the fuel consumption data is also obtained for CO2 emissions (combustion and process emissions) and net calorific value (NCV) of fuels consumed.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.2.2. Overview of inventory planning, preparation and management

1.2.2.1. GHG inventory, data collection, processing and storage

The preparation of Cyprus' GHG emissions inventory is primarily based on the application of the 2006 IPCC Guidelines.

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

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

- Stage 1: The first stage consists of data collection and checks for all source / sink categories. The main data sources used are the National Statistical Service, the national energy balance, the government ministries / agencies involved, along with the verified reports from installations under the EU ETS. Quality control of activity data include the comparison of the same or similar data from alternative data sources (e.g. National Statistical Service, EU ETS reports and energy balance) as well as time-series assessment in order to identify changes that cannot be explained. In cases where problems and / or inconsistencies are identified, the agency's representative, responsible for data providing, is called to explain the inconsistency and / or help solving the problem.

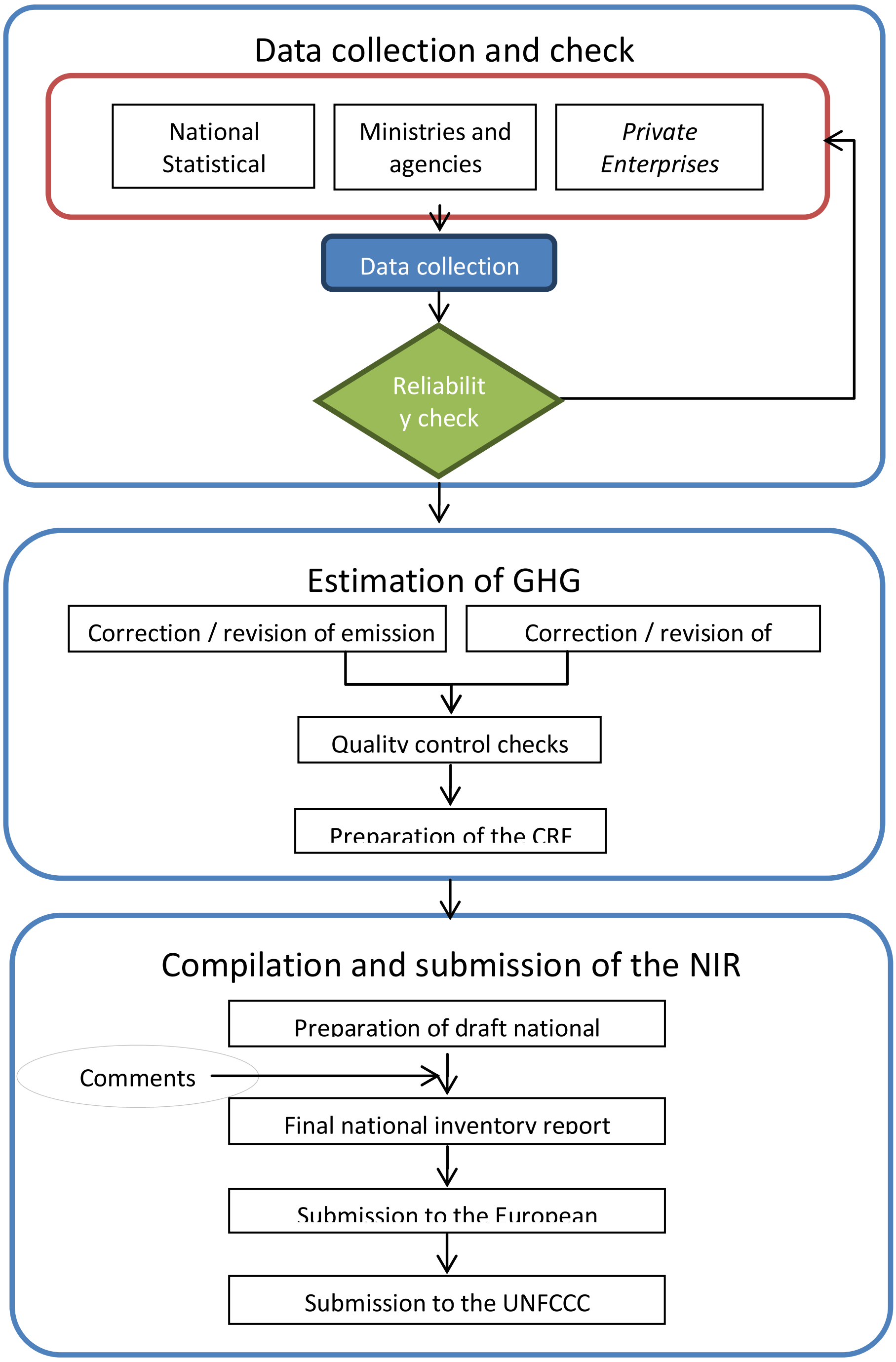

Figure 1.2. GHG emissions inventory preparation process in Cyprus

- Stage 2: Once the reliability of input data is checked and certified, emissions / removals per source / sink category are estimated. Emissions estimates are then transformed to the format required by the CRF Reporter. This stage also includes the evaluation of the emission factors used and the assessment of the consistency of the methodologies applied in relation to the provisions of the IPCC Guidelines, the IPCC Good Practice Guidance and the LULUCF Good Practice Guidance. Quality control checks, when at this stage, are related to time-series assessment as well as to the identification and correction of any errors / gaps while estimating emissions / removals and entering the data in the CRF Reporter.

- Stage 3: The last stage involves the compilation of the NIR and its internal check. During this period, the Inventory Team has to revise the report according to the observations and recommendations of the QA. On the basis of this interaction process, the final version of the report is compiled. The Director of the Department of Environment approves the inventory and then the contact points submit the NIR to the European Commission for compliance with Regulation (EU) No 525/2013 and thereafter to the UNFCCC secretariat.

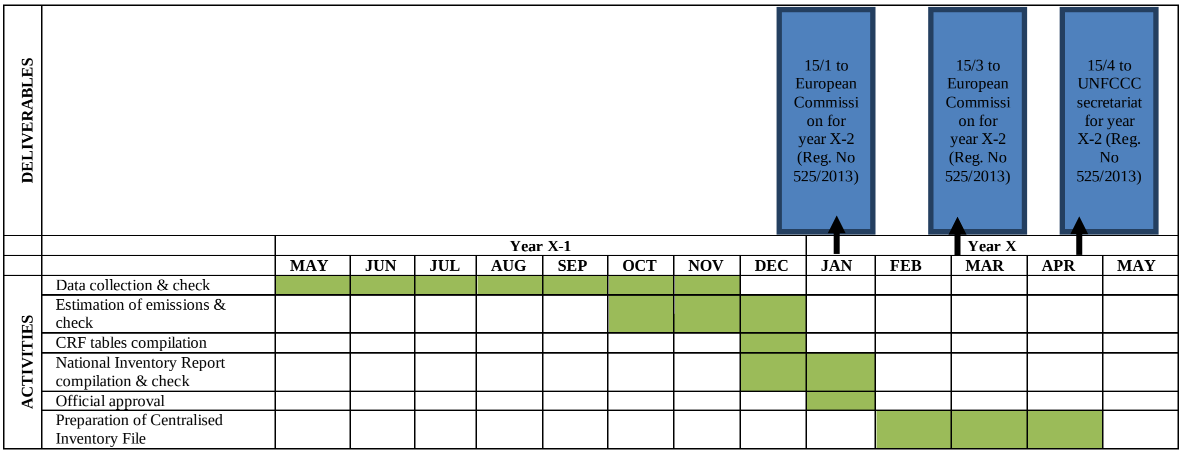

Figure 1.3. Timetable for inventory preparation

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

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

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

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

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

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

---

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

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

1.2.3. Quality assurance, quality control and verification plan

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

- stakeholder engagement (stakeholders = e.g. suppliers of data, reviewers, recipients, other inventory compiling institutes (e.g. NFR))
- data collection
- data management
- inventory compilation
- consolidating the inventory estimates (e.g. into a single national database)
- reporting.

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

The development and the implementation of an inventory QA/QC plan represents a key tool for meeting the objectives of National Systems under Article 5 Paragraph 1 of the Protocol as described in Decision 20/CP.7.

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

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

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

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

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

- data collection and processing,
- applying methods consistent with 2006 IPCC Guidelines for calculating / recalculating emissions or removals, and 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol
- making quantitative estimates of inventory uncertainty,
- archiving information and record keeping and
- compiling national inventory reports.

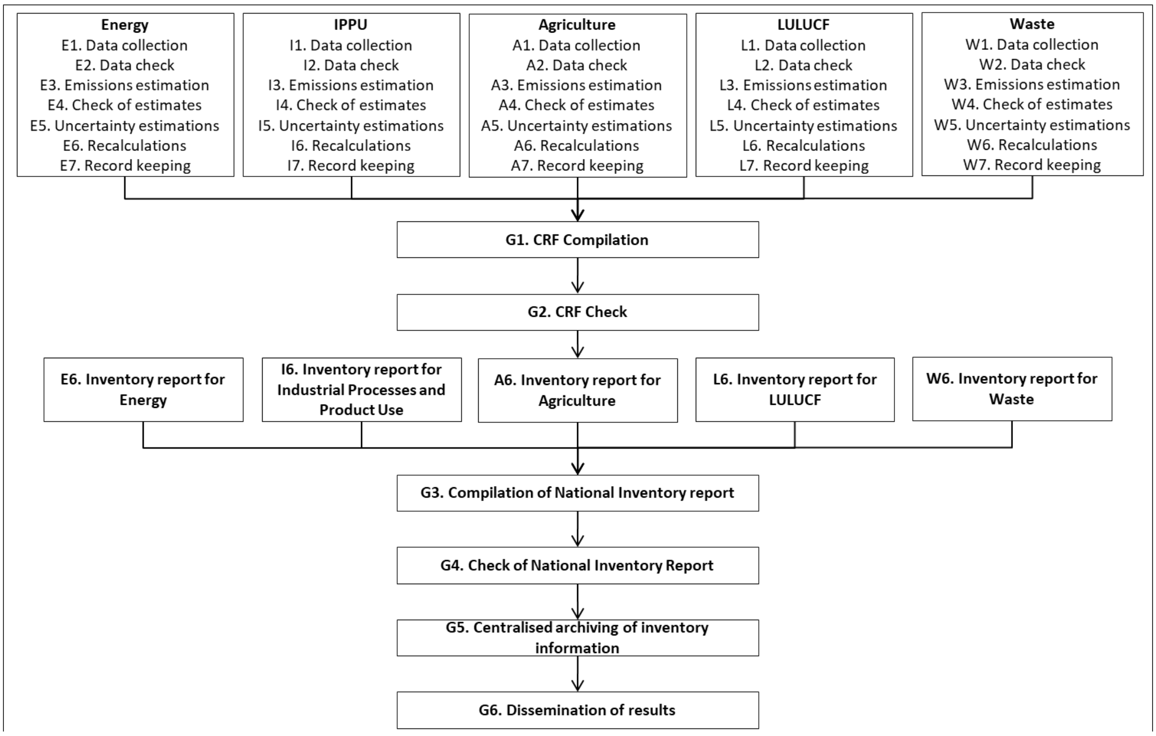

Figure 1.4. Flow chart of activities concerning emissions inventory

The QA/QC system developed covers the following processes:

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

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

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

Process	**Procedure code**	**Procedure**
Quality management	QM01	System review
	QM02	System improvement
	QM03	Training
	QM04	Record keeping
	QM05	Internal reviews
	QM06	Non-compliance-corrective and preventing actions
	QM07	Quality management system
	QM08	Documents control
	QM09	Internal communication
Quality control	QC01	Data collection

	QC02	Estimation of emissions/removals
	QC03	Data quality control check
	QC04	Input data record keeping
Archiving of inventory information	AI01	Centralised archiving of inventory information
	AI02	Compilation of reports
Quality assurance	QA01	Expert review of input data and parameters
	QA02	Expert review of GHG emissions/removals inventory
	QA03	Review from public
Uncertainty estimation	UE01	Uncertainty analysis
Inventory improvement	II01	Recalculations management

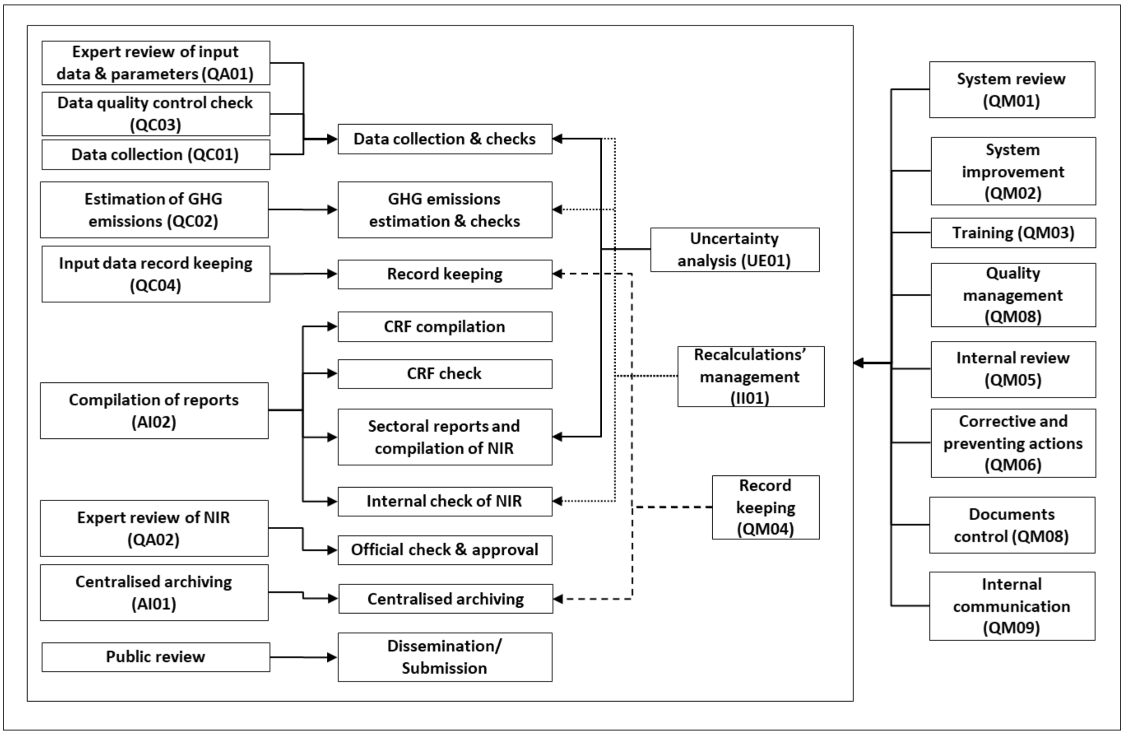

Figure 1.5. QA/QC process and procedures and inventory related activities

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

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

(a) an assessment whether all emission source categories and gases required under Regulation (EU) No 525/2013 are reported;
(b) an assessment whether emissions data time series are consistent;
(c) an assessment whether implied emission factors across Member States are comparable taking the IPCC default emission factors for different national circumstances into account;
(d) an assessment of the use of 'Not Estimated' notation keys where IPCC tier 1 methodologies exist and where the use of the notation key is not justified in accordance with paragraph 37 of the UNFCCC reporting guidelines on annual greenhouse gas inventories as included in Annex I to Decision 24/CP.19;
(e) an analysis of recalculations performed for the inventory submission, in particular if the recalculations are based on methodological changes;

(f) a comparison of the verified emissions reported under the Union's Emissions Trading System with the greenhouse gas emissions reported pursuant to Article 7 of Regulation (EU) No 525/2013 with a view of identifying areas where the emission data and trends as submitted by the Member State under review deviate considerably from those of other Member States;
(g) a comparison of the results of Eurostat's reference approach with the Member States' reference approach;
(h) a comparison of the results of Eurostat's sectoral approach with the Member States' sectoral approach;
(i) an assessment whether recommendations from earlier Union or UNFCCC reviews, not implemented by the Member State could lead to a technical correction;
(j) an assessment whether there are potential overestimations or underestimations relating to a key category in a Member State's inventory.

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

1.2.3.1. Roles, responsibilities and timing

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

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

Table 1.2. Timing and responsibilities

	Responsible	**Timing**
Data collection	Data providers Nicoletta Kythreotou[13]	by 30/11 of year X-1
Data check	Nicoletta Kythreotou[14] Florence Dubart (Energy, Agriculture) Demetris Demetriou (IPPU, Waste) Melina Menelaou (LULUCF)	by 30/11 of year X-1
Emissions estimation	Nicoletta Kythreotou Florence Dubart (Energy, Agriculture) Demetris Demetriou (IPPU, Waste) Melina Menelaou (LULUCF)	1/10-15/12 of year X-1
Check of estimates	Jonilda Kushta	1/10-15/12 of year X-1
Uncertainty estimations	Nicoletta Kythreotou (Energy, IPPU, Agriculture, Waste) Melina Menelaou (LULUCF)	1-30/12 of year X-1
Recalculations	Florence Dubart (Energy, Agriculture) Demetris Demetriou (IPPU, Waste) Melina Menelaou (LULUCF)	1-30/12 of year X-1
Record keeping	Florence Dubart (Energy, Agriculture) Demetris Demetriou (IPPU, Waste) Melina Menelaou (LULUCF) Angelos Violaris (checks)	1/10-30/12 of year X-1
CRF compilation	Nicoletta Kythreotou (Energy, IPPU, Agriculture, Waste) Melina Menelaou (LULUCF)	1-27/12 of year X-1

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

	Responsible	Timing
CRF check	Angelos Violaris	27-30/12 of year X-1
Sectoral reports	Florence Dubart (Energy, Agriculture) Demetris Demetriou (IPPU, Waste) Melina Menelaou (LULUCF)	1-30/12 of year X-1
Compilation of NIR	Angelos Violaris	20-30/12 of year X-1
Check of NIR		
- internal	Nicoletta Kythreotou	31/12 of year X-1 – 5/1 of year X
→ correction of any errors found	Florence Dubart Demetris Demetriou Melina Menelaou	5-8/1 of year X
- official (expert review)	Jonilda Kushta	8-11/1 of year X
→ correction of any errors found	Florence Dubart Demetris Demetriou Melina Menelaou	11-13/1 of year X
- Official check & approval	Theodoulos Mesimeris	13-15/1 of year X
Submission to European Commission	Nicoletta Kythreotou	15/1 of year X
Centralised archiving	Angelos Violaris	15/1 of year X
EU QA/QC procedure		15/1-28/2 of year X
Review by stakeholders & public		15/1-28/2 of year X
Corrections to NIR/calculations	Florence Dubart Demetris Demetriou Melina Menelaou	28/2-15/3 of year X
Final Submission to European Commission	Nicoletta Kythreotou	15/3 of year X
Submission to UNFCCC secretariat	Nicoletta Kythreotou	15/4 of year X

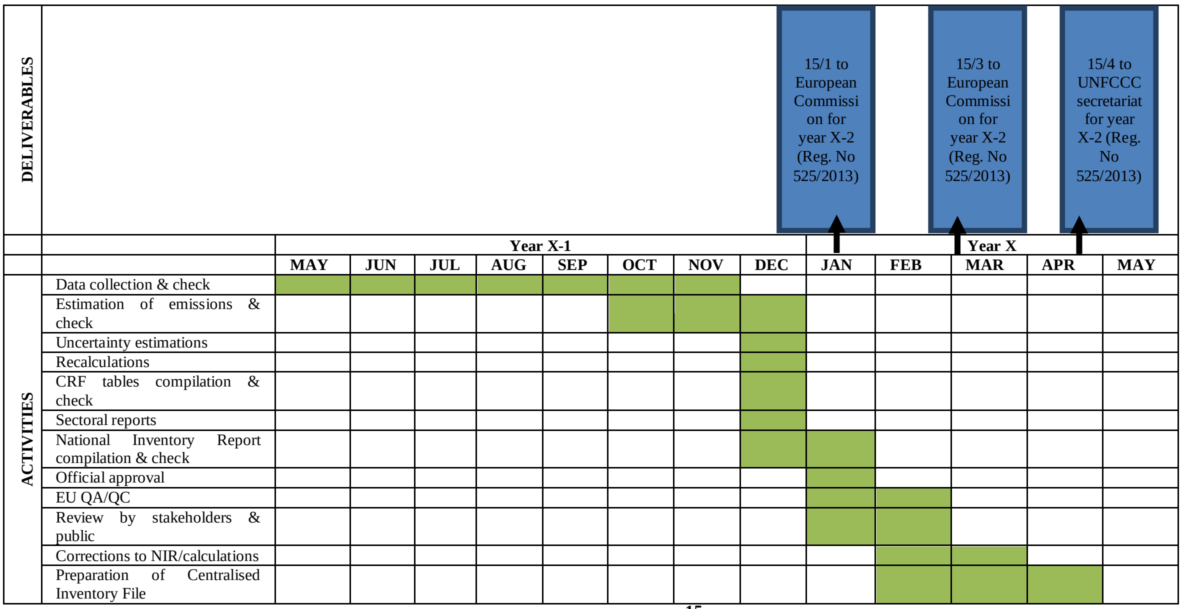

Figure 1.6. Timing and responsibilities of QA/QC tasks[15]

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

1.2.4. Changes in the national inventory arrangements since previous annual GHG inventory submission

In 2018 for the preparation of the 2019 submission, the estimation of the emissions from the sectors of 2F has been outsourced to a local expert.

1.3. Brief general description of methodologies and data sources used

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

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

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

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

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

The estimation of GHG emissions / removals per source / sink category is predominately based on the methods described in the revised 2006 IPCC Guidelines. The emission factors used were derived from the 2006 IPCC Guidelines and special attention was paid in selecting the emission factors that are most representative of practices and conditions in Cyprus. Furthermore, emission factors were obtained from plant specific information contained in EU ETS reports. Due to data unavailability, for the estimation of the emissions of the sectors Refrigeration and Air Conditioning (2F1), Foam Blowing Agents (2F2), Fire Protection (2F3) and Metered Dose Inhalers (2F4a) the implied emission factors per capita from the average of Greece, Italy, Malta and Spain (NIR2015) have been used. For Use of Electrical Equipment (2G1) and N2O from Product Uses (2G3), the implied emission factor per capita from Greece was used. Details on the methods applied for the calculation of emissions / removals are given

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

the chapters that follow. The methodologies and EF used for the compilation of the 2018 GHG inventory submission are presented in Table 1.3.

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

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

Category-Classification		Gas	EF	Method
1A1a.i	Energy Industries - Public electricity and heat production – Energy generation - Liquid fuels	CO_2	CS	CS
1A1a.i	Energy Industries - Public electricity and heat production – Energy generation Liquid fuels	CH_4/N_2O	D	T1
1A1b	Energy Industries – Petroleum Refining – Liquid fuels	$CO_2/CH_4/N_2O$	D	T1
1A1c.iv	Manufacture of solid fuels and Other Energy Industries – Charcoal production- biomass	$CO_2/CH_4/N_2O$	D	T1
1A2b	Manufacturing Industries and Construction – Non-ferrous Metals - Liquid fuels	$CO_2/CH_4/N_2O$	D	T1
1A2c	Manufacturing Industries and Construction – Chemicals – Liquid fuels	$CO_2/CH_4/N_2O$	D	T1
1A2c	Manufacturing Industries and Construction – Chemicals – Biomass	$CO_2/CH_4/N_2O$	D	T1
1A2d	Manufacturing Industries and Construction – Pulp, Paper and Print – Liquid fuels	$CO_2/CH_4/N_2O$	D	T1
1A2e.	Manufacturing Industries and Construction – Food processing, beverages and tobacco – Liquid fuels	$CO_2/CH_4/N_2O$	D	T1
1A2e.	Manufacturing Industries and Construction – Food processing, beverages and tobacco – Biomass	$CO_2/CH_4/N_2O$	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel	CO_2	CS	CS
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel	CH_4/N_2O	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – solid fuel	CO_2	CS	CS
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – solid fuel	CH_4/N_2O	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – other fossil fuel	$CO_2/CH_4/N_2O$	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – biomass (2000 and later)	$CO_2/CH_4/N_2O$	D	T1
1A2g (iii).	Manufacturing Industries and Construction – Other - Mining (excluding fuels) and Quarrying – liquid fuel	$CO_2/CH_4/N_2O$	D	T1
1A2g (v).	Manufacturing Industries and Construction - Other - Construction – liquid fuel	$CO_2/CH_4/N_2O$	D	T1
1A2g (viii).	Manufacturing Industries and Construction – Other -Non-specified Industry – liquid fuel	$CO_2/CH_4/N_2O$	D	T1
1A3a.	Transport - Domestic aviation – Jet kerosene	$CO_2/CH_4/N_2O$	D	T1
1A3bi.	Transport - Road transportation – Gasoline	$CO_2/CH_4/N_2O$	M	T2
1A3bi.	Transport - Road transportation - Diesel	$CO_2/CH_4/N_2O$	M	T2
1A3bi.	Transport - Road transportation - Biomass	$CO_2/CH_4/N_2O$	M	T3
1A3d	Transport - Domestic Navigation – Gas/Diesel Oil	$CO_2/CH_4/N_2O$	D	T1

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

Category-Classification		Gas	EF	Method
	solvent use including fungicides, road paving with asphalt, printing)			
2D3	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts	CO_2	D	D
2D3	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts	CH_4/N_2O	NA	NA
2F1	Product Uses as Substitutes for ODS - Refrigeration and air conditioning	HFCs	D,CS	T1,CS
2F2	Product Uses as Substitutes for ODS - Foam Blowing Agents	HFCs	CS	CS
2F3	Product Uses as Substitutes for ODS - Fire Protection	HFCs	CS	CS
2F4.	Product Uses as Substitutes for ODS - Aerosols	HFCs	CS	CS
2G3a	Other Product Manufacture and Use - N2O from product uses – Medical Applications	N_2O	CS	CS
2G3b	Other Product Manufacture and Use - N2O from product uses – Other –Propellant for pressure and aerosol products	N_2O	CS	CS
3A	Enteric Fermentation – Dairy Cattle	CH_4	CS	T2
3A	Enteric Fermentation - Non-dairy cattle, sheep, goats, horses, mules and asses and swine	CH_4	D	T1
3B1.1	Manure Management – Dairy Cattle and Non-dairy cattle	CH_4	D	T2
3B1.2 3B1.4	Manure Management – sheep, goats, horses, mules and asses, poultry	CH_4	D	T1
3B1.3	Manure Management –swine (market & breeding)	CH_4	D	T2
3B2.1 3B2.2 3B2.3 3B2.4	Direct N2O emissions – Dairy and non-dairy cattle, Sheep, swine (market & breeding), goats, horses, poultry, mules and asses	N_2O	D	T1
3B2.5	Indirect N2O emissions	N_2O	D	T1
3D1.1	Agricultural soils- Direct N2O Emissions From Managed Soils- Inorganic fertilizers	N_2O	D	T1
3D1.2a	Agricultural soils- Direct N2O Emissions From Managed Soils - Organic N fertilizers - Animal manure used as fertilizers	N_2O	D	T1
3D1.2b	Agricultural soils- Direct N2O Emissions From Managed Soils - Organic N fertilizers - Sewage sludge applied to soils	N_2O	D	T1
3D1.4	Agricultural soils- Direct N2O Emissions From Managed Soils - Crop residues	N_2O	D	T1
3D2.1	Indirect N2O emissions from managed soils – Atmospheric Deposition	N_2O	D	T1
3D2.2	Indirect N2O emissions from managed soils Nitrogen Leaching and run-off	N_2O	D	T1
3F1	Field Burning of Agricultural Residues – Cereals – Wheat, Barley, Oats	N_2O/CH_4	D	T1
3F2	Field Burning of Agricultural Residues – Pulses – Bean and Pulses	N_2O/CH_4	D	T1
3F3	Field Burning of Agricultural Residues –Tubers and Roots	N_2O/CH_4	D	T1
3H	Urea Application	CO_2	D	T1
5A1.a	Solid Waste Disposal - Managed waste disposal sites- Anaerobic	CH_4	D	T2
5A1.a	Solid Waste Disposal - Managed waste disposal	CO_2	NA	NA

Category-Classification		Gas	EF	Method
	sites- Anaerobic			
5A2.	Solid Waste Disposal - Unmanaged waste disposal sites	CH_4	D	T2
5A2.	Solid Waste Disposal - Unmanaged waste disposal sites	CO_2	NA	NA
5B1a	Biological treatment of solid waste – Composting- municipal solid waste	CH_4/N_2O	D	T1
5D1.	Wastewater Treatment and Discharge - Domestic wastewater	CH_4/N_2O	CS	T1
5D2.	Wastewater Treatment and Discharge - Industrial wastewater	CH_4	D	T1
5D2.	Wastewater Treatment and Discharge - Industrial wastewater	N_2O	OTH	OTH

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

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

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

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

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

[17] Available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004D0156&from=EN (no longer in force)

[18] Available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0087&from=EN

[19] Available at http://www.moa.gov.cy/moa/environment/environmentnew.nsf/All/E526DA8D521738B9C2258020002E364D?OpenDocument (in Greek)

Category-Classification		Data	Sources
1A2f.	Non-metallic minerals – biomass	Fuel consumption	ETS verified reports Statistical Service DLI
1A2g(iii).	Other - Mining (excluding fuels) and Quarrying – liquid fuel	Fuel consumption	Statistical Service
1A2g(v).	Other - Construction – liquid fuel	Fuel consumption	Statistical Service
1A2g(viii).	Other -Non-specified Industry – liquid fuel	Fuel consumption	Statistical Service
1A3a.	Domestic aviation – Jet kerosene	Fuel consumption	Statistical Service /EUROCONTROL
1A3bi.	Road transportation – Gasoline	Fuel consumption Vehicles registration	Statistical Service Dep. of Road Transport
1A3bi.	Road transportation - Diesel	Fuel consumption Vehicles registration	Statistical Service Dep. of Road Transport
1A3bi.	Road transportation - Biomass	Fuel consumption Vehicles registration	Statistical Service Dep. of Road Transport
1A3d	Domestic Navigation – Gas/Diesel Oil	Fuel consumption	Statistical Service
1A4a.	Commercial/institutional - Liquid fuel	Fuel consumption	Statistical Service DLI
1A4a.	Commercial/institutional - Biomass	Fuel consumption	Statistical Service DLI
1A4b.	Residential – Liquid fuel	Fuel consumption	Statistical Service DLI
1A4b.	Residential – Biomass	Fuel consumption	Statistical Service DLI
1A4ci.	Agriculture/forestry/fishing - Stationary- Liquid fuel	Fuel consumption	Statistical Service DLI
1A4ci.	Agriculture/forestry/fishing – Stationary- Biomass	Fuel consumption	Statistical Service DLI
1A4ciii	Agriculture/forestry/fishing – Fishing – Gas/Diesel Oil	Fuel consumption	Statistical Service
1A5a.	Other - Non-Specified – Stationary – Liquid fuel	Fuel consumption	Statistical Service
1A5a.	Other - Non-Specified – Stationary – Solid fuel	Fuel consumption	Statistical Service
1A5a.	Other - Non-Specified – Stationary – Biomass	Fuel consumption	Statistical Service
1A5b.	Other - Non-Specified – Liquid fuel	Fuel consumption	Statistical Service
1B2a4.	Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Refining/Storage	Fuel consumption	Statistical Service
2A1.	Cement production	Clinker production	ETS verified reports Statistical Service DLI
2A2	Lime Production	Lime production	Statistical Service DLI Installation
2A4a.	Other process uses of carbonates - Ceramics	Bricks and Tiles Production	ETS verified reports DLI
2A4b.	Other process uses of carbonates - Other uses of soda-ash	Soda – Ash Imports	Statistical Service
2D1.	Lubricant Use	Lubricants consumption	Statistical Service
2D2.	Paraffin Wax Use	Paraffin Wax Imports	Statistical Service

Category-Classification		**Data**	**Sources**
2D3.	Solvent Use (Dry cleaning, coating applications, chemical products, asphalt roofing, domestic solvent use including fungicides, road paving with asphalt, printing)	NMVOCs	DLI
2D3.	Solvent Use - Urea-based catalysts	Fuel consumption	Statistical Service
2F1.	Refrigeration and air conditioning	Commercial and industrial air-conditioning and refrigeration	Department of Environment – Inventory of equipment containing fluorinates and ozone depleting substances*
2F2	Foam Blowing Agents	Emissions Data	National Inventory of Malta, Spain, Italy, Greece
2F3	Fire Protection	Emissions Data	National Inventory of Malta, Spain, Italy, Greece
2F4.	Aerosols	Emissions Data	National Inventory of Malta, Spain, Italy, Greece
2G3a	N2O from product uses	Population	Statistical Service
2G3b	N2O from product uses	Population	Statistical Service
3A	Enteric Fermentation – Dairy Cattle	Livestock population milk yield* average weight*	Statistical Service DLI EUROSTAT Veterinary Services *Department of Agriculture
3A	Enteric Fermentation - Non-dairy cattle, sheep, goats, horses, mules and asses and swine	Livestock population	Statistical Service DLI EUROSTAT Veterinary Services Department of Agriculture
3B1.1	Manure Management – Dairy Cattle and Non-dairy cattle	Livestock population	Statistical Service DLI EUROSTAT Veterinary Services Department of Agriculture
3B1.2 3B1.4	Manure Management – sheep, goats, horses, mules and asses, poultry	Livestock population	Statistical Service DLI EUROSTAT Veterinary Services Department of Agriculture
3B1.3	Manure Management –swine (market & breeding)	Livestock population	Statistical Service DLI EUROSTAT Veterinary Services Department of Agriculture
3B2.1 3B2.2 3B2.3 3B2.4	Direct N2O emissions – Dairy and non-dairy cattle, Sheep, swine (market & breeding), goats, horses, poultry, mules and asses	Livestock population	Statistical Service DLI EUROSTAT Veterinary Services Department of Agriculture
3B2.5	Indirect N2O emissions	Livestock population	Statistical Service DLI EUROSTAT Veterinary Services Department of Agriculture
3D1.1	Agricultural soils- Inorganic fertilizers	Fertilizers use	Statistical Service Department of Agriculture

Category-Classification		Data	Sources
3D1.2a	Use of organic N fertilizers - Animal manure used as fertilizers	Fertiliser use Livestock population	Statistical Service Department of Agriculture
3D1.2b	Use of organic N fertilizers - Sewage sludge applied to soils	Fertiliser use Sewage sludge applied to soils	Statistical Service Department of Agriculture
3D1.4	Crop residues	Cultivated areas Crop production	Statistical Service
3D2.1	Indirect N2O emissions from managed soils – Atmospheric Deposition	Fertiliser use	Statistical Service Department of Agriculture
3D2.2	Indirect N2O emissions from managed soils Nitrogen Leaching and run-off	Fertiliser use Livestock population Sewage sludge applied to soils	Statistical Service Department of Agriculture
3F1	Field Burning of Agricultural Residues – Cereals – Wheat, Barley, Oats	Cultivated areas Crop production	Statistical Service
3F2	Field Burning of Agricultural Residues – Pulses – Bean and Pulses	Cultivated areas Crop production	Statistical Service
3F3	Field Burning of Agricultural Residues –Tubers and Roots	Cultivated areas Crop production	Statistical Service
3H	Urea Application	Urea use	Statistical Service
5A1.a	Managed waste disposal sites	Municipal solid waste production Recycling Population	Statistical Service Department of Environment
5A2.	Unmanaged waste disposal sites	Municipal solid waste production Population	Statistical Service Department of Environment
5B1a	Biological treatment of solid waste – Composting- municipal solid waste	Composting	Statistical Service
5D1.	Wastewater Treatment and Discharge - Domestic wastewater	Population connected	Statistical Service Water Development Department Department of Environment
5D2.	Wastewater Treatment and Discharge - Industrial wastewater	Industrial production	Statistical Service Department of Environment

*outsourced contract

1.3.1. Global Warming Potential

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

GWP for the greenhouse gases that are used in this inventory are according to Decision 24/CP.19[20] (Annex II).

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

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

Gas	Chemical Compound	100-year Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
HFC-32	CH_2F_2	675
HFC-125	CHF_2CF_2	3500
HFC-134a	CH_2FCF_3	1430
HFC-143a	CF_3CH_3	4470
HFC-227ea	CF_3CHFCF_3	3220
HFC-245fa	$CH_2FCF_2CHF_2$	1030
HCF-365mfc	$CH_3CF_2CH_2CH_2CF_3$	794
Sulphur hexafluoride	SF_6	22800
Nitrogen trifluoride	NF_3	17200

1.4. Brief description of key categories

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

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

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

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

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

The determination of the key categories for the Cyprus' inventory system is based on the application of the Tier 1 methodology (see Annex I for an analytic presentation of calculations) described in the 2006 IPCC Guidelines. Tier 1 methodology for the identification of key categories assesses the impacts of

[20] Decision 24/CP.19 Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention

various source categories on the level and the trend of the national emissions inventory. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms.

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

The key categories for Cyprus' inventory system (without LULUCF) for the year 2018 are presented in Table 1.6. Twelve key source categories are found in the energy sector, five in the IPPU sector, nine in agriculture and four in waste sector in 2018 (without LULUCF). Detailed presentation of the key category analysis is presented in Annex 1.

Table 1.6. Key categories for Cyprus' inventory system without LULUCF for 2018

IPCC Source category	Direct GHG	Level	Trend
1A1a. Public electricity and heat production	CO2	✓	✓
1A2e. Food processing, beverages and tobacco	CO2	✓	✓
1A2f. Non-metallic minerals	CO2	✓	✓
1A2g. Other (please specify)	CO2	✓	
1A3a. Domestic aviation	CO2		✓
1A3b. Road transportation	CO2	✓	✓
1A3b. Road transportation	CH4		✓
1A3b. Road transportation	N2O		✓
1A4a. Commercial/institutional	CO2	✓	✓
1A4b. Residential	CO2	✓	✓
1A4c. Agriculture/forestry/fishing	CO2	✓	
1A5b. Mobile	CO2		✓
2A1. Cement production	CO2	✓	✓
2A4. Other process uses of carbonates	CO2		✓
2D3. Other	CO2		✓
2F1. Refrigeration and air conditioning	HFCs	✓	✓
2G3. N_2O from product uses	N2O	✓	
3A1a. Dairy cattle	CH4	✓	✓
3A1b. Non-dairy cattle	CH4	✓	✓
3A2. Sheep	CH4	✓	✓
3A4a. Goats	CH4		✓
3B3. Swine	CH4		✓
3B3. Swine	N2O		✓
3B4d. Poultry	N2O		✓
3B5. Indirect N_2O emissions	N2O		✓
3D. Agricultural soils	N2O	✓	✓
5A1. Managed waste disposal sites	CH4	✓	✓
5A2. Unmanaged waste disposal sites	CH4	✓	✓
5D1. Domestic wastewater	CH4		✓
5D2. Industrial wastewater	CH4		✓

The methodology applied for the determination of the key categories with LULUCF is similar to the one presented above. The key categories identified for the year 2018 are presented in Table 1.7 (see Annex 1 for an analytical presentation of calculations). The comparison of the results of the analysis with and without LULUCF reveals no major differences in the source categories identified, apart from the categories from the LULUCF sector. In the analysis including LULUCF ten categories from the Energy Sector, four from the IPPU sector, seven from agriculture, four from the waste sector and nine from LULUCF have been identified as key.

Table 1.7. Key categories for Cyprus' inventory system with LULUCF for 2018

IPCC Source category	Direct GHG	Level	Trend
1A1a. Public electricity and heat production	CO2	✓	✓
1A2e. Food processing, beverages and tobacco	CO2	✓	✓
1A2f. Non-metallic minerals	CO2	✓	✓

1A2g. Other (please specify)	CO2	✓	
1A3a. Domestic aviation	CO2		✓
1A3b. Road transportation	CO2	✓	
1A3b. Road transportation	CO2	✓	
1A4a. Commercial/institutional	N2O		✓
1A4b. Residential	CO2	✓	✓
1A4c. Agriculture/forestry/fishing	CO2	✓	
2A1. Cement production	CO2	✓	✓
2A4. Other process uses of carbonates	CO2		✓
2F1. Refrigeration and air conditioning	HFCs	✓	✓
2G3. N2O from product uses	N2O	✓	
3A1a. Dairy cattle	CH4	✓	✓
3A1b. Non-dairy cattle	CH4	✓	
3A2. Sheep	CH4	✓	
3B3. Swine	CH4	✓	✓
3D. Agricultural soils	N2O	✓	✓
4A1. Forest land remaining forest land	CO2	✓	✓
4A2. Land converted to forest land	CO2	✓	✓
4B1. Cropland remaining cropland	CO2	✓	✓
4B2. Land converted to cropland	CO2		✓
4C1. Grassland remaining grassland	CO2	✓	✓
4E2. Land converted to settlements	CO2		✓
4F2. Land converted to other land	CO2		✓
4G. Harvested wood products	CO2		✓
5A1. Managed waste disposal sites	CH4	✓	✓
5A2. Unmanaged waste disposal sites	CH4	✓	✓
5D1. Domestic wastewater	CH4	✓	✓

1.5. General uncertainty evaluation

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

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

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

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

The uncertainty analysis was carried out without the LULUCF sector. The total uncertainty without LULUCF in 2018 is 9.46% and the trend uncertainty 2.19% compared to 1.61% and 1.61% respectively in 1990. The uncertainty evaluation is also submitted in xls format. Detailed presentation of the assessment of uncertainty is presented in Annex 2.

1.6. General assessment of completeness

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

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

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

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

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

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

In the present inventory report, estimates of GHG emissions in Cyprus for the years 1990-2018 are presented. All major sources are reported including emissions estimates for indirect greenhouse gases and SO2 (Annex 5).

The main deficiency identified, is associated to Transport of oil (1.B.2.a.3) and Distribution of oil products (1.B.2.a.5) for which no data/method is available to estimate the emissions. Moreover, there are still some empty cells in the xml. Work is in progress to fill all the cells and use the appropriate notation keys. Further details on deficiencies are provided in the appropriate chapter. A national inventory improvement plan is available and implemented.

Information related to the geographical scope

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

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

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

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

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

Implementation of recommendations and adjustments

The status of implementation of all the recommendations made to the 2018 NIR submission by the EU review team (TERT) during the two review processes are presented in Annex 6.

[21] http://www.mfa.gov.cy/mfa/mfa2016.nsf/mfa08_en/mfa08_en?OpenDocument

Chapter 2.
Trends in greenhouse gas emissions

The economy of Cyprus[22]

The economy of Cyprus can generally be characterised as small, open and dynamic, with services constituting its engine power. Since the accession of the country to the European Union on 1 May 2004, its economy has undergone significant economic and structural reforms that have transformed the economic landscape.

The tertiary sector (services) is the biggest contributor to GVA, accounting for about for about 86.5% in 2016. This development reflects the gradual restructuring of the Cypriot economy from an exporter of minerals and agricultural products in the period 1961-73 and an exporter of manufactured goods in the latter part of the 1970s and the early part of the 80s, to an international tourist, business and services center during the 1980s, 1990s and the 2000s. The secondary sector (manufacturing) accounted for around 11.4% of GVA in 2016. The primary sector (agriculture and fishing) is continuously shrinking and only reached 2.1% of GVA in 2016.

In terms of the recent economic performance of the economy, positive growth rate of 2.0% was recorded in 2015, after almost four years of recession and despite a challenging external environment. In 2016, the economy grew at a rate of 3.0%, significantly higher than the EU and euro area average (2.0% and 1.8% respectively).

Tourism sector constitutes one of the main drivers of economic growth in Cyprus. In 2017 and 2018, tourism exhibited a record number of tourist arrivals (increase by 14.6% and 7.8% respectively). The professional services sector turned out to be remarkably resilient during the economic crisis. This sector was also key in the turnaround of the Cyprus economy and is expected to remain important in the future years. Cyprus' shipping sector is also important for Cyprus. By combining strong geographical, institutional and commercial advantages Cyprus has managed to amass the 10th largest merchant fleet in the world and 3rd largest merchant fleet in the EU.

In the labour market, unemployment fared better than expected as it peeked to around 16.1% in 2014, despite projections of more than 20% of the labour force. In 2017 and 2018, unemployment reduced to 11% and 8.3% respectively and is expected to continue on a downward trend. An issue however of high concern, is the high rate of youth unemployment, as well as the long-term unemployment, even though both are on a declining path.

As regards public finances, targets have been met with considerable margins also in 2015, 2016, 2017 and 2018 with positive indications for the following years. This robust fiscal performance has supported debt sustainability, with public debt reaching its peak in 2015 (107.5% of GDP), with a declining trend commencing from 2016 onwards.

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

GHG emissions in 2018 were 8412 Gg CO2 eq. including LULUCF and 8811 Gg CO2 eq. excluding LULUCF. Total national emissions excluding LULUCF increased by 55% between 1990 and 2018 and decrease by 1.8% between 2017 and 2018. The total GHG emissions trends for the period 1990 – 2018

[22] Mrs. Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs Ministry of Finance, 1439 Nicosia – Cyprus. Tel. no.: +357 22 60 1231 Telefax: +357 22 60 2750 Email: mmatsi@mof.gov.cy

are presented in Table 2.1 and Figure 2.1 in kt CO_2 eq.

The GWP values used for the conversion of emissions estimates into the common unit of carbon dioxide equivalent are those presented in Table 1.4. It is noted that according to the IPCC Guidelines, emissions estimates for international marine and aviation bunkers were not included in the national totals, however they are reported separately as memo items.

Table 2.1. Total GHG emissions trend for the period 1990 – 2018

Total emissions (Gg CO2 eq.)	1990	2000	2005	2010	2015	2017	2018
With LULUCF	5471.47	8422.54	9087.33	9120.01	7913.60	8555.18	8412.39
Without LULUCF	5690.44	8457.56	9390.60	9518.12	8345.50	8974.40	8811.61

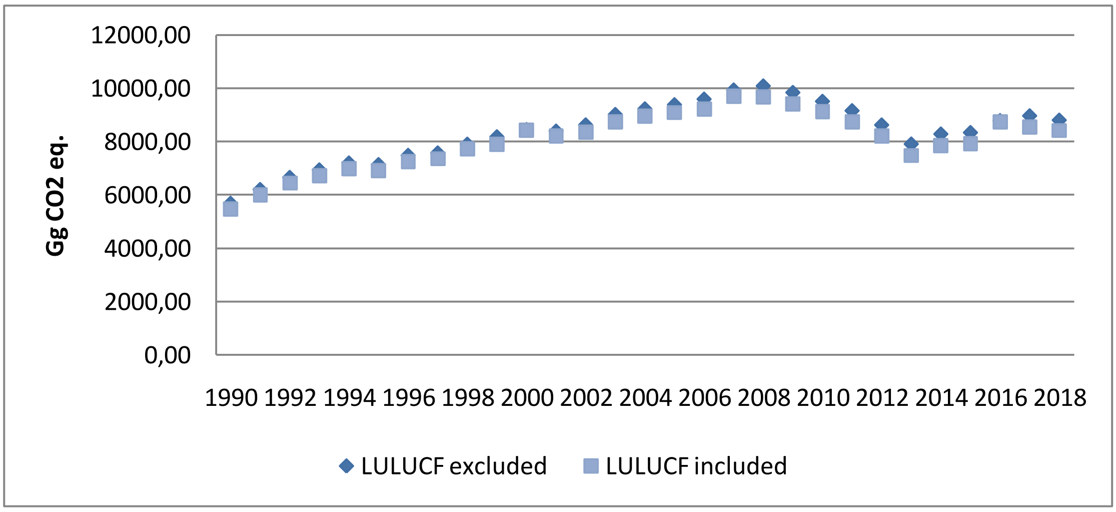

Figure 2.1. Total GHG emissions trend for the period 1990 – 2018

2.2. Description and interpretation of emission trends by sector

Energy, with 6479 Gg CO2 eq., continues to be the largest contributor to the total national GHG emissions (73.6% compared to the total without LULUCF). 3354 Gg CO2 eq. of these emissions is from the production of electricity, while another 2067 Gg CO2 eq. from transport. Table 2.2 and Figure 2.2 present the emissions for the period 1990-2018 by sector.

Table 2.2. GHG emissions by sector for the period 1990 – 2018

	Energy	IPPU	Agriculture	LULUCF	Waste	Total (incl. LULUCF)	Total (excl. LULUCF)
1990	3972.44	853.25	471.41	-218.97	393.34	5471.47	5690.44
1991	4506.04	828.32	475.42	-212.04	397.88	5995.62	6207.65
1992	4834.78	911.33	509.94	-218.38	406.63	6444.32	6662.69
1993	5012.86	975.58	540.73	-233.56	415.82	6711.42	6944.99
1994	5226.20	1021.15	530.09	-222.81	427.43	6982.07	7204.88
1995	5135.42	992.65	580.26	-238.77	435.53	6905.09	7143.86
1996	5432.24	1055.38	562.35	-244.44	440.35	7245.89	7490.33
1997	5556.95	1027.88	548.51	-225.59	448.65	7356.39	7581.99
1998	5901.52	989.74	562.80	-181.67	455.42	7727.82	7909.48
1999	6167.13	1011.33	545.60	-292.40	463.03	7894.70	8187.10
2000	6379.92	1053.93	552.17	-35.02	471.54	8422.54	8457.56
2001	6274.51	1044.36	601.53	-186.76	480.64	8214.28	8401.04
2002	6433.70	1092.02	620.83	-276.67	487.46	8357.34	8634.01
2003	6825.81	1105.82	602.56	-284.99	489.66	8738.86	9023.85
2004	6961.73	1197.75	583.21	-283.64	492.70	8951.76	9235.40
2005	7139.56	1218.04	532.83	-303.27	500.16	9087.33	9390.60
2006	7321.72	1231.32	547.99	-381.73	499.33	9218.65	9600.37
2007	7644.82	1258.23	539.87	-239.88	501.06	9704.11	9943.99

	Energy	IPPU	Agriculture	LULUCF	Waste	Total (incl. LULUCF)	Total (excl. LULUCF)
2008	7810.88	1259.59	515.55	-417.75	508.94	9677.21	10094.96
2009	7732.01	1094.86	508.93	-429.02	513.41	9420.18	9849.21
2010	7501.87	969.23	531.37	-398.11	515.65	9120.01	9518.12
2011	7202.00	925.44	520.55	-434.67	519.16	8732.47	9167.14
2012	6718.93	885.96	497.06	-421.38	529.52	8210.10	8631.48
2013	5799.49	1113.30	462.29	-439.78	540.84	7476.14	7915.92
2014	5962.75	1329.63	447.69	-435.67	551.20	7855.59	8291.26
2015	6086.00	1243.39	456.87	-431.89	559.24	7913.60	8345.50
2016	6485.44	1262.44	481.13	-49.78	565.09	8744.32	8794.10
2017	6591.98	1316.63	494.24	-419.22	571.54	8555.18	8974.40
2018	6479.73	1255.77	499.40	-399.22	576.71	8412.39	8811.61
Change 1990-2018	63.12%	47.17%	5.94%	82.31%	46.62%	53.75%	54.85%

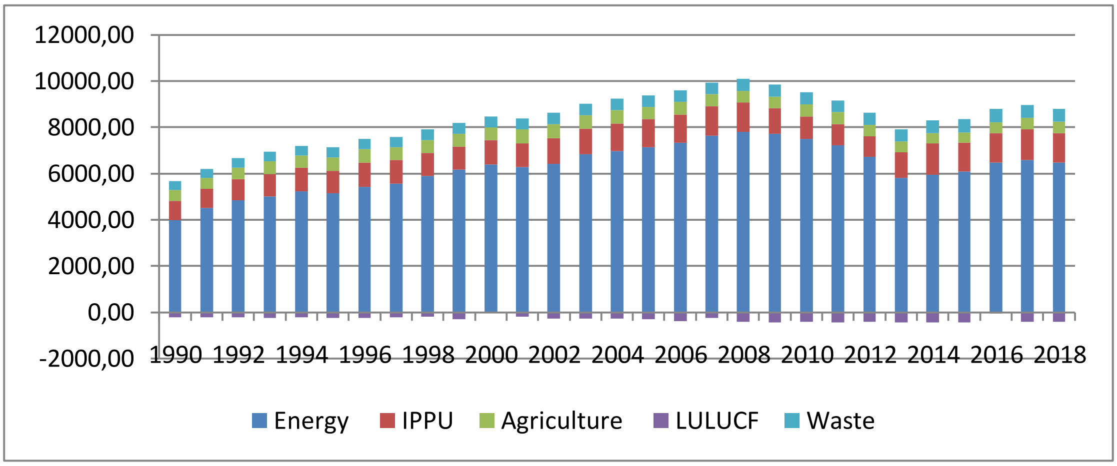

Figure 2.2. GHG emissions by sector for the period 1990 – 2018

2.3. Description and interpretation of emission trends by gas

GHG emissions trends by gas for the period 1990 - 2018 are presented in Table 2.3.

Table 2.3. GHG emissions trends by gas for the period 1990 - 2018

	1990	1991	1992	1993	1994
CO_2 emissions without LULUCF	4656.89	5146.61	5522.91	5766.97	6011.11
CO_2 emissions with LULUCF	4437.85	4934.35	5304.46	5532.86	5786.88
CH_4 emissions without LULUCF	661.43	673.09	691.22	715.69	728.93
CH_4 emissions with LULUCF	661.49	673.25	691.27	716.10	729.98
N_2O emissions without LULUCF	292.49	293.80	324.33	343.60	337.30
N_2O emissions with LULUCF	292.51	293.85	324.35	343.74	337.67
HFCs	79.60	94.13	124.20	118.69	127.49
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs	NO	NO	NO	NO	NO

and PFCs					
SF_6	0.03	0.03	0.03	0.04	0.05
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	5690.44	6207.65	6662.69	6944.99	7204.88
Total (with LULUCF)	5471.47	5995.62	6444.32	6711.42	6982.07
	1995	**1996**	**1997**	**1998**	**1999**
CO_2 emissions without LULUCF	5882.27	6233.23	6321.03	6614.65	6882.47
CO_2 emissions with LULUCF	5642.94	5987.86	6094.10	6428.45	6590.04
CH_4 emissions without LULUCF	750.07	767.00	771.18	772.64	776.03
CH_4 emissions with LULUCF	750.49	767.68	772.17	776.00	776.05
N_2O emissions without LULUCF	379.16	354.32	348.18	372.44	364.08
N_2O emissions with LULUCF	379.30	354.56	348.53	373.61	364.09
HFCs	132.31	135.72	141.53	149.68	164.45
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.06	0.07	0.07	0.07	0.07
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	7143.86	7490.33	7581.99	7909.48	8187.10
Total (with LULUCF)	6905.09	7245.89	7356.39	7727.82	7894.70
	2000	**2001**	**2002**	**2003**	**2004**
CO_2 emissions without LULUCF	7145.88	7021.41	7210.78	7605.55	7840.94
CO_2 emissions with LULUCF	7101.13	6831.38	6934.01	7320.14	7556.49
CH_4 emissions without LULUCF	792.52	824.17	848.41	840.21	835.49
CH_4 emissions with LULUCF	799.72	826.60	848.48	840.52	836.09
N_2O emissions without LULUCF	349.97	381.51	385.89	382.33	343.71
N_2O emissions with LULUCF	352.49	382.35	385.92	382.44	343.92
HFCs	169.12	173.87	188.85	195.67	215.15
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.08	0.08	0.08	0.09	0.10
NF_3	NO	NO	NO	NO	NO

Total (without LULUCF)	8457.56	8401.04	8634.01	9023.85	9235.40
Total (with LULUCF)	8422.54	8214.28	8357.34	8738.86	8951.76
	2005	**2006**	**2007**	**2008**	**2009**
CO_2 emissions without LULUCF	8031.30	8223.17	8538.92	8707.25	8453.80
CO_2 emissions with LULUCF	7727.76	7840.76	8292.49	8289.27	8024.38
CH_4 emissions without LULUCF	818.50	820.19	823.40	821.71	824.02
CH_4 emissions with LULUCF	818.70	820.70	828.26	821.89	824.31
N_2O emissions without LULUCF	316.77	329.73	324.40	312.04	304.37
N_2O emissions with LULUCF	316.84	329.91	326.10	312.10	304.48
HFCs	223.91	227.16	257.13	253.81	266.86
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.12	0.12	0.14	0.15	0.16
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	9390.60	9600.37	9943.99	10094.96	9849.21
Total (with LULUCF)	9087.33	9218.65	9704.11	9677.21	9420.18
	2010	**2011**	**2012**	**2013**	**2014**
CO_2 emissions without LULUCF	8089.01	7759.47	7234.89	6554.36	6934.59
CO_2 emissions with LULUCF	7689.38	7323.53	6812.10	6114.09	6498.37
CH_4 emissions without LULUCF	831.91	837.10	826.52	820.46	820.84
CH_4 emissions with LULUCF	833.04	838.04	827.57	820.83	821.25
N_2O emissions without LULUCF	321.21	308.55	303.41	280.19	275.50
N_2O emissions with LULUCF	321.60	308.88	303.78	280.32	275.64
HFCs	275.84	261.86	266.50	260.75	260.18
PFCs	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF_6	0.15	0.16	0.16	0.15	0.15
NF_3	NO	NO	NO	NO	NO
Total (without LULUCF)	9518.12	9167.14	8631.48	7915.92	8291.26
Total (with	9120.01	8732.47	8210.10	7476.14	7855.59

LULUCF)					
	2015	**2016**	**2017**	**2018**	**Change 1990-2018**
CO_2 emissions without LULUCF	6960.13	7368.23	7515.69	7332.76	57.46%
CO_2 emissions with LULUCF	6528.04	7302.23	7095.96	6932.54	56.21%
CH_4 emissions without LULUCF	832.43	858.37	875.26	884.55	33.73%
CH_4 emissions with LULUCF	832.57	870.38	875.64	885.29	33.83%
N_2O emissions without LULUCF	283.05	290.40	295.58	297.00	1.54%
N_2O emissions with LULUCF	283.10	294.61	295.71	297.26	1.62%
HFCs	269.72	276.93	287.70	297.14	273.29%
PFCs	NO	NO	NO	NO	0.00%
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	0.00%
SF_6	0.16	0.17	0.17	0.17	541.56%
NF_3	NO	NO	NO	NO	0.00%
Total (without LULUCF)	8345.50	8794.10	8974.40	8811.61	54.85%
Total (with LULUCF)	7913.60	8744.32	8555.18	8412.39	53.75%

Chapter 3.
Energy (CRF sector 1)

3.1. Overview of sector

Energy systems are for most economies largely driven by the combustion of fossil fuels. During combustion the carbon and hydrogen of the fossil fuels are converted mainly into carbon dioxide (CO2) and water (H2O), releasing the chemical energy in the fuel as heat. This heat is generally either used directly or used (with some conversion losses) to produce mechanical energy, often to generate electricity or for transportation. The energy sector is usually the most important sector in greenhouse gas emission inventories. The energy sector mainly comprises of exploration and exploitation of primary energy sources, conversion of primary energy sources into more useable energy forms in refineries and power plants, transmission and distribution of fuels and use of fuels in stationary and mobile applications. Emissions arise from these activities by combustion and as fugitive emissions, or escape without combustion.

The energy sector in Cyprus

A key challenge for Cyprus is its high dependency on fossil fuels for energy – the biggest share within the EU in fact, which makes it crucial for the country to develop both its hydrocarbon and renewable energy sources. Cyprus is reliant on fossil fuel imports for its electricity needs, and spends over 8% of its GDP to cover the costs.

The island also saw the biggest increase in energy demand among the EU28, growing 59% since 1990 from 1.6 million tonnes of oil equivalent (Mtoe) to 2.5 Mtoe in 2018. These figures may be low when compared with its larger EU partners, but a more accurate comparison would be Malta where consumption was only 0.8 Mtoe in 2015. However, Cyprus is determined to find a cleaner solution until it can exploit its own reserves.

The 13% Renewable Energy Sources (RES) goal for 2020[23] is set to be generated by wind farms, photovoltaic (PV) systems and biomass and biogas utilisation plants. In the end of 2018, the share of RES in the final energy consumption was 13.9% according to the provisions of the Directive 2009/28/EC. Latest data show that RES accounted for 9.3% of electricity production in 2018. RES power production rose 6% in 2017, compared to 2016, mainly due to an increase 18 % in the electricity production from photovoltaic systems. However wind farms generated almost 57% of electricity from RES in 2018.

In Cyprus, electricity from renewable sources is no more promoted through feed-in-tariff schemes since 2013 where a net metering and self-consumption scheme has been put in place. Moreover in 2016 a new scheme was announced for RES that will participate in the competitive market.

Access of electricity from renewable energy sources to the grid shall be granted according to the principle of non-discrimination.. Grid development is a matter of central planning (Transmission Grid Development Plan 2007-2016 by the Cypriot TSO). In addition, renewable heating and cooling (RES H&C) is promoted by support schemes offering subsidies to households for the installation of solar thermal systems.

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

The island also was awarded with projects that have won significant funding from 'NER300' – a financing instrument managed jointly by the European Commission, European Investment Bank and Member States. The two projects that will be funded are the EOS Green Energy Project and the Green+ Smart-Grid Project that have garnered a combined €71 million to develop innovative renewable ventures and smart grids in Cyprus.

However, the country's national grid system has certain intrinsic and technical limitations affecting RES penetration and reliability of the energy system – such as the lack of interconnections to the trans-European electricity networks, a limitation to the amount of intermittent renewable energy that can be connected to the electricity system, and a lack of centralised storage capability.

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

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

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

The Cyprus Energy Regulatory Authority (CERA) has worked towards the full opening up of the energy market and granting consumers the right to choose their own supplier – with expectations of a full liberalisation by June 2019. CERA's proposition is a 'net pool' model, where the operations of the state power company, EAC, are unbundled and the production and supply operations separated. EAC production would then enter into bilateral agreements with suppliers for the sale of energy at regulated prices. However, these plans have experienced some resistance from unions, as they are seen as moves which could put pressure to privatise the state power company.

Cyprus and a consortium led by China Petroleum Pipeline Engineering Co Ltd signed a contract for the construction of the nearly €300 million infrastructure for the import of liquefied natural gas (FSRU) for electricity generation, in December 2019. The LNG Terminal will include a floating storage and regasification unit (FSRU), a jetty for mooring the FSRU, a jetty borne gas pipeline and related infrastructure. The project is expected to be completed between end-2021 or early 2022

The electrical interconnection with Israel and Greece will be the next major challenge in the country energy sector. Cyprus is promoting the «EuroAsia Interconnector» project as aiming at commissioning in 2022-2023. The project will effectively contribute to the security of energy supply and reduction in CO2 emissions by allowing the countries in the region to use natural gas deposits as well as renewable energy sources for electricity generation.

3.1.1. Trends

The energy sector in Cyprus relies on fossil fuel combustion for meeting the bulk of energy requirements. Final consumption in 2018 amounted to approximately 87.3 PJ. 97.9% of the consumption in 2018 was from liquid fuels, 1.5% from solid fuels and 0.6% from biomass. In comparison to 1990, total fuel consumption in 2018 including biomass increased by 53%. Natural gas is currently not available in Cyprus.

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

The emissions from the energy sector in Cyprus increased by 63% during the period 1990-2018. The greatest increase in emissions was between 1990 and 2008 (97%), the emissions reached their peak (7811 Gg CO2 eq.). All the emissions in 2018 are from fuel combustion. The contribution of the emissions from the energy sector to the total without LULUCF in 2018 was 74% compared to 72% in 1990.

Energy is mainly responsible for carbon dioxide emissions, while it contributes also to methane and nitrous oxide emissions. Fugitive emissions from fuels have not been estimated since 2004 when the refining activities stopped in Cyprus. The contribution of each source and gas to the total emissions of the energy sector over the period 1990 to 2018 are presented in Table 3.1 and Figure 3.1.

Table 3.1. Emissions from energy 1990-2018

Gg CO2 eq.	**1990**	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**
1. Energy	**3973**	**6379**	**7140**	**7502**	**6086**	**6592**	**6480**
A. Fuel combustion (sectoral approach)	3972	6379	7140	7502	6085	6592	6480
1. Energy industries	1767	2965	3484	3881	3033	3299	3354
2. Manufacturing industries and construction	515	822	912	700	607	621	556
3. Transport	1245	1841	2115	2330	1894	2099	2067
4. Other sectors	434	731	610	571	530	552	479
5. Other	11	22	19	20	22	22	24
B. Fugitive emissions from fuels	0.40	0.75	NO	NO	NO	NO	NO
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.40	0.75	NO	NO	NO	NO	NO
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO
CO2	3929	6314	7093	7458	6049	6551	6439
CH4	0.50	0.54	0.59	0.66	0.59	0.64	0.61
N2O	0.10	0.18	0.11	0.09	0.07	0.09	0.09

* Manufacturing of charcoal does take place in Cyprus but does not appear in the table as the fuel consumed is solid biomass

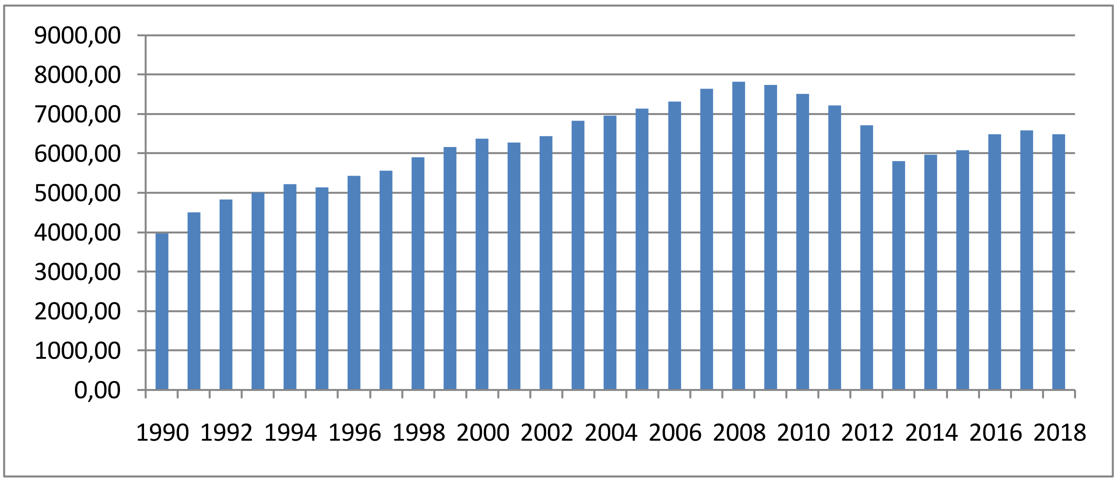

Figure 3.1. Emissions from the energy sector 1990-2018

3.1.2. Methodology

There are three methods provided in the IPCC Guidelines: two Tier 1 approaches (the 'Reference Approach' and the 'Sectoral Approach') and the Tier 2/Tier 3 approach (a detailed technology-based method, also called 'bottom-up' approach). For the Tier 1 Sectoral Approach, total CO_2 is summed across all fuels (excluding biomass) and all sectors. For Tiers 2 and 3, the Detailed Technology-Based Approach, total CO_2 is summed across all fuels and sectors, plus combustion technologies (e.g. stationary and mobile sources). Both approaches provide more disaggregated emission estimates, but also require more data. The sectoral approach is presented in this chapter. The reference approach is presented in details in Section 3.2.8. A comparison of the results of the two approaches is presented in Section 3.2.9.

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

Table 3.2. Methodology for the estimation of emissions from energy

Category-Classification		Gas	EF	Method
1A1a.i	Energy Industries - Public electricity and heat production – Energy generation - Liquid fuels	CO2	CS	CS
1A1a.i	Energy Industries - Public electricity and heat production – Energy generation Liquid fuels	CH4/N2O	D	T1
1A1b	Energy Industries – Petroleum Refining – Liquid fuels	CO2/CH4/N2O	D	T1
1A1c.iv	Manufacture of solid fuels and Other Energy Industries – Charcoal production- biomass	CO2/CH4/N2O	D	T1
1A2b	Manufacturing Industries and Construction – Non-ferrous Metals - Liquid fuels	CO2/CH4/N2O	D	T1
1A2c	Manufacturing Industries and Construction – Chemicals – Liquid fuels	CO2/CH4/N2O	D	T1
1A2c	Manufacturing Industries and Construction – Chemicals – Biomass	CO2/CH4/N2O	D	T1
1A2d	Manufacturing Industries and Construction – Pulp, Paper and Print – Liquid fuels	CO2/CH4/N2O	D	T1
1A2e.	Manufacturing Industries and Construction – Food processing, beverages and tobacco – Liquid fuels	CO2/CH4/N2O	D	T1
1A2e.	Manufacturing Industries and Construction – Food processing, beverages and tobacco – Biomass	CO2/CH4/N2O	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel	CO2	CS	CS
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – Liquid fuel	CH4/N2O	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – solid fuel	CO2	CS	CS
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – solid fuel	CH4/N2O	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – other fossil fuel	CO2/CH4/N2O	D	T1
1A2f.	Manufacturing Industries and Construction – Non-metallic minerals – biomass	CO2/CH4/N2O	D	T1
1A2g (iii).	Manufacturing Industries and Construction – Other - Mining (excluding fuels) and Quarrying – liquid fuel	CO2/CH4/N2O	D	T1
1A2g (v).	Manufacturing Industries and Construction - Other - Construction – liquid fuel	CO2/CH4/N2O	D	T1
1A2g	Manufacturing Industries and Construction –	CO2/CH4/N2O	D	T1

Category-Classification		Gas	EF	Method
(viii).	Other -Non-specified Industry – liquid fuel			
1A3a.	Transport - Domestic aviation – Jet kerosene	CO2/CH4/N2O	D	T1
1A3bi.	Transport - Road transportation – Gasoline	CO2/CH4/N2O	M	T2
1A3bi.	Transport - Road transportation - Diesel	CO2/CH4/N2O	M	T2
1A3bi.	Transport – Road transportation - LPG	CO2/CH4/N2O	D	T1
1A3bi.	Transport - Road transportation - Biomass	CO2/CH4/N2O	M	T2
1A3d	Transport - Domestic Navigation – Gas/Diesel Oil	CO2/CH4/N2O	D	T1
1A4a.	Other Sectors - Commercial/institutional - Liquid fuel	CO2/CH4/N2O	D	T1
1A4a.	Other Sectors - Commercial/institutional - Biomass	CO2/CH4/N2O	D	T1
1A4b.	Other Sectors - Residential – Liquid fuel	CO2/CH4/N2O	D	T1
1A4b.	Other Sectors - Residential – Biomass	CO2/CH4/N2O	D	T1
1A4ci.	Agriculture/forestry/fishing - Stationary- Liquid fuel	CO2/CH4/N2O	D	T1
1A4ci.	Agriculture/forestry/fishing – Stationary- Biomass	CO2/CH4/N2O	D	T1
1A4ciii	Agriculture/forestry/fishing – Fishing – Gas/Diesel Oil	CO2/CH4/N2O	D	T1
1A5a	Other - Non-Specified – Stationary – Liquid fuel	CO2/CH4/N2O	D	T1
1A5a	Other - Non-Specified – Stationary – Solid fuel	CO2/CH4/N2O	D	T1
1A5a	Other - Non-Specified – Stationary – Biomass	CO2/CH4/N2O	D	T1
1A5b	Other - Non-Specified – Mobile - Liquid fuel	CO2/CH4/N2O	D	T1
1B2a4	Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Refining/Storage	CH4	D	T1
1B2a4	Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Refining/Storage	CO2/N2O	NA	NA
1B2c1i	Fugitive Emissions from Fuels- Oil and Natural Gas and Other Emissions from Energy Production- Oil -Venting - tanker trucks	CH4	NA	NA

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

Key categories

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

Uncertainty

The uncertainty analysis is presented in Section 1.5.

3.1.3. Completeness

The emissions from energy are complete.

3.2. Fuel combustion (CRF 1.A)

3.2.1. Source category description

The emissions from the fuel combustion in Cyprus contribute 74% to the total national emissions excluding LULUCF in 2018 and increased by 67% during the period 1990-2018. The greatest increase in emissions was between 1990 and 2008 (97%), the emissions reached their peak (7811 Gg CO2 eq.). The majority of energy related GHG emissions in 2018 was derived from energy industries (51.8%), while transport contributed 31.6%, manufacturing industries and construction 10%, other sectors 8.2% and other 0.3% respectively.

The substantial increase of GHG emissions from road transport (67% between 1990 and 2018) is directly linked to the increase of vehicles fleet but also to the increase of transportation activity. The renewal of the passenger car fleet and the implied improvement of energy efficiency, limit the increase of GHG emissions. The implemented, adopted and planned measures for the improvement of public transport are expected to moderate the high use of passenger cars. The contribution of each source and gas to the total of the sector is presented in Table 3.3. The trend of the emissions from fuel consumption (1A) is presented in Figure 3.2.

Table 3.3. Emissions from fuel combustion 1990-2018

Gg CO2 eq.	1990	2000	2005	2010	2015	2017	2018
A. Fuel combustion activities	3972	6380	7140	7502	6086	6591	6480
1. Energy industries	1767	2965	3484	3880	3033	3299	3354
a. Public electricity and heat production	1681	2860	3483	3880	3033	3299	3354
b. Petroleum refining	86	104	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries*	0.21	0.48	0.33	0.24	0.18	0.33	0.21
2. Manufacturing industries and construction	515	822	912	700	607	623	557
a. Iron and steel	IE	IE	IE	IE	IE	IE	IE
b. Non-ferrous metals	4.9	7.2	6.5	5.1	3.0	2.2	2.2
c. Chemicals	2.2	4.3	3.6	2.1	6.4	4.5	7.9
d. Pulp, paper and print	4.8	9.2	5.2	3.7	3.1	2.1	2.6
e. Food processing, beverages and tobacco	73	132	82	60	56	68	66
f. Non-metallic minerals	382	577	726	556	491	478	422
g. Other	48	93	89	74	48	70	52
3. Transport	1242	1837	2111	2325	1891	2094	2067
a. Domestic aviation	26	18	13	7.7	0.9	0.8	0.9
b. Road transportation	1214	1818	2096	2315	1888	2092	2064
c. Railways	NO	NO	NO	NO	NO	NO	NO
d. Domestic navigation	2.2	1.7	2.4	3.1	2.0	1.7	2.2
4. Other sectors	434	731	610	571	530	551	479
a. Commercial/ institutional	76	117	100	120	88	112	110
b. Residential	302	507	421	374	358	355	290
c. Agriculture/ forestry/ fishing	56	106	89	77	83	85	79
5. Other	11	22	19	20	22	22	24
a. Stationary	11	22	19	17	19	18	19
b. Mobile	NO	NO	NO	3	3	4	5
CO2	3929	6314	7093	7458	6049	6551	6439
CH4	0.48	0.54	0.59	0.66	0.59	0.64	0.61
N2O	0.10	0.18	0.11	0.09	0.07	0.09	0.09

* The fuel consumed for Manufacturing of charcoal is solid biomass.

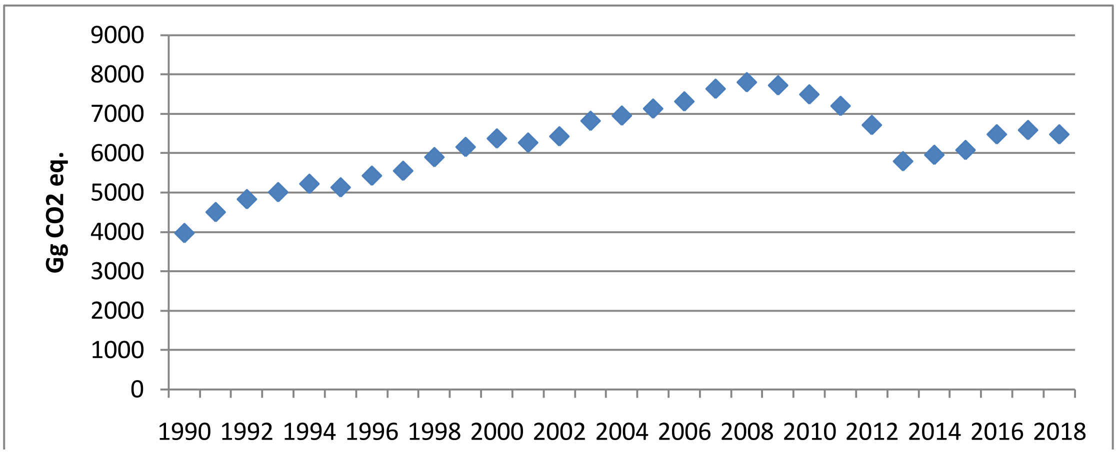

Figure 3.2. Emissions from fuel consumption 1990-2018

3.2.2. Methodological issues

Emission factors

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

Activity data

The predominant source of the activity data is the national energy balance prepared by the Statistical Service[24]. Data is available for all sources for the recent years. Therefore several assumptions have to be made to complete the time-series. Detailed presentation of the methodologies applied to complete the time-series for the years where data is not available is given in Annex 3.1. Other sources of data are the EU-ETS, EUCONTROL, Department of Road Transport and Department of Labour Inspection. Data sets are compared to national data obtained from the Department of Labour Inspection, the energy balance prepared by the Energy Service and international sources such as IEE and EUROSTAT. Detailed presentation of the data used is given in the respective section.

3.2.3. Energy industries (CRF 1A1)

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

3.2.3.1. Category description

The Electricity Authority of Cyprus (EAC) was the solely provider of electrical energy in Cyprus, until the introduction of electricity production from renewable energy sources. EAC remains the single electricity producer for the public. Heat production (included in 1A1a) does not occur in Cyprus. Refining activities in the country stopped in 2004 following a government decision not to upgrade it to EU standards, instead turning it into a fuel import and storage terminal. Consequently emissions from petroleum refinery (1A1b) are reported for the years 1990-2004 only. Emissions from the manufacture of solid fuels and other energy industries (1A1c) are reported for the first time in 2017 (production of charcoal).

The consumption of fossil fuels by energy industries in 2018 (43.1 PJ) increased by 84.9% compared to

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

1990 (23.3 PJ). Since 2005, when the refinery stopped its operations, the emissions from energy industries are entirely caused by the production of electricity (1A1a). Emissions from energy industries account for 38.1% of total national emissions without LULUCF for 2018, while in 1990 the contribution was 30.3%. The total GHG emissions from energy industries in 2018 (3.4 Tg CO2 eq.) increased by 88.8% compared to 1990 (1.8 Tg CO2 eq). The emissions from energy industries are presented in Table 3.4. During the period 2009-2013, a decreasing trend of emissions has been observed, attributed to the penetration of renewable energy technologies to the energy mix, and to the economic recession that the country is facing since 2010. The trend changes in 2014 to an increasing trend with an annual average of 4%. The emissions from energy industries (1A1) for the period 1990-2018 are presented in Figure 3.3.

Table 3.4. Emissions from energy industries 1990-2018

Gg CO2 eq.	**1990**	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**
1. Energy industries	1767	2965	3484	3880	3033	3299	3354
a. Public electricity and heat production	1681	2860	3483	3880	3033	3299	3354
b. Petroleum refining	86	104	NO	NO	NO	NO	NO
c. Manufacture of solid fuels and other energy industries*	0.21	0.48	0.33	0.24	0.18	0.33	0.21
CO2 (Gg)	1761	2955	3472	3868	3023	3288	3342
CH4 (Gg)	0.07	0.12	0.14	0.15	0.12	0.13	0.13
N2O (Gg)	0.01	0.02	0.03	0.03	0.02	0.03	0.03
Total (Gg CO2 eq.)	1767	2965	3484	3880	3033	3299	3353

* Manufacturing of charcoal does take place in Cyprus but does not appear in the table as the fuel consumed is solid biomass

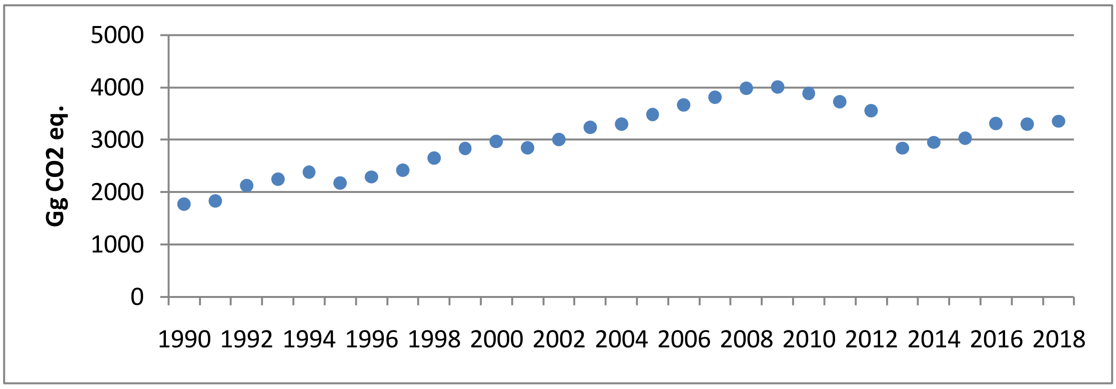

Figure 3.3. Energy industries emissions (1A1) 1990-2018

3.2.3.2. Methodological issues

<u>Main activity electricity and heat production (1A1a)</u>

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

The fuel consumption data for all the years was obtained in kt. The fuel consumption data used for the years 1990-2004 is presented in Table 3.5. Fuel consumption for the period 1990-2004 was converted from kt to TJ using the NCV of 2005 (40.446 TJ/kt for HFO and 42.815 TJ/kt for diesel) which is the earliest available country specific NCV. The emissions for 1990-2004 were estimated using the implied emission factors derived from the annual report of the company for 2005 (earliest available) in compliance with the ETS law: 76.67 t CO2/TJ HFO and 72.43 t CO2/TJ diesel. The emission factor was multiplied with the fuel consumption of the respective fuel. This method and the EF are considered as country specific method, since it does not follow the methodologies proposed by the IPCC guidelines.

The estimation of country- or plant-specific EF for these years (1990-2004) is not possible since the necessary information is not available[25].

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

	1990	1991	1992	1993	1994	1995	1996	1997
Fuel consumption (kt)								
HFO	540.4	560.5	644.6	694.8	726.4	661.2	702.5	742.9
Diesel	0.0	0.0	10.5	3.5	2.0	8.2	5.9	5.8
Net calorific value (TJ/kt)*								
HFO	40.446	40.446	40.446	40.446	40.446	40.446	40.446	40.446
Diesel	42.815	42.815	42.815	42.815	42.815	42.815	42.815	42.815
CO2 emissions (Gg)								
HFO	1675.8	1738.0	1999.0	2154.5	2252.6	2050.5	2178.5	2303.7
Diesel	0.0	0.0	32.62	10.79	6.09	25.45	18.39	17.83

	1998	1999	2000	2001	2002	2003	2004	
Fuel consumption (kt)								
HFO	810.9	856.1	900.5	893.8	930.8	1000.3	1042.1	
Diesel	11.6	21.0	18.7	3.7	1.6	5.1	8.4	
Net calorific value (TJ/kt)*								
HFO	40.446	40.446	40.446	40.446	40.446	40.446	40.446	
Diesel	42.815	42.815	42.815	42.815	42.815	42.815	42.815	
CO2 emissions (Gg)								
HFO	2514.8	2654.9	2792.5	2771.6	2886.5	3102.2	3231.6	
Diesel	35.91	64.97	57.89	11.48	4.91	15.73	26.14	

* NCV of 2005 data submitted through ETS

Detailed data on fuel consumption and other parameters are submitted annually by the installation since 2005 in compliance to the national Emissions Trading System law (110(I)/2011). The data collected through the ETS for the period 2005-2016 and used for the estimation of the emissions is presented in Table 3.6. For the years 2005-2015, the CO2 emissions as reported by the installation in compliance with the ETS law have been used.

Table 3.6. Data collected through the ETS for electricity production in Cyprus (2005-2015)

	2005	2006	2007	2008	2009	2010	2011	2012
Fuel consumption (kt)								
HFO	1103.2	1137.3	1174.7	1218.5	1163.1	1053.0	1057.8	895.5
Diesel	16.3	6.9	16.0	22.9	91.9	157.5	111.7	213.9
Net calorific value (TJ/kt)*								
HFO	40.446	40.460	40.463	40.690	40.795	40.641	40.741	40.791
Diesel	42.815	42.821	42.806	42.598	42.660	42.938	42.714	42.715
CO2 emissions (Gg)								
HFO	3421.2	3632.1	3751.9	3896.3	3707.6	3377.5	3373.4	2869.8
Diesel	50.60	21.28	49.72	70.98	284.84	490.53	336.65	676.13
Implied EF (Gg CO2/TJ)								
HFO	76.672	78.935	78.938	78.582	78.141	78.919	78.274	78.562
Diesel	72.431	72.421	72.444	72.798	72.640	72.532	70.572	74.018

	2013	2014	2015	2016	2017	2018		
Fuel consumption (kt)								
HFO	649.3	793.3	857.9	882.7	777.9	804.3		
Diesel	237.5	123.6	89.4	150.0	255.2	246.1		
Net calorific value (TJ/kt)*								

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

HFO	40.613	40.691	40.880	40.646	40.632	40.559		
Diesel	42.580	42.354	42.709	42.717	42.668	42.657		
CO2 emissions (Gg)								
HFO	2085.9	2553.1	2742.3	2828.1	2489.3	2570.7		
Diesel	743.85	387.23	280.73	471.94	798.54	771.62		
Implied EF (Gg CO2/TJ)								
HFO	79.098	79.089	78.196	78.827	78.753	78.807		
Diesel	73.571	73.980	73.560	73.670	73.330	73.499		

* weighted average based on consumption

The overall implied emission factor for CO2 emissions during the period 2005-2016 shows fluctuations that have been caused by (a) change in the consumption of each fuel; i.e. in years that more diesel is consumed the IEF reduces, while when more HFO consumed the IEF increases; (b) fluctuations in fuel quality and therefore NCV (whereas in previous years it is considered constant); (c) the age and efficiency of the electricity productions used.

Non-CO2 emissions were estimated using the default EF proposed by the IPCC 2006 guidelines (vol.2, pg. 2.16); i.e. 3 kg CH4 /TJ and 0.6 kg N2O /TJ for both fuels.

Petroleum refining (1Ab)

Data for the consumption of fuel for petroleum refining was obtained from the National Statistical Service in kt (Table 3.7). No information is available on the characteristics of the consumption reported as other oil products. The fuel consumption was converted to TJ using the default NCVs of 40.4 TJ/kt RFO, 40.2 TJ/kt other oil product and 49.5 TJ/kt refinery gas which is the default proposed by the 2006 IPCC guidelines (vol.2, pg. 1.18). CO2 emission factors are also the defaults proposed by the revised IPCC 2006 guidelines (vol. 2, pg. 2.16); i.e. 77.4 t CO2/TJ RFO, 73.3 t CO2/TJ other oil product and 57.6 t CO2/TJ refinery gas.

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

Fuel consumption (kt)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
RFO	11	12	13	13	14	17	16	14
Other products	0	0	0	0	0	0	0	0
Refinery gas	18	17	17	13	24	13	12	16
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	
RFO	15	16	16	0	0	0	0	
Other products	0	0	0	0	16	16	0	
Refinery gas	16	20	19	19	21	21	9	

Non-CO2 emissions were estimated using the default emission factors proposed by the IPCC 2006 guidelines for energy industries (vol. 2, pg. 2.16); i.e. 3 kg CH4/TJ and 0.6 kg N2O/TJ for RFO and other oil products and 1 kg CH4/TJ and 0.1 kg N2O/TJ for Refinery gas.

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

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

Emissions are estimated using the T1 methodology and the default EF proposed by the IPCC 2006 guidelines for wood (vol.2, pg. 2.17): 112000 kg CO2/TJ, 30 kg CH4/TJ and 4 kg N2O/TJ. This is the first time the emissions from this category are estimated and presented.

Table 3.8. Solid biomass consumed for the production of charcoal

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Solid biomass (TJ)	112	112	112	112	405	388	328	288

Charcoal produced (TJ)	29.5	29.5	29.5	29.5	147.5	118	118	88.5
Conversion efficiency	26.34%	26.34%	26.34%	26.34%	36.42%	30.41%	35.98%	30.73%

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Solid biomass (TJ)	314	281	248	253	235	209	184	174
Charcoal produced (TJ)	118	118	88.5	88.5	88.5	88.5	59.0	59.0
Conversion efficiency	37.58%	41.99%	35.69%	34.98%	37.66%	42.34%	32.07%	33.91%

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Solid biomass (TJ)	135	274	211	47	48	45	82	71
Charcoal produced (TJ)	59.0	118	88.5	29.5	29.5	29.5	29.5	29.5
Conversion efficiency	43.70%	43.07%	41.94%	62.77%	61.46%	65.56%	35.98%	41.55%

	2014	**2015**	**2016**	**2017**	**2018**			
Solid biomass (TJ)	58	94	163	171.9	111.6			
Charcoal produced (TJ)	29.5	29.5	59.0	73.5	47.7			
Conversion efficiency	50.86%	31.38%	36.20%	42.75%	42.75%			

3.2.3.3. Uncertainties and time-series consistency

In general, the uncertainty of emissions of the stationary combustion sector is relatively small. The uncertainty associated with activity data –i.e. fuel consumption- is less than 5%, since the AD are obtained from the national energy balance and are cross-checked with data from other sources (e.g. plant specific data). On the other hand, the uncertainty associated with emission factors is also very low for the case of CO2, less than 5%, since plant and country specific EFs are mainly applied. For the case of CH4 and N2O EFs, the uncertainty is higher, about 100 and 300% respectively, since IPCC defaults emission factors per technology / activity are applied. The results of uncertainty analysis are presented in Table 1.9. The detailed calculations of uncertainty are presented in Annex 2.

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

3.2.3.4. Category-specific QA/QC and verification

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

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

2. Emissions comparison: Verified ETS reports were used for the computation of plant specific CO2 EFs and NCVs. For quality control purposes emissions calculated by applying PS EFs and NCVs are compared with the emissions calculated by using IPCC defaults EFs and NCVs.

3.2.3.5. Category-specific recalculations

No recalculations to report.

3.2.3.6. Category-specific planned improvements

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

3.2.4. Manufacturing industries and construction (1A2)

3.2.4.1. Category description

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

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

The GHG emissions caused by energy consumption in manufacturing industries and construction in 2018 were 556 Gg CO2 eq. The total GHG emissions from manufacturing industries and construction in 2018 increased by 28% compared to 1990. There is no available information to explain the large change in emissions between 1990 and 1991. The emissions from manufacturing industries and construction 1990-2018 are presented in Figure 3.4 and Table 3.9.

Table 3.9. Emissions from manufacturing industries and construction 1990-2018

Gg CO2 eq.	1990	2000	2005	2010	2015	2016	2017	2018
2. Manufacturing industries and construction	515	822	912	700	607	603	621	556
a. Iron and steel	IE	IE	IE	IE	IE	IE	IE	IE
b. Non-ferrous metals	4.9	7.2	6.5	5.1	3.0	6.2	2.2	2.2
c. Chemicals	2.2	4.3	3.6	2.1	6.4	6.5	4.5	7.9
d. Pulp, paper and print	4.8	9.2	5.2	3.7	3.1	3.1	2.1	2.6
e. Food processing, beverages and tobacco	73	132	82	60	56	50	68	66
f. Non-metallic minerals	382	577	726	556	491	483	478	425
g. Other (*please specify*)	48	93	89	74	48	54	70	52
CO2 (Gg)	512.2	818.7	908.3	696.6	603.1	599.0	615.7	549.6
CH4 (Gg)	0.035	0.040	0.049	0.047	0.049	0.054	0.073	0.09
N2O (Gg)	0.006	0.007	0.009	0.008	0.008	0.009	0.011	0.01
Total (Gg CO2 eq.)	515	822	912	700	607	603	621	556

3.2.4.2. Methodological issues

Data

The data used to estimate the emissions for the industrial activities from energy consumption in manufacturing industries and construction 1990-2018 is presented in Table 3.10. Consumption for Iron and steel (1A2a) is included in Non-ferrous metals (1A2b). Consumption for Autoproducer electricity plants and CHP plants is included in Non-specified Industry (1A2m). Consumption for Transport Equipment (1A2g), Machinery (1A2h), Wood and wood products (1A2j) and Textile and Leather (1A2l) are reported separately for the first year. Additionally, any revisions in fuel consumption are indicated with red and any new sectors introduced are indicated with green.

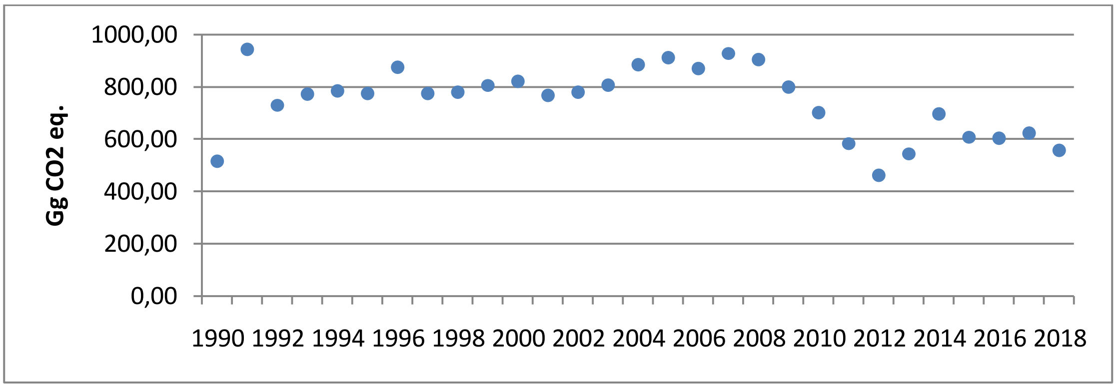

Figure 3.4. Emissions from energy use in manufacturing industries and construction (1A2) 1990-2018

Data for other bituminous coal in source category 1A2f for the years 2005-2018 is from reports submitted for ETS purposes by the cement installations. Waste (non-renewable) in source category 1A2f includes both industrial and municipal waste.

Methodology

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

<u>Non-ferrous metals (1A2b)</u>

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

Table 3.10. Fuel consumption in manufacturing industries and construction 1990-2018ttae
(a) 1990-2003

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

(b) 2004-2018

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1A2b Non-ferrous metals															
LPG	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.569	0.594
Diesel/gasoil	1.2	1.1	1.1	1.0	0.9	0.9	0.7	0.8	1.0	0.0	0.0	0.0	1.0	0.15	0.13
1A2c Chemical and petrochemical															
LPG														0.21	0.22
RFO												1.0	1.0	0.775	1.235
Diesel/gasoil	1.2	1.1	1.1	1.0	0.9	0.9	0.7	0.8	1.0	0.0	1.0	1.0	1.0	1.143	1.036
Solid biofuels (TJ)											42	52	21	21.6	18
1A2d Paper, pulp and printing															
LPG														0.285	0.297
RFO	2.8	1.6	1.1	1.6	1.5	1.0	1.2	2.0	1.1	1.0	1.0	1.0	1.0	0.57	0.52
Diesel/gasoil														0.03	0.03
1A2e Food, beverages and tobacco															
Diesel/gasoil	3.6	3.4	3.4	2.9	2.6	2.6	2.0	2.3	3.0	2.0	2.0	4.0	3.0	4.863	4.012
RFO	34.0	19.8	13.4	19.1	17.6	12.0	14.1	24.0	9.0	8.0	8.0	9.0	9.0	12.451	11.345
LPG	3.1	2.9	3.0	3.0	3.0	3.0	3.0	4.0	5.0	4.0	4.0	5.0	4.0	5.515	5.757
Solid biofuels (TJ)											44	7	36	50.159	67.191
Biogases (TJ)														0.03	0.23
Other kerosene														1.314	1.01
1A2f Non-Metallic Minerals															
Pet-coke (kt)	146.0	154.0	146.0	143.0	152.0	144.0	116.0	100.0	94.0	135.0	162.0	128.0	123.0	108.7	74.5
RFO (kt)	17.0	37.0	35.0	38.0	38.0	30.0	25.0	15.0	13.0	8.0	7.0	8.0	10.0	10.0	14.5
diesel (kt)	3.6	3.4	3.4	2.9	2.6	2.6	2.0	2.3	3.0	1.0	1.0	2.0	2.0	0.8	1.4
LPG (kt)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.4
other bituminous coal (kt)	57.0	54.7	54.3	49.5	44.6	23.5	27.4	12.3	0.0	0.0	4.2	6.0	0.8	5.1	22.6
Other kerosene (kt)														0.061	0.047
Solid biomass (TJ)	127.0	38.0	61.0	133.0	281.0	304.0	347.0	306.0	117.0	178.0	277.0	420.0	482.0	902.4	1235.1
Waste (non-renewable) (TJ)	71.0	138.0	73.0	288.0	239.0	276.0	299.0	56.2	24.0	45.0	316.0	516.0	663.0	837.5	961.1
1A2j Wood and wood products															
LPG														0.003	0.003
Diesel/gasoil														0.025	0.023
1A2i Mining and Quarrying															
Diesel (kt)	6	6	6	5	4	4	3	4	5	2	1	3	2	3.75	3.66
RFO (kt)														0.12	0.11
1A2g Transport Equipment															
Diesel (kt)														0.01	0.01

1A2h Machinery															
LPG														0.082	0.086
Diesel/Gasoil														0.257	0.224
1A2k Construction															
Diesel (kt)	6	6	6	5	4	4	3	4	5	5	6	6	7	8.845	7.17
RFO (kt)									1.0	1.0	3.0	2.0	3	2.42	2.2
1A2l Textiles and Leather															
Diesel (kt)														0.027	0.023
1A2m Non-specified Industry															
Diesel (kt)	3.6	3.4	3.4	3.9	2.6	2.6	2.0	4.3	5.0	3.0	2.0	2.0	2.0	1.852	2.18
RFO (kt)	16.3	12.6	11.5	24.4	20.9	17.0	14.7	12.0	3.0	5.0	7.0	1.0	2.0	1.287	0.44
Other oil products (kt)	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White spirit (kt)	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other kerosene (kt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0.0	0.0	0.007	0.005
LPG (kt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.23	0.24

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

Chemicals (1A2c)

According the energy balance gas-diesel oil, LPG, RFO and solid biomass are consumed by chemical industries (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The CO2, CH4 and N2O emissions from all fuels were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100 kg CO2/TJ, 3 kg CH4/TJ and 0.6 kg N2O/TJ for gas-diesel oil, 63100 kg CO2/TJ, 1 kg CH4/TJ and 0.1 kg N2O/TJ for LPG and 77400 kg CO2/TJ, 3 kg CH4/TJ and 0.6 kg N2O/TJ for RFO. Consumption of solid biomass is reported for the first time in 2014. The CO2, CH4 and N2O emissions from solid biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.19); i.e. 100000 kg CO2/TJ, 30 kg CH4/TJ and 4 kg N2O/TJ.

Pulp, Paper and Print (1A2d)

Fuel consumption for this category has been reported for the first time in the 2014 energy balance. However, the activity did take place in previous years. Therefore assumptions have been made to estimate the fuel consumption of the category (see previous Section) of the complete period. Consumption of RFO was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11).The CO2, CH4 and N2O emissions from RFO were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 77400 kg CO2/TJ, 3 kg CH4/TJ and 0.6 kg N2O/TJ. According to the energy balance LPG and Diesel were also consumed by pulp, paper and print for the first time in 2017. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The CO2, CH4 and N2O emissions from all fuels were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.18); i.e. 74100 kg CO2/TJ, 3 kg CH4/TJ and 0.6 kg N2O/TJ for gas-diesel oil, 63100 kg CO2/TJ, 1 kg CH4/TJ and 0.1 kg N2O/TJ for LPG

Food processing, beverages and tobacco (1A2e)

According the energy balance the fuels consumed by food processing, beverages and tobacco industries are LPG, gas-diesel, RFO and other kerosene (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The CO2, CH4 and N2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 63100 kg CO2/TJ, 1 kg CH4/TJ and 0.1 kg N2O/TJ for LPG, 74100 kg CO2/TJ, 3 kg CH4/TJ, 0.6 kg N2O/TJ for Gas-Diesel oil, 77400 kg CO2/TJ, 3 kg CH4/TJ, 0.6 kg N2O/TJ for RFO and 71900 kg CO2/TJ, 3 kg CH4/TJ and 0.6 kg N2O/TJ for other kerosene. Consumption of solid biomass is reported for the first time in 2014.The CO2, CH4 and N2O emissions from solid biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.19); i.e. 100000 kg CO2/TJ, 30 kg CH4/TJ and 4 kg N2O/TJ. Consumption of gas biomass is reported for the first time in 2009.The CO2, CH4 and N2O emissions from gas biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines (volume 2, pg. 2.19) assuming other biogas; i.e. 54600 kg CO2/TJ, 1 kg CH4/TJ and 0.1 kg N2O/TJ

Non-metallic minerals (1A2f)

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

All liquid fuel consumption (LPG, gas-diesel oil, RFO, other kerosene and pet-coke) was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). Pet-coke is consumed only by two cement producing installations during 1990-2011, which merged into one in 2011. These installations have been submitting annual emissions’ report according to the requirements of the ETS law 110(I)/2011, since 2005. The CO2 emissions from pet-coke for the period 2005- 2015 were used as reported for the ETS. CO_2 emissions for the period 1990-2004 were estimated using the IEF of 2005, resulting from the division of CO_2 emissions by the TJ fuel consumed (84.51 t CO_2/TJ). CH_4 and N_2O emissions for fuels were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 3 kg CH_4/TJ and 0.6 kg N_2O/TJ for gas-diesel oil, RFO and pet-coke and 1 kg CH_4/TJ and 0.1 kg N_2O/TJ for LPG.

Other bituminous coal was consumed during the period 1990-2011 by only one cement-producing installation, which has been submitting annual emissions' report according to the requirements of the ETS law 110(I)/2011, since 2005. The new installation (after 2011) consumed other bituminous coal in 2014 and 2015. Fuel consumption for the period 2005-2015 was obtained in TJ from the annual ETS reports. Fuel consumption for the period 1990-2004 was converted to TJ with the NCV of the first ETS report submitted (i.e. 2005), which was 29.824 TJ/kt. The CO_2 emissions from other bituminous coal for the period 2005-2013 were used as reported for the ETS. CO_2 emissions for the period 1990-2004 were estimated using the IEF of 2005, resulting from the division of CO_2 emissions by the TJ fuel consumed (92.60 t CO_2/TJ). CH_4 and N_2O emissions for other bituminous coal were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 10 kg CH_4/TJ and 1.5 kg N_2O/TJ.

Solid biomass data was available in TJ. Solid biomass is consumed by only one cement-producing installation, which has been submitting annual emissions' report according to the requirements of the ETS law 110(I)/2011, since 2005. The CO_2 emissions from solid biomass for the period 2005-2016 were used as reported for the ETS. CO_2, CH_4 and N_2O emissions for solid biomass were estimated using the default emission factors proposed by the IPCC 2006 guidelines for "other primary solid biomass" (volume 2, pg. 2.19); i.e. 100000 kg CO_2/TJ, 30 kg CH_4/TJ and 4 kg N_2O/TJ.

Non-renewable waste (industrial waste) data was available in TJ. Non-renewable waste is consumed by only one cement-producing installation, which has been submitting annual emissions' report according to the requirements of the ETS law 110(I)/2011, since 2005. The CO_2, CH_4 and N_2O emissions for non-renewable industrial waste were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.19); i.e. 143000 kg CO_2/TJ, 30 kg CH_4/TJ and 4 kg N_2O/TJ. In the industrial waste category, we report the non-biomass fraction of biomass incinerated; i.e. sewage sludge, tires, ASF, MBM and compost. The waste is incinerated for production of thermal energy in the furnace burning the raw material to produce the cement. The non-renewable municipal waste were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.19); i.e. 91700 kg CO_2/TJ, 30 kg CH_4/TJ and 4 kg N_2O/TJ.

Transport Equipment (1A2g)

According to the energy balance, transport equipment consume diesel (Table 3.10). Fuel consumption in the energy balance has been reported for the first time in 2017 and has been desegregated for the 2020 submission. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). CO_2, CH_4 and N_2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg CO_2/TJ, 3 kg CH_4/TJ and 0.6 kg N_2O/TJ.

Machinery (1A2h)

According to the energy balance, machinery consume diesel and LPG (Table 3.10). Fuel consumption in the energy balance has been reported for the first time in 2017 and has been desegregated for the 2020 submission. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). CO_2, CH_4 and N_2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg CO_2/TJ, 3 kg CH_4/TJ and 0.6 kg N_2O/TJ for diesel oil and 63100kg CO_2/TJ, 1 kg CH_4/TJ and 0.1 kg N_2O/TJ for LPG.

Mining (excluding fuels) and Quarrying (1A2i)

According the energy balance mining and quarrying industries consume diesel and RFO (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). CO_2, CH_4 and N_2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg CO_2/TJ, 3 kg CH_4/TJ and 0.6 kg N_2O/TJ for gas – diesel oil and 77400 kg CO_2/TJ, 3 kg CH_4/TJ and 0.6 kg N_2O/TJ for RFO.

Wood and wood products (1A2j)

Fuel consumption for this category was reported for the first time in 2017 in the energy balance. Wood and wood products consume diesel oil and LPG. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11.). CO_2, CH_4 and N_2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg CO_2/TJ, 3 kg CH_4/TJ and 0.6 kg N_2O/TJ for diesel oil and 63100kg CO_2/TJ, 1 kg CH_4/TJ and 0.1 kg N_2O/TJ for LPG.

Construction (1A2k)

According the energy balance construction industries consume only diesel (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). CO_2, CH_4 and N_2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg CO_2/TJ, 3 kg CH_4/TJ and 0.6 kg N_2O/TJ for gas – diesel oil.

Textile and Leather (1A2l)

According to the energy balance, the fuels consumed by Textile and Leather is diesel oil and has been reported for the first time in 2017. (Table 3.10). Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). CO_2, CH_4 and N_2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 74100kg CO_2/TJ, 3 kg CH_4/TJ and 0.6 kg N_2O/TJ.

Non-specified Industry (1A2m)

According the energy balance the fuels consumed by Non-specified industries are gas-diesel oil, RFO, other oil products and white spirit (Table 3.10). Other kerosene has been consumed in 2014, 2017 and 2018 by the gas exploration platforms. RFO consumption for 1990-2014 has been revised due to the addition of Pulp, Paper and Print industries. Gas-diesel oil consumption for 2017 has been revised due to the addition of Transport Equipment, Machinery, Wood and wood products and Textile and leather industries. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.11). The CO_2, CH_4 and N_2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.18); i.e. 74100 kg CO_2/TJ for Gas-Diesel oil, 77400 kg CO_2/TJ for RFO, 71900 kg CO_2/TJ for other kerosene, 73300 kg CO_2/TJ for white spirit and other oil products. The emission factors for CH_4 and N_2O are 3 kg CH_4/TJ, 0.6 kg N_2O/TJ for all fuels.

Table 3.11. Parameters used for the estimation of emissions

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

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

3.2.4.3. Uncertainties and time-series consistency

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

3.2.4.4. Category-specific QA/QC and verification

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

3.2.4.5. Category-specific recalculations

Recalculations for Manufacturing Industries and Construction have been carried out for 2017 due to revised values in the fuel consumption in the energy balance and disaggregation of Transport Equipment, Machinery, Textile and Leather and Wood and wood products. The revised values are reported in table 3.10 in red.

Recalculations have been also carried out for 2011-2018 for the waste (non-renewable) emissions for 1A2f Non-metallic Minerals after the TERT recommendation (CY-1A2f-2020-0001). The impact is presented in the table 3.12 below.

Table 3.12. Recalculations 1A2f non-renewable waste (2011-2018)

	2011	2012	2013	2014	2015	2016	2017	2018
NIR 2019 (kt CO2)	8.04	2.20	4.13	43.29	58.64	75.35	89.29	97.15
NIR 2020 (kt CO2)	0.57	2.20	4.13	43.29	58.65	65.62	87.37	96.23
Change	-92.89%	0.04%	0.0365	0.00%	0.02%	-12.92%	-2.15%	-0.95%

3.2.4.6. Category-specific planned improvements

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

3.2.5. Transport (1A3)

3.2.5.1. Category description

The activity category of transport, should include emissions from the combustion and evaporation of fuel for all transport activity (excluding military transport), regardless of the sector, specified by sub-categories below. Emissions from fuel sold to any air or marine vessel engaged in international transport (1 A 3 a i and 1 A 3 d i) should as far as possible be excluded from the totals and subtotals in this category and should be reported separately.

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

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

Between 1990 and 2018 emissions from transport increased by 66% (Table 3.13). During the same period the emissions from domestic aviation decreased by 97%, while emissions from road transport increased by 70%. In 2018 transport contributed 23.4% to the total emissions of the country without LULUCF and 31.9% to the emissions from the energy sector. Transport (1A3) emissions are also presented in Figure 3.5.

Table 3.13. Transport emissions 1990-2018

Gg CO2 eq.	1990	2000	2005	2010	2015	2017	2018
3. Transport	1245	1841	2115	2330	1895	2099	2067
a. Domestic aviation	26	18	13	7.7	0.9	0.8	0.9
b. Road transportation	1214	1818	2096	2315	1888	2095	2064
c. Railways	NO	NO	NO	NO	NO	NO	NO
d. Domestic navigation	2.2	1.7	2.4	3.1	2.0	1.7	2.2
CO2 (Gg)	1212	1793	2089	2310	1878	2082	2051
CH4 (Gg)	0.24	0.23	0.24	0.22	0.16	0.16	0.15
N2O (Gg)	0.08	0.14	0.07	0.05	0.04	0.04	0.04
Total (Gg CO2 eq.)	1242	1841	2115	2330	1895	2099	2067

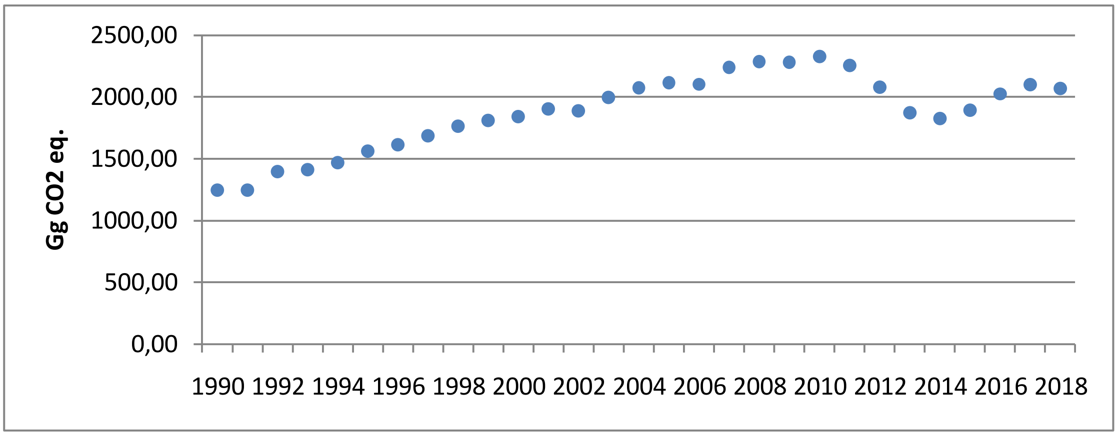

Figure 3.5. Transport (1A3) emissions 1990-2018

3.2.5.2. Methodological issues

Civil aviation (1A3a)

Civil aviation emissions should include emissions from international and domestic civil aviation, including take-offs and landings. Civil aviation comprises civil commercial use of airplanes, including: scheduled and charter traffic for passengers and freight, air taxiing, and general aviation. The emissions from civil aviation were estimated using the Tier 1 method proposed by 2006 IPCC guidelines. Information on fuel consumption for domestic flights is not available from national statistics. To estimate the emissions from aviation, the available information on fuel consumption from EUROCONTROL was used (Table 3.14) for 2005-2018. It is currently not possible to move to higher Tiers; it will be assessed again for future submissions.

Table 3.14. International and domestic flights' fuel consumptions, EUROCONTROL data (2005-2017)

Fuel consumption (kt)	2005	2006	2007	2008	2009	2010	2011	2012
Domestic	3.958	3.344	2.967	2.823	2.282	2.429	0.739	0.471
International	264.2	266.4	262.4	272.3	257.4	262.6	272.5	263.4
	2013	**2014**	**2015**	**2016**	**2017**	**2018**		
Domestic	0.305	0.191	0.286	0.179	0.260	0.277		
International	245.7	246.0	238.1	278.2	316.6	328.9		

The share of domestic flights to the total fuel consumption is presented in Table 3.15. It can be noticed that there is a decreasing trend in the share of domestic flights to the total fuel consumption. The trend for these years can be represented by the equation $y=-0.0014x+0.0154$. This equation was used to estimate the share of domestic flights to the total for the years 1990-2004 (Table 3.16), years for which data is not available for domestic flights. By multiplying the share by the total fuel consumption reported all under international flights by the Statistical Service for 1990-2004, the fuel consumption of domestic flights was estimated. The international flights consumption for 1990-2004 was revised by subtracting the estimated fuel consumption for domestic flights. The resulting fuel consumption for domestic and international flights for the years 1990-2004 is presented in Table 3.16. Fuel consumption obtained from the Statistical Service is in kt, and converted to TJ using the default NCV proposed by the 2006 IPCC Guidelines, i.e. 44.1 TJ/Gg (Table 1.2, pg.1.18, vol.2).

LTOs data was not possible to be used for the backcasting of the trend of the domestic/international aviation split, since there was no correlation between the available data and the LTOs (Figure 3.6). For the estimation of emissions, the default EF proposed by the IPCC 2006 guidelines are used; i.e. 44.1 TJ/kt, 71.5 t CO2/TJ, 0.5 kg CH4/TJ and 2 kg N2O/TJ.

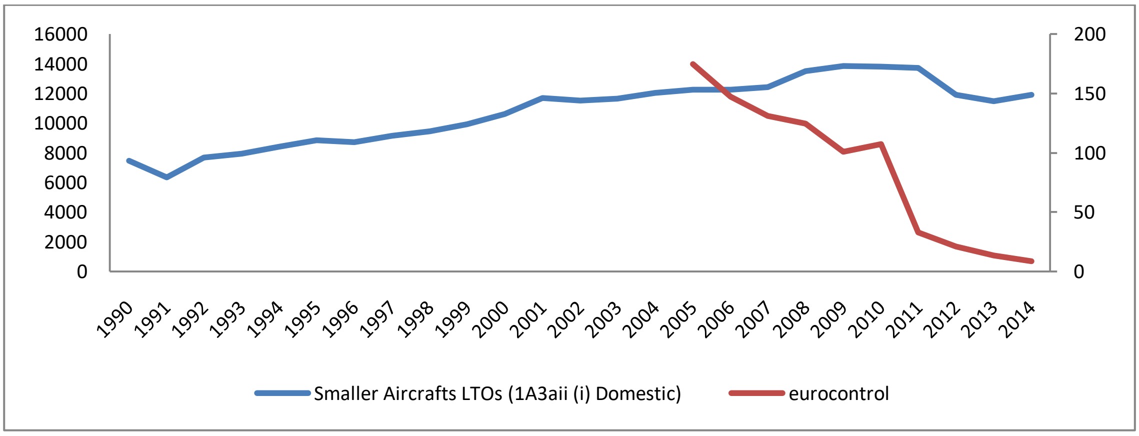

Figure 3.6. Smaller aircrafts LTOs and EUROCONTROL data for domestic flights

Table 3.15. Share of domestic flights to the total fuel consumption, EUROCONTROL data (2005-2018)

	2005	2006	2007	2008	2009	2010	2011	2012
Share of domestic to total	1.48%	1.24%	1.12%	1.03%	0.88%	0.92%	0.27%	0.18%
	2013	**2014**	**2015**	**2016**	**2017**	**2018**		
Share of domestic to total	0.12%	0.08%	0.12%	0.06%	0.08%	0.08%		

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

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

Road transport (1A3b)

Road transport emissions should include all combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on paved roads. GHG emissions from road transport were estimated using the COPERT 5 software. COPERT 5 is a MS Windows software program. In principle, COPERT 5 has been developed for use by the National Experts in order to estimate emissions from road transport which will be included in official annual national inventories. The use of a software tool to calculate road transport emissions allows for a transparent and standardized, hence consistent and comparable data collecting and emissions reporting procedure, in accordance with the requirements of international conventions and protocols and EU legislation.

The COPERT 5 methodology is part of the EMEP/CORINAIR Emission Inventory Guidebook 2016[26]. The Guidebook, developed by the UNECE Task Force on Emissions Inventories and Projections, is intended to support reporting under the UNECE Convention on Long-Range Transboundary Air Pollution and the EU directive on national emission ceilings.

COPERT 5 estimates emissions of all major air pollutants and GHG produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty vehicles, mopeds and motorcycles). Emissions estimated are distinguished in three sources:

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

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

In addition, the fuel consumed in this sector is taken into consideration. The COPERT 5 run estimates the fuel consumption (diesel and gasoline). These values are then compared to statistical fuel sold and the annual mileage values are corrected on the basis of the differences between calculated and statistical fuel consumption. A new COPERT run is performed with the adjusted data and all emissions are calculated.

COPERT 5 has been used for the calculations of the whole timeseries (1990 – 2018). The total number of road vehicles by type for the period 1990-2018 is shown in Table 3.17 and the corresponding trend is shown in Figure 3.7. Fuel consumption data was obtained from the energy balance prepared by the Statistical Service and is presented in Table 3.18. The calorific value used to convert mass to energy unit are according to the national energy balance; i.e. Diesel 43.0 TJ/kt, Gasoline 44.3 TJ/kt and Biodiesel 37.0 TJ/kt.

The emissions from vehicles consuming LPG have not been calculated using COPERT 5. They have been calculated with a Tier 1 method due to the lack of activity data. Fuel consumption obtained from the Statistical Service is in kt, and converted to TJ using the default NCV proposed by the 2006 IPCC Guidelines, i.e. 47.3 TJ/Gg (Table 1.2, pg.1.18, vol.2). For the estimation of emissions, the default EF proposed by the IPCC 2006 guidelines are used; 63100 kg CO2/TJ, 62 kg CH4/TJ and 0.2 kg N2O/TJ (IPCC 2006, page 3.21, vol.2).

Biofuels have been first introduced to the national energy mix in late 2007. Biofuel is mixed with diesel to a contribution ranging from 3-6.5%. During the first years (2007-2012), biofuels were solely from oil seeds. Since 2013 however, biodiesel used in Cyprus has an increasing contribution of used cooking oils (8.5% in 2013, 61.3% in 2014, 63.2% in 2015 and 97.1% in 2016).[27]

According to the certificates of sustainability criteria which accompanied imported biofuels, all biofuels consumed in Cyprus were from biomass. The raw material used was cooking oil or oil crops.

Table 3.17. Number of vehicles by type

	1990	2000	2005	2010	2015	2017	2018
Buses	2743	3313	3727	5505	5512	5770	6131
Heavy Duty Trucks	10439	12667	16364	19595	17028	17649	18371
Mopeds & Motorcycles	64457	59403	59924	55001	52168	58303	54593
Light Commercial Vehicles	69708	116672	125586	125507	115597	120153	123901

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

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

Passenger Cars	195330	302088	416758	536137	576755	629750	663842

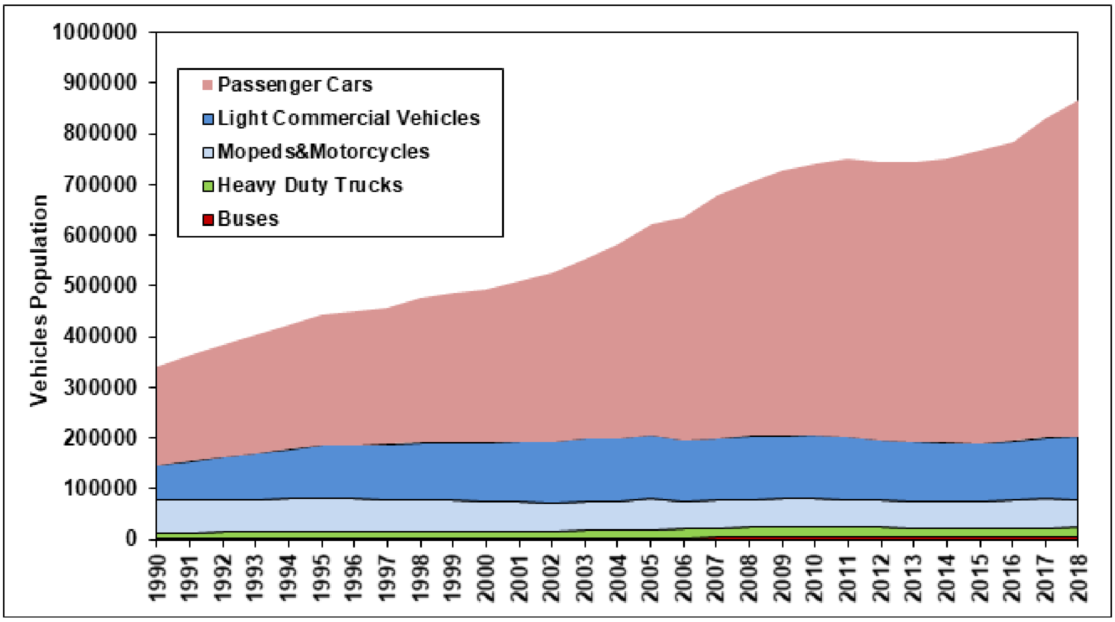

Figure 3.7. Trend of vehicles population in the Road transport sector

Table 3.18. Fuel consumed by road transport (kt) during 1990-2018

kt	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Gasoline	163	170	172	169	180	183	186	191	195	203
Diesel	209	201	245	254	260	284	297	313	333	339
Biodiesel	0	0	0	0	0	0	0	0	0	0
LPG	0	0	0	0	0	0	0	0	0	0

kt	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gasoline	206	219	228	252	282	303	323	352	373	383
Diesel	349	355	340	351	353	345	322	336	329	320
Biodiesel	0	0	0	0	0	0	0	1	16	17
LPG	0	0	0	0	0	0	0	0	0	0

kt	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Gasoline	390	385	372	349	341	345	354	351	342	
Diesel	328	312	271	231	223	241	273	299	298	
Biodiesel	17	18	18	17	11	11	10	10	10	
LPG	0	0	0	0	0	0	0	0	0.4	

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

Domestic water-borne navigation emissions should include emissions from fuels used by vessels of all flags that depart and arrive in the same country (excluding fishing, which should be reported under 1 A 4 c iii, and military, which should be reported under 1 A 5 b).

Estimation of emission from domestic water-borne navigation activities has been made possible due to data obtained from the Statistical Service on fuel consumption for the years 1998-2015 (Table 3.19). The consumption for remaining years has been estimated assuming the following: (a) for the years 1990-1997 the contribution of domestic water-borne navigation activities to road transport was assumed the same as 1998 (0.33%), (b) for 2017 and 2018, activity data has been obtained from the Statistical Service. 2017 activity data has been revised.

Calorific values and emission factors of road diesel for the estimation of emissions from domestic water-borne navigation are according to IPCC2006: NCV 43 TJ/kt (volume 2, pg. 1.18), 74100 kg CO_2/TJ (volume 2, pg. 3.50), 3.9 kg CH_4/TJ and 3.9 kg N_2O/TJ (assumed same as road - default, volume 2, pg. 3.21).

Table 3.19. Diesel consumption by domestic water-borne navigation activities

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Activity (kt)	0.69	0.66	0.81	0.84	0.86	0.94	0.98	1.03	1.10	1.24

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Activity (kt)	0.53	0.43	0.56	0.43	0.60	0.73	0.56	0.63	0.76	1.49

	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Activity (kt)	0.95	0.89	0.63	0.47	0.56	0.63	0.47	0.65	0.67	

3.2.5.3. Uncertainties and time-series consistency

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

3.2.5.4. Category-specific QA/QC and verification

EUROCONTROL has performed detailed, Tier 3, calculations from 2005 which were taken into account for comparison.

3.2.5.5. Category-specific recalculations

Recalculations have been performed for 1A3d ii Domestic water-borne navigation for the year 2016 and 2017 due to revised values in the energy balance with no significant difference in the emissions.

3.2.5.6. Category-specific planned improvements

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

3.2.6. Other sectors (1A4)

3.2.6.1. Category description

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

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

GHG emissions from other sectors in 2017 increased by 10% compared to 1990 emissions (from 434 Gg CO_2 eq in 1990 to 479 Gg CO_2 eq in 2018). Table 3.20 presents the trend between 1990 and 2018. Other sectors contribute 5.4% to the total emissions of the country in 2018 without LULUCF and 7.4% to the emissions from the energy sector. The emissions from Other sources (1A4) are presented in Figure 3.6.

Table 3.20. GHG emissions from Other sectors 1990-2018

	1990	2000	2005	2010	2015	2017	2018
4. Other sectors	434	731	610	571	530	552	479
a. Commercial/institutional	76	117	100	120	88	112	110
b. Residential	302	507	421	372	358	355	290
c. Agriculture/forestry/fishing	56	106	89	77	83	85	79

CO2 (Gg)	430.40	725.39	604.60	563.22	521.74	543.59	471.92
CH4 (Gg)	0.10	0.14	0.15	0.16	0.26	0.27	0.24
N2O (Gg)	0.003	0.005	0.005	0.004	0.005	0.005	0.005
Total (Gg CO2 eq.)	434	731	610	569	530	552	479

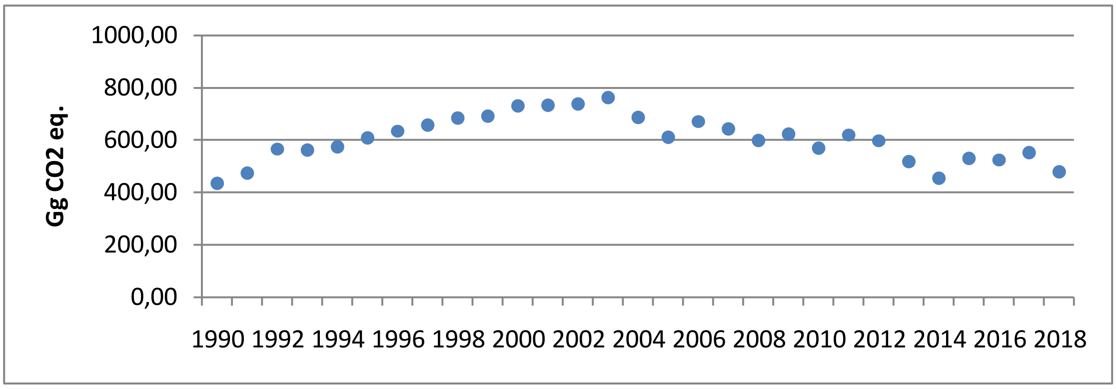

Figure 3.9. Other sectors (1A4) emissions 1990-2018

3.2.6.2. Methodological issues

Due to the unavailability of consumption data for several years and sectors, using the fuel consumption data as published by the Statistical Service, would create issues of consistence and comparability. Therefore it was decided to complete the period using assumptions. The activity data used for the estimation of GHG emissions of other sectors is presented in Table 3.21.

Gas biomass consumed by agriculture includes all biogas consumption. Diesel consumption by agriculture was revised to exclude diesel consumed for fishing (in red). Fuel consumption for fishing is added. Moreover RFO consumption by Off-road Vehicles and Other Machinery (1A4c ii) consumption is included in road transport (1A3b). Consumption of RFO, Diesel and biomass in 1A4a Commercial / Institutional was revised for the year 2017, due to revision of the energy balance and other kerosene consumption has been reported for 2017 and 2018. Consumption of Diesel and LPG was revised in 1A4b Residential for 2017, as well as consumption of solid biomass was revised for the years 2009-2018, due to revision of the energy balance. Biogas consumption in 1A4ci Stationary has been revised for 2017, due to revision of the energy balance. The consumption of biogas by autoproducers is accounted under category 1.A.4.c.i because all the production and consumption of biogas occurs at farms with anaerobic digesters.

The GHG emissions from “other sectors” were estimated according to the IPCC2006 guidelines. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 3.22). The oxidation factor used is 1, as proposed by the IPCC 2006 guidelines (pg. 1.20).The CO2, CH4 and N2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (IPCC2006, pg. 2.20-2.22, oil) as presented in Table 3.20.

Table 3.21. Fuel consumption for “Other sectors” for the period 1990-2018

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

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1A4a Commercial / Institutional											
Gas-diesel oil (kt)	20	19	23	20	16	17	13	13	15	18.18	16.33
RFO (kt)	2	2	2	2	4	4	2	3	4	4.21	3.2
LPG (kt)	14	13	13	14	14	12	11	12	11	13.17	13.75
Other kerosene (kt)											
Solid biofuels (TJ)	15	15	15	13	16	16	16	15	15	17	17
Biogas (TJ)		11	12	11	11	11	11	11	12	17	45
Charcoal (kt)	7	6	6	6	6	6	6	7	7	7.07	5.98
1A4b Residential											
Other kerosene (kt)	14	19	14	16	17	12	9	14	14	14.25	9.30
Gas-diesel oil (kt)	78	83	70	80	76	62	57	65	65	65.04	53.44
LPG (kt)	34	36	34	38	37	33	31	34	35	32.47	28.45
Solid biofuels (TJ)	123	500	260	339	419	353	2491	551	531	691.33	709.2
Charcoal (kt)	6	5	5	6	6	6	6	7	8	8.64	8.51
1A4c Agriculture / Forestry / Fishing / Fish farms											
1A4c i Stationary											
Gas-diesel oil (kt)	23	20	19	22	21	21	19	22	21	22.11	20.57
LPG (kt)	1	1	1	1	1	1	0	2	2	2.42	2.53
Biogas (TJ)	78	198	262	437	465	455	464	460	475	419.39	442.72
1A4c iii Fishing											
Gas-diesel oil (kt)	3	4	4	3	3	2	2	2	2	2	1.79

Table 3.22. Parameters used for the estimation of emissions from other sectors

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

3.2.6.3. Uncertainties and time-series consistency

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

3.2.6.4. Category-specific QA/QC and verification

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

3.2.6.5. Category-specific recalculations

Recalculations for 1A4a Commercial / Institutional, 1A4b Residential and 1A4c I Stationary have been performed due to revision of activity data by the Statistical Service for the year 2017.

Table 3.23. 1A4a Commercial / Institutional recalculations (Gg CO2 eq.)

	2017
2018 submission	542.8
2019 submission	551.97
% difference	16.5%

3.2.6.6. Category-specific planned improvements

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

3.2.7. Non-Specified (1A5)

3.2.7.1. Category description

All remaining emissions from fuel combustion that are not specified elsewhere should be reported under Non-Specified (1A5). Emissions from fuel delivered to the military in the country and delivered to the military of other countries that are not engaged in multilateral operations should also be included. Emissions for 2017 have been recalculated due to revised energy balance.The emissions during the period 1990-2018 are presented in Table 3.24 and Figure 3.10.

Table 3.24. GHG emissions from Other (Not elsewhere specified-Stationary) 1990-2018

	1990	2000	2005	2010	2015	2017	2018
5. Other	11	22	19	20	22	22	24
a. Stationary	11	22	19	17	19	18	19.4
b. Mobile	NO	NO	NO	3.2	3.2	3.8	4.5
CO2 (Gg)	11.00	21.43	19.03	20.29	22.27	21.48	23.87
CH4 (Gg)	0.0015	0.0029	0.0060	0.0062	0.0030	0.0029	0.0032
N2O (Gg)	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Total (Gg CO2 eq.)	11	22	19	20	22	22	24

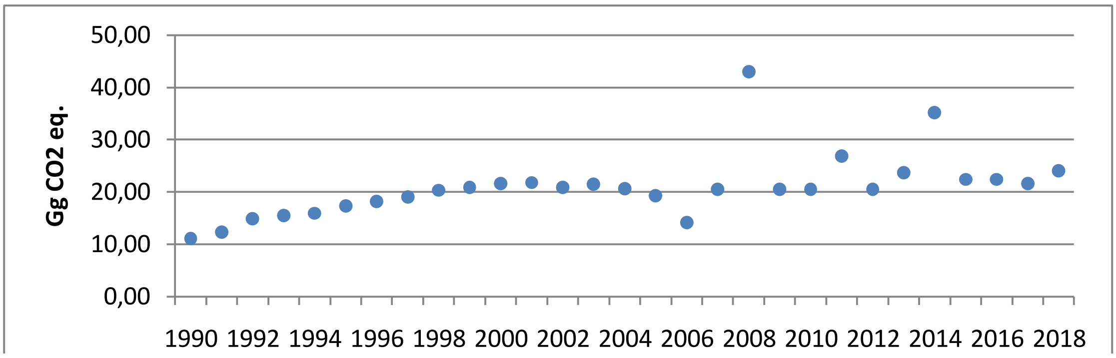

Figure 3.10. GHG emissions from Other (Not elsewhere specified-Stationary) (1A5) 1990-2018

3.2.7.2. Methodological issues

Due to the unavailability of consumption data for several years and sectors, using the fuel consumption data as published by the Statistical Service, would create issues of consistence and comparability. Therefore it was decided to complete the period using assumptions. Details on the methodology developed and applied are given in Annex 3. The activity data used for the estimation of GHG emissions of other sectors is presented in Table 3.25. Consumption of Gas-diesel oil and Lignite is allocated to stationary combustion, whereas consumption of jet kerosene to mobile combustion.

Table 3.25. Other non-specified fuel consumption 1990-2018

	1990	1991	1992	1993	1994	1995	1996	1997
Gas-diesel oil (kt)	3	4	5	5	5	5	6	6
Lignite (kt)	0	0	0	0	0	0	0	0
Jet kerosene (kt)	0	0	0	0	0	0	0	0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Gas-diesel oil (kt)	6	7	7	7	7	7	6	6
Lignite (kt)	0	0	0	0	0	0	1	1
Jet kerosene (kt)	0	0	0	0	0	0	0	0
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Gas-diesel oil (kt)	4	6	13	5	5	6	5	5
Lignite (kt)	1	1	1	1	1	1	1	1
Jet kerosene (kt)	0	0	0	1	1	2	1	2
	2014	**2015**	**2016**	**2017**	**2018**			
Gas-diesel oil (kt)	9	6	6	5.533	6.075			
Lignite (kt)	0	0	0	0	0			
Jet kerosene (kt)	2	1	1	1.22	1.43			

Methodology

The GHG emissions were estimated according to the IPCC2006 guidelines. Fuel consumption was converted to TJ using the default NCV proposed by the IPCC 2006 guidelines (Table 1.23). The CO2, CH4 and N2O emissions were estimated using the default emission factors proposed by the IPCC2006 guidelines (volume 2, pg. 2.22) as presented in Table 3.26.

Table 3.26. Parameters used for the estimation of other emissions

Fuel	NCV (TJ/kt)	kg CO_2 /TJ	kg CH_4 /TJ	kg N_2O /TJ
Diesel	43.0	74100	10	0.6
Jet kerosene	44.1	71500	10	0.6
Lignite	11.9	101000	300	1.5
Solid Biomass	11.6	100000	300	4.0

3.2.7.3. Uncertainties and time-series consistency

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

3.2.7.4. Category-specific QA/QC and verification

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

3.2.7.5. Category-specific recalculations

Emissions for 1A5b Mobile have been recalculated for the year 2017 due to revised activity data by the Statistical Service in the energy balance.

3.2.7.6. Category-specific planned improvements

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

3.2.8. Reference approach (1AB)

The Reference Approach is a top-down approach, using a country's energy supply data to calculate the emissions of CO2 from combustion of mainly fossil fuels. The Reference Approach is a straightforward method that can be applied on the basis of relatively easily available energy supply statistics. Excluded carbon has increased the requirements for data to some extent. However, improved comparability between the sectoral and reference approaches continues to allow a country to produce a second independent estimate of CO2 emissions from fuel combustion with limited additional effort and data requirements.

Both sectoral approach and the reference approach are to estimate a country's CO2 emissions from fuel combustion and to compare the results of these two independent estimates. Significant differences may indicate possible problems/mistakes with the activity data, net calorific values, carbon content, excluded carbon calculation, etc.

The Reference Approach is designed to calculate the emissions of CO2 from fuel combustion, starting from high level energy supply data. The assumption is that carbon is conserved so that, for example, carbon in crude oil is equal to the total carbon content of all the derived products. The Reference Approach does not distinguish between different source categories within the energy sector and only estimates total CO2 emissions from Source category 1A, Fuel Combustion. Emissions derive both from combustion in the energy sector, where the fuel is used as a heat source in refining or producing power, and from combustion in final consumption of the fuel or its secondary products.

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

Step 1: Estimation of apparent consumption

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

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

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

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

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

The values were multiplied by the net calorific values listed in Table 3.27 to provide the energy consumed in TJ. The NCV values used were the defaults proposed by the IPCC 2006 guidelines (volume 2, pg. 1.18) except for pet-coke and other bituminous coal. Pet-coke and other bituminous coal are consumed only from one cement producing installation. Therefore the NCV implied by the annual reports submitted according to national ETS legislation (law no. 110(I)/2011), instead of the default proposed by the IPCC were used, which is available for the years 2000-2014; for the years 1990-1999 the NCV was assumed the same as 2000.

Step 3: Estimation of carbon content

Total carbon included in each fuel is calculated by multiplying energy consumption by an emission factor (Table 3.27) that reflects the amount of carbon per energy unit for each fuel. The result gives the maximum amount of carbon that could be potentially released if all carbon in the fuels were converted to CO_2. The carbon emission factor of fuels used in the reference approach, are based predominately on the 2006 IPCC guidelines. The exceptions are pet-coke, other bituminous coal, waste (non-biomass fraction) and solid biomass. Pet-coke and other bituminous coal are consumed only from one cement producing installation. Therefore it was preferred to use the carbon emission factor implied by the annual reports submitted according to national ETS legislation (law no. 110(I)/2011), instead of the default proposed by the IPCC. Waste (non-biomass fraction) and solid biomass show annual variations because of the difference in ratios of the different types of waste and solid biomass consumed to the total.

Step 4: Estimation of carbon stored in products

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

Step 5: Estimation of carbon unoxidised during fuel use

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

Step 6: Estimation of CO_2 emissions

Carbon emissions from all fuels are multiplied by 44/12 to be converted to CO_2 emissions and are summed giving the total amount of CO_2 released in the atmosphere. The emissions estimated with the reference approach are presented in Table 3.28. Detailed presentation of the results is available in Annex 4.

Table 3.27. Net calorific value (TJ/kt) and carbon emission factors (t CO2/kt) of fuels consumed in Cyprus used for the reference approach

(a) Net calorific value (TJ/kt) and carbon emission factors (t CO2/kt) that remain constant for the period 1990-2017

	Conversion factor (TJ/kt)	Carbon emission factor (tC/TJ)
Crude oil	42.3	20.0
Gasoline	44.3	18.9
Jet kerosene	44.1	19.5
Other kerosene	43.8	19.6
Gas-diesel oil	43.0	20.2
Residual fuel oil	40.4	21.1

LPG	47.3	17.2
Bitumen	40.2	22.0
Lubricants	40.2	20.0
Pet-coke	32.5	table (b)
Other oil-refinery gas	49.5	15.7
Other oil-White spirit & SBP	40.2	20.0
Other bituminous coal	table (b)	table (b)
Lignite	11.9	27.6
Waste (non-biomass fraction)	NA	table (b)
Solid biomass	NA	table (b)

(b) Net calorific value (TJ/kt) and carbon emission factors (t CO2/kt) that are not constant for the period 1990-2018

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

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

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NCV (TJ/kt)							
Other bituminous coal	28.621	28.621	29.995	28.360	25.950	26.080	26.819
Implied CEF (tC/TJ)							
Pet-coke	23.047	23.047	24.160	24.659	24.486	25.578	25.515
Other bituminous coal	25.254	25.254	25.156	22.815	25.788	25.661	25.794
C EF (tC/TJ)							
Waste (non-biomass fraction)	39.00	39.00	39.00	39.00	39.00	39.00	39.00
Solid biomass	28.542	28.971	28.956	28.664	28.511	28.438	28.569

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NCV (TJ/kt)							
Other bituminous coal	25.517	NO	NO	23.210	25.675	25.675	24.680
Implied CEF (tC/TJ)							
Pet-coke	25.301	24.795	25.238	25.583	25.150	25.313	28.710
Other bituminous coal	25.620	NO	NO	25.890	25.876	25.877	25.563
C EF (tC/TJ)							
Waste (non-biomass fraction)	39.00	25.00	25.00	37.36	30.996	30.996	27.553
Solid biomass	28.647	29.115	29.250	28.918	28.852	28.942	28.772

	2018
NCV (TJ/kt)	
Other bituminous coal	25.8
Implied CEF (tC/TJ)	
Pet-coke	24.609

Other bituminous coal	25.800
C EF (tC/TJ)	
Waste (non-biomass fraction)	27.298
Solid biomass	28.239

Table 3.28. Apparent consumption (TJ) and CO2 emissions (Gg) estimates according to the reference approach 1990-2017

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Liquid Fuels							
Apparent consumption	54,217	55,995	65,169	69,671	79,517	68,842	76,855
CO2	4,029	4,177	4,774	5,119	5,832	5,067	5,647
Solid Fuels							
Apparent consumption	2,682	2,682	719	857	747	553	498
CO2	248	248	67	79	69	51	46
Waste (non-biomass fraction)							
Apparent consumption	NO	NO	NO	NO	NO	NO	NO
CO2	NO	NO	NO	NO	NO	NO	NO
Biomass							
Apparent consumption	287	262	260	259	726	686	671
CO2	29	27	26	26	75	71	70

	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Liquid Fuels							
Apparent consumption	75,064	79,987	80,533	86,407	85,371	86,500	94,650
CO2	5,511	5,856	6,012	6,289	6,222	6,309	6,953
Solid Fuels							
Apparent consumption	525	719	830	1,355	1,423	1,399	1,447
CO2	49	67	77	125	132	130	134
Waste (non-biomass fraction)							
Apparent consumption	NO	NO	NO	NO	18	NO	15
CO2	NO	NO	NO	NO	3	NO	2
Biomass							
Apparent consumption	565	614	487	515	551	606	694
CO2	59	64	51	53	57	63	72

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Liquid Fuels							
Apparent consumption	88,272	89,985	93,586	98,345	104,335	101,715	97,847
CO2	6,418	6,514	6,841	7,217	7,636	7,482	7,107
Solid Fuels							
Apparent consumption	1,643	1,500	1,632	1,402	1,050	560	709
CO2	152	139	151	117	99	53	67
Waste (non-biomass fraction)							
Apparent consumption	71	138	73	288	239	276	299
CO2	10	20	10	41	34	39	43
Biomass							
Apparent consumption	608	565	570	915	1,524	1,581	1,552
CO2	64	60	61	95	141	139	133

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Liquid Fuels							
Apparent consumption	94,738	88,673	75,925	77,428	78,321	84,258	86,875
CO2	6,895	6,505	5,596	5,765	5,803	6,202	6,410
Solid Fuels							
Apparent consumption	318	12	12	157	155	21	125
CO2	30	1	1	15	15	2	12
Waste (non-biomass fraction)							

	1990	1991	1992	1993	1994	1995	1996
Apparent consumption	56	24	45	316	516	663	902
CO2	8	2	4	43	59	66	91
Biomass							
Apparent consumption	1,775	1,667	1,506	1,472	1,558	1,625	1,756
CO2	147	133	120	121	130	138	151

	2018
Liquid Fuels	
Apparent consumption	85,799
CO2	6,289
Solid Fuels	
Apparent consumption	582
CO2	55
Waste (non-biomass fraction)	
Apparent consumption	962
CO2	96
Biomass	
Apparent consumption	2,049
CO2	183

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

The data used in the reference and the sectoral approach and the resulting emissions are presented in Annex 4. The comparison of the fuel consumption and the emissions is summarised in Table 3.29.

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

Table 3.29. Difference between Reference and Sectoral Approach 1990-2018

	1990	1991	1992	1993	1994	1995	1996
Fuel consumption (PJ)							
Sectoral approach	52.2	58.9	63.7	66.5	67.9	67.4	71.1
Apparent energy consumption*	56.8	58.4	64.6	69.2	78.9	68.4	75.9
Difference	8.9%	-0.9%	1.5%	4.1%	16.1%	1.5%	6.6%
CO2 (Gg)							
Reference approach	4281	4425	4840	5199	5907	5112	5693
Sectoral approach	3927	4457	4781	4956	5164	5069	5362
Difference	9.0%	-0.7%	1.2%	4.9%	14.4%	0.8%	6.2%

	1997	1998	1999	2000	2001	2002	2003
Fuel consumption (PJ)							
Sectoral approach	72.8	77.3	80.7	83.7	82.3	84.4	89.5
Apparent energy consumption*	74.2	79.0	79.2	85.5	84.9	85.5	94.0
Difference	1.9%	2.2%	-1.9%	2.2%	3.2%	1.4%	5.0%
CO2 (Gg)							
Reference approach	5560	5923	5933	6415	6356	6438	7089
Sectoral approach	5483	5823	6085	6310	6202	6359	6746
Difference	1.4%	1.7%	-2.5%	1.7%	2.5%	1.3%	5.1%

	2004	2005	2006	2007	2008	2009	2010

Fuel consumption (PJ)							
Sectoral approach	91.4	93.5	94.4	98.5	100.8	100.2	97.2
Apparent energy consumption*	87.0	88.4	92.2	97.2	102.6	99.9	95.4
Difference	-4.8%	-5.5%	-2.3%	-1.3%	1.8%	-0.3%	-1.8%
CO2 (Gg)							
Reference approach	6581	6673	7002	7375	7734	7574	7217
Sectoral approach	6910	7088	7271	7591	7756	7682	7453
Difference	-4.8%	-5.9%	-3.7%	-2.8%	-0.3%	-1.4%	-3.2%

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Fuel consumption (PJ)							
Sectoral approach	94.3	88.0	75.7	76.8	79.1	84.4	85.99
Apparent energy consumption*	92.1	86.9	74.7	76.7	77.8	83.2	85.97
Difference	-2.2%	-1.2%	-1.3%	0.0%	-1.7%	-1.4%	-0.03%
CO2 (Gg)							
Reference approach	6933	6508	5601	5824	5877	6270	6513
Sectoral approach	7162	6675	5761	5924	6045	6442	6548
Difference	-3.2%	-2.5%	-2.8%	-1.7%	-2.8%	-2.7%	-0.26%

	2018
Fuel consumption (PJ)	
Sectoral approach	84.55
Apparent energy consumption*	85.42
Difference	1.03%
CO2 (Gg)	
Reference approach	6441
Sectoral approach	6391
Difference	0.78%

* excluding non-energy use, reductants and feedstocks

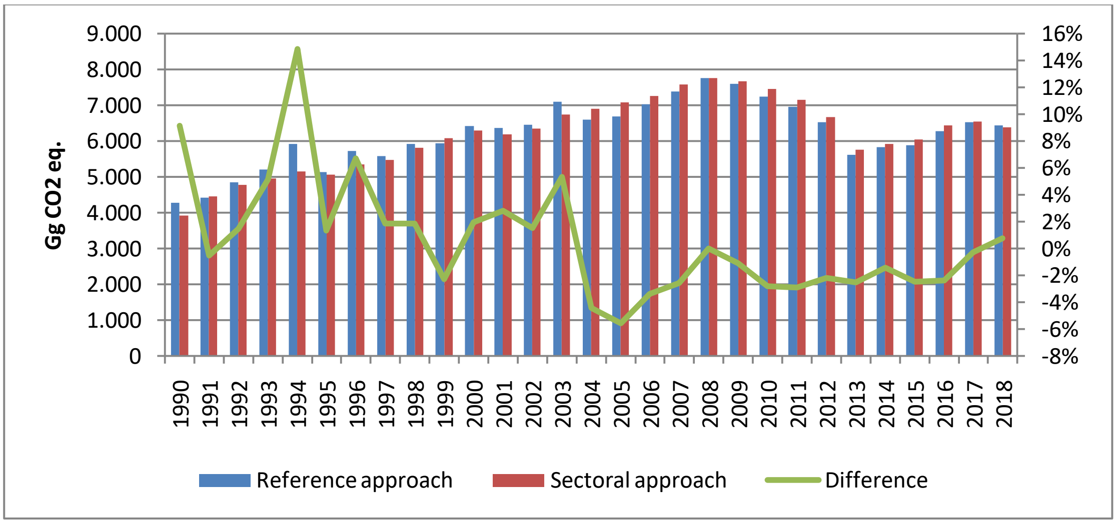

Figure 3.11. CO2 emissions from fuel combustion using sectoral and reference approach

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

3.2.10.1. Category description

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

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

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

3.2.10.2. Methodological Issues

The calculation of carbon dioxide emissions from non-energy use of fuels is according to the methodology proposed by the IPCC2006 guidelines. NCVs, carbon emission factor and fraction of C stored are according to the guidelines (Table 3.30). Non-energy fuel use, carbon dioxide emissions and the amount of carbon stored in the final products are presented in Table 3.31.

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

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

Table 3.30. Parameters used for the calculation of emissions

	Lubricants	**Bitumen**
NCV (TJ/kt)	40.2	40.2
Carbon emission factor (t/TJ)	20.00	22.00
Oxidation factor	1	1

Table 3.31. Fuel consumption, carbon stored and CO2 emissions for Feedstocks and non-energy use of fuels

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Lubricants								
Consumption (kt)	1.9	3.7	5.5	6	11	11	12	11
Carbon excluded (Gg)	1.528	2.975	4.422	4.824	8.844	8.844	9.648	8.844
CO_2 (Gg)	5.60	10.91	16.21	17.69	32.43	32.43	35.38	32.43
Bitumen								
Consumption (kt)	33	19	50	59	58	51	55	60
Carbon excluded (Gg)	29.19	16.80	44.22	52.18	51.30	45.10	48.64	53.06
CO_2 (Gg)	107.01	61.61	162.14	191.33	188.08	165.38	178.35	194.57

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Lubricants								
Consumption (kt)	4	5	7	9	8	8	11	10
Carbon excluded (Gg)	3.216	4.02	5.628	7.236	6.432	6.432	8.844	8.04
CO_2 (Gg)	11.79	14.74	20.64	26.53	23.58	23.58	32.43	29.48
Bitumen								
Consumption (kt)	75	86	85	81	84	69	66	71
Carbon excluded (Gg)	66.33	76.06	75.17	71.64	74.29	61.02	58.37	62.79
CO_2 (Gg)	243.21	278.88	275.64	262.67	272.40	223.75	214.02	230.24

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Lubricants								
Consumption (kt)	11	10	10	10	11	10	9	7
Carbon excluded (Gg)	8.844	8.04	8.04	8.04	8.844	8.04	7.236	5.628
CO_2 (Gg)	32.43	29.48	29.48	29.48	32.43	29.48	26.53	20.64

Bitumen								
Consumption (kt)	65	60	69	57	74	64	35	26
Carbon excluded (Gg)	57.49	53.06	61.02	50.41	65.45	56.60	30.95	22.99
CO_2 (Gg)	210.78	194.57	223.75	184.84	239.97	207.54	113.50	84.31

	2014	**2015**	**2016**	**2017**	**2018**			
Lubricants								
Consumption (kt)	7	8	8	7.849	7.67			
Carbon excluded (Gg)	5.628	6.432	6.432	6.292	6.161			
CO_2 (Gg)	20.64	23.58	23.58	23.07	22.59			
Bitumen								
Consumption (kt)	22	21	36	38.95	40.16			
Carbon excluded (Gg)	19.46	18.57	31.84	34.45	35.51			
CO_2 (Gg)	71.34	68.10	116.74	126.31	130.22			

3.2.10.3. Uncertainties and time-series consistency

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

3.2.10.4. Category-specific QA/QC and verification

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

3.2.10.5. Category-specific recalculations

No recalculations to be reported.

3.2.10.6. Category-specific planned improvements

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

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

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

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

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

3.3.1.1. Category description

Based on the above, the fugitive emissions from oil for Cyprus are caused by refining. For refining, no emissions are reported after 2004 when the refinery stop operating (NO). Table 3.32 presents the emissions of the source. Methane emissions from refining activities (1.B.2.A.4) only occur during 1990-2004 when the refinery was operating.

Transport of oil (1.B.2.a.3) according to the definition of the IPCC 2006 Guidelines, took place only during the time the refinery was operating; i.e. 1990-2004, and has not been taking place ever since. For the period the refinery was operating there is no activity data available to estimate emissions, therefore NE is used, while NO is used for the period after 2004.

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

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

Table 3.32. Fugitive emissions from oil during 1990-2018, in tons

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Refining (t CH_4)	16.2	19.43	18.51	19.89	23.07	21.09	19.36	26.56	27.56	30.05	29.87
Venting (t CO_2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Venting (t CH_4)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Refining (t CH_4)	29.44	27.66	24.73	7.11	NO	NO	NO	NO	NO	NO	NO
Venting (t CO_2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Venting (t CH_4)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**				
Refining (t CH_4)	NO	NO	NO	NO	NO	NO	NO				
Venting (t CO_2)	NA	NA	NA	NA	NA	NA	NA				
Venting (t CH_4)	NA	NA	NA	NA	NA	NA	NA				

3.3.1.2. Methodological issues

Refining activities (1.B.2.A.4)

GHG emissions from oil until 2004 when the refinery was operating are estimated according to the Tier 1 methodology described in the IPCC 2006 guidelines. The activity data used in presented in Table 3.33. The activity data is from the energy balance of the National Statistical Service. The emission factor 0.0218 kg CH4 /m3[28] for oil refined, is according to the IPCC 2006 guidelines, Table 4.2.4, pg. 4.53.

Table 3.33. Oil refined during 1990-2004, kt

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

[28] 2.6+4.1)/2=3.35 kg/m^3

3.3.1.3. Uncertainties and time-series consistency

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

3.3.1.4. Category-specific QA/QC and verification

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

3.3.1.5. Category-specific recalculations

Refining activities (1.B.2.A.4)

After the TERT recommendation, a unit conversion mistake and the CH_4 EF were corrected from 0.00335 kg CH_4/ m3 to 0.0218 kg CH_4/ m3 and implied a change of 550.7%. The impact of recalculations on emissions is shown in the table 3.34.

Table 3.34 Impact of recalculations on emissions for 1990-2004.

(Gg CO2 eq.)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NIR 2019 emissions	0.062	0.075	0.071	0.076	0.089	0.081	0.074	0.102	0.106	0.115
NIR 2020 emissions	0.405	0.486	0.463	0.497	0.577	0.527	0.484	0.664	0.689	0.751

(Gg CO2 eq.)	2000	2001	2002	2003	2004
NIR 2019 emissions	0.115	0.113	0.106	0.095	0.027
NIR 2020 emissions	0.747	0.736	0.691	0.618	0.178

3.3.1.6. Category-specific planned improvements

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

3.4. CO2 transport and storage (CRF 1.C)

Not occurring

3.5. Memo items (1.D)

All emissions from fuels used for international aviation (bunkers) and multilateral operations pursuant to the Charter of UN are to be excluded from national totals, and reported separately as memo items. Memo items are emissions that have to be estimated and reported but do not count towards the national total. The activities that occur in Cyprus under this category are International bunkers (1D1) and CO_2 from biomass (1D3). The emissions during the period 1990-2018 are presented below.

Table 3.35. Emissions from memo items (Gg CO2 eq.)

Gg CO2 eq.	1990	2000	2005	2010	2015	2017	2018
1D1. International bunkers	910	1448	1768	1431	1534	1822	1914
1D3. CO2 from biomass	30	57	63	180	203	260	289

3.5.1. International bunkers (1D1)

3.5.1.1. Category description

Emissions from flights and vessels of all flags that are engaged in international water-borne navigation that depart in one country and arrive in a different country should be included in international bunkers. Emissions from international bunkers as estimated for the period 1990-2018 are presented in Table 3.36.

Table 3.36. Emissions from international bunkers 1990-2018

Gg CO2 eq.	1990	2000	2005	2010	2015	2017	2018
International bunkers	910	1448	1768	1431	1534	1822	1914
Aviation	724	834	840	835	757	1007	1046
Navigation	185	614	928	596	777	815	868
CO2 (Gg)	901	1434	1750	1416	1518	1803	1894
CH4 (Gg)	0.02	0.05	0.08	0.05	0.07	0.07	0.07
N2O (Gg)	0.03	0.04	0.05	0.05	0.05	0.06	0.06
Total (Gg CO2 eq.)	910	1448	1768	1431	1534	1822	1914

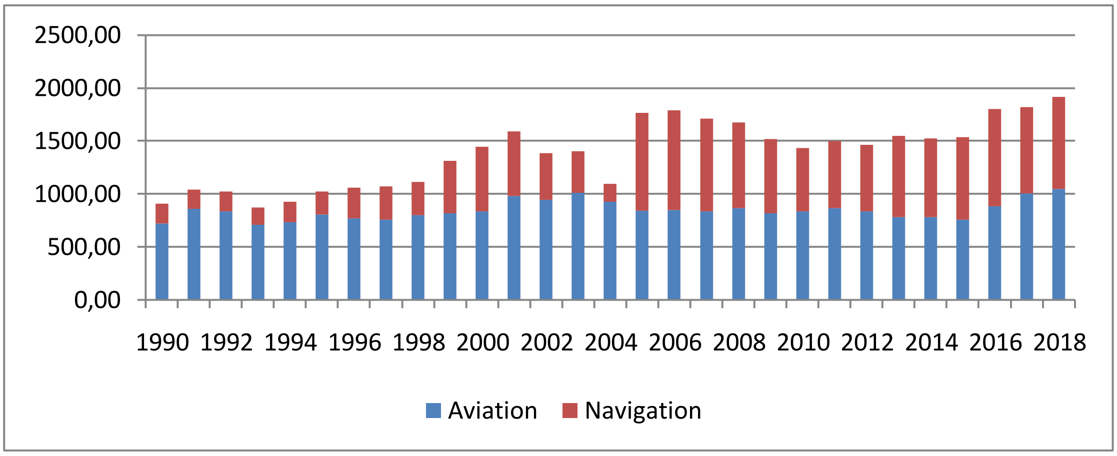

Figure 3.12. Emissions from international bunkers 1990-2018

3.5.1.2. Methodological issues

Activity data used for the estimation of emissions from bunkers is presented in Table 3.37. Data for all fuels except jet-kerosene was obtained from the energy balance of the national statistical service in kt of fuel consumed. Details on the method the consumption of jet-kerosene has been estimated are presented in section 3.2.5.2 and Annex 3. NCV and emission factors (Table 3.38) are the defaults proposed by the IPCC 2006 guidelines; i.e. 44.1 TJ/kt, 71.5 t CO2/TJ, 0.5 kg CH4/TJ and 2 kg N2O/TJ.

Table 3.37. Fuel consumption for international aviation and maritime activities 1990-2018 (kt)

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

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Jet Kerosene	262	308	297	318	290	264	266	262	272	257

Gas/Diesel Oil	50	47	33	36	27	67	106	104	88	73
RFO	143	145	105	88	27	225	190	171	165	146

	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Jet Kerosene	263	272	263	246	246	238	278	317	329	
Gas/Diesel Oil	53	58	69	83	80	75	95	101	117	
RFO	134	141	128	157	153	169	193	154	154	

Table 3.38. Parameters used for the calculation of emissions

Fuel	NCV (TJ/kt)	kg CO2/TJ	kg CH4/ TJ	kg N2O/ TJ
Jet Kerosene	44.10	71500	0.5	2
Gas/Diesel Oil	43	74100	3.9	3.9
RFO	40.4	77400	3	0.6

3.5.1.3. Uncertainties and time-series consistency

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

3.5.1.4. Category-specific QA/QC and verification

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

3.5.1.5. Category-specific recalculations

No recalculations to be reported.

3.5.1.6. Category-specific planned improvements

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

3.5.2. CO2 emissions from biomass (1.D.3)

3.5.2.1. Category description

Biomass in the energy sector is consumed by the sectors presented in Table 3.39. The resulting emissions from combustion of biomass are presented in Table 3.40.

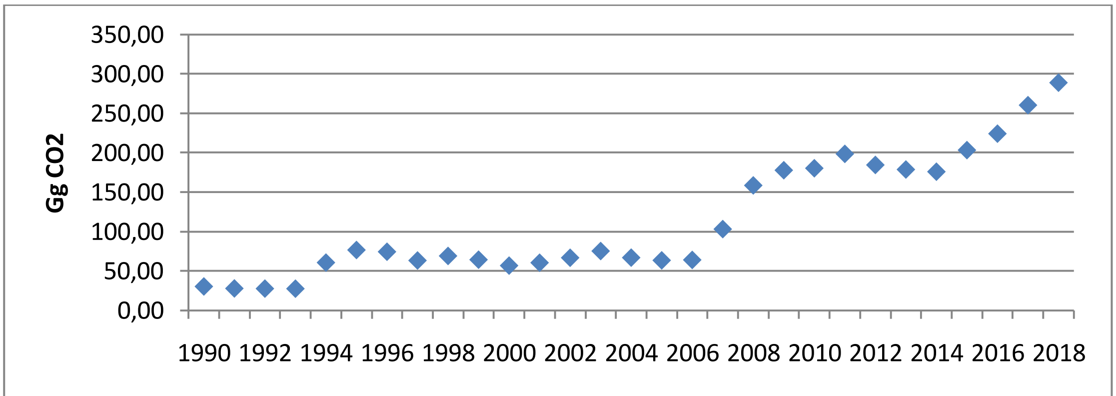

Figure 3.13. Emissions from biomass 1990-2018

Table 3.39. Activities consuming biomass in Cyprus

Source category	Solid biofuels	Charcoal	Liquid biofuels	Gas biofuels

1A1c Manufacture of solid fuels and other energy industries	✓			
1A2c Chemical and petrochemical	✓			
1A2e Food, beverages and tobacco	✓			
1A2f Non-metallic minerals	✓			
1A3b Road transport			✓	
1A4a Commercial and public services	✓	✓		✓
1A4b Residential	✓	✓		
1A4c Agriculture/ Forestry				✓

Table 3.40. Emissions from CO2 from biomass 1990-2018

	1990	2000	2005	2010	2015	2017	2018
CO2 from biomass (Gg)	30	57	64	180	203	260	289

3.5.2.2. Methodological issues

Already described in the Sections where the biomass consumption occurs.

3.5.2.3. Uncertainties and time-series consistency

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

3.5.2.4. Category-specific QA/QC and verification

Already described in the Sections where the biomass consumption occurs.

3.5.2.5. Category-specific recalculations

Already described in the Sections where the biomass consumption occurs.

3.5.2.6. Category-specific planned improvements

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

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

4.1. Overview of sector

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

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

In addition, greenhouse gases often are used in products such as refrigerators, foams or aerosol cans. For example, HFCs are used as alternatives to ozone depleting substances (ODS) in various types of product applications. Similarly, sulphur hexafluoride (SF_6) and N_2O are used in a number of products used in industry (e.g., SF6 used in electrical equipment, N_2O used as a propellant in aerosol products primarily in food industry) or by end-consumers (e.g., SF_6 used in running-shoes, N_2O used during anaesthesia).

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

4.1.1. Emissions trend

Historic evolution of industrial activity in Cyprus[29]

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

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

The Protocol for the Customs Union and Accession to the EU provided for the elimination of all restrictions to trade and increased competition in the local market. This had a major impact on the

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

industrial sector which had to face fierce competition both from EU markets and third countries.

1990-2002

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

2004-2009

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

2009-2014

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

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

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

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

2015-2018

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

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

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

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

Competitiveness of the industrial sector is still low. This is mainly due to low productivity, high production costs and, in general, increased supply chain costs resulting from the small size of the market, the insularity of the economy and its geographic and energy "isolation", its limited resources, its low capacity for innovation (mainly due to a low percent of investment in R&D and to the very small size of businesses), insufficient use and implementation of quality standards, and lack of adequate tangible and intangible infrastructure. The Cyprus New Industrial Strategy Policy framework and action plan will help tackle these challenges and provide solutions aiming at creating the right environment for industry regeneration, increasing production and exports, technological upgrading, creating new jobs, developing innovation and improving infrastructure.

Emissions

In 2018, GHG emissions from Industrial processes accounted for 14.2% of total emissions excluding LULUCF compared to 14.5% in 1990. The emissions have increased by 47% compared to 1990. 69% of the industrial processes emissions are from mineral production, 24% is from consumption of Halocarbons and SF_6, 5% is from Other Product Manufacture and Use and the remaining 2% is from non-energy products from fuels and solvent use.

Table 4.1. Total GHG emissions (in Gg CO_2 eq) from Industrial Processes, 1990 – 2018

	1990	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**
2. Industrial Processes	**853.25**	**1053.93**	**1218.04**	**969.23**	**1243.39**	**1316.63**	**1255.77**
A. Mineral industry	717.07	802.75	894.10	589.98	888.12	934.98	863.42
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from	8.63	27.73	40.61	40.61	22.39	29.55	30.12

fuels and solvent use							
E. Electronic industry	NO	NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes	79.60	169.12	223.91	275.84	269.72	287.70	297.14
G. Other product manufacture and use	47.95	54.34	56.33	62.80	63.15	64.39	65.09
H. Other	NO	NO	NO	NO	NO	NO	NO
CO_2 (Gg)	725.74	830.59	937.83	630.61	910.53	964.55	893.55
N_2O (Gg)	0.161	0.182	0.189	0.210	0.21	0.215	0.218
HFC (Gg CO_2 eq.)	79.60	169.12	223.91	275.84	269.72	287.70	297.14
SF_6 (Gg)	0.000001	0.000003	0.000005	0.000007	0.000007	0.000007	0.000007
Total	**853.25**	**1053.93**	**1218.04**	**969.23**	**1243.39**	**1316.63**	**1255.77**

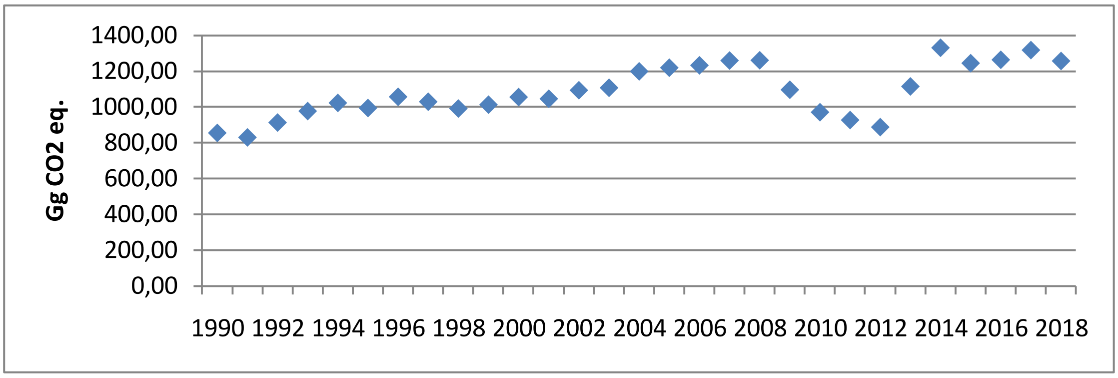

Figure 4.1. GHG emissions from Industrial Processes (sector 2) for the period 1990 – 2018

4.1.2. Completeness

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

Table 4.2. Industrial Processes – completeness

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

	CO_2	N_2O	HFC	PFC	SF_6
2G3. N2O from product uses		✓	NO	NO	NO
2G4. Other	✓				

NO: Not occurring

4.1.3. Methodology

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

Table 4.3. Industrial processes – methodologies and emission factors applied

Category-Classification		Gas	EF	Method
2A1.	Industrial Processes and Product Use – Mineral Industry - Cement production	CO_2	CS	CS
2A2	Industrial Processes and Product Use – Mineral Industry - Lime Production	CO_2	D	T1
2A4a	Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Ceramics	CO_2	CS	CS
2A4b	Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Other uses of soda-ash	CO_2	D	T1
2A4b	Industrial Processes and Product Use – Mineral Industry - Other process uses of carbonates - Other uses of soda-ash	CH_4/N_2O	NA	NA
2D1	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use- Lubricant Use	CO_2	D	T1
2D1	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use- Lubricant Use	CH_4/N_2O	NA	NA
2D2	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use - Paraffin Wax Use	CO_2	D	T1
2D2	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use - Paraffin Wax Use	CH_4/N_2O	NA	NA
2D3	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other (Dry cleaning, coating applications, chemical products, asphalt roofing, domestic solvent use including fungicides, road paving with asphalt, printing)	CO_2	CS	CS
2D3	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other (Dry cleaning, coating applications, chemical products, asphalt roofing, domestic solvent use including fungicides, road paving with asphalt, printing)	CH_4/N_2O	NA	NA
2D3	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts	CO_2	D	D
2D3	Industrial Processes and Product Use – Non Energy Products from Fuels and Solvent Use – Other - Urea-based catalysts	CH_4/N_2O	NA	NA
2F1	Product Uses as Substitutes for ODS -	HFCs	D	T2a

Category-Classification		Gas	EF	Method
	Refrigeration and air conditioning			
2F2	Product Uses as Substitutes for ODS - - Foam Blowing Agents	HFCs	CS	CS
2F3	Product Uses as Substitutes for ODS - - Fire Protection	HFCs	CS	CS
2F4.	Product Uses as Substitutes for ODS - Aerosols	HFCs	CS	CS
2G3a	Other Product Manufacture and Use - N_2O from product uses – Medical Applications	N_2O	CS	CS
2G3b	Other Product Manufacture and Use - N_2O from product uses – Other –Propellant for pressure and aerosol products	N_2O	CS	CS

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

4.2. Mineral products (2.A)

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

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

Emissions from mineral products in 2018 increased by 20% compared to 1990. The largest emitter continues to be cement production with 97.7% of the emissions (compared to 93.1% in 1990). The mineral materials produced in Cyprus are directly associated with the construction industry. Therefore, the economic situation in Cyprus after 2008 that directly affected constructions is also visible in the trend of the emissions of the sector. In 2013 however, even though the economic situation did not improve, emissions increase due to an increase in cement production caused by increase in exports.

Table 4.4. Emissions from mineral industry 1990-2018 (Gg CO_2)

Gg CO_2	1990	2000	2005	2010	2015	2017	2018
A. Mineral industry	717.07	802.75	894.10	589.98	888.12	934.98	863.42
1. Cement production	667.66	762.71	821.81	555.05	877.13	918.95	843.35
2. Lime production	5.33	5.41	12.06	7.20	2.36	3.18	5.33
3. Glass production	NO	NO	NO	NO	NO	NO	NO
4. Other process uses of carbonates	44.08	34.63	60.23	27.74	8.64	12.86	14.74
CO_2 (Gg)	717.07	802.75	894.10	589.98	888.12	934.98	863.42
Total (Gg CO_2)	717.07	802.75	894.10	589.98	888.12	934.98	863.42

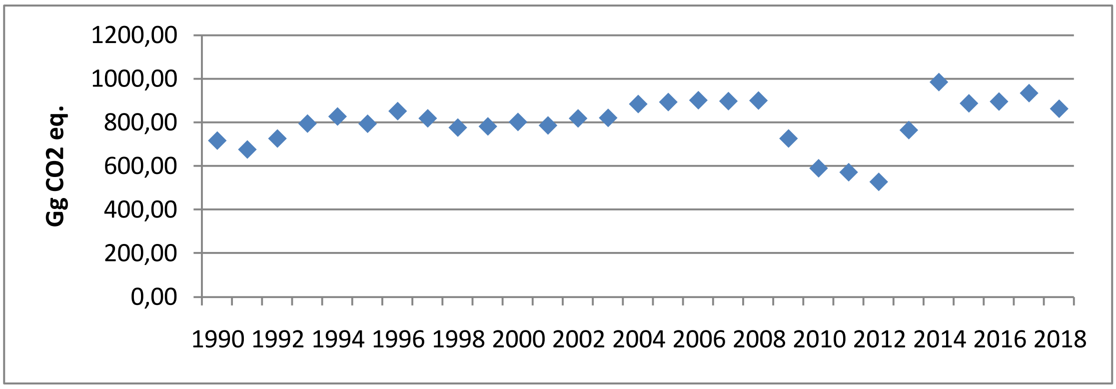

Figure 4.2. GHG emissions from Mineral products (2A) for the period 1990 – 2018

4.2.1. Cement production (2.A.1)

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

The emissions for the source category are presented in Table 3 and Figure 3. After 2008 there was sharp decrease in activity of the construction industry in Cyprus, which is reflected in the emissions. The sharp increase between 2013 and 2014 is due to an increase of exports, while between 2014 and 2015 there was a reduction in demand for exports, which caused a reduction in production.

Table 4.5. CO_2 emissions for Cement production (2.A.1) 1990-2018

	1990	2000	2005	2010	2015	2017	2018
Gg CO_2	668	763	822	555	877	919	843

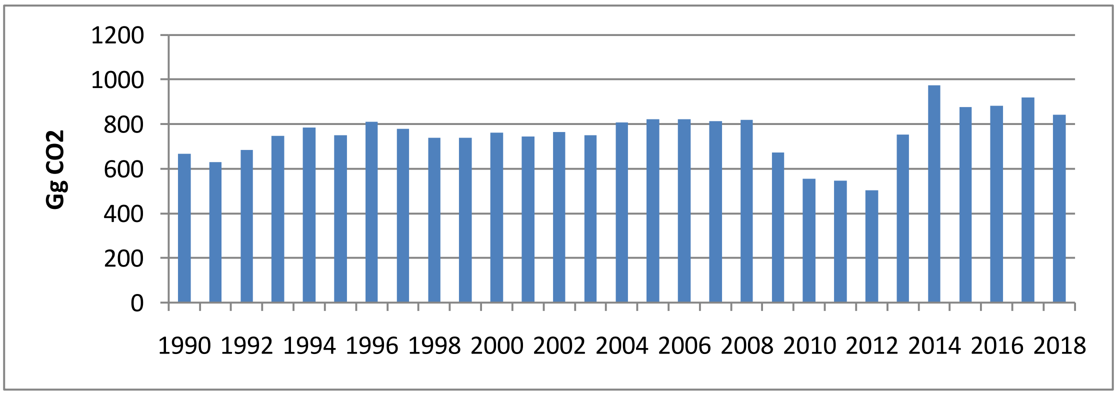

Figure 4.3. CO_2 emissions for Cement production (2.A.1) 1990-2018

In Cyprus, there is one cement producing installation, which provides information regarding CO_2 emissions in accordance to the EU-ETS legislation. Industrial installations covered by the EU ETS are required to have an approved monitoring plan for monitoring and reporting annual emissions. Every year, operators must submit an emissions report. The data for a given year must be verified by an accredited verifier by 31 March of the following year[30]. The EU ETS Directive was adopted in 2003 and the system was launched in 2005. The cap on allowances for the first trading period was set at national level through National Allocation Plans (NAPs)[31]. For the preparation of the NAP for the first trading period (2005-2007) historical data was collected for relevant installations. For the two cement installations that were operating at the time, data was available from 1997.

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

4.2.1.1. Methodological issues

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

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

Information regarding CO_2 emissions is annually submitted from 2005 in accordance to the EU-ETS legislation. Emissions are estimated using tier 3 methodologies. The CO_2 emissions are reported through templates provided by the European Commission for annual emission reports that are based on the Monitoring and Reporting Regulation[32]. The emissions for 2005-2016 are used as submitted by the installations for the EU-ETS (Table 4.6) that are estimated according to EU legislation and are verified by external verifier accredited by the national authorities. The emissions for the period 1997-2004 the data submitted by the installations for the preparation of the National Allocation Plan 2005-2007 was used that is also verified by an external verifier, and approved by the European Commission based on the relevant EU legislation.

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

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

	1990	1991	1992	1993	1994	1995	1996	1997
Clinker production (Gg)								
Installation 1	353	390	380	382	383	369	359	374
Installation 2	895	786	902	1015	1083	1035	1158	1085
Total	1249	1176	1282	1397	1466	1405	1516	1459
CO_2 process emissions (Gg)								
Installation 1								190
Installation 2								590
Total								780
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Clinker production (kt)								
Installation 1	337	334	362	361	373	363	367	330
Installation 2	1045	1047	1065	1033	1059	1043	1142	1143
Total	1382	1382	1428	1394	1432	1405	1509	1473
CO_2 process emissions (Gg)								

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

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

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

Installation 1	180	180	193	193	200	194	197	195
Installation 2	560	560	569	552	566	557	610	626
Total	740	740	763	745	766	751	808	822
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2008**	**2009**
Clinker production (kt)								
Installation 1	365	350	368	231	260	76	368	231
Installation 2	1177	1166	1158	1033	783	961	1158	1033
Total	1542	1515	1526	1264	1043	1037	1526	1264
CO_2 process emissions (Gg)								
Installation 1	198	190	200	125	140	41	200	125
Installation 2	623	622	618	548	415	505	618	548
Total	821	812	818	673	555	546	818	673
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Clinker production (kt)								
Installation 1	260	76	0	0	0	0	0	0
Installation 2	783	961	953	1418	1822	1641	1648	1717
Total	1043	1037	953	1418	1822	1641	1648	1717
CO_2 process emissions (Gg)								
Installation 1	140	41	0	0	0	0	0	0
Installation 2	415	505	505	752	974	877	883	919
Total	555	546	505	752	974	877	883	919
	2018							
Clinker production (kt)								
Installation 1	0							
Installation 2	1593							
Total	1593							
CO_2 process emissions (Gg)								
Installation 1	0							
Installation 2	843							
Total	843							

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

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

4.2.1.2. Uncertainties and time-series consistency

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

4.2.1.3. Category-specific QA/QC and verification

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

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

4.2.1.4. Category-specific recalculations

No recalculations to be reported.

4.2.1.5. Category-specific planned improvements

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

4.2.2. Lime Production (2.A.2)

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

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

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

Table 4.7. CO_2 emissions for Lime production (2.A.2) 1990-2018

	1990	2000	2005	2010	2015	2017	2018
Gg CO_2	5.33	5.41	12.06	7.19	2.36	3.18	5.33

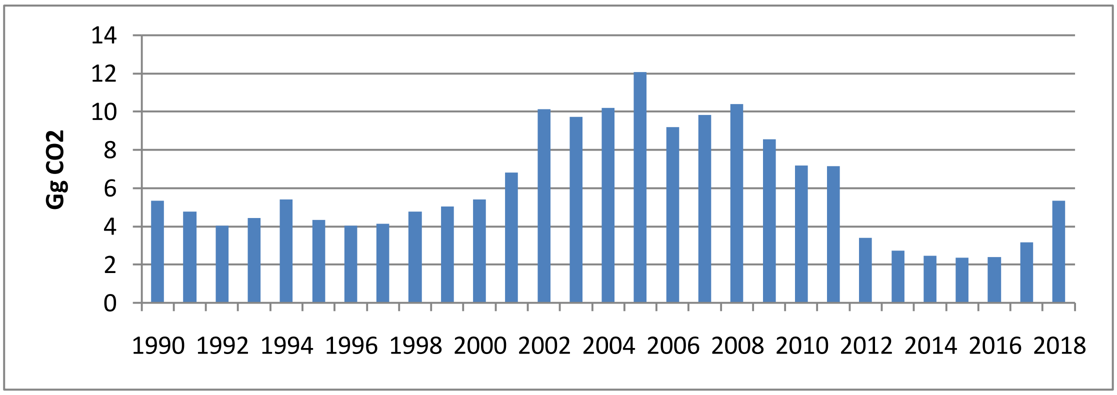

Figure 4.4. CO_2 emissions for Lime production (2.A.2) 1990-2018

4.2.2.1. Methodological issues

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

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

Table 4.8. Slaked lime production (t)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999

Production (t)	7330	6570	5540	6080	7440	5980	5550	5688	6579	6907
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Production (t)	7439	9372	13934	13367	14004	16583	12640	13494	14285	11753
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Production (t)	9890	9829	4659	3746	3366	3244	3277	4369	7333	

4.2.2.2. Uncertainties and time-series consistency

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

4.2.2.3. Category-specific QA/QC and verification

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

4.2.2.4. Category-specific recalculations

No recalculations to be reported.

4.2.2.5. Category-specific planned improvements

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

4.2.3. Glass Production (2.A.3)

The publication 'Industrial Statistics – 2014' (page 159) available on the website of the Statistical Service of Cyprus, in Cyprus presents the manufacture of flat glass, fibre glass and glass articles. However, from the information obtained by the Statistical Service it has been revealed that glass production does not take place in Cyprus; only shaping and processing of imported glass. Therefore glass production is not occurring in Cyprus.

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

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

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

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

Soda ash production and consumption (including sodium carbonate, Na_2CO_3) results in the release of CO_2. According to information received by the customs office[33] soda ash in Cyprus is imported by a betonite quarry, lab supplies companies, swimming pools companies, building materials companies, and cleaning products companies.

The emissions for the source category are presented in Table 4.9 and Figure 4.5. After 2008 there was sharp decrease in activity of the construction industry in Cyprus, which is reflected in the amount of bricks and tiles used (and therefore produced) and the respective emissions. Another reason for the reduction of emissions since 2013 is that one ETS installation and the one non-ETS installation have ceased operation. It is currently not clear whether they will recommence operation or go for closure.

Table 4.9. CO_2 emissions for Other Process Uses of Carbonates (2.A.4) 1990-2018

Gg CO_2	1990	2000	2005	2010	2015	2017	2018
Ceramics	43.8	34.1	60.0	27.4	8.5	12.7	14.6
Soda-ash	0.26	0.56	0.28	0.30	0.13	0.19	0.17
TOTAL	44.08	34.63	60.23	27.74	8.64	12.86	14.74

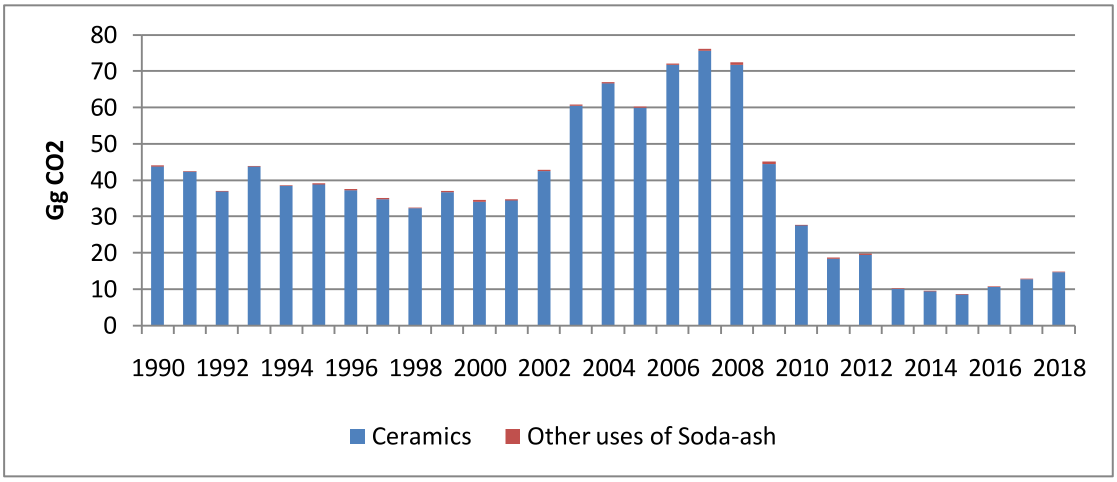

Figure 4.5. CO_2 emissions for Other Process Uses of Carbonates (2.A.4) 1990-2018

4.2.4.1. Ceramics

4.2.4.1.1. Methodological issues

In 2018, there were five ceramics producing installations, which provide information regarding CO_2 emissions in accordance to the EU-ETS legislation. Industrial installations covered by the EU ETS are required to have an approved monitoring plan for monitoring and reporting annual emissions. Every year, operators must submit an emissions report. The data for a given year must be verified by an accredited verifier by 31 March of the following year[34]. The EU ETS Directive was adopted in 2003 and the system was launched in 2005. The cap on allowances for the first trading period was set at national level through National Allocation Plans (NAPs)[35]. For the preparation of the NAP for the first trading period (2005-2007) historical data was collected for relevant installations. For the eight ceramics installations that were operating at the time, data was available from 2001.

Production data was obtained from the installations that operate in Cyprus (Table 4.10). For the period 1990-2015 there were 8 installations in operation, 7 in 2016, 6 in 2017 and 5 in 2018.

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

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

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

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

Information regarding CO_2 emissions is annually submitted from 2005 in accordance to the EU-ETS legislation. Emissions are estimated using tier 3 methodologies. The CO_2 emissions are reported through templates provided by the European Commission for annual emission reports that are based on the Monitoring and Reporting Regulation[36]. The emissions for 2005-2016 are used as submitted by the installations for the EU-ETS (Table 4.10) that are estimated according to EU legislation and are verified by external verifier accredited by the national authorities. The emissions for the period 2001-2004 the data submitted by the installations for the preparation of the National Allocation Plan 2005-2007 was used that is also verified by an external verifier, and approved by the European Commission based on the relevant EU legislation.

For the period 2001-2012, the emissions of the non-ETS installation were estimated using the emission factor of 0.160 tCO_2/t ceramics was used, which is the implied emission factor estimated from the CO_2 process emissions reported by the eight ceramics producing installations for 2003 (highest available). The highest emission factor was chosen, since being a non-ETS installation it does not have to regulate its emissions and therefore does not take any measures to reduce emissions. The emissions were estimated by multiplying the IEF by the non-ETS ceramics production (Table 4.7). The additional, non-ETS installation ceased its operation therefore there are no additional emissions to those reported under the ETS.

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

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

Table 4.10. Ceramics production (Gg)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Total production (Gg)	355.4	343.0	299.7	354.2	311.2	315.3	301.2
ETS production (Gg)							
Non-ETS production (Gg)							
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total production (Gg)	281.7	261.3	297.9	276.3	277.8	332.4	377.9
ETS production (Gg)					271.4	314.5	364.2
Non-ETS production (Gg)					6.3	17.9	13.7
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total production (Gg)	483.9	504.0	491.4	512.4	545.9	356.2	291.5
ETS production (Gg)	470.4	493.2	483.6	500.4	532.9	338.4	282.1
Non-ETS production (Gg)	13.6	10.8	7.8	12.0	13.0	17.8	9.3
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total production (Gg)	223.0	168.0	90.0	83.7	84.5	111.6	152.6
ETS production (Gg)	211.4	161.7	90.0	83.7	84.5	111.6	152.6
Non-ETS production (Gg)	11.5	6.3	0	0	0	0	0
	2018						
Total production (Gg)	151.8						
ETS production (Gg)	151.8						
Non-ETS production (Gg)	0						

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

Table 4.11. CO_2 process emissions of the ETS ceramics installations and estimated annual implied emission factor (2001-2018)

	2001	2002	2003	2004	2005	2006	2007
ETS CO_2 emissions (Gg)	33.5	39.6	58.2	64.6	58.2	70.4	73.7
IEF (Gg CO_2/Gg product)	0.123	0.126	0.160	0.137	0.118	0.146	0.147
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
ETS CO_2 emissions (Gg)	69.7	41.6	25.9	16.5	18.5	10.0	9.4
IEF (Gg CO_2/Gg product)	0.131	0.123	0.092	0.078	0.114	0.111	0.112
	2015	**2016**	**2017**	**2018**			
ETS CO_2 emissions (Gg)	8.5	10.6	12.7	14.6			
IEF (Gg CO_2/Gg product)	0.101	0.095	0.083	0.096			

4.2.4.1.2. Uncertainties and time-series consistency

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

4.2.4.1.3. Category-specific QA/QC and verification

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

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

4.2.4.1.4. Category-specific recalculations

No recalculations to be reported.

4.2.4.1.5. Category-specific planned improvements

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

4.2.4.2. Other uses of soda ash

4.2.4.2.1. Methodological issues

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

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

Activity data (Table 4.12) was obtained from Statistical Service from imports' statistics. It was assumed that all imported quantities have been consumed in the year the import has taken place. The imports of soda ash suffered a sharp increase for 2010 (1438 t), 51% above the 2009 value (711 t) and for 2015 the imports are the lowest of the entire time series (326 t), which also affected the emissions. According to information obtained from the Customs Department, the main consumers of soda ash in Cyprus (90%) are engaged with the production of building materials. Since 2010 there was a large decline in the building industry, and this is reflected in the consumption of building products and subsequently imports and use of soda ash.

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Imports of Soda ash (t)	615	499	383	502	504	529	1063	789	808	832
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Imports of Soda ash (t)	1345	823	1003	813	837	664	1179	1132	1479	1438
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Imports of Soda ash (t)	711	771	560	353	401	322	447	449	402	

4.2.4.2.2. Uncertainties and time-series consistency

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

4.2.4.2.3. Category-specific QA/QC and verification

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

4.2.4.2.4. Category-specific recalculations

No recalculations to be reported.

4.2.4.2.5. Category-specific planned improvements

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

4.3. Chemical Industry (2.B)

4.3.1. Carbide production (2.B.5)

According to the imports statistics, there is import of carbides of calcium to Cyprus. According to information received by the customs office[37] carbides products are imported by a company importing raw materials for mattresses. Therefore, carbides of calcium are not used for the production of acetylene.

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

4.4.1. Category description

According to the 2006 Guidelines, "Non-energy products" are primary or secondary fossil fuels which are used directly for their physical or diluent properties. Examples are: lubricants, paraffin waxes, bitumen, and white spirits. In Cyprus there are imports and consumption of lubricants, paraffin waxes and bitumen. Lubricants in Cyprus are consumed by transport, while according to the information obtained from the Customs[38], paraffin wax is imported by dental and lab suppliers, importers of agricultural and beauty products and candle makers. The total CO_2 emissions from non-energy products

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

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

from fuels and solvent use are presented in Table 4.13 and Figure 4.6.

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

Gg CO_2	1990	2000	2005	2010	2015	2017	2018
D. Non-energy products from fuels and solvent use	**8.63**	**27.73**	**43.70**	**40.61**	**22.39**	**29.55**	**30.12**
1. Lubricant use	1.12	4.13	5.90	6.49	4.72	4.61	4.52
2. Paraffin wax use	0.06	0.07	0.00	0.03	0.08	0.06	0.06
3. Other	7.45	23.53	37.80	34.09	17.59	24.88	25.54
Dry cleaning	0.44	0.44	0.42	0.13	0.12	0.12	0.06
Coating applications	3.83	3.52	8.39	7.70	3.62	4.47	4.78
Chemical products	0.09	0.11	0.13	0.07	0.02	0.02	0.02
Asphalt roofing	0.10	0.11	0.09	0.16	0.03	0.03	0.03
Domestic solvent use	1.55	1.84	1.96	2.22	2.24	2.28	2.31
Road paving with asphalt	0.01	0.02	0.01	0.02	0.00	0.00	0.00
Printing	0.44	0.74	0.76	0.54	0.56	0.58	0.50
Other	NO	15.08	24.39	21.69	9.86	15.69	16.35
Urea-based catalysts	1.00	1.67	1.65	1.56	1.15	1.41	1.47
CO_2	8.63	27.73	43.70	40.61	22.39	29.55	30.12
Total	**8.63**	**27.73**	**43.70**	**40.61**	**22.39**	**29.55**	**30.12**

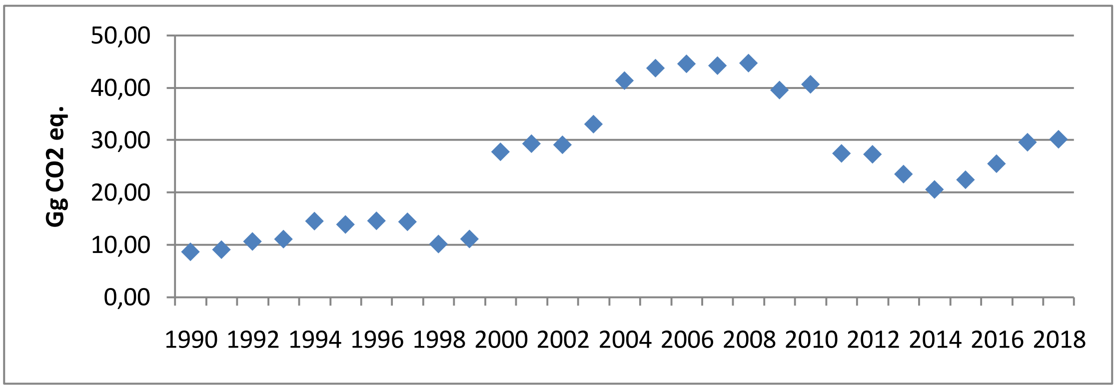

Figure 4.6. Emissions from non-energy Products from Fuels and Solvent Use (2D) 1990-2018

4.4.2. Methodological issues

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

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

4.4.2.1. Lubricant Use (2D1)

Lubricant consumption is obtained in kt from Energy balance by the National Statistical Service (Table 4.14). Consumption data was not available from the energy balance for the years 1990-1992. The activity data for the years after 1993 shows a trend only for the period 1993-1996 (Figure 4.7). The

1993-1996 trend was used to extrapolate backwards to obtain activity data for 1990-1992.

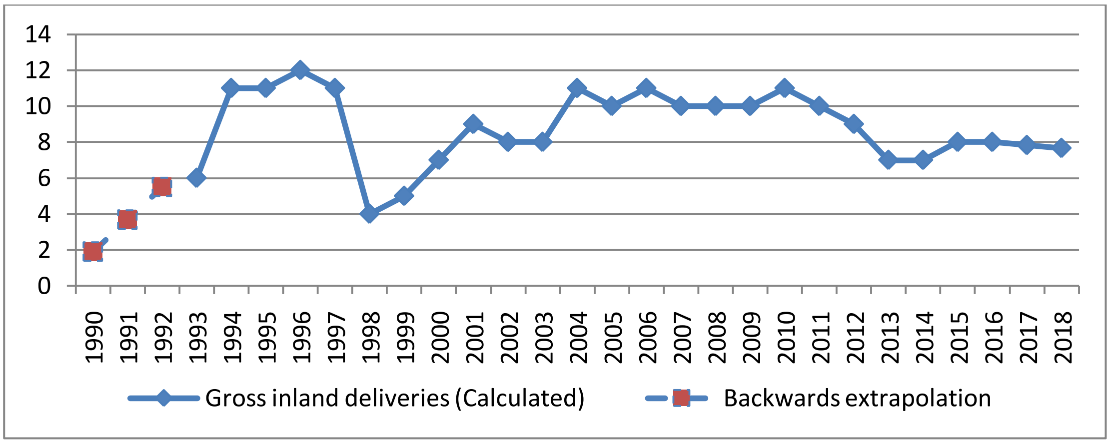

Figure 4.7. Lubricant consumption 1990-2018 (kt)

The calculation of CO_2 emissions from Lubricants was estimated using Tier1 methodology suggested by the IPCC Guidelines (equation 5.2, pg. 5.7, volume 3).

$$CO_2\ Emissions = LC \bullet CCLubricant \bullet ODULubricant \bullet 44/12$$

Lubricant consumption is converted to TJ using 40.2 TJ/kt, i.e. the default proposed by the 2006 guidelines, (Table 1.2, pg.1.18, vol.2). Carbon content (*CCLubricant*) is assumed to be 20 while ODU factor is assumed to be 0.2, as proposed by the IPCC 2006 guidelines (table 1.3, pg.1.21, volume 2; table 5.2, pg. 5.9, volume 3 respectively).

Table 4.14. Lubricant consumption in Cyprus (kt)

	1990	1991	1992	1993	1994	1995	1996
Lubricant consumption (kt)	2	4	6	6	11	11	12
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Lubricant consumption (kt)	11	4	5	7	9	8	8
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Lubricant consumption (kt)	11	10	11	10	10	10	11
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Lubricant consumption (kt)	10	9	7	7	8	8	7.829
	2018						
Lubricant consumption (kt)	7.633						

4.4.2.2. Paraffin Wax Use (2D2)

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

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

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

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

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

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Imports of paraffin wax (kt)	0.108	0.179	0.252	0.354	0.362	0.134	0.159
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Imports of paraffin wax (kt)	0.117	0.147	0.179	0.111	0.178	0.155	0.185
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Imports of paraffin wax (kt)	0.150	0.005	0.028	0.095	0.060	0.099	0.049
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Imports of paraffin wax (kt)	0.035	0.071	0.074	0.099	0.131	0.320	0.100
	2018						
Imports of paraffin wax (kt)	0.105						

4.4.2.3. Other (2D3)

<u>Solvent Use</u>

Carbon dioxide emissions from other product use are calculated from NMVOC emissions (Table 4.16), assuming that the carbon content of NMVOC (C) is 60%[39] (carbon content fractions for NMVOCs from road paving with asphalt is 50% and from asphalt roofing is 80%[40]). NMVOC emissions are obtained from the Department of Labour Inspection that is responsible for the preparation of the air pollutants inventory for Directive 2001/81/EC. The estimation of NMVOC emissions is based on the CONINAIR methodology. Therefore the equation applied for the estimation of the CO_2 emissions is the following:

$$CO_2 \text{ emissions (Gg)} = C * \text{NMVOC emissions (Gg)} * 44/12$$

Table 4.16. NMVOCs emissions used for the estimation of CO_2 emissions from Solvent use

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Dry cleaning	0.2002	0.2003	0.2003	0.2004	0.2005	0.2006	0.2007
Coating applications	1.7387	1.4241	1.5170	1.5202	1.7083	1.4102	1.4097
Chemical products	0.0388	0.0388	0.0388	0.0413	0.0442	0.0471	0.0498
Asphalt roofing	0.0325	0.0325	0.0325	0.0325	0.0325	0.0325	0.0325
Domestic solvent use	0.7045	0.7237	0.7430	0.7595	0.7745	0.7876	0.7996
Road paving with	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075

[39] 2006 IPCC Guidelines volume 3, p. 5.17, the default fossil carbon content fraction of NMVOC is 60 per cent by mass

[40] 2006 IPCC Guidelines volume 3, p. 5.16.

asphalt							
Printing	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Other	0	0	0	0	0	0	0

	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Dry cleaning	0.2008	0.2009	0.2012	0.2021	0.2005	0.2004	0.2001
Coating applications	1.5604	1.4476	1.4578	1.6020	1.4785	2.2579	2.8364
Chemical products	0.0474	0.0490	0.0512	0.0500	0.0597	0.0636	0.0625
Asphalt roofing	0.0325	0.0325	0.0325	0.0366	0.0298	0.0324	0.0308
Domestic solvent use	0.8102	0.8195	0.8286	0.8370	0.8466	0.8564	0.8675
Road paving with asphalt	0.0075	0.0075	0.0075	0.0084	0.0069	0.0075	0.0071
Printing	0.2000	0.2000	0.3273	0.3355	0.3801	0.3075	0.2884
Other	0	0	0	6.85644	7.0690	6.5514	7.7469

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Dry cleaning	0.1998	0.1930	0.1100	0.1110	0.0789	0.0602	0.0605
Coating applications	3.5522	3.8150	4.0272	4.3205	3.3507	3.1421	3.4997
Chemical products	0.0674	0.0574	0.0600	0.0580	0.0254	0.0278	0.0302
Asphalt roofing	0.0368	0.0293	0.0265	0.0246	0.0233	0.0396	0.0529
Domestic solvent use	0.8796	0.8928	0.9095	0.9317	0.9563	0.9829	1.0078
Road paving with asphalt	0.0085	0.0068	0.0061	0.0057	0.0054	0.0091	0.0122
Printing	0.3399	0.3446	0.3628	0.3195	0.4469	0.3260	0.2464
Other	9.9306	11.0846	11.0721	10.8674	11.9954	9.9608	9.8578

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Dry cleaning	0.0600	0.0539	0.0265	0.0262	0.0527	0.0261	0.0526
Coating applications	1.5792	1.6311	1.4271	1.2511	1.6473	1.7419	2.0322
Chemical products	0.0137	0.0145	0.0120	0.0099	0.0111	0.0111	0.0111
Asphalt roofing	0.0516	0.0403	0.0213	0.0098	0.0089	0.0111	0.0086
Domestic solvent use	1.0344	1.0391	1.0296	1.0164	1.0180	1.0258	1.0370
Road paving with asphalt	0.0119	0.0093	0.0049	0.0023	0.0020	0.0026	0.0020
Printing	0.3347	0.2658	0.2072	0.2618	0.2526	0.2651	0.2655
Other	5.9957	6.2986	5.5350	4.3654	4.4814	5.6651	7.2540

	2018						
Dry cleaning	0.0262						
Coating	2.1742						

applications							
Chemical products	0.0107						
Asphalt roofing	0.0111						
Domestic solvent use	1.0511						
Road paving with asphalt	0.0026						
Printing	0.2273						
Other	7.4339						

Urea-based catalysts

The methodology applied is the recommended by the 2006 IPCC guidelines guidelines (pg. 3.12, volume 2). More specifically equation 3.2.2 (emission=activity*12/60*purity*44/12) is applied. No national data is available, therefore (a) Activity data is estimated using the recommendation given in the guidelines, i.e. 1-3% of diesel consumption by vehicle; 2% is used.(b) Purity is assumed 32.5%, which is also recommended by the guidelines, i.e. 1-3% of diesel consumption by vehicle; 2% is used. The diesel consumption used is the same as presented in Table 3.17. The resulting activity data used is presented in Table 4.17.

Table 4.17. Activity data used for estimation of emissions from Urea-based catalysts

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Activity (kt)	4.19	4.03	4.90	5.08	5.20	5.68	5.94	6.26	6.66	6.78
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Activity (kt)	6.99	7.09	6.81	7.01	7.07	6.91	6.45	6.73	6.58	6.39
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Activity (kt)	6.56	6.24	5.43	4.61	4.47	4.81	5.46	5.90	6.16	

4.4.3. Uncertainties and time-series consistency

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

4.4.4. Category-specific QA/QC and verification

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

4.4.5. Category-specific recalculations

CO_2 emissions have been recalculated for the following:

- For “asphalt roofing”, due to the change of carbon content fractions for NMVOCs (C) from 60% to 80% according to the 2006 IPCC Guideline, Vol. 3, p. 5.16
- For “road paving” with asphalt, due to the change of carbon content fractions for NMVOCs (C) from 60% to 50% according to the 2006 IPCC Guideline, Vol. 3, p. 5.16
- For “other”, due to the recalculations of the NMVOC emission for the whole period
- For Urea-based catalysts, CO_2 emissions have been recalculated for the year 2017, due to revision of diesel consumption for road transport for the specific year. Emissions decreased for the particular year from 1.4237 to 1.4065 Gg CO_2, which corresponds to a reduction of emissions by

1.2%.

The impact of recalculations on emissions is shown in Table 4.18 and Figure 4.8.

Table 4.18. CO_2 emissions from Solvent use recalculations

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
NIR2019 emissions (Gg CO2)	16.63	15.98	16.23	16.28	16.73	16.11	16.15
NIR2020 emissions (Gg CO2)	6.45	5.80	6.05	6.10	6.55	5.93	5.96
change	-61.2%	-63.7%	-62.7%	-62.6%	-60.9%	-63.2%	-63.1%
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NIR2019 emissions (Gg CO2)	16.50	16.27	17.99	19.75	20.28	20.31	23.55
NIR2020 emissions (Gg CO2)	6.31	6.09	6.41	21.87	22.18	22.63	26.51
change	-61.7%	-62.6%	-64.3%	10.7%	9.3%	11.4%	12.6%
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NIR2019 emissions (Gg CO2)	29.87	30.39	29.40	29.61	30.68	26.80	30.65
NIR2020 emissions (Gg CO2)	33.06	36.15	36.48	36.62	37.16	32.03	32.52
change	10.7%	19.0%	24.1%	23.7%	21.1%	19.5%	6.1%
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NIR2019 emissions (Gg CO2)	18.14	19.29	18.58	15.87	16.96	17.15	17.88
NIR2020 emissions (Gg CO2)	20.01	20.60	18.19	15.28	16.45	19.25	23.47
change	10.3%	6.8%	-2.1%	-3.7%	-3.0%	12.2%	31.3%

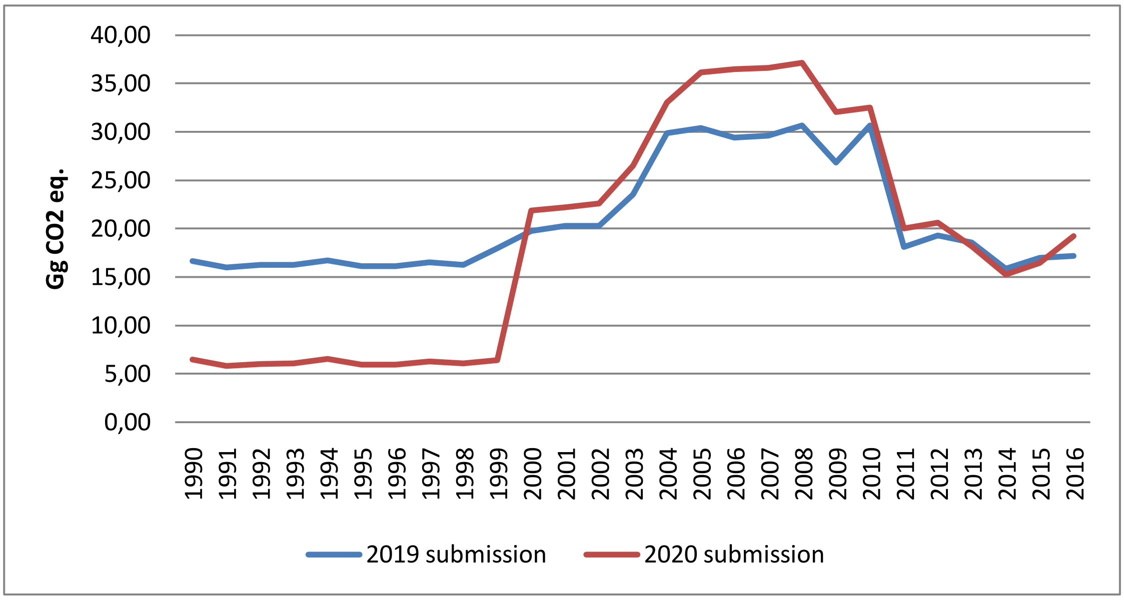

Figure 4.8. CO_2 emissions from Solvent use recalculations

4.4.6. Category-specific planned improvements

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

4.5. Electronic Industry Emissions (2.E)

This source category is not occurring in Cyprus.

4.6. Product uses as substitutes for ozone depleting substances (2.F)

Hydrofluorocarbons (HFCs) and, to a very limited extent, perfluorocarbons (PFCs), are serving as alternatives to ozone depleting substances (ODS) being phased out under the Montreal Protocol. Current and expected application areas of HFCs and PFCs include: refrigeration and air conditioning, fire suppression and explosion protection, aerosols, solvent cleaning, foam blowing; and other applications. HFCs and PFCs are not controlled by the Montreal Protocol because they do not contribute to depletion of the stratospheric ozone layer. HFCs are chemicals containing only hydrogen, carbon, and fluorine. HFCs and PFCs have high global warming potentials (GWPs) and, in the case of PFCs, long atmospheric residence times.

4.6.1. Category description

Emissions have been estimated for the following source categories of 2.F: 2F1. Refrigeration and air conditioning, 2F2. Foam Blowing Agents, 2F3. Fire Protection and 2F4. Aerosols. Due to data unavailability, emissions have been estimated using a country specific methodology for source categories 2F2, 2F3 and 2F4, while for source category 2F1 the calculation of emissions is based on Tier 2a methodology (see next section). According to the available information, manufacturing of refrigeration and air-conditioning equipment does not occur in Cyprus therefore the activity is reported NO. Moreover, Solvents (2F5) and Other Applications (2F6) are also not occurring in Cyprus. The total emissions by gas and source for the period 1990-2018 are presented in Table 4.18 and Figure 4.9.

Table 4.18. Emissions from consumption of halocarbons 1990-2018

	1990	2000	2005	2010	2015	2017	2018
F. Product uses as substitutes for ODS	**79.60**	**169.12**	**223.91**	**275.84**	**269.72**	**287.70**	**297.14**
1. Refrigeration and air conditioning	79.60	165.10	218.48	266.78	260.74	278.65	288.09
2. Foam blowing agents	NE,NO	0.09	0.54	1.03	1.27	1.28	1.28
3. Fire protection	NE,NO	0.30	1.24	2.93	4.24	4.27	4.27
4. Aerosols	NO	3.63	3.65	5.10	3.47	3.50	3.50
5. Solvents	NO	NO	NO	NO	NO	NO	NO
6. Other applications	NO	NO	NO	NO	NO	NO	NO
HFC-32	12.82	21.41	27.50	31.35	30.04	31.76	32.76
HFC-125	14.61	24.67	31.69	36.32	34.38	36.45	37.60
HFC-134a	8.17	37.08	51.12	71.07	73.46	78.97	81.81
HFC-143a	1.82	3.35	4.31	5.14	4.43	4.8	4.96
HFC-227ea	NO	0.09	0.39	0.91	1.32	1.33	1.33
Total	**79.60**	**169.12**	**223.91**	**275.84**	**269.72**	**287.70**	**297.14**

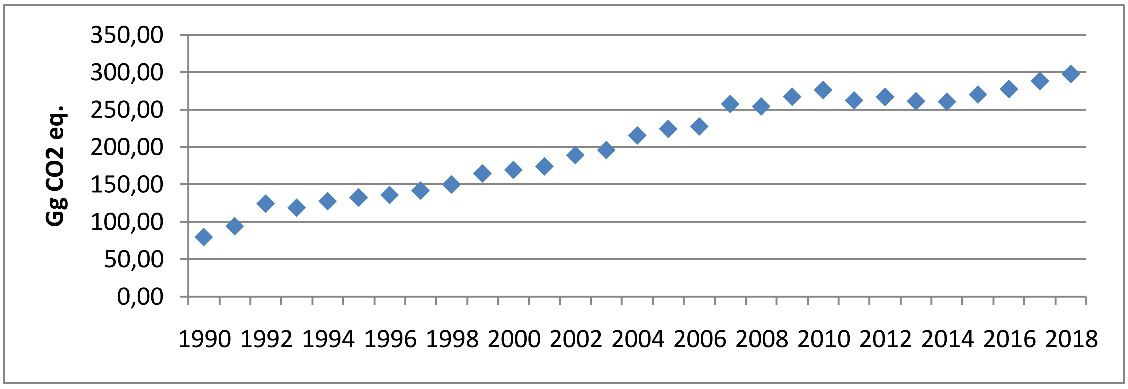

Figure 4.9. Emissions from consumption of halocarbons 1990-2018

4.6.2. Methodological issues

Due to insufficient information for a long period of time, it was decided to use a country specific methodology for the estimation of the emissions from the sources 2F2, 2F3 and 2F4.

2F1

The calculation of GHG emissions from Refrigeration and Air Condition (RAC) systems is based on Tier 2a methodology suggested by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). The Tier 2a methodology:

a) Considers the phase out or the phase down of CFCs and HCFCs depending on the Montreal Protocol schedule and possible national or regional regulations, in order to establish the refrigerant choice for all applications;
b) Defines the typical refrigerant charge and the equipment lifetime per sub-application;
c) Defines the emission factors for refrigerant charge, during operation, at servicing and at end-of-life.

RAC systems have been classified into six sub-application categories, listed below:

i. Domestic refrigeration,
ii. Commercial refrigeration including different types of equipment, from vending machines to centralised refrigeration systems in supermarkets,

iii. Industrial refrigeration including food processing and cold storage,
iv. Transport refrigeration including equipment and systems used in refrigerated trucks, containers, reefers, and wagons,
v. Stationary air conditioning including air-to-air systems, heat pumps, and chillers for building and residential applications,
vi. Mobile air-conditioning systems used in passenger cars, truck cabins, buses, and trains.

Refrigerant emissions at a year **t** from each of the six sub-applications of RAC systems were calculated separately. These emissions result from:

$E_{containers,t}$ = emissions related to the management of refrigerant containers
$E_{charge,t}$ = emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged
$E_{lifetime,t}$ = annual emissions from the banks of refrigerants associated with the six sub-applications during operation (fugitive emissions and ruptures) and servicing
$E_{end\text{-}of\text{-}life,t}$ = emissions at system disposal

Equations for estimating average emission rates for the above-mentioned sectors are outlined below and were calculated on a refrigerant-by-refrigerant basis for all equipment.

Refrigerant management of containers

$$E_{containers,t} = RM_t * \frac{c}{100}$$

Where:
$E_{containers,\ t}$ = emissions from all HFC containers in year t, kg
RM_t = HFC market for new equipment and servicing of all refrigeration application in year t, kg
c = emission factor of HFC container management of the current refrigerant market, percent

Refrigerant charge emissions of new equipment

$$E_{charge,t} = M_t * \frac{k}{100}$$

Where:
$E_{charge,\ t}$ = emissions during system manufacture/assembly in year t, kg
M_t = amount of HFC charged into new equipment in year t (per sub-application), kg
k = emission factor of assembly losses of the HFC charged into new equipment (per sub-application), percent

Emissions during lifetime (operation and servicing)

$$E_{operation,2017} = B_{2017} * \frac{x}{100}$$

Where:
$E_{lifetime,\ t}$ = amount of HFC emitted during system operation in year t, kg
B_t = amount of HFC banked in existing systems in year t (per sub-application), kg
x = annual emission rate (i.e., emission factor) of HFC of each sub-application bank during operation, accounting for average annual leakage and average annual emissions during servicing, percent

Emissions at end-of-life

$$E_{end-of-life,t} = M_{t-d} * \frac{p}{100} * (1 - \frac{n_{rec,d}}{100})$$

Where:
$E_{end\text{-}of\text{-}life,\ t}$ = amount of HFC emitted at system disposal in year t, kg
$M_{t\text{-}d}$ = amount of HFC initially charged into new systems installed in year (t-d), kg

p = residual charge of HFC in equipment being disposed of expressed in percentage of full charge, percent
$\eta_{rec,d}$ = recovery efficiency at disposal, which is the ratio of recovered HFC referred to the HFC contained in the system, percent

The emission factors used are predominately the defaults proposed by the IPCC guidelines. These default values reflect the current state of knowledge about the industry and are provided as ranges rather than point estimates.

Other data, assumptions and emission parameters used in preparation of RAC systems emissions inventory for each sub-category are listed below.

Mobile Air Conditioning (MAC) systems

Activity Data / Emission Factors	**Source**
Registration of vehicles at the end of each year	Statistical Service of Cyprus
Container Heels (c) • Heels from service containers are recovered, therefore $E_{containers,t} = 0$	IPCC guidelines
Nominal charge of each MAC (m_t) • Average value of m=0.7 kg, which is typical of small to medium-sized passenger cars	IPCC guidelines
Assembly Losses (k) • MAC systems are imported pre-charged, therefore $E_{charge,\ t}$ = 0	IPCC guidelines

Annual Emission Rate (x)
• This factor accounts for both leaks from equipment as well as any emissions during service
  ○ Annual Emissions Rate from leaks = 10%
  ○ Annual Emission Rate during servicing = 2%
  ○ x = 12%
	IPCC guidelines

Residual Charge in MACs Disposed (p) • p = 25%	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 25%	IPCC guidelines
Other assumptions	
• All new vehicles sold from January 2017 uses R1234yf or R774 as MAC refrigerant (MACs Directive 2006/40/EC[41]) • Introductory year of R134a as MAC refrigerant was 1992 • Vehicles with MAC systems for year 1996-2001 was 60%[42]. The same percentage (60%) was used for years 1992-1995. For the following years, linear interpolation was used. • MACs are serviced every 5 years	

Domestic Refrigeration

Activity Data / Emission Factors	**Source**
Number of households	Statistical Service of Cyprus
Number of refrigerators per households • 1.17 refrigerators per household	Demetriou, D., Polatides, H., Haralambopoulos, D, (2010).

[41] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006L0040

[42] Establishing the Leakage Rates of MACs, 2013, DG Environment (EC)

	Integrated Energy Planning for the Residential Sector: The case-study of Cyprus. Energy Sources, Part B: Economics, Planning and Policy.
Number of freezers per households • 0.30 freezers per household	Demetriou, D., Polatides, H., Haralambopoulos, D, (2010)
Container Heels (c) • Generally refrigerators and freezers are not serviced during their lifetime, therefore $E_{containers,t} = 0$	IPCC guidelines
Nominal charge of each refrigerator and freezer (m_t) • m=0.3 kg	IPCC guidelines
Assembly Losses (k) • Refrigerators and freezers are imported pre-charged, therefore $E_{charge,\ t} = 0$	IPCC guidelines
Lifetime (d) • d = 15 years	IPCC guidelines
Annual Emission Rate (x) • x = 0.3%	IPCC guidelines
Residual Charge in Refrigerators and Freezers Disposed (p) • p = 40%	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 35%	IPCC guidelines
Other assumptions	
• Refrigerants used for domestic refrigerators and freezers (with bold the refrigerants used for the calculation of the emissions): **R134a (30%)**, **R404A (40%)**, R600a (30%)	

Transport Refrigeration (TR)

Activity Data / Emission Factors	**Source**
Number of TRs sold each year	Department of Road Transport, Cyprus
Container Heels (c) • Heels from service containers are recovered, therefore $E_{containers,t} = 0$	IPCC guidelines
Nominal charge of each TR (m_t) • m=4.5 kg	IPCC guidelines
Assembly Losses (k) • TR systems are imported pre-charged, therefore $E_{charge,\ t} = 0$	IPCC guidelines
Lifetime (d) • d = 15 years	IPCC guidelines
Annual Emission Rate (x) • This factor accounts for both leaks from equipment as well as any emissions during service o Annual Emissions Rate from leaks = 15% o Annual Emission Rate during servicing = 10% • x = 25%	IPCC guidelines
Residual Charge in TRs Disposed (p) • p = 75%	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 25%	IPCC guidelines
Other assumptions	
• Refrigerants used for TRs: R134a (30%), R404A (70%) • TRs are serviced each year	

Industrial Refrigeration (IR)

Activity Data / Emission Factors	Source
Bank in Existing Equipment (B_t) for the year 2018 (using national GDP) • 9382.22 kg (R404A) • 354.85 kg (R134a) • 374.62 kg (R507A)	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy
Bank in Existing Equipment (B_t) for the year 2017 • 9016.15 kg (R404A) • 341.00 kg (R134a) • 374.62 kg (R507A)	Industrial and Commercial RAC Inventory 2017, Cyprus
Bank in Existing Equipment (B_t) for previous years • The national GDP was used to determine the banks for previous years in order to complete the time-series	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy
Container Heels (c) • Heels from service containers are recovered, therefore $E_{containers,t} = 0$	IPCC guidelines
Nominal charge of each IR (m_t) • m=100 kg	IPCC guidelines
Assembly Losses (k) • IR systems are imported pre-charged, therefore $E_{charge,\ t} = 0$	IPCC guidelines
Lifetime (d) • d = 20 years	IPCC guidelines

Annual Emission Rate (x)
• This factor accounts for both leaks from equipment as well as any emissions during service
  o Annual Emissions Rate from leaks = 10%
  o Annual Emission Rate during servicing =5%
• x = 15%
	IPCC guidelines

Residual Charge in IRs Disposed (p) • p = 75%	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 35%	IPCC guidelines
Other assumptions	
• Refrigerants used for IRs (with bold the refrigerants used for the calculation of the emissions): **R404A (82.7%)**, R22 (5%), **R134a (3.1%)**, **R507A (3.3%)**, R434A (3.8%) [Industrial and Commercial RAC Inventory 2017, Cyprus] • IRs are serviced each year	

Commercial Refrigeration (CR)

Activity Data / Emission Factors	Source
Bank in Existing Equipment (B_t) for the year 2018 (using national GDP) • 39399.00 kg for Stand-alone Commercial Applications (R404A) • 9849.75 kg for Medium & Large Commercial Refrigeration (R404A) • 2966.92 kg for Stand-alone Commercial Applications (R134A) • 741.73 kg for Medium & Large Commercial Refrigeration (R134A) • 822.40 kg for Stand-alone Commercial Applications (R410A)	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy

• 205.60 kg for Medium & Large Commercial Refrigeration (R410A) • 1195.11 kg for Stand-alone Commercial Applications (R407C) • 298.78 kg for Medium & Large Commercial Refrigeration (R407C) • 1167.56 kg for Stand-alone Commercial Applications (R507A) • 291.89 kg for Medium & Large Commercial Refrigeration (R507A)	
Bank in Existing Equipment (B_t) for the year 2017 • 37861.74 kg for Stand-alone Commercial Applications (R404A) • 9645.43 kg for Medium & Large Commercial Refrigeration (R404A) • 2851.16 kg for Stand-alone Commercial Applications (R134A) • 712.79 kg for Medium & Large Commercial Refrigeration (R134A) • 790.31 kg for Stand-alone Commercial Applications (R410A) • 197.58 kg for Medium & Large Commercial Refrigeration (R410A) • 1148.48 kg for Stand-alone Commercial Applications (R407C) • 287.12 kg for Medium & Large Commercial Refrigeration (R407C) • 1122.01 kg for Stand-alone Commercial Applications (R507A) • 280.50 kg for Medium & Large Commercial Refrigeration (R507A)	Industrial and Commercial RAC Inventory 2017, Cyprus
Bank in Existing Equipment (B_t) for previous years • The national GDP was used to determine the banks for previous years in order to complete the time-series	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy
Container Heels (c) • Heels from service containers are recovered, therefore $E_{containers,t} = 0$	IPCC guidelines
Nominal charge of each CR (m_t) • m=5 kg for Stand-alone Commercial Applications • m= 100 kg for Medium & Large Commercial Refrigeration	IPCC guidelines
Assembly Losses (k) • Stand-alone Commercial Applications systems are imported pre-charged, therefore $E_{charge,\ t} = 0$ • Medium & Large Commercial Refrigeration systems are charged on-site o Assembly Losses = 1.5%	IPCC guidelines
Lifetime (d) • d = 12 years	IPCC guidelines

Annual Emission Rate (x)
• This factor accounts for both leaks from equipment as well as any emissions during service
• Stand-alone Commercial Applications
  o Annual Emissions Rate from leaks = 8%
  o Annual Emission Rate during servicing =2%
  o x = 10%
• Medium & Large Commercial Refrigeration
	IPCC guidelines

○ Annual Emissions Rate from leaks = 15% ○ Annual Emission Rate during servicing =5% ○ x = 20%	
Residual Charge in CRs Disposed (p) • p = 40% for Stand-alone Commercial Applications • p = 75% for Medium & Large Commercial Refrigeration	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 35% for Stand-alone Commercial Applications • n_{rec} = 35% for Medium & Large Commercial Refrigeration	IPCC guidelines
Other assumptions	
• Refrigerants used for IRs (with bold the refrigerants used for the calculation of the emissions): **R404A (78.9%)**, **R134A (5.9%)**, R22 (4.2%), **R410A (1.7%)**, **R407C (2.4%)**, **R507A (2.3%)** [Industrial and Commercial RAC Inventory 2017, Cyprus]Stand-alone Commercial Applications accounts approximate 80% of the total CR systems [Industrial and Commercial RAC Inventory 2017, Cyprus] • Medium & Large Commercial Refrigeration accounts approximate 20% of the total CR systems [Industrial and Commercial RAC Inventory 2017, Cyprus] • Stand-alone Commercial Applications systems are serviced every 5 years • Medium & Large Commercial Refrigeration systems are serviced each year	

Stationary Air Conditioning systems

Residential A/C	
Activity Data / Emission Factors	**Source**
Number of households	Statistical Service of Cyprus
Percentage of households having split A/C units • 87%	Demetriou, D., Polatides, H., Haralambopoulos, D, (2010). Integrated Energy Planning for the Residential Sector: The case-study of Cyprus. Energy Sources, Part B: Economics, Planning and Policy.
Number of A/C units per households • 2.65 A/C units per household	Demetriou, D., Polatides, H., Haralambopoulos, D, (2010).
Container Heels (c) • Heels from service containers are recovered, therefore $E_{containers,t}$ = 0	IPCC guidelines
Nominal charge of each Residential A/C unit (m_t) • m=3 kg	IPCC guidelines
Assembly Losses (k) • A/C units are imported pre-charged, therefore $E_{charge, t}$ = 0	IPCC guidelines
Lifetime (d) • d = 15 years	IPCC guidelines
• This factor accounts for both leaks from equipment as well as any emissions during service ○ Annual Emissions Rate from leaks = 5% ○ Annual Emission Rate during servicing =2% • x = 7%	IPCC guidelines
Residual Charge in Residential A/C units Disposed (p) • p = 40%	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 40%	IPCC guidelines
Other assumptions	
• Refrigerants used for Residential A/C units: R410A (45%), R407C (30%), R22 (25%) [Based on results from Industrial and Commercial RAC Inventory 2017, Cyprus] • Residential A/C units are serviced every 5 years	

Commercial A/C, including heat pumps	
Activity Data / Emission Factors	**Source**
Bank in Existing Equipment (B_t) for the year 2018 (using national GDP) • 30971.28 kg (R410A) • 22812.75 kg (R407C)	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy
Bank in Existing Equipment (B_t) for the year 2017 • 29762.85 kg (R410A) • 21922.65 kg (R407C)	Industrial and Commercial RAC Inventory 2017, Cyprus
Bank in Existing Equipment (B_t) for previous years • The national GDP was used to determine the banks for previous years in order to complete the time-series	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy
Container Heels (c) • Heels from service containers are recovered, therefore $E_{containers,t} = 0$	IPCC guidelines
Nominal charge of each Commercial A/C unit (m_t) • m=3 kg	IPCC guidelines
Assembly Losses (k) • A/C units are imported pre-charged, therefore $E_{charge,\ t} = 0$	IPCC guidelines
Lifetime (d) • d = 15 years	IPCC guidelines

• This factor accounts for both leaks from equipment as well as any emissions during service
  o Annual Emissions Rate from leaks = 5%
  o Annual Emission Rate during servicing =2%
• x = 7%
	IPCC guidelines

Residual Charge in Commercial A/C units Disposed (p) • p = 40%	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 40%	IPCC guidelines
Other assumptions	
• Refrigerants used for Commercial A/C units: R410A (45%), R407C (30%), R22 (25%) [Industrial and Commercial RAC Inventory 2017, Cyprus] • Commercial A/C units are serviced every 5 years	
Chillers	
Activity Data / Emission Factors	**Source**
Bank in Existing Equipment (B_t) for the year 2018 (using national GDP) • 81492.95 kg (R410A) • 29272.78 kg (R407C) • 30242.61 kg (R134A)	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy
Bank in Existing Equipment (B_t) for the year 2017 • 78313.28 kg (R410A) • 28130.62 kg (R407C) • 29062.62 kg (R134A)	Industrial and Commercial RAC Inventory 2017, Cyprus
Bank in Existing Equipment (B_t) for previous years • The national GDP was used to determine the banks for previous years in order to complete the time-series	Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy
Container Heels (c) • Heels from service containers are recovered, therefore $E_{containers,t} = 0$	IPCC guidelines

Nominal charge of each chiller system (m_t) • m=50 kg	IPCC guidelines
Assembly Losses (k) • Chiller systems are imported pre-charged, therefore $E_{charge,\ t}$ = 0	IPCC guidelines
Lifetime (d) • d = 20 years	IPCC guidelines
• This factor accounts for both leaks from equipment as well as any emissions during service o Annual Emissions Rate from leaks = 5% o Annual Emission Rate during servicing =5% • x = 10%	IPCC guidelines
Residual Charge in Chiller systems Disposed (p) • p = 90%	IPCC guidelines
Recovery Efficiency (n_{rec}) [%] • n_{rec} = 50%	IPCC guidelines
Other assumptions	
• Refrigerants used for Chiller systems (with bold the refrigerants used for the calculation of the emissions): **R410A (47.5%)**, **R407C (17%)**, **R134a (17.5%)**, R22 (15.5%) [Industrial and Commercial RAC Inventory 2017, Cyprus] • Chiller systems are serviced every year	

The main deficiency identified in preparation of inventory is associated with the lack of reporting obligation for importers of bulk F-gases and F-gas equipment in the early years to establish the time-series for the categories of "Industrial Refrigeration", "Commercial Refrigeration" and "Stationary A/C systems". Data for these categories were established for each year going back to 1950 through a correlation to the annual national GDP.

2F2, 2F3 and 2F4

The methodology applied consisted of the following steps:

(a) The stock emissions from the four sources (2F2, 2F3 and 2F4) for Greece, Italy, Malta and Spain were obtained from the NIR2017 submissions to the UNFCCC for the years 1990-2015 (CRF – Table 2(II).B-H). The four countries were selected due to their similarity in social and economic conditions to Cyprus. Any fluorinated ozone-depleting substances (ODSs) not imported to Cyprus in bulk, as well as emissions other than those from stocks were disregarded in an effort to better historically match and appraise the situation. Therefore, only the following gases have been taken into account: HFC-32, HFC-125, HFC-134a, HFC-143a and HFC-227ea.

(b) The amounts of substitutes of ODSs used by the four model countries were tabulated in tonnes and modified by their 100-year global warming potential (GWP) to calculate the t CO_2 eq. emissions from each source. The substitutes of ODSs applicable to the estimation of emissions from stocks in Cyprus are listed in Table 1.4 (Section 1.4.3). The equivalent emissions are thus calculated as: substitute of ODS amount (t) × GWP (t CO_2eq/t).

(c) The t CO_2 eq. emissions from each substance and subcategories are, then, summed per year and divided by the average total population of each country obtained from EUROSTAT (Table 4.20) to provide for the annual per capita emissions (Table 4.21) for the years 1990-2015.

(d) The annual per capita emissions average of the four countries for 2F1 and only Spain, Italy and Greece for 2F2, 2F3 and 2F4 (see notes) were, in turn, used to calculate the total t CO_2 equivalent annual emissions from stocks in Cyprus, based on the population of Cyprus for each corresponding year (Table 4.22). The emissions of 2016 were estimated assuming that the per capita emissions are the same as 2015 and the population of Cyprus for 2016.

Emissions from these sources were kept constant for 2017 and 2018.

Notes

- Malta was excluded from the calculation of the average per capita emissions for the source **2F2**, because of outstanding high values of per capita HFC emissions in 2004 and 2009. With Malta excluded, the average per capita emissions is very uniformly increasing through the time series (Figure 4.10).

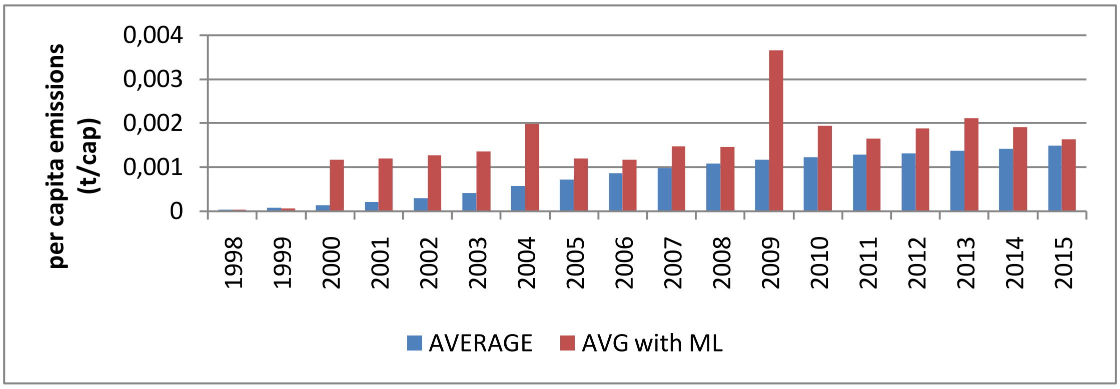

Figure 4.10. Average per capita emissions for 2F2 with and without Malta 1998-2015 (t/cap)

- Malta was excluded from the calculation of the average per capita emissions for the source **2F3**, because of outstanding high (2004) and low (2008) values of per capita HFC. With Malta excluded, the average per capita emissions is very uniformly increasing through the time series (Figure 4.11).

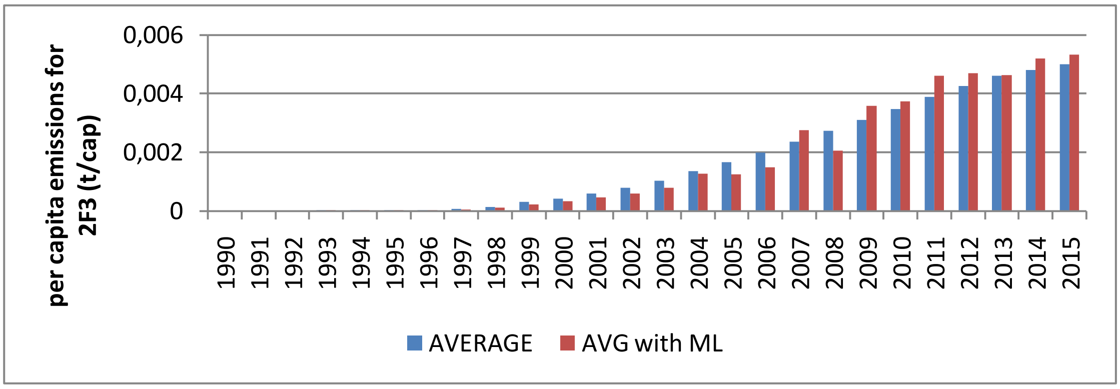

Figure 4.11. Average per capita emissions for 2F3 with and without Malta 1990-2015 (t/cap)

- Malta was excluded from the calculation of the average per capita emissions for the source **2F4**, because of very large fluctuations of the per capita HFC. With Malta excluded, the average per capita emissions show less fluctuation through the time series (Figure 4.12).

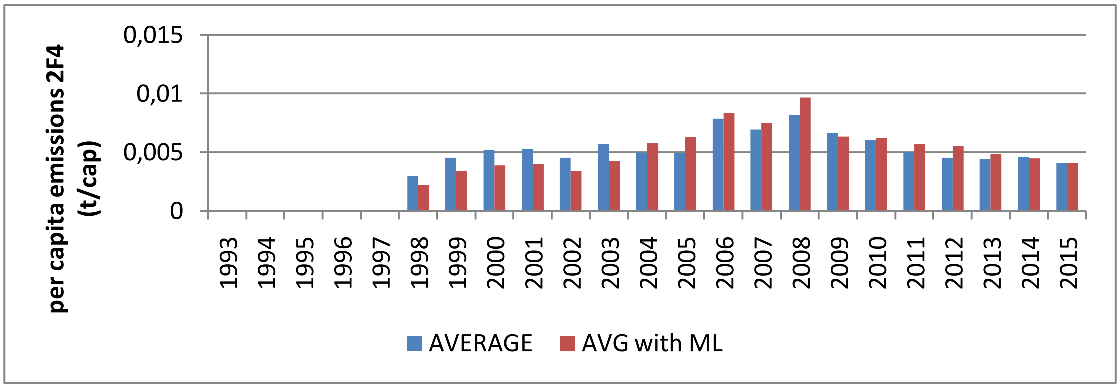

Figure 4.12. Average per capita emissions for 2F4 with and without Malta 1993-2015 (t/cap)

(e) The emissions estimated have been reported in CRFreporter as unspecified mix of hydrofluorocarbons, and divided in each sector (e.g. commercial, industrial refrigeration etc.) by factoring the t CO2 eq. percent contribution (Table 4.23) to their combined total annual emission estimated for Cyprus (Table 4.24). The emissions for 2016 were estimated assuming the same factors and contribution as 2015. Moreover, the following have been taken into account during the calculations:

- 2F2: According to the information submitted by the four countries and the imports of bulk gases in Cyprus, all emissions have been assumed to be HCF-134a and from closed cells.
- 2F3: According to the information submitted by the Greece, Italy and Malta, all emissions have been assumed to be HFC-227ea.
- 2F4: For the source MDI-aerosols, only the emissions from Metered Dose Inhalers have been taken into account, since Aerosols do not occur in Cyprus. Moreover, according to the information submitted by the four countries, all emissions have been assumed to be HFC-134a.

Table 4.20. Average total population used for the estimation of per capita emissions from 2F activities (EUROSTAT)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Greece	10196792	10319927	10399061	10460415	10512922	10562153	10608800
Italy	56719240	56758521	56797087	56831821	56843400	56844303	56860281
Malta	354170	357727	361260	364704	367941	370433	372687
Spain	38850435	38939049	39067745	39189400	39294967	39387017	39478186

	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Greece	10661259	10720509	10761698	10805808	10862132	10902022	10928070
Italy	56890372	56906744	56916317	56942108	56974100	57059007	57313203
Malta	375236	377516	379360	381363	393028	395969	398582
Spain	39582413	39721108	39926268	40263216	40756001	41431558	42187645

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Greece	10955141	11020362	11048473	11077841	11107017	11121341	11104899
Italy	57685327	58143979	58438310	58826731	59095365	59277417	59379449
Malta	401268	403834	405308	406724	409379	412477	414508
Spain	42921895	44397319	45226803	45954106	46362946	46576897	46742697

	2011	**2012**	**2013**	**2014**	**2015**		
Greece	11045011	10965211	10892413	10820883	10770521		
Italy	59539717	60233948	60789140	60730582	60627498		
Malta	416268	419455	423374	427364	431874		
Spain	46773055	46620045	46480882	46444832	46484533		

Table 4.21. Per capital emissions by source from 2F activities (kg CO2 eq.)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
2F2								
Spain	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2F3								
Spain	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.12
Italy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09
AVERAGE	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.07
2F4								
Spain	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.20
Italy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.07

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
2F2								
Spain	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.11
Italy	0.10	0.23	0.39	0.60	0.86	1.19	1.62	2.02
Greece	0.00	0.00	0.00	0.01	0.03	0.03	0.03	0.03

AVERAGE	0.03	0.08	0.13	0.20	0.30	0.41	0.57	0.72
2F3								
Spain	0.21	0.34	0.50	0.74	0.97	1.24	1.60	1.92
Italy	0.00	0.29	0.40	0.54	0.69	0.90	1.18	1.48
Greece	0.23	0.30	0.38	0.53	0.73	0.98	1.28	1.62
AVERAGE	0.15	0.31	0.43	0.60	0.80	1.04	1.35	1.67
2F4								
Spain	8.87	12.80	13.55	12.77	10.24	12.98	9.68	9.21
Italy	0.00	0.78	2.04	3.10	3.31	4.08	5.25	5.51
Greece	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE	2.96	4.53	5.20	5.29	4.52	5.69	4.98	4.91

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2F2								
Spain	0.16	0.20	0.22	0.23	0.24	0.25	0.26	0.27
Italy	2.38	2.69	2.97	3.22	3.42	3.57	3.65	3.70
Greece	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.12
AVERAGE	0.86	0.97	1.07	1.16	1.23	1.28	1.32	1.36
2F3								
Spain	2.26	2.74	3.26	3.83	4.41	5.08	5.75	6.36
Italy	1.76	2.08	2.38	2.67	2.97	3.30	3.51	3.76
Greece	1.95	2.25	2.53	2.81	3.07	3.31	3.51	3.70
AVERAGE	1.99	2.36	2.73	3.10	3.48	3.90	4.26	4.61
2F4								
Spain	8.37	8.38	8.96	8.51	7.31	6.44	5.64	5.75
Italy	5.70	5.47	5.20	5.08	4.74	4.22	3.67	3.41
Greece	9.59	7.01	10.50	6.42	6.18	4.37	4.37	4.06
AVERAGE	7.89	6.95	8.22	6.67	6.08	5.01	4.56	4.41

	2014	**2015**						
2F2								
Spain	0.28	0.28						
Italy	3.75	3.92						
Greece	0.20	0.28						
AVERAGE	1.41	1.49						
2F3								
Spain	6.52	6.51						
Italy	3.99	4.36						
Greece	3.92	4.13						
AVERAGE	4.81	5.00						
2F4								
Spain	6.24	5.15						
Italy	3.37	2.94						
Greece	4.19	4.18						
AVERAGE	4.60	4.09						

Table 4.22. Total population used for the estimation of emissions from 2F activities

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Population	587100	603100	619200	632900	645400	656300	666300	675200	682900

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Population	690500	690497	705500	713700	722900	733000	744000	757900	776400

	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Population	796900	819100	839800	862000	865900	858000	847000	848300	854800

Table 4.23. Contribution of activities to 2F emissions

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
2F2								

Closed cells	100%	100%	100%	100%	100%	100%	100%	100%
2F3								
Fire protection	100%	100%	100%	100%	100%	100%	100%	100%
2F4								
Metered dose inhalers	100%	100%	100%	100%	100%	100%	100%	100%

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
2F2								
Closed cells	100%	100%	100%	100%	100%	100%	100%	100%
2F3								
Fire protection	100%	100%	100%	100%	100%	100%	100%	100%
2F4								
Metered dose inhalers	100%	100%	100%	100%	100%	100%	100%	100%

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2F2								
Closed cells	100%	100%	100%	100%	100%	100%	100%	100%
2F3								
Fire protection	100%	100%	100%	100%	100%	100%	100%	100%
2F4								
Metered dose inhalers	100%	100%	100%	100%	100%	100%	100%	100%

	2014	**2015**						
2F2								
Closed cells	100%	100%						
2F3								
Fire protection	100%	100%						
2F4								
Metered dose inhalers	100%	100%						

Table 4.24. Total 2F emissions from Stocks estimated for Cyprus (t CO_2 eq.)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
2F2	0	0	0	0	0	0	0	0	23
2F3	0	0	0	1	3	7	19	46	99
2F4	0	0	0	0	0	14	28	46	2019

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
2F2	53	91	142	211	296	416	536	649	755
2F3	215	300	426	570	753	992	1245	1507	1830
2F4	3126	3589	3734	3224	4111	3649	3653	5978	5400

	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
2F2	856	950	1033	1107	1139	1171	1194	1268	1277
2F3	2172	2541	2926	3358	3687	3954	4076	4242	4274
2F4	6550	5464	5102	4320	3950	3783	3896	3472	3498

4.6.3. Uncertainties and time-series consistency

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

4.6.4. Category-specific QA/QC and verification

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

4.6.5. Category-specific recalculations

The emissions for the whole period have been recalculated for the 2020 submission for the following sub-categories:

- Commercial Refrigeration (2F1a): Refrigerants R410A, R407C and R507A were added to the calculations of the emissions and annual national GDP values were revised
- Industrial Refrigeration (2F1c): Refrigerant R507A was added to the calculation of the emissions and annual national GDP values were revised
- Transport Refrigeration (2F1d): Implementation of a new methodology (n last year submission (2019) we changed the methodology (Tier 2a) for calculating emissions from 2F1. Regarding transport refrigeration, we didn't had the data on time to implement the new methodology. For this year submission (2020), we had the data and we apply the new methodology also for transport refrigeration)
- MAC systems (2F1e): New Activity Data were obtained from the Statistical Service of Cyprus
- Stationary A/C Systems (2F1f): Annual national GDP values were revised

The impact of recalculations is presented in the following table and figure.

Table 4.25. 2F Recalculations

2F1 (t CO2 eq.)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
2020 submission	79600.3	94128.3	124203.2	118685.9	127487.4	132306.5
2019 submission	63884.5	76024.2	84418.1	79140.6	82192.9	91897.3
change	*24.6%*	*23.8%*	*47.1%*	*50%*	*55.1%*	*44%*
Impact on total	*0.4%*	*0.4%*	*0.7%*	*0.7%*	*0.8%*	*0.7%*
2F1 (t CO2 eq.)	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
2020 submission	135719.5	141527.8	149681.8	164449.1	169117.8	173871.7
2019 submission	95913.6	99600.7	103641.8	113278.1	116195.6	117270.3
change	*41.5%*	*42.1%*	*44.4%*	*45.2%*	*45.5%*	*48.3%*
Impact on total	*0.7%*	*0.7%*	*0.7%*	*0.7%*	*0.7%*	*0.8%*
2F1 (t CO2 eq.)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
2020 submission	188848.9	195669.0	215151.9	223914.6	227158.3	257130.1
2019 submission	125788.8	128993.6	141276.9	188685.6	189653.9	216552.3
change	*50.1%*	*51.7%*	*52.3%*	*18.7%*	*19.8%*	*18.7%*
Impact on total	*0.8%*	*0.8%*	*0.9%*	*0.5%*	*0.5%*	*0.5%*
2F1 (t CO2 eq.)	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2020 submission	253808.5	266855.1	275838.1	261863.0	266495.3	260751.3
2019 submission	207762.2	215560.2	236586.8	210647.1	213352.2	205924.0
change	*22.2%*	*23.8%*	*16.6%*	*24.3%*	*24.9%*	*26.6%*
Impact on total	*0.5%*	*0.6%*	*0.5%*	*0.7%*	*0.8%*	*0.9%*
2F1 (t CO2 eq.)	**2014**	**2015**	**2016**	**2017**		
2020 submission	260179.6	269720.4	276931.6	287702.3		
2019 submission	203865.5	241472.8	236230.3	240514.0		
change	*27.6%*	*11.7%*	*17.2%*	*19.6%*		
Impact on total	*0.8%*	*0.4%*	*0.5%*	*0.2%*		

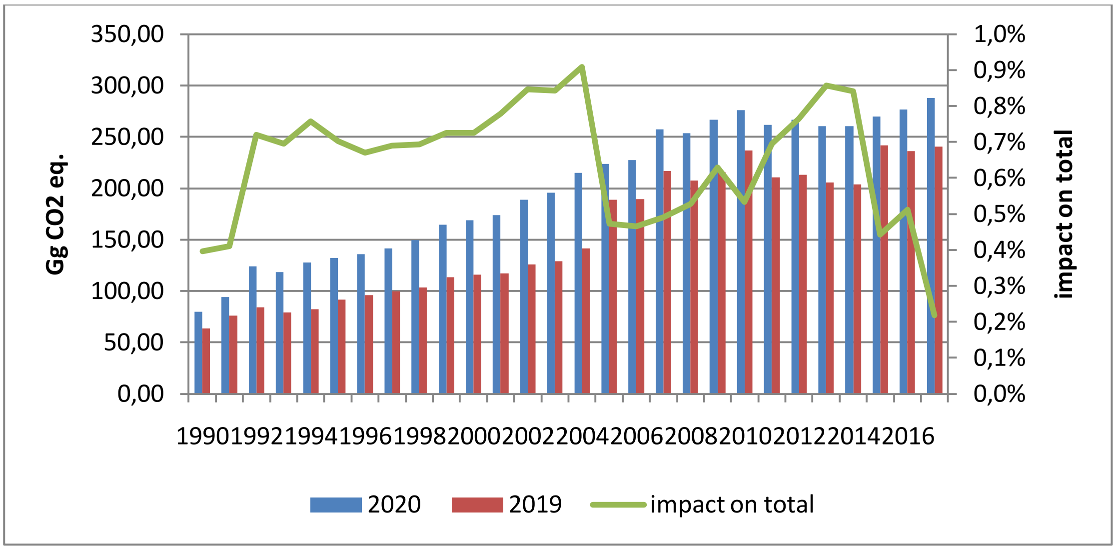

Figure 4.13. 2F1 recalculations

4.6.6. Category-specific planned improvements

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

4.7. Other Product Manufacture and Use (2G)

According to the 2006 IPCC Guidelines, the source category 2G should include emissions for the activities Electrical Equipment (2G1) (Manufacture, Use and Disposal of Electrical Equipment), SF6 and PFCs from Other Product Uses (2G2) (Military Applications, Accelerators and other), N2O from Product Uses (2G3) (Medical Applications, Propellant for Pressure and Aerosol Products and other) and Other (2G4). According to the available information the activities that take place in Cyprus are Use of Electrical Equipment (2G1b), Medical Applications of N2O (2G3a) and Propellant for Pressure and Aerosol Products (2G3b). The total emissions by gas and source for the period 1990-2017 are presented in Table 4.26 and Figure 4.14.

Table 4.26. Emissions from Other Product Manufacture and Use (2G)

	1990	2000	2005	2010	2015	2017
G. Other product manufacture and use	**41.37**	**49.30**	**52.50**	**59.27**	**59.87**	**61.00**
1. Electrical equipment	0.03	0.08	0.12	0.15	0.16	0.17
2. SF_6 and PFCs from other product use	NO	NO	NO	NO	NO	NO
3. N_2O from product uses	41.30	49.11	52.36	59.09	59.69	60.83
4. Other	0.04	0.12	0.03	0.02	0.01	0.01
CO2 (Gg)	0.04	0.12	0.03	0.02	0.01	0.01
N2O (Gg)	0.14	0.16	0.18	0.20	0.20	0.20
SF6 (kg)	1.13	3.34	5.04	6.59	7.20	7.25
Total (Gg CO2 eq.)	**41.37**	**49.30**	**52.50**	**59.27**	**59.87**	**61.00**

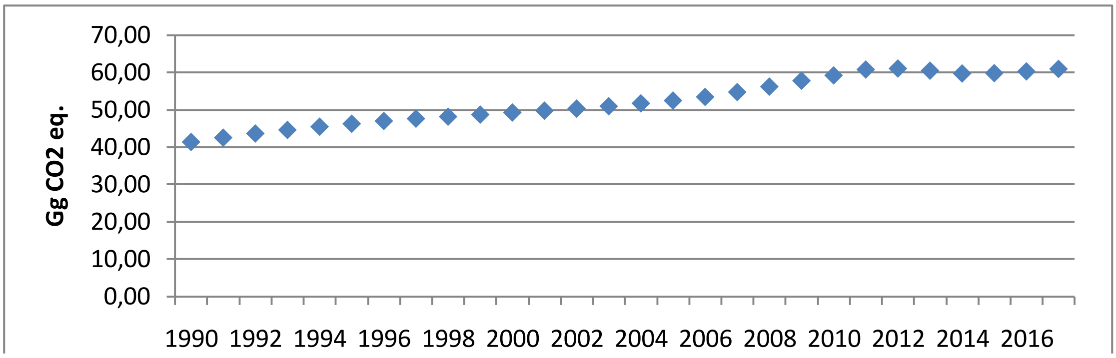

Figure 4.14. Emissions from Other Product Manufacture and Use (2G)

4.7.1. Electrical Equipment (2G1)

Sulphur hexafluoride (SF6) is used for electrical insulation and current interruption in equipment used in the transmission and distribution of electricity. Emissions occur at each phase of the equipment life cycle, including manufacturing, installation, use, servicing, and disposal. Most of the SF6 used in electrical equipment is used in gas insulated switchgear and substations (GIS) and in gas circuit breakers (GCB), though some SF6 is used in high voltage gas-insulated lines (GIL), outdoor gas-insulated instrument transformers and other equipment. The aforementioned applications may be divided into two categories of containment.

Electrical equipment is the largest consumer and most important use of SF6, globally. It significantly contributes to worldwide SF6 emissions. However, the importance of this source varies considerably from region to region and from country to country.

4.7.1.1. Methodological issues

Due to insufficient information for a long period of time, it was decided to use a country specific methodology for the estimation of the emissions from Electrical Equipment (2G1).

The methodology applied consisted of the following steps:

(a) The stock emissions from the 2G1 for Greece, Italy, Malta and Spain were obtained from the NIR2017 submissions to the UNFCCC for the years 1990-2015 (CRF – Table 2(II).B-H). The four countries were selected due to their similarity in social and economic conditions to Cyprus.

(b) The amounts SF6 used by the four model countries were tabulated in tonnes and modified by their 100-year global warming potential (GWP) to calculate the t CO2 eq. emissions from each source. The substitutes of ODSs applicable to the estimation of emissions from stocks in Cyprus are listed in Table 1.4 (Section 1.4.3). The equivalent emissions are thus calculated as: substitute of ODS amount (t) × GWP (t CO2eq/t).

(c) The t CO2 eq. emissions from each substance are, then, summed per year and divided by the average total population of each country obtained from EUROSTAT (Table 4.16) to provide for the annual per capita emissions (Table 4.27) for the years 1990-2015.

(d) The annual per capita emissions average of only Spain, Italy and Greece were, in turn, used to calculate the total t CO2 equivalent annual emissions from stocks in Cyprus, based on the population of Cyprus for each corresponding year (Table 4.17). The emissions of 2016 were estimated assuming that the per capita emissions are the same as 2015 and the population of Cyprus for 2016.

    Malta was excluded from the calculation of the average per capita emissions for the source 2G1, because of outstanding high values of per capita HFC emissions in 2011 and 2013. With Malta excluded, the average per capita emissions is more uniform through the time series (Figure 4.15).

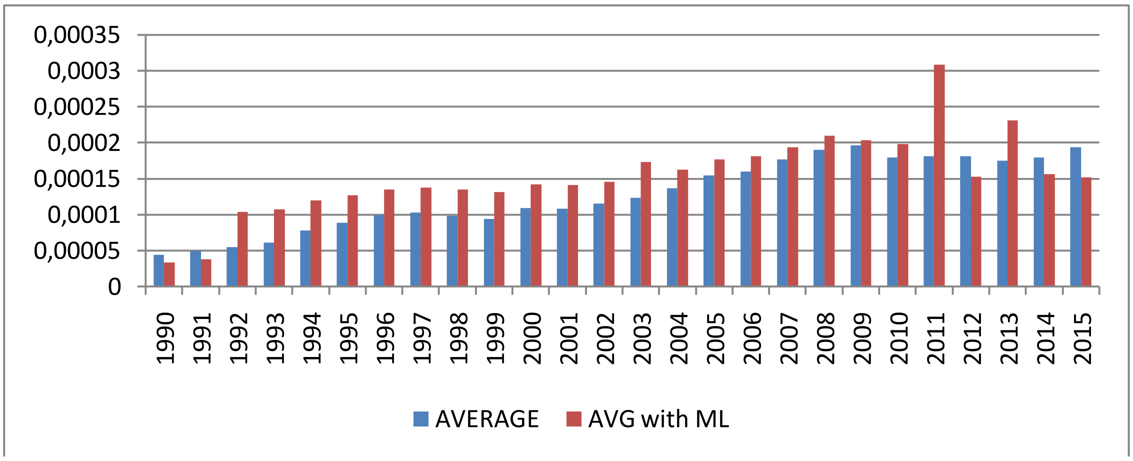

Figure 4.15. Average per capita emissions for 2G1 with and without Malta 1990-2015 (t/cap)

(e) Consumption of SF6 for 2G1 was reported in the CRF reporter in tonnes by dividing the total t CO2 equivalent annual emissions by the GWP of the gas. The reported emissions are presented in Table 4.28.

Table 4.27. Annual per capita emissions for 2G1

	1990	1991	1992	1993	1994	1995	1996	1997
Malta	1.9E-06	1.9E-06	0.00025	0.00025	0.00024	0.00024	0.00024	0.00024
Spain	0.0001	0.00011	0.00011	0.00011	0.00012	0.00012	0.00013	0.00013
Italy	1.8E-05	1.8E-05	1.9E-05	1.9E-05	2E-05	2E-05	2.1E-05	2.1E-05
Greece	1.2E-05	2.5E-05	3.8E-05	5.2E-05	9.9E-05	0.00012	0.00015	0.00016
AVERAGE without Malta	4.4E-05	5E-05	5.5E-05	6.1E-05	7.8E-05	8.9E-05	9.9E-05	0.0001

	1998	1999	2000	2001	2002	2003	2004	2005
Malta	0.00024	0.00024	0.00024	0.00024	0.00024	0.00032	0.00024	0.00024
Spain	0.00014	0.00014	0.00014	0.00015	0.00015	0.00016	0.00018	0.00019
Italy	2.1E-05	2.2E-05	2.2E-05	2.2E-05	2.3E-05	2.3E-05	2.4E-05	3.5E-05
Greece	0.00014	0.00012	0.00016	0.00016	0.00017	0.00019	0.00021	0.00024
AVERAGE without Malta	9.9E-05	9.4E-05	0.00011	0.00011	0.00012	0.00012	0.00014	0.00015

	2006	2007	2008	2009	2010	2011	2012	2013
Malta	0.00024	0.00024	0.00027	0.00023	0.00026	0.00069	6.8E-05	0.0004
Spain	0.00021	0.00023	0.00024	0.00024	0.00026	0.00025	0.00026	0.00026
Italy	4.5E-05	5.4E-05	4.1E-05	2.8E-05	3.3E-05	2.9E-05	2.9E-05	3E-05
Greece	0.00023	0.00025	0.00029	0.00032	0.00025	0.00026	0.00025	0.00024
AVERAGE without Malta	0.00016	0.00018	0.00019	0.0002	0.00018	0.00018	0.00018	0.00018

	2014	2015						
Malta	8.58E-05	2.75E-05						
Spain	0.000263	0.000276						
Italy	2.85E-05	2.95E-05						
Greece	0.000247	0.000275						
AVERAGE without Malta	0.00018	0.000193						

Table 4.28. SF6 emissions for 2G1, as reported in CRFreporter

	1990	1991	1992	1993	1994	1995	1996	1997
SF6 (t)	0.00113	0.00132	0.0015	0.00169	0.00221	0.00255	0.00289	0.00305

	1998	1999	2000	2001	2002	2003	2004	2005
SF6 (t)	0.00295	0.00286	0.00334	0.00336	0.0036	0.0039	0.00439	0.00504

	2006	2007	2008	2009	2010	2011	2012	2013
SF6 (t)	0.00532	0.00601	0.00665	0.00704	0.00659	0.00684	0.00688	0.0066

	2014	2015	2016					
SF6 (t)	0.006673	0.007195	0.007250					

4.7.1.2. Uncertainties and time-series consistency

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

4.7.1.3. Category-specific QA/QC and verification

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

4.7.1.4. Category-specific recalculations

No recalculations to be reported.

4.7.1.5. Category-specific planned improvements

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

4.7.2. SF6 and PFCs from Other Product Uses (2G2)

No information is available to support that SF6 and PFCs from Other Product Uses occurs in Cyprus.

4.7.3. N_2O from Product Uses (2G3)

Evaporative emissions of nitrous oxide (N_2O) can arise from various types of product use, including: Medical applications (anaesthetic use, analgesic use and veterinary use), Use as a propellant in aerosol products, primarily in food industry (pressure-packaged whipped cream, etc.), etc. In general, medical applications and use as a propellant in aerosol products are likely to be larger sources than others. In Cyprus these are the two activities identified as consumers of N_2O.

4.7.3.1. Methodological issues

Medical Applications (2G3a)

The emission calculation of the total N_2O emissions is based on the number of hospital beds in Cyprus multiplied by the average consumption of anaesthetic per bed (emission factor). The emission factor is 10.3 kg N_2O/bed/year and is derived by the EU GHG Inventory Report 2013[43]. This is not the recommended methodology given in the 2006 IPCC guidelines, but as we have been unable, at the moment, to obtain the data required to follow the default methodology (sales of N_2O for anaesthetic use) this was considered the best approach to a country specific estimate for this source.

It has been assumed that all of the nitrous oxide used for anaesthetics will eventually be released to the

[43] https://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2013

atmosphere. The number of beds used for the emission calculations were obtained from the Statistical Service of Cyprus.

Propellant for Pressure and Aerosol Products (2G3b)

The necessary activity data is not available to estimate emissions according to the 2006 IPCC guidelines; therefore a country specific methodology has been developed.

The method uses the total population of Cyprus (Table 4.22) and the emission factor per capita of 0.214 kg N_2O per capita in the equation:

$$N_2O\ emissions\ (Gg) = population * emission\ factor\ per\ capita\ (kg\ N_2O/capita) / 10^6$$

The emission factors have been obtained by the National GHG Inventory Report of Greece for the year 2013. Greece was chosen due to the social, climatic and economic similarities that exist between the two countries.

The results as reported in CRFreporter for N_2O emissions from Product Uses are presented in Table 4.29.

Table 4.29. N_2O emissions (Gg) from Product Uses

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
2G3a	0.0351	0.0349	0.0346	0.0344	0.0342	0.0340	0.0337
2G3b	0.1256	0.1291	0.1325	0.1354	0.1381	0.1404	0.1426
TOTAL	0.1607	0.1639	0.1671	0.1699	0.1723	0.1744	0.1763
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2G3a	0.0321	0.0317	0.0316	0.0324	0.0316	0.0318	0.0318
2G3b	0.1445	0.1461	0.1478	0.1493	0.1510	0.1527	0.1547
TOTAL	0.1766	0.1778	0.1794	0.1817	0.1826	0.1846	0.1865
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2G3a	0.0317	0.0293	0.0295	0.0300	0.0307	0.0313	0.0305
2G3b	0.1569	0.1592	0.1622	0.1661	0.1705	0.1753	0.1797
TOTAL	0.1885	0.1885	0.1917	0.1962	0.2012	0.2066	0.2102
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
2G3a	0.0308	0.0308	0.0303	0.0300	0.0298	0.0301	0.0306
2G3b	0.1845	0.1853	0.1836	0.1813	0.1815	0.1829	0.1849
TOTAL	0.2152	0.2161	0.2139	0.2113	0.2114	0.2116	0.2155
	2018						
2G3a	0.0304						
2G3b	0.1874						
TOTAL	0.2178						

4.7.3.2. Uncertainties and time-series consistency

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

4.7.3.3. Category-specific QA/QC and verification

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

4.7.3.4. Category-specific recalculations

The emissions for Medical Applications (2G3a) have been recalculated due to the change in the methodology of emission estimation. The impact of recalculations is presented in the following table and figure.

Table 4.30. CO_2 emissions from Medical Applications (2G3a) - Recalculations

	1990	1991	1992	1993	1994	1995	1996
NIR2019 (Gg CO_2)	0.0130	0.0134	0.0137	0.0141	0.0143	0.0146	0.0148
NIR2020 (Gg CO_2)	0.0351	0.0349	0.0346	0.0344	0.0342	0.0340	0.0337
change	169.1%	160.3%	151.9%	144.9%	138.6%	133.1%	127.9%
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NIR2019 (Gg CO_2)	0.0150	0.0152	0.0153	0.0155	0.0157	0.0158	0.0160
NIR2020 (Gg CO_2)	0.0321	0.0317	0.0316	0.0324	0.0316	0.0318	0.0318
change	114.0%	109.1%	106.4%	109.3%	101.8%	101.0%	97.9%
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NIR2019 (Gg CO_2)	0.0163	0.0165	0.0168	0.0172	0.0177	0.0182	0.0186
NIR2020 (Gg CO_2)	0.0317	0.0293	0.0295	0.0300	0.0307	0.0313	0.0305
change	94.6%	77.5%	75.3%	74.3%	73.3%	72.2%	63.4%
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NIR2019 (Gg CO_2)	0.0191	0.0192	0.0190	0.0188	0.0188	0.0188	0.0192
NIR2020 (Gg CO_2)	0.0308	0.0308	0.0303	0.0300	0.0298	0.0301	0.0306
change	60.8%	60.2%	58.9%	59.5%	58.3%	59.6%	59.3%

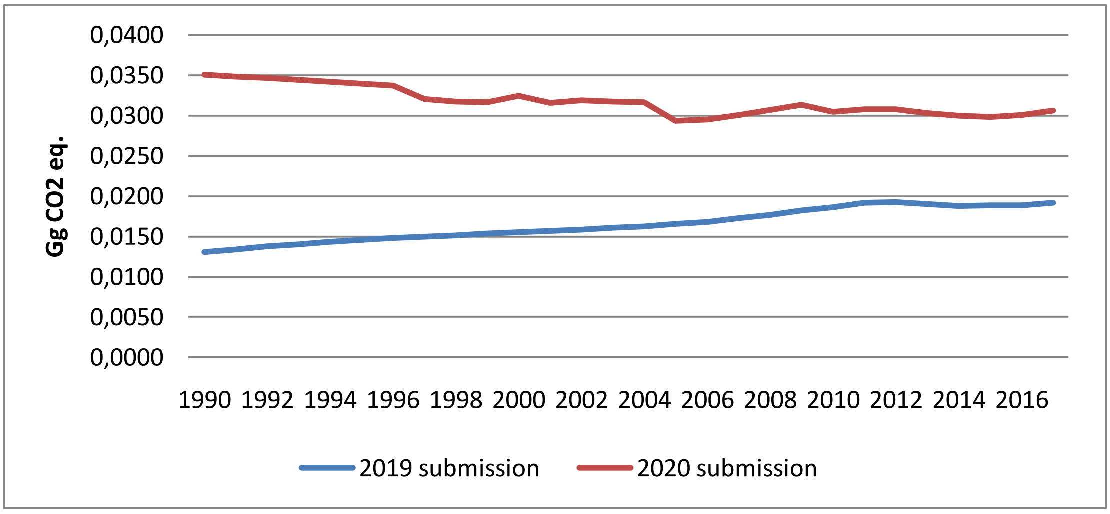

Figure 4.16. CO_2 emissions from Medical Applications (2G3a) - Recalculations

4.7.3.5. Category-specific planned improvements

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

4.7.4. Other product manufacture and use (2G4)

Source category 2G4 in Cyprus includes the emissions associated with Tobacco combustion. The emissions are estimated from NMVOCs estimates.

4.7.3.1. Methodological issues

Carbon dioxide emissions from other are calculated from NMVOC emissions (Table 4.31; with red the recalculated values), assuming that the carbon content of NMVOC is 60%[44]. NMVOC emissions are obtained from the Department of Labour Inspection that is responsible for the preparation of the air pollutants inventory for Directive 2001/81/EC. The estimation of NMVOC emissions is based on the CONINAIR methodology. Therefore the equation applied for the estimation of the CO_2 emissions is the following:

$$CO_2 \text{ emissions (Gg)} = 60\% * \text{NMVOC emissions (Gg)} * 44/12$$

Table 4.31. NMVOCs emissions used for the estimation of CO_2 emissions from Other (2G4)

Gg	1990	1991	1992	1993	1994	1995	1996	1997
Other	0.0185	0.0185	0.0202	0.0056	0.0056	0.0163	0.0173	0.0193
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Other	0.0197	0.0275	0.0518	0.0159	0.0149	0.0107	0.0160	0.0139
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Other	0.0087	0.0091	0.0088	0.0098	0.0105	0.01900	0.02065	0.01621
	2014	**2015**	**2016**	**2017**	**2018**			
Other	0.00643	0.01480	0.01215	0.01302	0.01183			

4.7.4.2. Uncertainties and time-series consistency

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

4.7.4.3. Category-specific QA/QC and verification

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

4.7.4.4. Category-specific recalculations

No recalculations to report.

4.7.4.5. Category-specific planned improvements

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

[44] 2006 IPCC Guidelines volume 3, p. 5.17, the default fossil carbon content fraction of NMVOC is 60 per cent by mass

Chapter 5.
Agriculture (CRF sector 3)

5.1. Overview of sector

In agricultural activities there are many processes leading to emissions and removals of greenhouse gases, which can be widely dispersed in space and highly variable in time. The factors governing emissions and removals can be natural and anthropogenic, direct and indirect, and it can be difficult to clearly distinguish between causal factors.

Livestock production can result in methane (CH4) emissions from enteric fermentation and both CH4 and nitrous oxide (N2O) emissions from livestock manure management systems. Cattle are an important source of CH4 in many countries because of their large population and high CH4 emission rate due to their ruminant digestive system. Methane emissions from manure management tend to be smaller than enteric emissions, with the most substantial emissions associated with confined animal management operations where manure is handled in liquid-based systems. Nitrous oxide emissions from manure management vary significantly between the types of management system used and can also result in indirect emissions due to other forms of nitrogen loss from the system.

According to the 2006 IPCC Guidelines, the following source categories are included in this sector: Enteric fermentation (3.A), Manure management (3.B), Rice cultivation (3.C), Agricultural soils (3.D), Prescribed burning of savannas (3.E), Field burning of agricultural residues (3.F), Liming (3.G), Urea Application (3.H), Other Carbon-containing fertilizers (3.I). In Cyprus, rice cultivation (3.C), prescribed burning of savannas (3.E) and Liming (3.G) do not take place and are therefore reported as NO.

5.1.1. Emission trends

The agricultural sector of Cyprus[45]

Although abundant with fresh produce and a sunny climate, farming in Cyprus is faced with droughts and environmental challenges, as well as an ongoing struggle for economic relevance. In the early years of Cyprus' independence, the contribution of the agricultural sector to GDP was about 20%, whereas today it has dropped to around 1.7% and employs 4% of the workforce. However, the sector has tackled these trials and tribulations head-on by adopting new technologies, bringing new products to the market and widening its customer base.

Agriculture has shown remarkable resilience and production has remained at stable levels, despite recent macroeconomic challenges – proving there are positive future prospects for the sector if it continues to develop on a more professional, niche and scientific basis. New structural reforms are also set to increase competitiveness and productivity, allowing Cyprus to become more dynamic, export-oriented and most importantly to adopt a mentality of continuous modernisation.

Cyprus' agricultural share of total domestic exports is around 13.4%, and it is quintessentially Mediterranean with health-promoting foods such as citrus fruit, vegetables, grapes and potatoes. As for processed agricultural goods, Cyprus' key exports are halloumi, fruit and vegetable juices, meats and wines. The island's famous halloumi cheese has become one of the top export products for Cyprus.

[45] Cyprus Profile, 2017, Green Growth and Niche Products, available at http://www.cyprusprofile.com/en/sectors/agriculture-and-food (accessed 19/12/2017)

The most important crops produced in Cyprus are: cereals (wheat, barley); melons (watermelons, sweet melons); vegetables (potatoes, carrots, tomatoes, cucumbers); and other fruit and tree crops, such as grapes, oranges, lemons, grapefruit, apples, pears, peaches, cherries, bananas, almonds, olives and carobs. An area of success has been the marketing of the Cyprus potato – one of the most important agricultural export products and easily recognisable by its reddish peel and extraordinary taste. Thanks to climatic conditions, fresh new Cyprus potatoes intended for export are available to European markets far before the traditional continental season.

Emissions

Emissions from Agriculture accounted for 5.7% of total emissions in 2018 (without LULUCF), compared to 8.7% in 1990. Emissions increased by 5.0% compared to 1990. Agriculture is responsible for mainly methane and nitrous oxide emissions. In 2018 agriculture contributed 35% to the total methane emissions and 81% to the total nitrous oxide emissions. The total emissions by gas and source from agricultural activities for the period 1990-2018 in Cyprus are presented in Table 5.1 and Figure 5.1.

Table 5.1. GHG emissions from Agriculture, for the period 1990 – 2018

Gg CO_2 eq.	1990	2000	2005	2010	2015	2017	2018
3. Agriculture	**471.41**	**552.17**	**532.83**	**531.37**	**456.87**	**494.24**	**499.4**
A. Enteric fermentation	196.97	224.21	228.47	235.38	224.39	255.66	261.53
B. Manure management	135.58	181.96	170.73	158.57	116.35	117.80	118.25
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	135.01	143.69	131.99	136.13	114.96	120.04	119.17
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	2.03	0.65	0.68	0.55	0.76	0.33	0.23
G. Liming	NO	NO	NO	NO	NO	NO	NO
H. Urea application	1.82	1.67	0.97	0.74	0.40	0.42	0.22
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO
J. Other	NO	NO	NO	NO	NO	NO	NO
CO2 (Gg)	1.82	1.67	0.97	0.74	0.40	0.42	0.22
CH4 (Gg)	10.72	12.85	12.72	12.67	11.12	12.27	12.47
N2O (Gg)	0.68	0.77	0.72	0.72	0.60	0.63	0.63
Total (Gg CO2 eq.)	**471.23**	**552.35**	**532.98**	**531.62**	**457.27**	**494.73**	**499.4**

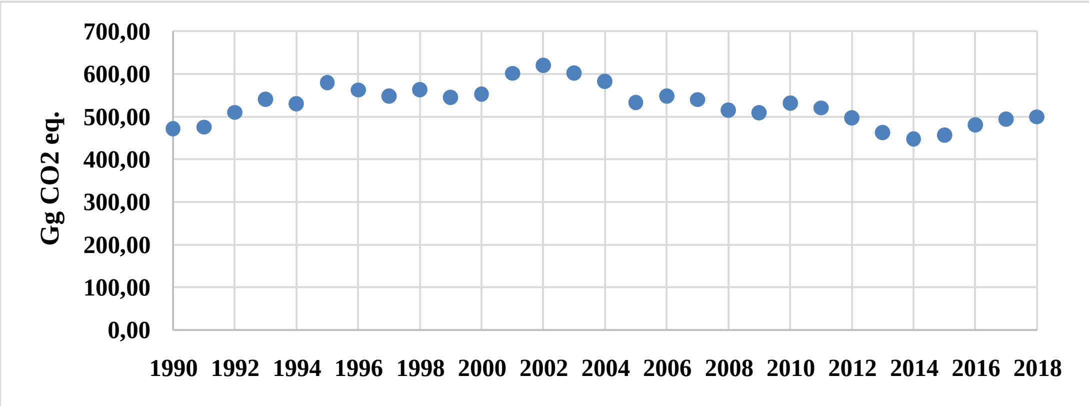

Figure 5.1. Emissions from Agriculture, 1990 – 2018

5.1.2. Methodology

The calculation of GHG emissions from Agriculture is based on the methodologies and emission factors suggested by the 2006 IPCC Guidelines. Data used for the estimation of the emissions was obtained from the National Statistical Service, the Department of Agriculture, the Veterinary services and other sources. Tier 1 method with default IPCC 2006 emission factors are used for all calculations except enteric fermentation emissions from cattle (3A1a) and manure management of cattle (3B1.1) and swine (3B1.3) that are estimated using Tier 2. The methodologies and emission factors used are summarised in Table 5

Table 5.2. Agriculture – methodologies and emission factors applied

Category-Classification		Gas	EF	Method
3A	Enteric Fermentation – Dairy Cattle	CH4	CS	T2
3A	Enteric Fermentation - Non-dairy cattle, sheep, goats, horses, mules and asses and swine	CH4	D	T1
3B1.1 3B1.3	Manure Management – Dairy Cattle and Non-dairy cattle, swine (market & breeding)	CH4	D	T2
3B1.2 3B1.4	Manure Management – sheep, goats, horses, mules and asses, poultry	CH4	D	T1
3B2.1 3B2.2 3B2.3 3B2.4	Direct N2O emissions – Dairy and non-dairy cattle, Sheep, swine (market & breeding), goats, horses, poultry, mules and asses	N2O	D	T1
3B2.5	Indirect N2O emissions	N2O	D	T1
3D1.1	Agricultural soils- Direct N2O Emissions From Managed Soils- Inorganic fertilizers	N2O	CS	T1
3D1.2a	Agricultural soils- Direct N2O Emissions From Managed Soils - Organic N fertilizers - Animal manure used as fertilizers	N2O	D	T1
3D1.2b	Agricultural soils- Direct N2O Emissions From Managed Soils - Organic N fertilizers - Sewage sludge applied to soils	N2O	D	T1
3D1.2c	Agricultural soils- Direct N2O Emissions From Managed Soils - Organic N fertilizers – Other organic fertilizers applied to soils	N2O	D	T1
3D1.4	Agricultural soils- Direct N2O Emissions From Managed Soils - Crop residues	N2O	D	T1
3D2.1	Indirect N2O emissions from managed soils – Atmospheric Deposition	N2O	D	T1
3D2.2	Indirect N2O emissions from managed soils Nitrogen Leaching and run-off	N2O	D	T1
3F1	Field Burning of Agricultural Residues – Cereals – Wheat, Barley, Oats	N2O/ CH4	D	T1
3F2	Field Burning of Agricultural Residues – Pulses – Bean and Pulses	N2O/ CH4	D	T1
3F3	Field Burning of Agricultural Residues –Tubers and Roots	N2O/ CH4	D	T1
3H	Urea Application	CO2	D	T1

T1, T2: IPCC methodology Tier 1, 2 respectively; D: IPCC default methodology and emission factor;

Key categories

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

Uncertainty

The uncertainty analysis is presented in Section 1.5.

Completeness

Table 5.3 gives an overview of the IPCC source categories included in this chapter and presents the status of emissions estimates from all sub-sources in agriculture. Methane emissions from agricultural soils are not estimated since appropriate methodologies have not been developed yet.

Table 5.3. Agriculture – Inventory completeness

Source category	CO_2	CH_4	N_2O
3A. Enteric fermentation		✓	
3B. Manure management		✓	✓
3C. Rice cultivation		NO	
3D. Agricultural soils		NE	✓
3E. Prescribed burning of savannahs		NO	NO
3F. Field burning of agricultural residues		✓	✓
3G. Liming	NO		
3H. Urea Application	✓		
3I. Other Carbon – containing Fertilizers	NO		

NO: Not occurring; NE: Not estimated due to method unavailability

5.2. Enteric Fermentation (3A)

Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. The amount of methane that is released depends on the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed consumed. Ruminant livestock (e.g., cattle, sheep) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses). The ruminant gut structure fosters extensive enteric fermentation of their diet.

Methane emissions from enteric fermentation in 2018 account for 72% of total GHG emissions from Agriculture and 25% of the total methane emissions excluding LULUCF. Methane emissions from enteric fermentation are presented in Table 5.4 and Figure 5.2.

Table 5.4. CH4 emissions from Enteric Fermentation (3A) 1990-2018

Gg CH4	1990	2000	2005	2010	2015	2017	2018
A. Enteric fermentation	**7.88**	**8.97**	**9.14**	**9.42**	**8.97**	**10.21**	**10.46**
1. Cattle	4.05	4.46	4.66	4.53	4.88	5.82	6.16
Dairy cattle	2.21	2.72	2.78	2.75	3.01	3.74	3.94
Non-dairy cattle	1.84	1.75	1.88	1.78	1.86	2.09	2.22
2. Sheep	2.32	1.97	2.15	2.63	2.38	2.57	2.49
3. Swine	0.42	0.61	0.64	0.70	0.54	0.53	0.54
4. Other livestock	1.09	1.92	1.68	1.56	1.18	1.29	1.27
Goats	1.03	1.89	1.65	1.54	1.17	1.29	1.25
Horses	0.01	0.02	0.02	0.01	0.01	0.01	0.01
Mules and Asses	0.05	0.02	0.01	0.01	0.00	0.00	0.01
CH4	7.88	8.97	9.14	9.42	8.97	10.21	10.46
Total	**7.88**	**8.97**	**9.14**	**9.42**	**8.97**	**10.21**	**10.46**

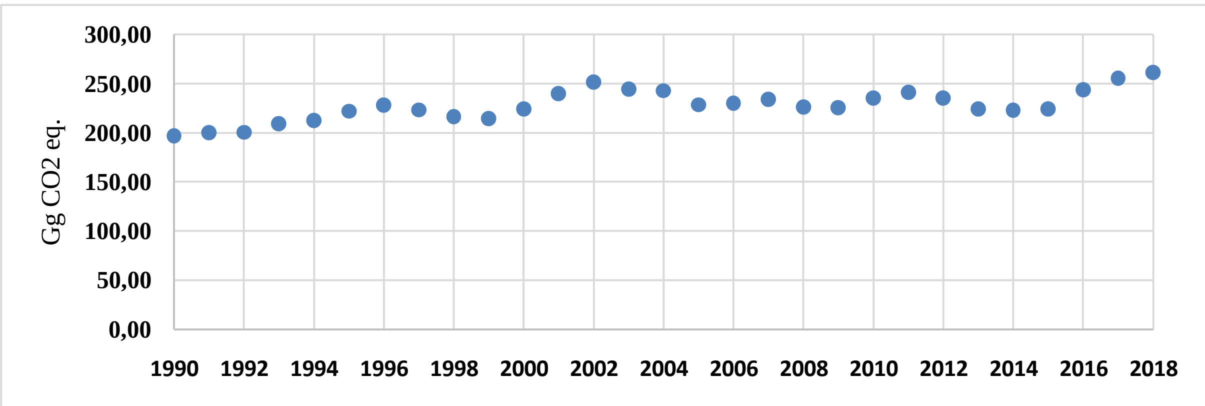

Figure 5.2. CH4 emissions from Enteric Fermentation (3A) 1990-2018 in Gg CO2 eq.

5.2.1. Methodological issues

Tier 1 methodology is applied and the default emission factors suggested by the IPCC Guidelines are used for the estimation of methane emissions from enteric fermentation for non-dairy cattle, sheep, goats, horses, mules and asses and swine. The emissions from dairy cattle are estimated using Tier 2 methodology. Poultry emissions were not estimated, since an emission factor is not available in the IPCC guidelines.

5.2.1.1. Activity data

The animal population used for the calculation of methane emissions from enteric fermentation is the annual average and it is presented in Table 5.5. The source of animal population is the Department of Agriculture, except horses, mules and asses. Following a recommendation of the ERT in the Saturday Paper prepared during the in-country review of the 2016 submission to the UNFCCC, the population for horses, mules and asses was obtained from the Agricultural Censuses of the Statistical Service for the years 1985, 1994, 2002 and 2010 and linearly interpolated to complete the time series. Information after 2010 was available for the mules and asses by the Veterinary Services but was not available for the horses therefore the decreasing trend that exists between 2003 and 2010 is used to extrapolate population for 2011-2018 using equation y=-58.571x+1220.6 .

Table 5.5. Animal population for 1990 – 2018 (in 1000s)

	Dairy cattle	Other cattle	Sheep	Breeding swine[a]	Market swine[b]	Horses	Mules and Asses	Goats	Poultry
1990	22.4	32.3	290.0	33.8	244.2	0.46	5.03	205.0	3694
1991	23.1	31.9	295.0	37.6	258.7	0.43	4.44	205.0	3403
1992	23.9	31.9	285.0	42.4	299.5	0.41	3.85	200.0	3838
1993	25.6	35.5	275.0	43.6	325.8	0.38	3.26	198.0	4551
1994	27.6	36.8	255.0	48.0	308.2	0.35	2.67	210.0	4313
1995	29.5	38.6	250.0	48.4	325.7	0.44	2.53	220.0	4460
1996	27.3	42.8	252.0	48.9	350.7	0.53	2.39	240.0	4749
1997	25.5	36.9	245.0	53.3	361.5	0.62	2.26	302.0	4816
1998	23.8	32.0	240.0	49.8	381.5	0.71	2.12	322.0	4894
1999	24.1	30.2	233.0	44.2	374.3	0.80	1.98	346.0	4823
2000	23.5	30.7	246.0	52.1	356.3	0.89	1.84	378.6	4830
2001	24.4	29.1	296.6	55.7	395.6	0.98	1.70	427.1	4873
2002	26.2	31.9	294.0	56.3	435.1	1.07	1.56	459.5	5037
2003	26.6	31.9	264.6	55.6	432.5	1.16	1.42	407.9	5015
2004	26.1	34.2	279.0	51.7	418.8	1.10	1.29	378.0	4547
2005	24.6	33.0	268.9	50.6	379.1	1.04	1.16	329.3	4419
2006	23.9	32.2	272.2	53.0	399.7	0.99	1.03	344.9	3775
2007	23.7	31.2	292.2	54.0	396.3	0.93	0.90	368.1	3978
2008	23.6	32.0	267.3	48.3	416.6	0.87	0.78	318.4	3892
2009	23.2	30.9	300.2	47.0	416.2	0.81	0.65	280.8	3793
2010	23.4	31.3	328.9	46.3	417.4	0.75	0.52	307.4	3793
2011	24.1	32.8	355.9	40.5	398.7	0.69	0.63	290.2	3678
2012	24.1	32.8	346.8	36.3	358.4	0.64	0.70	271.2	3488
2013	24.7	32.5	313.5	35.1	322.8	0.58	0.84	243.1	3091
2014	25.3	34.2	293.0	31.8	326.2	0.52	0.91	232.0	3677
2015	26.2	32.7	296.9	32.1	326.2	0.46	0.96	233.9	3154
2016	28.5	34.5	304.2	32.6	319.6	0.40	1.00	246.6	3261
2017	30.1	36.6	321.5	33.2	317.0	0.34	1.16	257.6	3360
2018	31.9	38.9	311	33.8	328.2	0.28	1.20	250.4	3475

[a] sows; [b] all except sows

5.2.1.2. Methodological issues

<u>Dairy cattle, Tier 2</u>

Methane emissions from the enteric fermentation of dairy cattle are estimated according to the Tier 2 IPCC methodology, as it is described in the IPCC Guidelines (pg. 10.31, volume 4). The calculation of the CH_4 emission factor for is based on the following equation (eqn 10.21, pg. 10.30, volume 4):

$$EF = [[(GE * (YM/100) * 365\ days/yr] / 55.65\ MJ/kg\ CH_4]$$

where EF is the estimated emission factor for CH4 (kg CH_4/head/yr), GE is the gross energy intake (MJ/head/day) and Ym is the methane conversion rate which is the fraction of the gross energy in feed converted to CH_4.

The calculation of gross energy is based on the following equation (eqn 10.16, pg. 10.21, volume 4):

$$GE = \{[(NE_m + NE_a + NE_l + NE_{work} + NE_p) / REM] + [(NE_g+NE_{wool})/ REG]\} / (DE\% / 100)$$

where NE_m is the net energy required for animal maintenance in MJ/day, NE_a is the net energy for animal activity in MJ/day, NE_l is the net energy for lactation in MJ/day, NE_{work} is the net energy for work, NE_p is the net energy required for pregnancy in MJ/day, REM is the ratio of the net energy available in a diet for maintenance to digestible energy consumed, NE_g is the net energy for growth in MJ/day, $NE_{wool}$is the net energy required to produce a year of wool, REG is the ratio of net energy available for growth in a diet to digestible energy consumed and DE% is the digestible energy expressed as a percentage of gross energy.

The dairy cattle population used for the calculation of methane emissions from enteric fermentation is presented in Table 5.6. Information for average weight (W), live body weight (BW), mature body weight (MW), milk production and digestibility of feed has been obtained from the Department of Agriculture[46]. The remaining parameters have the value of the default proposed by the IPCC GPG. The fat percentage in milk is assumed 3.5% taking into account the suggestion that was made during the volunteered participation of Cyprus in the Effort Sharing Decision review (ESD review) that was took place in 2014. Table 5.6 presents the values used for the calculations, while Table 5.7 presents the daily milk production and the % pregnant population. The resulting Gross energy (GE) and the emissions factors (EFs) for the period 1990-2018 are presented in Table 5.8.

GE estimates have been revised due to the Identification of a mistake in the calculations. More specifically, it was found that GE was calculated with constant milk production of 1990 instead of annual milk production, which was corrected in this submission. The revised GE and the respective EF estimated are presented in Table 5.8

Moreover, GE estimates have been affected of the change of DE from 60 to 68.

Table 5.6. Information for the application of Tier 2 methodology for dairy cattle

Parameter	Value	Source
Average weight (W), kg	550	Department of Agriculture
Net energy maintenance coefficient (Cf_i)	0.386	IPCC Guidelines (cattle, Table 10.4, pg. 10.16, vol. 4)
Activity coefficient (C_a)	0.00	IPCC Guidelines (stall, Table 10.5, pg. 10.17, vol. 4)
Live body weight (BW), kg	550	Department of Agriculture
Growth coefficient (C)	0.8	IPCC Guidelines (eqn.10.6, pg. 10.17, vol. 4)
Mature body weight of an adult animal (MW), kg	550	Department of Agriculture
Daily weight gain (WG), kg/day	0	IPCC Guidelines (footnote 1, pg. 10.12,vol.4)
Fat in milk	3.5%	Recommendation which was identified by technical Expert review team during the Review 2014
Hours of work / day	0	Department of Agriculture
$C_{pregnancy}$	0.10	IPCC Guidelines (table 10.7, pg.10.20, vol.4)
Digestibility of feed, DE	68	Recommendation of the review expert of the TERT

[46] Mr. George Papaioannou, Agricultural Officer, Department of Agriculture, tel. no. +357 22408566

		(comment no. CY-3A-2016-0002)
CH4 conversion rate (Ym)	0.065	IPCC Guidelines (table 10.12, pg.10.30, vol.4)

Table 5.7. Daily milk production per dairy cow (kg) and per cent pregnant population of cows in Cyprus

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Milk production (kg/day/cow)	12.22	12.30	12.25	12.60	12.49	12.90	13.84	14.30
% pregnant population*	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Milk production (kg/day/cow)	15.40	15.07	17.07	15.89	14.77	16.71	15.86	16.41
% pregnant population	81.3	81.3	81.3	81.3	81.3	81.3	81.3	80.3

Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2009**	**2010**	**2011**
Milk production (kg/day/cow)	15.89	14.77	16.71	15.86	16.41	17.95	17.64	17.42
% pregnant population	81.3	81.3	81.3	81.3	80.3	76.3	76.3	72.2

Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Milk production (kg/day/cow)	17.29	16.96	17.18	17.08	19.26	19.68	19.60	
% pregnant population	72.2	72.2	72.2	72.2	72.2	72.2	72.2	

* No data available for 1990-2003, 2010 and 2011. 1990-2003 assumed that is equal to 2004, 2010 assumed equal to 2009 and 2011, 2013 to 2018 assumed equal to 2012.

Table 5.8. Gross energy (GE) and emissions factor (EF) for dairy cattle for the period 1990 – 2018

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
GE (MJ/head/day)	231.8	232.4	232.0	234.9	234.0	237.3	244.8	248.6
EF (kg CH_4/head/yr)	98.8	99.1	98.9	100.1	99.8	101.2	104.4	106.0

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
GE (MJ/head/day)	257.4	254.7	270.9	261.4	252.3	268.0	261.2	265.5
EF (kg CH_4/head/yr)	109.7	108.6	115.5	111.4	107.6	114.3	111.3	113.2

Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GE (MJ/head/day)	270.4	267.3	275.1	277.3	274.9	272.6	271.5	268.9
EF (kg CH_4/head/yr)	115.3	114.0	117.3	118.2	117.2	116.2	115.8	114.6

Year	**2014**	**2015**	**2016**	**2017**	**2018**			
GE (MJ/head/day)	270.7	269.9	287.5	290.8	290.2			
EF (kg CH_4/head/yr)	115.4	115.1	122.5	124.0	123.7			

Non-dairy cattle, sheep, goats, horses, mules and asses and swine; Tier 1

The methane emission factors used for enteric fermentation of non-dairy cattle, sheep, goats, horses, mules and asses and swine for the application of the Tier 1 methodology, are according to the IPCC 2006 guidelines (volume 4, pg. 10.29, Table 10.11) and are presented in Table 5.9. Poultry emissions were not estimated, since an emission factor is not available in the IPCC guidelines (volume 4, pg.10.28, Table 10.10). The animal populations used are presented in Table 5.5.

Table 5.9. Methane emission factor applied for enteric fermentation, according to animal

	Emission factor (kg CH_4/head)	Source
Non-dairy cattle	57	IPCC 2006, pg. 10.29, volume 4, western Europe*
Sheep	8	IPCC 2006, pg. 10.28, volume 4, developed
Swine	1.5	IPCC 2006, pg. 10.28, volume 4, developed
Horses	18	IPCC 2006, pg. 10.28, volume 4, developed
Mules and asses	10	IPCC 2006, pg. 10.28, volume 4, developed
Goats	5	IPCC 2006, pg. 10.28, volume 4, developed

* Milk production closer to North America but production system as Western Europe

5.2.2. Uncertainties and time-series consistency

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

5.2.3. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. Animal population is compared between four data sources: Statistical Service, DLI, EUROSTAT and Department of Agriculture.

5.2.4. Category-specific recalculations

3.A.4 Mules and asses : CH_4 emissions were recalculated for the years 2011-2017 due to updated number of mules and asses. The source of the animal population is the Cyprus Veterinary Services,

5.2.5. Category-specific planned improvements

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

5.3. Manure management (3B)

The term ‘manure’ is used here collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock. The decomposition of manure under anaerobic conditions (i.e., in the absence of oxygen) during storage and treatment, produces CH4. Emissions of CH4 related to manure handling and storage are reported under ‘Manure Management.’ The main factors affecting CH4 emissions are the amount of manure produced and the portion of the manure that decomposes anaerobically. The former depends on the rate of waste production per animal and the number of animals, and the latter on how the manure is managed.

Direct N2O emissions occur via combined nitrification and denitrification of nitrogen contained in the manure. The emission of N2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment. The production and emission of N2O from managed manures requires the presence of either nitrites or nitrates in an anaerobic environment preceded by aerobic conditions necessary for the formation of these oxidized forms of nitrogen.

5.3.1. Category description

5.3.1.1. Animal waste management in Cyprus[47]

Most small-scale pig farms in Cyprus use mechanical separation for the treatment of their waste. The separated liquid is sent to evaporation lagoons or is used for irrigation, and the solid fraction is used as soil improver. Nine large pig farms have installed a combination of anaerobic / aerobic treatment plants (Anaerobic digestion). The treated liquid fraction is used for irrigation or washing the housing areas or placed in evaporation lagoons. The produced biogas is combusted onsite by Combined Heat Power generators for the production of heat and electricity. Both heat and electricity are consumed at the farms. Any excess electricity is sold to the electricity provider and directed to the electricity distribution network. Heat is not distributed outside the farm because there is no heat distribution network in Cyprus. The emissions from the electrical energy from the biogas used onsite and offsite has been taken into account in the energy sector according to the national energy balance.

The waste from cattle, sheep, goats, horses, mules and asses are collected and left to dry before applied on land for soil improver (Solid storage and dry lot). Poultry waste is characterised by high content of solids (almost dry) and it is collected, left to dry and then used as soil improver (Solid storage and dry lot).

Manure management is responsible for methane and nitrous oxide emissions. Methane is produced during the anaerobic decomposition of manure, while nitrous oxide is produced during the storage and treatment of manure before its use as fertilizer.

Emissions from manure management in 2018 accounted for 1.3% of the total national emissions without LULUCF. CH_4 and N_2O from manure management in 2018 accounted for 16% and 37% of GHG emissions from Agriculture respectively. Total emissions in 2018 decreased by 13% compared to 1990 levels because of the improvement of waste management practices. CH_4 and N_2O emissions from manure management for the period 1990 – 2018 are presented in Table 5.10 and Figure 5.3.

Table 5.10. CH_4 and N_2O emissions from manure management for 1990 – 2018

Gg CO2 eq.	1990	2000	2005	2010	2015	2017	2018
B. Manure management	**135.58**	**181.96**	**170.73**	**158.57**	**116.35**	**117.8**	**118.25**
1. Cattle	17.80	18.00	18.99	17.96	18.99	21.66	21.66
Dairy cattle	10.99	11.51	12.04	11.40	12.35	14.23	15.04
Non-dairy cattle	6.88	6.38	6.89	6.44	6.38	7.12	7.62
2. Sheep	10.46	8.87	9.69	11.87	10.69	11.58	11.21
3. Swine	62.30	92.00	82.81	74.02	42.31	37.97	35.57
4. Other livestock	20.48	31.71	28.19	24.48	18.92	19.65	20.76
Goats	9.99	18.46	16.07	14.98	11.39	12.55	12.21
Horses	0.07	0.14	0.17	0.12	0.07	0.05	0.04
Mules and Asses	0.44	0.16	0.10	0.06	0.05	0.05	0.11
Poultry	9.97	12.95	11.85	9.33	7.42	7.01	8.4
Other	NO	NO	NO	NO	NO	NO	NO
5. Indirect N_2O emissions	24.38	31.54	31.18	30.47	25.95	27.51	28.04

[47] Kythreotou, N., G. Florides, S.A. Tassou, 2010. Production and management of biodegradable waste in Cyprus a paper published in the proceedings of SEEP2010 Conference Proceedings, June 29th– July 2nd 2010, Bari, Italy

CH4 (Gg)	2.78	3.86	3.56	3.24	2.12	2.03	2.01
N2O (Gg)	0.22	0.29	0.27	0.26	0.21	0.22	0.23
Total (Gg CO2 eq.)	135.6	182.0	170.7	158.6	116.4	117.8	118.3

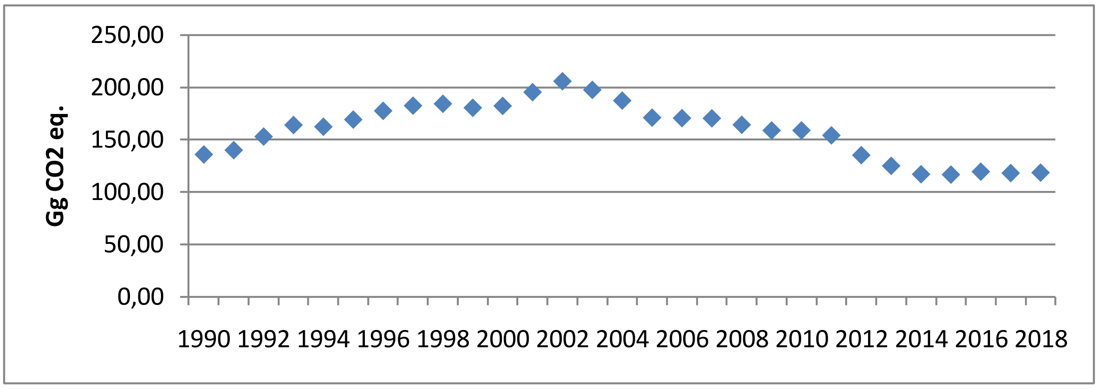

Figure 5.3. Emissions from manure management, 1990 – 2018

5.3.2. Methodological issues

5.3.2.1. CH_4 emissions (3B1)

The best way to determine emission factors is to conduct non-invasive or non-disturbing measurements of missions in actual systems representative of those in use in the country. These field results can be used to develop models to estimate emission factors (Tier 3). Such measurements are difficult to conduct, and require significant resources and expertise, and equipment that may not be available. There are two alternatives for developing emission factors, with the selection of emission factors depending on the method (i.e., Tier 1 or Tier 2) chosen for estimating emissions. Tier 2 methodology is applied for swine, dairy and other cattle, and Tier 1 applied for sheep, horses, goats, poultry mules and asses.

Tier 1: When using the Tier 1 method, methane emission factors by livestock category or subcategory are used (Table 5.11). The EFs for manure management were chosen according to the manure management practices that are applied in Cyprus for the particular specie[48]. The animal population used is presented in Table 5.5.

Table 5.11. Emission factors used for the estimation of methane emissions from manure management

Animal	kg CH_4/head/yr	Source
Sheep	0.28	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate
Goats	0.20	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4– developed countries, temperate
Horses	2.34	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate
Mules and asses	1.10	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate
Laying chicken	0.03	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate/dry
Broiler chicken	0.02	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate
Turkeys	0.09	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 –

[48]The choice for the EFs was based on personal communication with Mr. Antis Athanasiades the responsible officer for manure management at the Department of Environment (Pollution Prevention Unit, aathanasiades@environment.moa.gov.cy, +35722408935).

Animal	kg CH_4/head/yr	Source
		developed countries, temperate
Other Poultry	0.03	Table 10.15, pg.10.40, IPCC 2006 guidelines, volume 4 – developed countries, temperate/ducks

Tier 2: The Tier 2 method relies on two primary types of inputs that affect the calculation of methane emission factors from manure: Manure characteristics and Manure management system characteristics. Manure characteristics includes the amount of volatile solids (VS) produced in the manure and the maximum amount of methane able to be produced from that manure (Bo). Volatile substance excretion (VS) and Bo are as recommended for Eastern Europe by 2006 IPCC Guidelines in Annex 10A.2 (Table 5.12). Manure management system characteristics, includes the types of systems used to manage manure and a system-specific methane conversion factor (MCF) that reflects the portion of Bo that is achieved. For the development of the EF equation 10.23 (pg. 10.41, vol. 4, 2006 IPCC guidelines) is applied. Waste management practices applied according to animal type is presented in Table 5.13. Information on waste management practices has been obtained from personal communication with Mr. Antis Athanasiades (Environment Officer, Pollution Control Unit[49]), due to unavailability of any other references on distribution of animal waste to waste management practice. The emissions are estimated by multiplying the EF developed by the animal population (Table 5.5).

Table 5.12. Volatile substance excretion (VS) and Bo for T2 methodology (2006 IPCC Guidelines, vol. 4, Annex 10A.2)

Animal	VS (kg/hd/day)	Bo (m^3CH4/kg VS)	Table
Dairy cows	4.5	0.24	10A-4
Other cattle	2.7	0.17	10A-5
Market swine	0.3	0.45	10A-7
Breeding swine	0.5	0.45	10A-8

Table 5.13. Waste management per technology contribution

Animal	1990-2000	2001	2002	2003	2004	2005	2006
Dairy Cattle							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Anaerobic digestion	0%	0%	0%	0%	0%	0%	0%
Non-Dairy Cattle							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Anaerobic digestion	0%	0%	0%	0%	0%	0%	0%
Sheep							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Goats							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Horses							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Mules and asses							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Market Swine							
Aerobic treatment	100%	97%	94%	91%	88%	85%	82%
Anaerobic digestion	0%	3%	6%	9%	12%	15%	18%
Breading Swine							
Aerobic treatment	100%	97%	94%	91%	88%	85%	82%
Anaerobic digestion	0%	3%	6%	9%	12%	15%	18%
Poultry							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	98%
Anaerobic digestion	0%	0%	0%	0%	0%	0%	2%
Animal	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Dairy Cattle							
Solid storage and dry lot	100%	99%	99%	99%	99%	97%	97%

[49] 15/11/2017, Tel. +357 22 408935, email aathanasiades@environment.moa.gov.cy

Anaerobic digestion	0%	1%	1%	1%	1%	3%	3%
Non-Dairy Cattle							
Solid storage and dry lot	100%	99%	99%	99%	99%	97%	97%
Anaerobic digestion	0%	1%	1%	1%	1%	3%	3%
Sheep							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Goats							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Horses							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Mules and asses							
Solid storage and dry lot	100%	100%	100%	100%	100%	100%	100%
Market Swine							
Aerobic treatment	79%	76%	73%	70%	70%	60%	60%
Anaerobic digestion	21%	24%	27%	30%	30%	40%	40%
Breading Swine							
Aerobic treatment	79%	76%	73%	70%	70%	60%	60%
Anaerobic digestion	21%	24%	27%	30%	30%	40%	40%
Poultry							
Solid storage and dry lot	96%	94%	92%	90%	90%	90%	90%
Anaerobic digestion	4%	6%	8%	10%	10%	10%	10%
Animal	**2014**	**2015**	**2016**	**2017**	**2018**		
Dairy Cattle							
Solid storage and dry lot	95%	95%	95%	95%	95%		
Anaerobic digestion	5%	5%	5%	5%	5%		
Non-Dairy Cattle							
Solid storage and dry lot	95%	95%	95%	95%	95%		
Anaerobic digestion	5%	5%	5%	5%	5%		
Sheep							
Solid storage and dry lot	100%	100%	100%	100%	100%		
Goats							
Solid storage and dry lot	100%	100%	100%	100%	100%		
Horses							
Solid storage and dry lot	100%	100%	100%	100%	100%		
Mules and asses							
Solid storage and dry lot	100%	100%	100%	100%	100%		
Market Swine							
Aerobic treatment	50%	50%	50%	45%	40%		
Anaerobic digestion	50%	50%	50%	55%	60%		
Breading Swine							
Aerobic treatment	50%	50%	50%	45%	40%		
Anaerobic digestion	50%	50%	50%	55%	60%		
Poultry							
Solid storage and dry lot	90%	85%	80%	80%	80%		
Anaerobic digestion	10%	15%	20%	20%	20%		

5.3.2.2. N_2O emissions (3B2)

The level of detail and methods chosen for estimating N2O emissions from manure management systems depend upon national circumstances. Tier 2 methodology is applied for calculating direct N2O emissions from manure management systems as follows:

Tier 2 entails multiplying the total amount of N excretion (from all livestock species/categories) in each type of manure management system by an emission factor for that type of manure management system (Equation 10.25, pg. 10.54, vol. 4, 2006 IPCC Guidelines). Emissions are then summed over all manure management systems. IPCC default N2O emission factors and default nitrogen excretion data, whereas manure management system data is country specific.

The annual nitrogen excretion rate per animal type using the nitrogen excretion rates (kg N ex/animal/year) is shown in Table 5.14. These are the defaults proposed by the IPCC methodologies. The Nitrogen excretion rate has been determined by the IPPC 2006 Guidelines equation 10.30, pg. 10.57. The animal population used is presented in Table 5.5. It should be noted that Cyprus has used Western Europe default values for N excretion and Eastern Europe default values for CH4 for manure management. The reason of different approach is that manure management practises for cattle waste used in Cyprus are more appropriate to be categorised under Eastern Europe. However for the calculation of the N2O emissions from manure management, the factor has been changed to Western Europe, due to the high milk production, based on the comment received by the UNFCCC review team in 2013.

Table 5.14. Default values for Nitrogen excretion rate (IPCC 2006 guidelines, volume 4, table 10.19, pg. 10.59)

Animal	Default values for Nitrogen excretion rate (kg N /animal/day)
Dairy Cattle	0.48
Non-Dairy Cattle	0.33
Market swine	0.51
Breading swine	0.42
Sheep	0.85
Poultry	0.83
Goats	1.28
Horses	0.26
Mules and asses	0.26

The annual nitrogen excretion per waste management system is estimated by multiplying the % of waste allocated to a particular system by the estimated annual nitrogen excretion per animal type. The total annual nitrogen excretion per waste management system (regardless animal type) is then multiplied by the kgN2O-N/kg N ex coefficient, to estimate the N_2O emissions. The kgN2O-N/kg N ex coefficients used are presented in Table 5.15.

Table 5.15. kg N_2O-N/kg N ex coefficients per technology used

Animal	kgN_2O-N/kg N ex	Source
Solid storage and dry lot	0.005	2006 IPCC Guidelines, volume 4, pg. 10.62, table 10.21
Aerobic treatment (forced aeration)	0.005	
Anaerobic digestion	0.000	

3B2.5. Indirect N_2O emissions from Manure Management

I. Indirect N_2O emissions from volatilisation of N from Manure Management

To estimate the indirect N2O emissions from manure management four steps were applied, according to Tier 1 methodology: (a) Estimation of annual nitrogen excretion per animal type (kg N ex/year), (b) Allocation of waste to waste management system used, (c) Estimation of amount of manure nitrogen that is lost due to volatilisation (d) Estimation of N2O emissions using the totals volatilisation N-losses (kg N/yr). The indirect N2O emissions were estimated using the equation 10.27 (pg. 10.56, volume 4 2006 IPCC guidelines):

The annual nitrogen excretion per animal type using the nitrogen excretion rates (kg N ex/animal/year) is shown in Table 5.13. These are the defaults proposed by the IPCC methodologies. The animal population used is presented in Table 5.5.

The distribution of waste to the waste management systems has been estimated based on the information presented in Table 5.14.

The annual amount of manure nitrogen that is lost due to volatilisation ($N_{volatilisation-MMS}$) is estimated by multiplying the % of waste allocated to a particular waste management system by the annual nitrogen excretion per animal estimated in step (a) and by multiplying the % of managed manure nitrogen for livestock category T in the manure system S ($Frac_{GASMS}$ (%)). The per cent of managed manure nitrogen for livestock is presented in Table 5.16.

The total annual amount of manure nitrogen that is lost due to volatilisation ($N_{vol.atilization\ -MMS}$) is multiplied by the emission factor for N2O emissions from atmospheric deposition of nitrogen on soils and water surfaces (EF_4) to estimate the N2O emissions. The emission factor used is 0.01 kg N2O-N (default value). The equation used to estimate the indirect N2O emissions from volatilisation summarised in the equation $N_2O_{G(mm)} = (N_{volatilisation\ -MMS} * EF_4) * 44/28$.

Table 5.16. Default values for volatilisation N losses

Animal	Manure management system	N volatilisation losses	Source
Dairy cattle	Solid storage	30%	Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines
	Anaerobic digestion	40%	Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared by EU experts in Oct 2018
Non-dairy cattle	Solid storage	45%	Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines
	Anaerobic digestion	40%	Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared by EU experts in Oct 2018
Market swine	Anaerobic digestion	48%	Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared by EU experts in Oct 2018
	Aerobic treatment	48%	Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines
Breeding swine	Anaerobic digestion	48%	Assume same as liquid: based on recommendation from review during EU review 2018, according to a follow-up paper on N-cycle prepared by EU experts in Oct 2018
	Aerobic treatment	48%	Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines
Sheep	Solid storage	12%	No default available for this animal - use other. IPCC guidelines, volume 4, pg. 10.65, table 10.22
Goats	Solid storage	12%	
Horses	Solid storage	12%	
Mules and Asses	Solid storage	12%	
Poultry	Solid storage	40%	Table 10.22, pg. 10.65, vol. 4, 2006 IPCC guidelines: Poultry with litter
	Anaerobic digestion	40%	Assume same as solid storage: based on recommendation from review during EU review 2018*

* anaerobic digestion decreases the N losses from the poultry manure in form of NH3. The time of the pre-storage is not too long and the digestate is stored covered.

II. Indirect N_2O emissions from leaching and runoff of nitrogen from manure management

Tier 2 calculation of N volatilisation in forms of NH3 and NOx from manure management systems is based on multiplication of the amount of nitrogen excreted (from all livestock categories) and managed in each manure management system by a fraction of volatilised nitrogen (see Equation 10.26, pg. 10.54, vol. 4, 200 IPCC Guidelines). N losses are then summed over all manure management systems.

The Tier 2 method is applied using default nitrogen excretion data, default fractions of N losses and country specific manure management system data.

Indirect N2O emissions from leaching and runoff of nitrogen from manure management have been estimated using eqns. 10.28 and 10.29 (pg. 10.56 - 10.57, vol. 4) of the IPCC 2006 guidelines. The annual nitrogen excretion per animal type using the nitrogen excretion rates (kg N ex/animal/year) is shown in Table 5.13. These are the defaults proposed by the IPCC methodologies. The animal population used is presented in Table 5.5.

Due to fact that CY has (a) low precipitation during very little time period in a year; (b) uncovered solid manure storage (therefore some leaching takes place), it was decided to change the Frac(leachMS) from 10% to the lowest recommended from the typical range proposed by the guidelines is 1-20% (pg. 10.56, vol. 4); i.e. 1%.

The default emission factor for N2O emissions from nitrogen leaching and runoff, kg N2O-N/kg N leached and runoff (EF5) proposed by the IPCC guidelines is used, 0.0075 kg N2O-N (kg N leaching/runoff)-1 (vol. 4, Chapter 11, Table 11.3).

5.3.3. Uncertainties and time-series consistency

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

5.3.4. Category-specific QA/QC and verification

QA/QC and verification activities are presented in Section 1.2.3. Animal population is compared between four data sources: Statistical Service, DLI, EUROSTAT and Department of Agriculture.

5.3.5. Category-specific recalculations

N2O emissions from other cattle and mules and asses were recalculated due to changes to the animal mass and animal population respectively.

a) Non-dairy cattle: The weighted average mass was calculated taking into consideration the age subcategories presented in the table below:

Table 5.17. Non-dairy cattle Mass

Age (months)	Weight (Kg)
0 to 8	227
8 to 12	318
12 to 16	408
16 to 24	544

The impact on the emissions is presented below:

Table 5.18. Recalculations for N2O emissions for non-dairy cattle

Gg N2O	1990	1991	1992	1993	1994	1995
2019 submission	0.0107	0.0106	0.0106	0.0117	0.0122	0.0128
2020 submission	0.0110	0.0109	0.0110	0.0120	0.0124	0.0130

% change	-2.41%	-2.77%	-3.32%	-2.88%	-1.57%	-1.42%
Gg N2O	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
2019 submission	0.0142	0.0122	0.0106	0.0100	0.0102	0.0096
2020 submission	0.0145	0.0122	0.0106	0.0099	0.0099	0.0097
% change	-2.00%	0.29%	-0.06%	1.42%	3.35%	-0.86%
Gg N2O	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
2019 submission	0.0106	0.0106	0.0113	0.0109	0.0107	0.0103
2020 submission	0.0105	0.0103	0.0110	0.0107	0.0104	0.0102
% change	1.11%	2.96%	3.19%	2.07%	2.44%	0.85%
Gg N2O	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2019 submission	0.0105	0.0101	0.0103	0.0108	0.0105	0.0105
2020 submission	0.0101	0.0098	0.0099	0.0102	0.0096	0.0095
% change	4.07%	3.21%	4.24%	5.71%	8.90%	10.90%
Gg N2O	**2014**	**2015**	**2016**	**2017**		
2019 submission	0.0108	0.0103	0.0113	0.0115		
2020 submission	0.0098	0.0094	0.0104	0.0105		
% change	10.05%	9.58%	9.10%	9.90		

b) Mules and asses: The N2O emissions were recalculated for the time series 2011-2017 due to change in the animal population. The data source is the Veterinary Service. The impact on the emissions is presented below:

Table 5.19. Recalculations for N2O emissions for mules and asses

Gg N2O	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
2019 submission	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2020 submission	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002
% change	-7.71%	-25.49%	-43.84%	-53.21%	-59.91%	-65.19%
Gg N2O	**2017**					
2019 submission	0.0001					
2020 submission	0.0002					
% change	-73.11%					

5.3.6. Category-specific planned improvements

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

5.4. Rice cultivation (CRF source category 3C)

Not occurring.

5.5. Agricultural soils (3D)

Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. Nitrification is the aerobic microbial oxidation of ammonium to nitrate, and denitrification is the anaerobic microbial reduction of nitrate to nitrogen gas (N2). Nitrous oxide is a gaseous intermediate in the reaction sequence of denitrification and a by-product of nitrification that leaks from microbial cells into the soil and ultimately into the atmosphere. One of the main controlling factors in this reaction is the availability of inorganic N in the soil. This methodology, therefore, estimates N2O emissions using human-induced net N additions to soils (e.g., synthetic or organic fertilizers, deposited manure, crop residues, sewage sludge). Direct emissions of N2O from managed soils are estimated separately from indirect emissions, though using a common set of activity data.

Total emissions from agricultural soils in 2018 contributed 24% to the emissions from agriculture and 1.3% to the total emissions of the country (excluding LULUCF). Agricultural soils also contributed 41% to the N2O emissions of the country excluding LULUCF. Total emissions from soils in 2018 reduced by 11% compared to 1990. Emissions from agricultural soils for the period 1990 – 2018 are presented in Table 5.20 and Figure 5.5.

Table 5.20. N_2O emissions from agricultural soils for 1990 – 2018

Gg CO2 eq.	**1990**	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**
3D1. Direct N2O emissions from managed soils	118.10	124.27	113.94	117.64	99.47	103.56	102.73
1. Inorganic N fertilizers	58.19	49.34	40.24	43.87	35.28	36.72	36.64
2. Organic N fertilizers	55.41	72.51	70.24	70.64	60.05	64.72	64.60
a. Animal manure applied to soils	55.33	72.29	69.76	69.73	59.03	63.75	63.13
b. Sewage sludge applied to soils	0.07	0.22	0.48	0.74	0.13	0.23	0.13
c. Other organic fertilizers applied to soils	NO	NO	NO	0.16	0.89	0.74	0.74
3. Urine and dung deposited by grazing animals	NO	NO	NO	NO	NO	NO	NO
4. Crop residues	4.50	2.41	3.46	3.13	4.14	2.12	1.49
5. Mineralization/ immobilization associated with loss/gain of soil organic matter	NO	NO	NO	NO	NO	NO	NO
6. Cultivation of organic soils	NO	NO	NO	NO	NO	NO	NO
7. Other	NO	NO	NO	NO	NO	NO	NO
3D2. Indirect N2O Emissions from managed soils	16.90	19.44	18.07	18.51	15.54	16.62	16.44
1. Atmospheric deposition	16.90	19.44	18.07	18.51	15.54	16.62	16.44
2. Nitrogen leaching and run-off	NO	NO	NO	NO	NO	NO	NO
N2O (Gg)	0.45	0.48	0.44	0.46	0.39	0.40	0.34
Total (Gg)	**0.45**	**0.48**	**0.44**	**0.46**	**0.39**	**0.40**	**0.34**

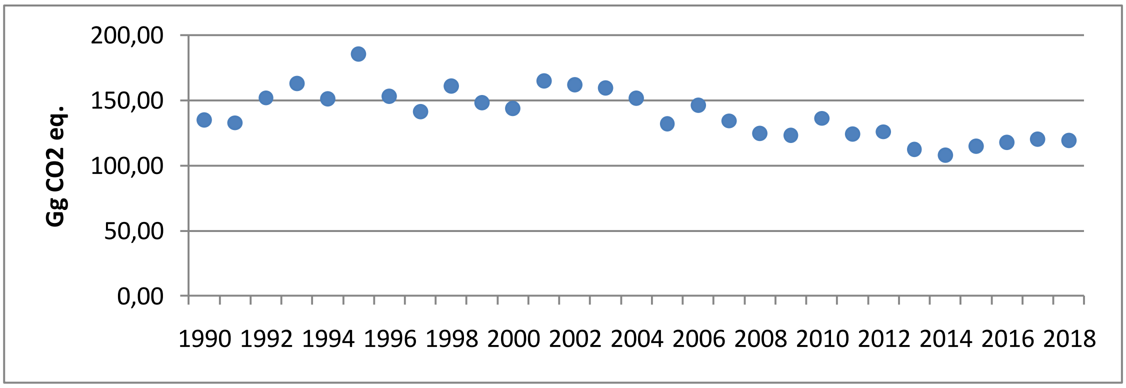

Figure 5.4. N2O emissions from agricultural soils 1990 – 2018 (Gg CO2 eq.)

5.5.1. Direct N2O emissions from managed soils (3D1)

In most soils, an increase in available N enhances nitrification and denitrification rates which then increase the production of N2O. Increases in available N can occur through human-induced N additions or change of land-use. The following N sources are included in the methodology for estimating direct N2O emissions from managed soils: synthetic N fertilizers (FSN), organic N applied as fertiliser (e.g., animal manure, compost, sewage sludge, rendering waste) (FON), urine and dung N deposited on pasture, range and paddock by grazing animals (FPRP), N in crop residues (above-ground and below-ground), including from N-fixing crops and from forages during pasture renewal (FCR).

N mineralisation associated with loss of soil organic matter resulting from change of land use or management of mineral soils (FSOM); and drainage/management of organic soils (FOS) are not considered for the GHG inventory of Cyprus as there is no management of mineral soils and organic soils in Cyprus[50].

5.5.1.1. Methodological issues

In its most basic form, direct N2O emissions from managed soils are estimated using Equation 11.1 in the 2006 IPCC Guidelines (vol. 4, pg. 11.7) using the following:

Inorganic N fertilizers (3D1.1)

N_2O emissions from the use of inorganic N fertilizers were estimated using Tier 1 methodology suggested by the 2006 IPCC Guidelines. Emission factor EF1 (kg N2O-N/kg N) is assumed 0.01, as proposed by the 2006 IPCC Guidelines (Table 11.1, pg.11.11, volume 4, 2006 IPCC guidelines). Activity data is obtained from the Department of Agriculture[51].

Table 5.21. N input from application of inorganic fertilizers for the period (in kt) 1990-2018

Year	1990	1991	1992	1993	1994	1995	1996	1997
Inorganic fertilizers (kg N)	12.426	12.169	14.760	16.189	14.289	20.526	13.628	11.126

Year	1998	1999	2000	2001	2002	2003	2004	2005
Inorganic fertilizers (kg N)	14.601	11.561	10.537	12.359	10.579	11.198	10.738	8.593

Year	2006	2007	2008	2009	2010	2011	2012	2013
Inorganic fertilizers (kg N)	11.291	8.198	7.499	7.674	9.369	7.138	8.319	7.051

Year	2014	2015	2016	2017	2018			
Inorganic fertilizers (kg N)	6.693	7.533	8.073	7.841	7.824			

Organic N fertilizers - Animal Manure applied to soils (3D1.2a)

Tier 1 methodology of the 2006 IPCC Guidelines is applied. The estimate of managed manure nitrogen available for application to managed soils is based on the equation 10.34 in the 2006 IPCC Guidelines (vol. 4, pg. 10.56). Animal population used is as presented in Table 5.5, annual average N excretion per animal of species/ category T in the country is based on defaults proposed by the 2006 IPCC Guidelines (Table 5.15 above), while the fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country is as presented in Table 5.17. The amount of managed manure nitrogen for livestock category T that is lost in the manure

[50] personal communication Melina Menelaou, LULUCF expert, Climate Action Unit, Department of Environment (tel. +357 22 408959, mmenelaou@environment.moa.gov.cy)

[51] George Theophanous, Agriculture Officer, Department of Agriculture (tel. +357 22464028, gtheophanous@da.moa.gov.cy) – Fertilizer Control Board

management system S $Frac_{LossMS}$ (%) is shown in Table 5.22 – defaults recommended by the 2006 IPCC Guidelines (Table 10.22, pg. 10.65, vol. 4). The amount of estimated volatilisation N-losses is presented in Table 5.23. Amount of nitrogen from bedding is not known therefore assumed 0.

Managed manure nitrogen available for application to managed soils is then multiplied by the default emission factor for N2O emissions from N inputs EF1 (0.01 kg N2O-N/kg N) as recommended by the 2006 IPCC Guidelines (table 11.1, pg.11.11, vol.4) and converted to N2O by multiplication with 44/28.

Table 5.22. Default values for nitrogen loss due to volatilisation of NH3 and NOx from manure management

Animal	Manure management system	N loss due to volatilisation of NH3 and NOx from manure management
Dairy cattle	Solid storage	60%
	Anaerobic digestion	60%
Non-dairy cattle	Solid storage	50%
	Anaerobic digestion	60%
Market swine	Anaerobic digestion	52%
	Aerobic treatment	52%
Breeding swine	Anaerobic digestion	52%
	Aerobic treatment	52%
Sheep	Solid storage	85%
Goats	Solid storage	85%
Horses	Solid storage	85%
Mules and Asses	Solid storage	85%
Poultry	Solid storage	50%
	Anaerobic digestion	50%

Table 5.23. Volatilisation N-losses (kg N)

	1990	1991	1992	1993	1994	1995	1996	1997
Volatilisation N-losses (kg N)	11834	11908	12231	12720	12697	13108	13678	14489

	1998	1999	2000	2001	2002	2003	2004	2005
Volatilisation N-losses (kg N)	14635	14752	15419	17028	17950	16795	16138	14881

	2006	2007	2008	2009	2010	2011	2012	2013
Volatilisation N-losses (kg N)	14952	15590	14498	14131	14866	14701	13933	12787

	2014	2015	2016	2017	2018			
Volatilisation N-losses (kg N)	12647	12558	13060	13562	13609			

Organic N fertilizers - Sewage sludge applied to soils (3D1.2b)

Tier 1 methodology of the 2006 IPCC Guidelines is applied. The treated sewage sludge applied to land data was obtained from the national statistics and the relevant reports from the Department of Environment[52]. Data was available for all wastewater treatment plants for the years 2004 and 2005. Data for the public waste water treatment plants was available for 2004-2012. All data was available in tonnes of dry matter. The sewage sludge used in agriculture during 1990-2003 and 2006-2014, was

[52] Perikenti, S. 2011&2013. Questionnaire according to Commission Decision 94/741/EC for the report of the Member States on the transposition and implementation of Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture, amended by Directive 91/692/EEC. Department of Environment

estimated using (a) the ratio of the public treatment plants compared to all treatment plants for 2004 and 2005 and (b) the percentage of the population served by a sewer system data for 1997 to 2004. The resulting data is presented in Table 5.25. Information on population connected to UWWS (%) on which the estimation on sludge production is based is available only until 2015. To estimate emissions for 2016, it was assumed that the population connected is the same as 2015; therefore sludge production used in agriculture is the same.

Nitrogen content per kg dry sludge was assumed 3% for all years and was obtained from S. Perikenti[53]. The resulting nitrogen in sewage sludge applied on land is presented in Table 5.25. The fraction of N input converted to N_2O (EF6) is assumed 0.01 kg N_2O-N/kg sewage-N produced, as proposed by the IPCC guidelines.

Table 5.24. Dry sludge applied to soils and nitrogen in sewage sludge (kg)

	1990	1991	1992	1993	1994	1995
Dry sludge (kg)	517390	583589	704000	748000	737000	891000
Nitrogen in sewage sludge (kg)	15522	17508	21120	22440	22110	26730

	1996	1997	1998	1999	2000	2001
Dry sludge (kg)	1232000	1320000	1408000	1463000	1573000	1749000
Nitrogen in sewage sludge (kg)	36960	39600	42240	43890	47190	52470

	2002	2003	2004	2005	2006	2007
Dry sludge (kg)	2013000	2530000	3135000	3427000	3116000	5745000
Nitrogen in sewage sludge (kg)	60390	75900	94050	102810	93480	172350

	2008	2009	2010	2011	2012	2013
Dry sludge (kg)	6515000	7903000	5294000	3912000	2756000	2924000
Nitrogen in sewage sludge (kg)	195450	237090	158820	117360	82680	87720

	2014	2015	2016	2017	2018	
Dry sludge (kg)	1391000	936000	1613100	1075000	937000	
Nitrogen in sewage sludge (kg)	41730	28080	48393	32250	28110	

Other organic fertilizers applied to soils (3D1.2c)

Even though there is overproduction of compost in Cyprus, all produced compost is stored as there is no demand for application on land.[54] Nevertheless to exclude the possibility of underestimating emissions, for the purposes of estimation of emissions from this source, it was assumed that all compost produced from waste management activities is consumed in-country by agriculture. Data on composting in Cyprus has been first collected in 2010 (Table 5.25). Information on other qualitative parameters of the compost applied on land and used for the calculations has been obtained from one of the largest green waste management companies of Cyprus: 96% dry matter and 1.0187 % N . N2O emissions are estimated by multiplying the calculated Ncomp by EF1 (0.01 default, table 11.1, pg. 11.11, vol.4, 2006 IPCC guidelines) and then by 44/28.

Table 5.25. Activity data used for the calculation of N2O emissions from Other organic fertilizers applied to soils (3D1.2c)

	2010	2011	2012	2013	2014
TOTAL composting (1000t wet mass)	7.89	14.95	22.98	19.62	29.58
wet compost (kg)	7890000	14950000	22980000	19620000	29580000
Dry compost (kg)	3156000	5980000	9192000	7848000	11832000
N COMP (kg N)	34306	65003	99917	85308	128614

[53] Environment Officer responsible for sewage treatment plants, email dated 18/10/2013

[54] Personal communication with Constantinos Ioannides (10/11/2017), Waste management permitting officer, Pollution Prevention Unit, Department of Environment (tel. +357 22408958, cioannides@environment.moa.gov.cy)

	2015	2016	2017	2018	
TOTAL composting (1000t wet mass)	43.86	43.49	36.52	36.52	
wet compost (kg)	43860000	43490000	36520000	36520000	
Dry compost (kg)	17544000	17396000	14608000	14608000	
N COMP (kg N)	190703	189095	158789	158789	

Urine and dung deposited by grazing animals (3D1.3)

Not occurring: A very small percentage of the sheep and goats are grazing; however no information is available to make an estimation or an assumption on the population grazing[55].

Crop residues (3D1.4)

The term FCR refers to the amount of N in crop residues (above-ground and below-ground), including N-fixing crops, returned to soils annually. It is estimated from crop yield statistics and default factors for above-/belowground residue to yield ratios and residue N contents. In addition, the method accounts for the effect of residue burning or other removal of residues. Because different crop types vary in residue to yield ratios, renewal time and N contents, separate calculations are performed for major crop types and then N values from all crop types are summed up. Equation 11.6 in the 2006 IPCC Guidelines (pg. 11.14, vol. 4) provides the equation to estimate N from crop residues and forage/pasture renewal, for a Tier 1 approach.

Crop production (t/yr) and cultivated area (ha) data per crop is obtained from Statistical Service (Table 5.26). Crop yield is estimated by dividing the crop production by the area; the results are tabulated in Table 5.26. Harvested annual dry matter yield per crop (Crop(T)) is estimated by multiplying the 2006 IPCC Guidelines default dry matter fraction (DRY) (Table 5.25 obtained from table 11.2, pg.11.17, vol.4) with the estimated Crop yield (YieldFresh) (eqn 11.7, pg.11.15, vol.4, 2006 IPCC Guidelines). Using the defaults values shown in Table 5.26 for Slope, Intercept, NAGT, RBGT and NBGT (table 11.2, pg.11.17, vol.4) above ground residue dry matter AGDM_T (kg/ha) and ratio of above-ground residues dm to harvested crop RAGT (kg/dm) are estimated. The results are shown in Table 5.26.

FracBURN (kg N/kg crop-N) shown in Table 5.26, is considered as default for developing countries in 1990 (0.25) linearly declined to default for developed (0.1) in 2008. After that year, this factor has been kept constant. This assumption was based on general knowledge of the sector and in the fact that a normative banning crop residues burning came into place in 2003. The relevant legislation is the Fire Prevention of Outdoors Law of 1988 (220/1988) as amended by 109(I)2002. 0.1 is used because according to the expert judgement of firefighters there is illegal burning of agricultural residues taking place, based on observations in the field. There are no statistics on this type of fires. No details are available to support any deviation from the 10% default.

The resulting estimations of area burnt are presented in Table 5.26. For the calculation of FCR, FracRenewT and FracRemoveT are assumed 1 and 0 respectively according to defaults proposed by 2006 Guidelines (pg.11.14, vol.4).

Due to unavailability of proposed defaults for Cf for crops other than wheat in the 2006 IPCC Guidelines, a desk study was performed for the values used by countries with similar climatic conditions with Cyprus; i.e. Greece, Spain, Malta and Italy. Malta and Spain report Cf as NO. Values for Cf used are presented in Table 5.27. The values used by Greece were used for Barley and Oats, while for Beans & pulses (legumes) and Potatoes (tubers) 0.40 was used, based on the expert judgement of Dr. Michalis Omirou[56]. In previous submissions, Cf was considered the same as wheat for all crops. This has resulted in recalculation of FCR for the whole time series for all crops except wheat.

[55] Personal communication with Dr. Petros Mavromatis (22/11/2017), head of sheep and goat farming division, Department of Agriculture (tel. +357 22408555, pmavrommatis@da.moa.gov.cy)

[56] personal Communication 16/11/2017 Dr. Michalis Omirou, Agricultural Research Officer, Agricultural Research Institute (Tel. +357-22403146, michalis.omirou@ari.gov.cy)

N2O emissions are estimated by multiplying the calculated FCR by EF1 (0.01 default, table 11.1, pg. 11.11, vol.4, 2006 IPCC guidelines) and then by 44/28.

Table 5.26. Crop production (t/yr), cultivated area (ha), Crop yield (kg/ha), CropT (kg dm/ha), above ground residue dry matter $AGDM_T$ (kg/ha), ratio of above-ground residues dm to harvested crop RAGT (kg/dm), Area Burnt (ha/yr) and FCR (kg N/yr) per crop

	1990	**1991**	**1992**	**1993**	**1994**	**1995**
Crop production (t/yr)						
Wheat	10400	5600	10500	11700	8000	12297
Barley	98000	59500	171000	193000	154000	133818
Oats	100	80	145	100	150	174
Beans & pulses (legumes)	3505	3000	3629	3607	3157	3992
Potatoes (tubers)	185900	179650	195400	199000	135000	207699
Cultivated area (ha)						
Wheat	5100	4900	5000	5000	3300	3500
Barley	52330	43790	60000	64000	60000	57500
Oats	100	100	110	140	200	220
Beans & pulses (legumes)	1350	1173	1145	1103	810	1039
Potatoes (tubers)	8000	8690	9625	8080	7500	8313
Crop yield (YieldFresh), kg/ha						
Wheat	2039	1143	2100	2340	2424	3514
Barley	1873	1359	2850	3016	2567	2327
Oats	1000	800	1318	714	750	792
Beans & pulses (legumes)	2596	2558	3169	3270	3898	3842
Potatoes (tubers)	23238	20673	20301	24629	18000	24986
CropT (kg dm/ha)						
Wheat	1815	1017	1869	2083	2158	3127
Barley	1667	1209	2537	2684	2284	2071
Oats	890	712	1173	636	668	705
Beans & pulses (legumes)	2363	2327	2884	2976	3547	3496
Potatoes (tubers)	5112	4548	4466	5418	3960	5497
above ground residue dry matter AGDM_T (kg/ha)						
Wheat	2741	1536	2823	3145	3258	4722
Barley	1634	1186	2486	2631	2239	2030
Oats	811	649	1068	579	608	642
Beans & pulses (legumes)	2671	2631	3260	3364	4009	3952
Potatoes (tubers)	512	456	448	543	397	551
Area Burnt (ha/yr)						
Wheat	1275	1184	1167	1125	715	729
Barley	13083	10583	14000	14400	13000	11979
Oats	25	24	26	32	43	46
Beans & pulses (legumes)	338	283	267	248	176	216
Potatoes (tubers)	2000	2100	2246	1818	1625	1732
FCR (kg N/yr)						
Wheat	80498	43770	82845	93187	64317	99783
Barley	674235	413301	1198813	1365700	1099865	964526
Oats	580	468	856	596	903	1058
Beans & pulses (legumes)	30322	26049	31625	31549	27713	35171
Potatoes (tubers)	173144	167960	183362	187395	127630	197017
TOTAL	958778	651547	1497502	1678428	1320428	1297555

	1996	**1997**	**1998**	**1999**	**2000**	**2001**
Crop production (t/yr)						
Wheat	13000	11500	11500	14000	10000	10500
Barley	128000	36000	54000	112700	37600	116500
Oats	190	280	320	400	350	380
Beans & pulses (legumes)	3700	3558	3684	3764	3308	3383
Potatoes (tubers)	228000	81500	138092	161500	117000	121000

Cultivated area (ha)						
Wheat	3700	5250	5800	6600	6150	5400
Barley	55000	37500	53000	52000	45000	50200
Oats	240	270	290	340	330	370
Beans & pulses (legumes)	857	890	893	913	832	832
Potatoes (tubers)	9125	7000	7500	6800	6500	5715
Crop yield (YieldFresh), kg/ha						
Wheat	3514	2190	1983	2121	1626	1944
Barley	2327	960	1019	2167	836	2321
Oats	792	1037	1103	1176	1061	1027
Beans & pulses (legumes)	4317	3998	4125	4123	3976	4066
Potatoes (tubers)	24986	11643	18412	23750	18000	21172
CropT (kg dm/ha)						
Wheat	3127	1950	1765	1888	1447	1731
Barley	2071	854	907	1929	744	2065
Oats	705	923	982	1047	944	914
Beans & pulses (legumes)	3929	3638	3754	3752	3618	3700
Potatoes (tubers)	5497	2561	4051	5225	3960	4658
above ground residue dry matter AGDM_T (kg/ha)						
Wheat	4722	2944	2665	2851	2186	2614
Barley	2030	838	889	1891	729	2025
Oats	642	841	895	954	860	833
Beans & pulses (legumes)	4440	4112	4243	4240	4089	4182
Potatoes (tubers)	551	257	406	524	397	467
Area Burnt (ha/yr)						
Wheat	740	1006	1063	1155	1025	855
Barley	11000	7188	9717	9100	7500	7948
Oats	48	52	53	60	55	59
Beans & pulses (legumes)	171	171	164	160	139	132
Potatoes (tubers)	1825	1342	1375	1190	1083	905
FCR (kg N/yr)						
Wheat	106458	95041	95904	117800	84896	89924
Barley	930991	264279	399952	841909	283450	885574
Oats	1165	1731	1996	2517	2222	2434
Beans & pulses (legumes)	32716	31575	32811	33644	29675	30456
Potatoes (tubers)	217061	77940	132456	155429	113035	117298
TOTAL	1288391	470567	663120	1151299	513277	1125686

	2002	**2003**	**2004**	**2005**	**2006**	**2007**
Crop production (t/yr)						
Wheat	12900	14280	9930	9249	7520	10712
Barley	128400	150000	100990	60286	58372	52007
Oats	500	410	490	650	943	814
Beans & pulses (legumes)	3358	2410	3280	3291	3348	3318
Potatoes (tubers)	148500	127500	131650	152500	127500	155500
Cultivated area (ha)						
Wheat	5900	7225	7450	5264	5389	5287
Barley	51300	65007	58448	52517	48914	34019
Oats	400	513	808	4368	4919	4250
Beans & pulses (legumes)	847	834	808	796	855	737
Potatoes (tubers)	5700	5511	5380	6190	4290	6290
Crop yield (YieldFresh), kg/ha						
Wheat	2186	1976	1333	1757	1395	2026
Barley	2503	2307	1728	1148	1193	1529
Oats	1250	799	606	149	192	192
Beans & pulses (legumes)	3965	2890	4059	4134	3916	4502
Potatoes (tubers)	26053	23136	24470	24637	29720	24722
CropT (kg dm/ha)						

Wheat	1946	1759	1186	1564	1242	1803
Barley	2228	2054	1538	1022	1062	1361
Oats	1113	711	540	132	171	170
Beans & pulses (legumes)	3608	2630	3694	3762	3563	4097
Potatoes (tubers)	5732	5090	5383	5420	6538	5439
above ground residue dry matter AGDM_T (kg/ha)						
Wheat	2939	2657	1792	2362	1876	2723
Barley	2184	2013	1508	1002	1041	1334
Oats	1013	648	492	121	156	156
Beans & pulses (legumes)	4078	2972	4175	4252	4027	4630
Potatoes (tubers)	574	510	539	543	655	545
Area Burnt (ha/yr)						
Wheat	885	1024	993	658	629	573
Barley	7695	9209	7793	6565	5707	3685
Oats	60	73	108	546	574	460
Beans & pulses (legumes)	127	118	108	100	100	80
Potatoes (tubers)	855	781	717	774	501	681
FCR (kg N/yr)						
Wheat	111442	124436	87280	81983	67223	96553
Barley	984444	1159913	787612	474186	462956	415852
Oats	3230	2672	3221	4328	6323	5503
Beans & pulses (legumes)	30338	21852	29844	30049	30677	30508
Potatoes (tubers)	144444	124469	128969	149919	125765	153941
TOTAL	1273898	1433342	1036926	740465	692944	702357

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Crop production (t/yr)						
Wheat	24720	14690	18890	23740	22923	15180
Barley	34960	40092	46060	45720	48100	36010
Oats	373	2040	780	740	800	740
Beans & pulses (legumes)	3312	3312	4319	3690	4374	4263
Potatoes (tubers)	115000	112500	82000	126080	82200	105480
Cultivated area (ha)						
Wheat	4990	5761	7560	10590	8550	6920
Barley	30680	22444	25970	24954	28853	23530
Oats	3034	2950	510	369	419	310
Beans & pulses (legumes)	554	596	507	548	694	583
Potatoes (tubers)	5110	4970	4260	5070	4550	4640
Crop yield (YieldFresh), kg/ha						
Wheat	4954	2550	2499	2242	2681	2194
Barley	1140	1786	1774	1832	1667	1530
Oats	123	692	1529	2005	1909	2387
Beans & pulses (legumes)	5978	5557	8519	6734	6303	7312
Potatoes (tubers)	22505	22636	19249	24868	18066	22733
CropT (kg dm/ha)						
Wheat	4409	2269	2224	1995	2386	1952
Barley	1014	1590	1578	1631	1484	1362
Oats	109	615	1361	1785	1699	2125
Beans & pulses (legumes)	5440	5057	7752	6128	5735	6654
Potatoes (tubers)	4951	4980	4235	5471	3975	5001
above ground residue dry matter AGDM_T (kg/ha)						
Wheat	6658	3427	3358	3013	3604	2949
Barley	994	1559	1548	1599	1455	1335
Oats	100	561	1240	1625	1547	1934
Beans & pulses (legumes)	6148	5715	8761	6925	6482	7520
Potatoes (tubers)	496	499	425	548	399	501
Area Burnt (ha/yr)						
Wheat	499	576	756	1059	855	692

Barley	3068	2244	2597	2495	2885	2353
Oats	303	295	51	37	42	31
Beans & pulses (legumes)	55	60	51	55	69	58
Potatoes (tubers)	511	497	426	507	455	464
FCR (kg N/yr)						
Wheat	224647	133506	171676	215757	208327	137961
Barley	281867	323196	371307	368563	387759	290302
Oats	2549	13861	5296	5024	5431	5024
Beans & pulses (legumes)	30558	30558	39847	34045	40356	39331
Potatoes (tubers)	114252	111768	81479	125250	81683	104793
TOTAL	653872	612888	669605	748639	723556	577412

	2014	**2015**	**2016**	**2017**	**2018**	
Crop production (t/yr)						
Wheat	4440	35360	6902	16592	15330	
Barley	2720	52180	2907	18754	7920	
Oats	200	600	352	248	400	
Beans & pulses (legumes)	4205	4899	4000	4145	710	
Potatoes (tubers)	117500	95920	122803	111410	106500	
Cultivated area (ha)						
Wheat	6140	11970	8386	8678	10200	
Barley	18940	20560	14536	10953	12800	
Oats	230	320	367	490	220	
Beans & pulses (legumes)	639	715	498	493	390	
Potatoes (tubers)	4910	4740	5041	4440	4220	
Crop yield (YieldFresh), kg/ha						
Wheat	723	2954	823	1912	1503	
Barley	144	2538	200	1712	619	
Oats	870	1875	959	506	1818	
Beans & pulses (legumes)	6581	6852	8032	8408	1821	
Potatoes (tubers)	23931	20236	24361	25092	25237	
CropT (kg dm/ha)						
Wheat	644	2629	733	1702	1338	
Barley	128	2259	178	1524	551	
Oats	774	1669	854	450	1618	
Beans & pulses (legumes)	5988	6235	7309	7651	1657	
Potatoes (tubers)	5265	4452	5359	5520	5552	
above ground residue dry matter AGDM_T (kg/ha)						
Wheat	972	3970	1107	2570	2020	
Barley	126	2214	175	1494	540	
Oats	705	1519	778	411	1473	
Beans & pulses (legumes)	6768	7047	8260	8646	1873	
Potatoes (tubers)	528	446	537	553	556	
Area Burnt (ha/yr)						
Wheat	614	1197	839	868	1020	
Barley	1894	2056	1454	1095	1280	
Oats	23	32	37	49	22	
Beans & pulses (legumes)	64	72	50	49	39	
Potatoes (tubers)	491	474	504	444	422	
FCR (kg N/yr)						
Wheat	40364	321353	62743	150797	139334	
Barley	21992	420609	23483	151184	63877	
Oats	1359	4074	2391	1686	2716	
Beans & pulses (legumes)	38796	45199	36904	38242	6552	
Potatoes (tubers)	116730	95306	121997	110676	105798	
TOTAL	219241	886540	247517	452585	318277	

Table 5.27. Default dry matter fraction (DRY), Slope, Intercept, NAGT, RBGT, NBGT per crop

Crop	DRY	Slope	Intercept	NAGT	RBGT	NBGT
Wheat	0.89	1.51	0.52	0.006	0.24	0.009
Barley	0.89	0.98	0.59	0.007	0.22	0.014
Oats	0.89	0.91	0.89	0.007	0.25	0.008
Beans & pulses (legumes)	0.91	1.13	0.85	0.008	0.19	0.008
Potatoes (tubers)	0.22	0.10	1.06	0.019	0.20	0.014

Table 5.28. Crop residue that is burned (FracBURN)

Year	1990	1991	1992	1993	1994	1995	1996	1997
FracBURN	0.25	0.24	0.23	0.23	0.22	0.21	0.20	0.19

Year	1998	1999	2000	2001	2002	2003	2004	2005
FracBURN	0.18	0.18	0.17	0.16	0.15	0.14	0.13	0.13

Year	2006	2007	2008-					
FracBURN	0.12	0.11	0.10					

Table 5.29. Cf

Crop	Cf	source
Wheat	0.90	default - table 2.6, pg.2.49, vol.4, IPCC2006
Barley	0.89	Greece - NIR2017
Oats	0.89	Greece - NIR2017
Beans & pulses (legumes)	0.40	expert judgement - Michalis Omirou tel. 16/11/2017
Potatoes (tubers)	0.40	expert judgement - Michalis Omirou tel. 16/11/2017

Mineralization/immobilization associated with loss/gain of soil organic matter (3D1.5)

Not occurring

Cultivation of organic soils (3D1.6)

Not occurring

Other (3D1.7)

Not occurring

5.5.1.2. Uncertainties and time-series consistency

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

5.5.1.3. Category-specific QA/QC and verification

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

5.5.1.4. Category-specific recalculations

3D1.2b Sewage Sludge applied to soils: new data on sewage applied on land was available in 2019 for the year 2017, which caused the recalculation of the emissions for 2017. The emissions increased from 0.76 t N2O to 0.51 t N2O corresponding to a decrease of 33.4%.

5.5.1.5. Category-specific planned improvements

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

5.5.2. Indirect N2O emissions from managed soils (3D2)

In addition to the direct emissions of N2O from managed soils that occur through a direct pathway, emissions of N2O also take place through two indirect pathways. The first of these pathways is the volatilisation of N as NH3 and oxides of N (NOx), and the deposition of these gases and their products NH4+ and NO3- onto soils and the surface of lakes and other waters. The second pathway is the leaching and runoff from land of N from synthetic and organic fertiliser additions, crop residues, mineralisation of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals.

The methodology described in this section addresses the following N sources of indirect N2O emissions from managed soils arising from agricultural inputs of N: synthetic N fertilizers (FSN); organic N applied as fertiliser (e.g., applied animal manure, compost, sewage sludge, rendering waste and other organic amendments) (FON); urine and dung N deposited on pasture, range and paddock by grazing animals (FPRP); N in crop residues (above- and below-ground), including N-fixing crops and forage/pasture renewal returned to soils (FCR). N mineralisation associated with loss of soil organic matter resulting from change of land use or management on mineral soils (FSOM) because it does not occur in Cyprus.

5.5.2.1. Methodological issues

For both Atmospheric deposition (3D2.1) and Leaching/Runoff (3D2.2) Tier 1 methodology according to 2006 IPCC Guidelines is applied.

Atmospheric deposition (3D2.1)

The N2O emissions from atmospheric deposition of N volatilised from managed soil are estimated using Equation 11.9 in the 2006 IPCC Guidelines (pg. 11.21, vol.4) using the following data and parameters:

- FSN, annual amount of synthetic fertiliser N applied to soils (kg N/yr): same as presented in Table 5.19;
- FracGASF, fraction of synthetic fertiliser N that volatilises as NH3 and NOx, kg N volatilised / kg of N applied: default of 0.1 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4);
- FON, annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N / yr: is the total nitrogen input to the soil from the categories animal manure applied to soils and sewage sludge, as estimated for category Organic N fertilizers (3D1.2) – total FON presented in Table 5.30.
- FPRP, annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr): considered 0 for Cyprus - a very small percentage of the sheep and goats are grazing, however no information is available to make an estimation or an assumption on the population grazing[57]
- FracGASM, fraction of applied organic N fertiliser materials (FON) and of urine and dung N deposited by grazing animals (FPRP) that volatilises as NH3 and NOx, kg N volatilised / kg of N applied or deposited: default of 0.2 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4);
- EF4, emission factor for N2O emissions from atmospheric deposition of N on soils and water surfaces, kg N–N2O / kg NH3–N + NOx–N volatilized: default of 0.01 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4, IPCC2006)

The resulting N2O(ATD) –N is presented in Table 5.29. N2O(ATD) –N is converted to N2O by multiplication with 44/28. Recalculations have been performed for the whole time series caused by the change in Animal manure applied to soils (kgN).

Table 5.30. FON and N2O(ATD) –N (kg N / yr)

Year	1990	1991	1992	1993	1994	1995
FON	11849316	11925993	12252295	12742814	12718974	13135077

[57] Personal communication with Dr. Petros Mavromatis (22/11/2017), head of sheep and goat farming division, Department of Agriculture (tel. +357 22408555, pmavrommatis@da.moa.gov.cy)

N2O(ATD) –N	36125	36021	39265	41675	39727	46796

Year	1996	1997	1998	1999	2000	2001
FON	13715025	14528959	14677288	14795444	15465785	17080230
N2O(ATD) –N	41058	40184	43956	41152	41469	46519

Year	2002	2003	2004	2005	2006	2007
FON	18010006	16871333	16231630	14983613	15045175	15762548
N2O(ATD) –N	46599	44941	43201	38560	41381	39723

Year	2008	2009	2010	2011	2012	2013
FON	14693149	14367978	15059476	14882990	14115853	12960002
N2O(ATD) –N	36885	36410	39488	36904	36551	32971

Year	2014	2015	2016	2017	2018	
FON	12817039	12776610	13297355	13752854	13795600	
N2O(ATD) –N	32327	33086	34668	35347	35415	

Leaching/Runoff (3D2.2)

The N2O emissions from leaching and runoff in regions where leaching and runoff occurs are estimated using Equation 11.10 in the 2006 IPCC Guidelines (pg. 11.21, vol.4) using the following data and parameters:

- FSN, annual amount of synthetic fertiliser N applied to soils (kg N/yr): same as presented in Table 5.19;
- FON, annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N / yr: is the total nitrogen input to the soil from the categories animal manure applied to soils and sewage sludge, as estimated for category Organic N fertilizers (3D1.2) – total FON presented in Table 5.29.
- FPRP, annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr): considered 0 for Cyprus - a very small percentage of the sheep and goats are grazing, however no information is available to make an estimation or an assumption on the population grazing[58]
- FCR, amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually in regions where leaching/runoff occurs, kg N/yr: as estimated for Crop residues (3D1.4) and presented in Table 5.24
- FSOM, annual amount of N mineralised in mineral soils associated with loss of soil C from soil organic matter as a result of changes to land use or management in regions where leaching/runoff occurs, kg N / yr: not occurring in Cyprus therefore 0.
- FracLEACH, fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff, kg N / kg of N additions: default of 0 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4), since in Cyprus precipitation is lower than evapotranspiration throughout most of the year (G. Theophanous[59]). Excessive irrigation beyond the crop irrigation needs has to be practiced in order for leaching to occur. Irrigation in Cyprus is practiced through advance irrigation systems, like drip and sprinkler irrigation. Therefore, plants are irrigated based on their needs and leaching may rarely occur. In that case, it would concern the surface soil layer (less than a meter deep), not reaching the aquifer in any case. In addition, surface irrigation, which may facilitate leaching, is not practiced anymore in Cyprus.
- EF5, emission factor for N2O emissions from N leaching and runoff, kg N2O–N / kg N leached

[58] Personal communication with Dr. Petros Mavromatis (22/11/2017), head of sheep and goat farming division, Department of Agriculture (tel. +357 22408555, pmavrommatis@da.moa.gov.cy)

[59] Information to support this statement has been provided by Mr. George Theophanous, Agriculture Officer, Department of Agriculture (tel. +357 22464028, gtheophanous@da.moa.gov.cy).

Article : Panagiotis Dalias et al., 2018, Adjustment of Irrigation Schedules as a Strategy to Mitigate Climate Change Impacts on Agriculture in Cyprus, Agriculture 2019, 9, 4.

and runoff: default of 0.0075 as proposed by the 2006 IPCC Guidelines (table 11.3, pg.11.24, vol.4, IPCC2006)

$N2O_L$–N is converted to N2O by multiplication with 44/28. Due to the fact the FracLEACH is zero, the resulting emissions are zero for the whole reporting period.

5.5.2.2. Uncertainties and time-series consistency

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

5.5.2.3. Category-specific QA/QC and verification

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

5.5.2.4. Category-specific recalculations

No recalculations to be reported.

5.5.2.5. Category-specific planned improvements

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

5.5.3. Prescribed burning of savannas (3E)

Not occurring in Cyprus.

5.5.4. Field burning of agricultural residues (3F)

Large quantities of agricultural wastes are produced, from farming systems world-wide, in the form of crop residue. Burning of crop residues is not thought to be a net source of carbon dioxide (CO2) because the carbon released to the atmosphere during burning is reabsorbed during the next growing season. However, crop residue burning is a net source of CH4, CO, NOx, and N2O. This section accounts for emissions of these non-CO2 gases from field burning of agricultural crop residues. Burning of agricultural wastes in the fields is a common practice in the developing world; it is used primarily to clear remaining straw and stubble after harvest and to prepare the field for the next cropping cycle. In Cyprus, field burning of agricultural residues was a widespread practice until 2003 when a normative banning crop residues burning came into place (Fire Prevention of Outdoors Law of 1988 (220/1988) as amended by 109(I)/2002). Total emissions from field burning of agricultural residues for the period 1990-2017 are presented in Table 5.31 and Figure 5.9.

Table 5.31. Field burning of agricultural residues emissions, 1990-2017

Gg CO2 eq.	1990	2000	2005	2010	2015	2017	2018
3F	**2.03**	**0.65**	**0.68**	**0.55**	**0.76**	**0.33**	**0.23**
3.F.1 Cereals	1.96	0.61	0.65	0.53	0.74	0.31	0.22
3.F.2 Pulses	0.032	0.020	0.015	0.016	0.018	0.015	0.002
3.F.3 Tubers and Roots	0.036	0.015	0.015	0.006	0.007	0.09	0.008
CH4 (t)	62.0	19.7	20.7	16.7	23.3	10.1	7.1
N2O (t)	1.61	0.51	0.54	0.43	0.61	0.24	0.18
Total (Gg CO2 eq.)	**2.03**	**0.65**	**0.68**	**0.55**	**0.76**	**0.33**	**0.23**

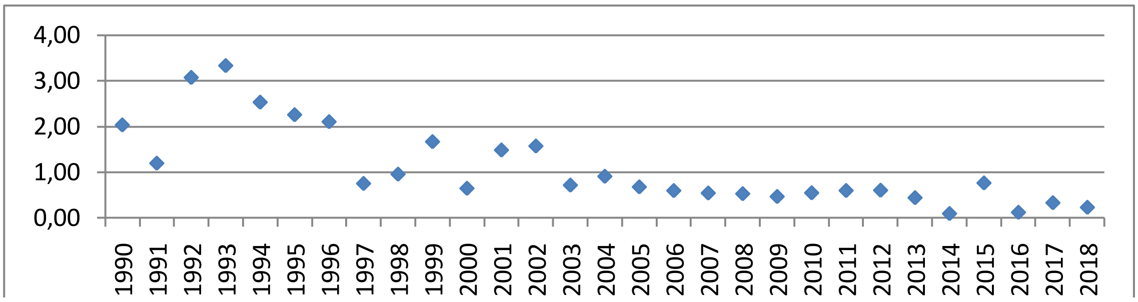

Figure 5.9. Field burning of agricultural residues emissions, 1990-2018 (Gg CO2 eq.)

5.5.4.1. Methodological issues

A generic methodology to estimate the emissions of individual greenhouse gases for any type of fire is summarised in Equation 2.27 (pg. 2.42, vol. 4, 2006 IPCC Guidelines) using the following:

- A, area burnt, ha: data already presented in Table 5.2
- M_B, mass of fuel available for combustion, tonnes/ha: data already presented in Table 5.25 (above ground residue dry matter AGDM_T)
- C_f, combustion factor, dimensionless: data already presented in Table 5.28
- G_{ef}, emission factor, g/ kg dry matter burnt: 2.7 g CH4/kg DM burnt, 0.07 g N2O/kg DM burnt (according to default values in Table 2.5, pg. 2.47, vol. 4, 2006 IPCC Guidelines). According to the 2006 IPCC guidelines, for combustion of non-woody biomass in Grassland and Cropland, CO2 emissions do not need to be estimated and reported, because it is assumed that annual CO2 removals (through growth) and emissions (whether by decay or fire) by biomass are in balance.

Recalculations have occurred due to revision of the Cf and corrections in the method applied (t dry mass (M_B*Cf) in 2017 submission was estimated using the default available dry biomass for combustion recommended by 2006 IPCC Guidelines (vol.4, pg.2.46, table 2.4), whereas in 2018 submission the above ground residue dry matter AGDM_T is used as M_B).

5.5.4.2. Uncertainties and time-series consistency

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

5.5.4.3. Category-specific QA/QC and verification

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

5.5.4.4. Category-specific recalculations

No recalculations to be reported.

5.5.4.5. Category-specific planned improvements

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

5.5.5. Liming (3G)

Soils on Cyprus vary between lithosols, leptosols, regosols, gypsisols, solonchaks, solonetz, vertisols, and cambisols based on the World Reference Base of Food and Agriculture Organization of the United

Nations soil classification system[60], that all have pH of 7 or above. Additionally according to information provided by the Department of Agriculture[61] there is no information, data or documents to support that liming does take place in Cyprus. The expert judgement of Mr. Mousouliotis is to report liming activities as NO.

5.5.6. Urea application (3H)

Adding urea to soils during fertilisation leads to a loss of CO2 that was fixed in the industrial production process. Urea (CO(NH2)2) is converted into ammonium (NH4+), hydroxyl ion (OH-), and bicarbonate (HCO3-), in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, bicarbonate that is formed evolves into CO2 and water. This source category is included because the CO2 removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector (IPPU Sector). The GHG inventory is developed using Tier 1 approach. Total emissions from urea application for the period 1990-2018 are presented in Table 5.32 and Figure 33.

Table 5.32. Urea application emissions, 1990-2017

	1990	2000	2005	2010	2015	2017	2018
Urea application (Gg CO2)	1.82	1.67	0.97	0.74	0.40	0.42	0.22

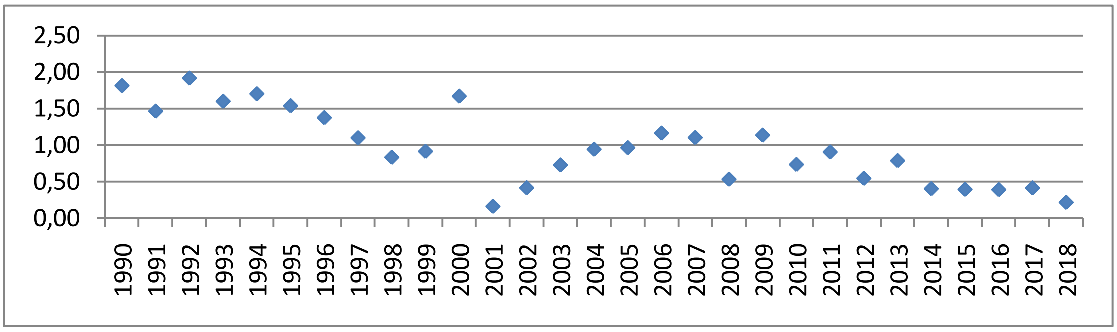

Figure 5.10. Urea application emissions, 1990-2018 (Gg CO2 eq.)

5.5.6.1. Methodological issues

The steps for estimating CO2–C emissions from urea applications are:

Step 1: Estimate the total amount of urea applied annually to a soil in the country (M): Data of urea sales in Cyprus is obtained from the Department of Agriculture[62] (Table 5.33). Activity data is based on the assumption that all sold urea in a given year is consumed in the same year.

Step 2: Apply an overall emission factor (EF) of 0.20 for urea, which is equivalent to the carbon content of urea on an atomic weight basis (20% for $CO(NH_2)_2$).

Step 3: Estimate the total CO2–C emission based on the product of the amount of urea applied, the emission factor and Equation 11.13 in 2006 IPCC Guidelines (pg. 11.32, vol. 4). Total CO2–C emission estimated in presented in Table 5.33.

Step 4: Multiply by 44/12 to convert CO2–C emissions into CO2.

Table 5.33. Urea consumption in Cyprus (t) and total CO2–C emission (tC/yr)

---

[60] Zomeni A., Camera C., Bruggeman A., Zissimos A., Christoforou I., Noller J., 2014, Digital soil map of Cyprus (1:25,000); AGWATER - Options for sustainable agricultural production and water use in Cyprus under global change; Scientific Report 6; Deliverable D15, D16. The Cyprus Institute, Nicosia, 15 p.

[61] Andreas Mousouliotis, Agriculture Officer, Department of Agriculture (tel. +357 22464016, amousouliotis@da.moa.gov.cy)

[62] George Theophanous, Agriculture Officer, Department of Agriculture (tel. +357 22464028, gtheophanous@da.moa.gov.cy) – Fertilizer Control Board

Year	1990	1991	1992	1993	1994	1995	1996	1997
Urea consumption (t)	2475	2000	2615	2185	2323	2101	1879	1502
CO2–C emission (tC/yr)	495	400	523	437	465	420	376	300

Year	1998	1999	2000	2001	2002	2003	2004	2005
Urea consumption (t)	1140	1250	2280	227	572	997	1291	1318
CO2–C emission (tC/yr)	228	250	456	45	114	199	258	264

Year	2006	2007	2008	2009	2010	2011	2012	2013
Urea consumption (t)	1590	1508	732	1553	1006	1239	748.4	1078
CO2–C emission (tC/yr)	318	302	146	311	201	248	150	216

Year	2014	2015	2016	2017	2018			
Urea consumption (t)	555	543	538	570	305			
CO2–C emission (tC/yr)	111	109	108	114	61			

5.5.6.2. Uncertainties and time-series consistency

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

5.5.6.3. Category-specific QA/QC and verification

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

5.5.6.4. Category-specific recalculations

No recalculations to be reported.

5.5.6.5. Category-specific planned improvements

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

5.5.7. Other carbon-containing fertilizers (3I)

NO

5.5.8. Other (please specify) (3J)

NO

Chapter 6.
Land use, land-use change and forestry (CRF sector 4)

6.1. Overview of sector

Cyprus is an island in the Mediterranean Sea. It measures 240 kilometers long from end to end and 100 kilometers wide at its widest point. It lies between latitudes 34° and 36° N, and longitudes 32° and 35° E. Since 1974 the northern part of Cyprus has been under occupation by Turkey and **beyond the effective control of the Cyprus Government**. For comparability purposes with the rest of the National Inventory sectors of this report, following the recommendations of the U.N. Experts Review Team (September 2016 Saturday Paper Report) GHG emissions/ removals are reported only for the lands under the effective control of the Government as managed land. The rest of the island is considered to be "unmanaged' and no GHG emissions/removals calculations will be included in this report, even though, the activity data is available for the whole of the country.

6.1.1. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Land areas are represented using the IPCC Approach 2 (total land-use area, including changes between categories). The essential feature of Approach 2 is that it provides an assessment of both the net losses or gains in the area of specific land-use categories and what these conversions represent (i.e., changes both from and to a category) but without spatially-explicit location data. The final result of this Approach is presented as a non-spatially explicit land-use conversion matrixes covering the period 1990 until the currently reported year.

Land use data for Cyprus are sourced from the CORINE land cover (CLC) inventory[63] data (for details see Chapter 6.2.3). Three CORINE data sets covering the years 2000, 2006 and 2012 were included in the preparation of this NIR. In order to retain consistency among GHG estimates reported for different years the total land area for 2000 and 2006 was adjusted using a proportional approach to the area covered by the 2012 CORINE data set. The adjusted data allowed for establishment of two land use matrixes 2000 – 2006 and 2006 - 2012. Both matrixes were linearly interpolated/ extrapolated to obtain annual land use change data for all individual years within these periods. The 2000 – 2006 annual land use change data were extrapolated backwards to obtain annual land use change data for the period 1990 – 2000 (due to lack of measured data, it was assumed that for all reported lands the pre-1990 land uses were not different from the land use in 1990). The 2006 – 2012 annual land use change data were extrapolated forwards to obtain annual land use change data for the period 2012 to the reported year. The latter extrapolated data will be replaced/ supplemented by the measured data if acquired in the future.

The surface area of the smallest unit mapped in the CORINE project is 25 hectares however, the sensitivity for land cover change is 5 ha. As the first approximation, it is assumed that the possible overestimation and underestimation of the individual land use categories and land use changes among these land use categories within the smallest units mapped in the CORINE nullify within the reporting unit. This assumption will be checked against other data of sensitivity comparable to the threshold area used in the definition of forest when the data are available.

[63] http://land.copernicus.eu/pan-european/corine-land-cover/view

6.1.2. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The IPCC 2006 identifies six broad land-use categories for the purpose of estimating and reporting greenhouse gas emissions and removals from land use and land-use conversions: (i) Forest Land; (ii) Cropland; (iii) Grassland; (iv) Wetlands; (v) Settlements; and (vi) Other Land. In the preparation of this inventory the generic definitions of the categories referred to in IPCC 2006 guidelines were implemented in a country specific way described below based on the national definition of forest.

6.1.2.1. Definition of forest

Cyprus adopted the following definition of Forest for GHG reporting under the Convention and the Kyoto Protocol:

> ***Forest** comprises of land covered by forest trees which covers at least 0.3 hectares, where the tree crown cover is at least 10 per cent and the minimum tree height is of 5 meters (at maturity).*

The forest definition adopted by Cyprus is in line with the Forest National Law of 2012 (25 (I)/2012) and in accordance with the definition used for its reporting for the Global Forest Resource assessment under the Food and Agriculture Organization of the United Nations (FAO FRA 2015). This definition is also consistent with the guidance of the national definition of forest contained in Decision 16/CMP.1.

It should be noted that the Department of Forests (Department of Forests, CY-1414 Nicosia, Cyprus) applied the following definition of forest in its reporting under the FRA 2015[64]: Forest comprises land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds at maturity in situ. It does not include land that is predominantly under agricultural or urban land use.

It should also be noted that according to the Forest National Law of 2012 (25 (I)/2012) the area threshold of 0.3 hectare is to be implemented in all future reports covering any period since the year 2012.

6.1.2.2. The land-use categories for greenhouse gas inventory reporting

Subsequent to the guidance contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories the following national definitions of land-use categories were developed for the purpose of preparation of the GHG inventories:

<u>(i) Forest Land</u>

This category contains all lands that meet the definition of forest. It also includes forest roads, cleared tracts, firebreaks and other small open areas within the forest as well as reforested areas or burnt areas or other areas that temporarily have low plant cover due to human intervention or natural causes, but does not include municipal parks and gardens. Forest land contains only areas covered with trees that according to the Forest National Law of 2012 (25 (I)/2012) are considered as forest trees.

The forest land is further divided into two subcategories: coniferous forest and broadleaved forest based on the dominant tree species.

<u>(ii) Cropland</u>

This category contains cropped land, including lands with woody vegetation (i.e. fruit trees) where the vegetation does not meet the definition of forest. In particular, this category includes land principally occupied by agriculture, including: arable land, annual and permanent crops as well as vineyards, fruit trees and berry plantations, olive groves and other similar types of cultivation.

[64] Forest Data Reporting Package for 2015, FAO, page 12, Table 1.2.1 Data sources.

The cropland is further divided into two subcategories: annual cropland and woody cropland based on the dominant type of cultivated vegetation.

(iii) Grassland

This category includes rangelands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as bushes and sclerophyllous vegetation that fall below the threshold values used in the Forest Land category. The category also includes all pastures, natural grassland and scarcely vegetated areas.

The grassland is further divided into two subcategories: grass and woody grassland based on the dominant type of land cover.

(iv) Wetlands

This category contains areas of land that is covered or saturated by water for all or part of the year and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. In particular, it contains: inland and salt marshes, water courses and water bodies.

(v) Settlements

This category contains all developed land, including transportation infrastructure and human settlements of any size. In particular, it contains: industrial and commercial units, urban areas, port areas, airports, construction, mineral extraction and waste dump sites.

(vi) Other Land

This category includes bare soil, rock, beaches, dunes and sand plains and all land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, i.e. to retain the entire Cyprus area unchanged among the reported years.

Table 6.1 presents the implementation of the CORINE land cover (CLC) inventory[65] data to land categorization approach based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Table 6.1. The correspondence between the CORINE land cover categories identified in Cyprus and the IPCC 2006 six broad land-use categories as implemented in the Cyprus conditions.

LULUCF Land-Use Categories	CORINE land cover	CLC code
Broadleaved Forest	Broad leaved forest	311
Coniferous Forest	Coniferous forest	312
Coniferous Forest	Mixed forest	313
Coniferous Forest	Transitional woodland/shrub	324
Woody CL	Vineyards	221
Woody CL	Fruit trees and berry plantations	222
Woody CL	Olive groves	223
Woody CL	Complex cultivation	242
Woody CL	Land principally occupied by agriculture, with significant areas of natural vegetation	243
Annual CL	Non-irrigated arable land	211
Annual CL	Permanently irrigated land	212
Annual CL	Annual crops associated with permanent crops	241
Woody GL	Sclerophyllous vegetation	323
Grass GL	Pastures	231
Grass GL	Natural grassland	321
Grass GL	Scarcely vegetated areas	333
SL	Continuous urban fabric	111

65 http://land.copernicus.eu/pan-european/corine-land-cover/view

LULUCF Land-Use Categories	CORINE land cover	CLC code
SL	Discontinuous urban fabric	112
SL	Industrial or commercial units	121
SL	Road and rail networks and associated land	122
SL	Port areas	123
SL	Airports	124
SL	Mineral extraction sites	131
SL	Dump sides	132
SL	Construction sites	133
SL	Green urban areas	141
SL	Sport and leisure facilities	142
WL	Inland marshes	411
WL	Salt marshes	421
WL	Water courses	511
WL	Water bodies	512
OL	Beaches, dunes and sand plains	331
OL	Bare rock	332
	Burnt areas*	334

*Burned areas were distributed among the remaining land use categories based on the previous land use. In Cyprus, burning of vegetation does not lead to land use change.

The CORINE land cover (CLC) categories listed in Table 6 above exhaust all land uses existing in Cyprus. This ensures that the land categories system implemented in this inventory is complete hence, all land areas may be classified by these categories in a unique way without duplication.

All lands subject to the effective control of the Republic of Cyprus are considered as managed.

Table 6.2 presents the areas of the IPCC 2006 land-use sub/categories based on the raw data from the CORINE annual land use data set (k ha).

Table 6.2. The IPCC 2006 land-use sub/categories data based on the raw data from the CORINE annual land use data set (k ha). Resolution for detection of individual land uses is 25 ha. The data refer to the areas under the effective control of the Cyprus Government (Managed Lands).

	Year 2000	Year 2006	Year 2012
	k ha	k ha	k ha
Managed Lands			
Broadleaved Forest	0.763	0.608	0.608
Coniferous Forest	154.720	158.204	158.252
Annual Cropland	124.182	121.845	121.507
Woody Cropland	126.103	128.095	127.083
Grass Grassland	26.444	23.725	23.395
Woody Grassland	112.921	107.504	107.453
Wetland	3.382	3.864	3.968
Settlements Land	48.460	54.319	55.898
Other Land	4.821	3.633	3.632
Total Managed Land Area (k ha)	**601.796**	**601.796**	**601.796**
Unmanaged Lands			
All categories	**322.348**	**322.348**	**322.348**
Total Land Area (k ha)	**924.144**	**924.144**	**924.144**

6.1.3. GHG emissions and removals by LULUCF categories

Emissions (-) and removals (+) from Sector 4 LULUCF by sub-categories are presented in Table 6.3. Note that the emission/removal data for harvested wood products (HWP) are included in the estimates for Forest Land (includes Forest Land remaining Forest Land and Land converted to Forest Land) hence, the column HWP is provided for information only.

Table 6.3. Emissions and removals (+/-) from Sector 4 LULUCF by sub-categories (k t CO2 eq).

Year	Total	FL	CL	GL	WL	SL	OL	HWP
1990	-219,0	-45,5	-138,9	-134,1	-1,0	1,8	95,5	3,3
1991	-212,0	-47,4	-138,5	-133,1	-1,0	1,8	95,5	10,8
1992	-218,4	-53,3	-141,1	-132,2	-2,0	3,3	95,5	11,4
1993	-233,6	-54,8	-143,7	-131,2	-3,1	4,8	95,5	-1,1
1994	-222,8	-46,9	-146,3	-130,2	-4,1	6,3	95,5	2,9
1995	-238,8	-62,6	-148,9	-129,2	-5,1	7,8	95,5	3,8
1996	-244,4	-65,5	-151,5	-128,2	-6,1	9,3	95,5	2,1
1997	-225,6	-55,0	-154,1	-127,2	-7,2	10,8	95,5	11,6
1998	-181,7	-3,0	-156,7	-126,2	-8,2	12,3	95,5	4,7
1999	-292,4	-110,0	-159,4	-125,2	-9,2	13,8	95,5	2,1
2000	-35,0	133,3	-162,0	-124,2	-10,2	15,3	95,5	17,3
2001	-186,8	-25,1	-164,6	-123,2	-11,3	16,8	95,6	25,1
2002	-276,7	-115,2	-167,2	-122,2	-12,3	18,3	95,6	26,4
2003	-285,0	-122,9	-169,8	-121,2	-13,3	19,7	95,6	26,9
2004	-283,6	-120,6	-172,4	-120,2	-14,3	21,2	95,6	27,1
2005	-303,3	-139,1	-175,0	-119,2	-15,4	22,7	95,6	27,1
2006	-381,7	-125,1	-174,0	-123,1	-15,4	23,0	6,4	26,5
2007	-239,9	21,9	-173,8	-123,3	-15,6	23,5	6,4	20,9
2008	-417,7	-155,0	-173,6	-123,4	-15,7	24,0	6,4	19,5
2009	-429,0	-173,0	-173,4	-123,5	-15,9	24,5	6,4	25,9
2010	-398,1	-143,0	-173,2	-123,7	-16,0	25,0	6,5	26,4
2011	-434,7	-181,8	-170,8	-123,8	-15,2	24,0	6,5	26,4
2012	-421,4	-170,4	-168,3	-123,9	-14,3	23,0	6,5	26,1
2013	-439,8	-190,8	-165,9	-124,1	-13,4	22,0	6,5	25,9
2014	-435,7	-188,2	-163,5	-124,2	-12,5	21,1	6,5	25,2
2015	-431,9	-186,5	-161,0	-124,3	-11,6	20,1	6,5	25,0
2016	-49,8	192,7	-158,6	-124,5	-10,8	20,1	6,5	24,7
2017	-419,2	-179,5	-156,2	-124,6	-9,9	20,1	6,5	24,3
2018	-399,2	-162,4	-153,8	-124,7	-9,0	20,1	6,5	24,1

6.1.4. Emission Trends

The total LULUCF sector represents GHG sink during the entire period 1990 – 2018. The sink has an increasing tendency; however, in years of exceptional extent of forest fires (2000, 2007 and 2016) the tendency is visibly broken (see Figure 6. 1). Overall the sink in the total LULUCF increases from -219.0 kt CO2 eq. in 1990 to -399.2 kt CO2 eq. in 2018 but drops (emissions) due to forest fires to -49.8 kt CO2 eq. in 2016.

The Cropland remaining Cropland, Land converted to Cropland Forest, Grassland remaining Grassland and Land converted to Grassland categories are all sinks over the entire period 1990 – 2018. National data on these categories are limited to area only hence, all emission/removal factors used in calculations of the GHG sources/sinks estimates are default data of unknown error.

The Forest Land remaining Forest Land and Land converted to Forest Land categories are important contributors to the sink in the LULUCF sector. The categories represent sink for all years except years when forest fires affect significantly great areas.

The Wetlands remaining Wetlands and Lands converted to Wetlands represent minor sink, while Settlements and Lands converted to Settlements represent minor source, during the entire period 1990 – 2017.

The Other Land remaining Other Land and Land converted to Other Land categories represent GHG source during the entire period 1990 – 2018. The source is significant until 2005 and then decreases to a minor value.

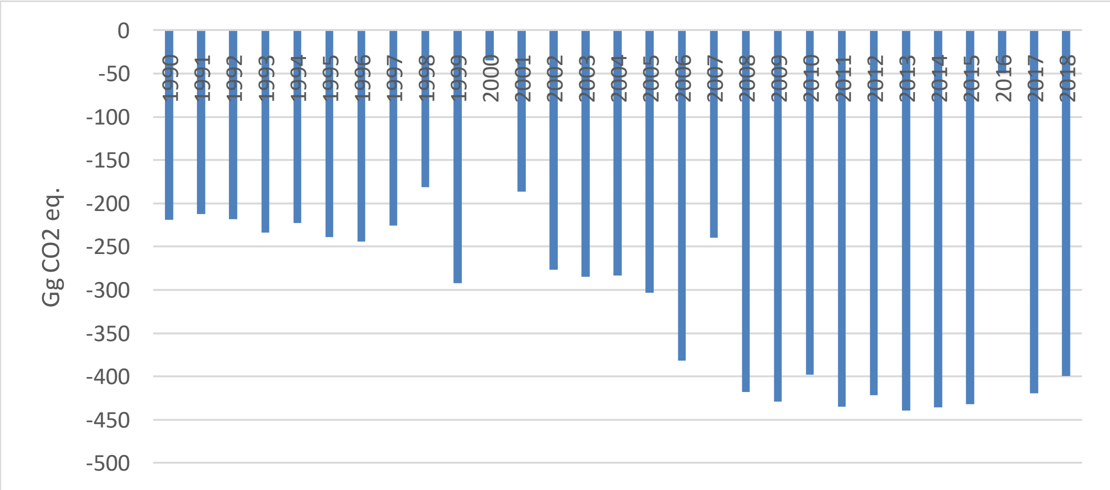

Figure 6.1. Removal (-) trend for the entire LULUCF sector in the period 1990 – 2018

6.2. Forest Land (4A)

6.2.1. Description

Area and ownership of Cyprus forest

The total area of State forests (high forests) is about 172,700 ha and forest occupies the 11,57% of the total area of Cyprus. An area of about 139,053 ha or 80,46% of the total State forest area is situated in the area under the control of the Government whilst the remaining 19,54% is found in the area of Cyprus beyond the control of the Government. According to the last survey, private forests and other forested State land cover 24,74% of the total area of Cyprus. Private forests are small holdings scattered all over Cyprus and are mainly located in distant mountainous and rural areas.

Floristic composition of Cyprus forests

Nearly half the area of the island is covered by tree vegetation that has been degraded by human activities. Forest is composed mainly of coniferous species like the Calabrian pine (Pinus brutia), the black pine (Pinus nigra), the Cedar (Cedrus brevifolia) and the Cypress (Cypressus sempervirens). Maquis vegetation includes species like Lentisk (Pistacia lentiscus), Juniper (Juniperus phoenicea), Maple (Acer obtusifolium) and Strawberry tree (Arbutus andrachne), while garigue lands consist of the Rock rose (Cistus spp.), Thyme (Thymus capitatus), Thorny-broom (Calycotome villosa), Thorny gorse (Genista fasselata) and Spiny burnet (Sarcopoterium spinosum). There are also minor areas consisting of young coniferous plantations (source: Forest Department, Ministry of Agriculture, Rural Development and Environment, Cyprus).

6.2.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases, is described in Chapter 6.1.1 “Information on approaches used for representing land areas and on land-use databases used for the inventory preparation”.

6.2.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 “The land-use categories for greenhouse gas inventory reporting”.

Table 6.4 presents data on land converted to/remaining in the Broadleaved Forest subcategory. Note that this subcategory does not contain any land converted to it.

Table 6.4. Data on area of land remaining in the same land use subcategory (from Broadleaved Forest to Broadleaved Forest) and areas of land converted to Broadleaved Forest subcategory from other land use sub/categories.

Year	Land converted to Broadleaved Forest from:								Total area
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land	
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	1.022	0	0	0	0	0	0	0	1.022

1991	0.996	0	0	0	0	0	0	0	0.996
1992	0.970	0	0	0	0	0	0	0	0.970
1993	0.944	0	0	0	0	0	0	0	0.944
1994	0.918	0	0	0	0	0	0	0	0.918
1995	0.892	0	0	0	0	0	0	0	0.892
1996	0.866	0	0	0	0	0	0	0	0.866
1997	0.840	0	0	0	0	0	0	0	0.840
1998	0.815	0	0	0	0	0	0	0	0.815
1999	0.789	0	0	0	0	0	0	0	0.789
2000	0.763	0	0	0	0	0	0	0	0.763
2001	0.737	0	0	0	0	0	0	0	0.737
2002	0.711	0	0	0	0	0	0	0	0.711
2003	0.685	0	0	0	0	0	0	0	0.685
2004	0.659	0	0	0	0	0	0	0	0.659
2005	0.633	0	0	0	0	0	0	0	0.633
2006	0.608	0	0	0	0	0	0	0	0.608
2007	0.608	0	0	0	0	0	0	0	0.608
2008	0.608	0	0	0	0	0	0	0	0.608
2009	0.608	0	0	0	0	0	0	0	0.608
2010	0.608	0	0	0	0	0	0	0	0.608
2011	0.608	0	0	0	0	0	0	0	0.608
2012	0.608	0	0	0	0	0	0	0	0.608
2013	0.608	0	0	0	0	0	0	0	0.608
2014	0.608	0	0	0	0	0	0	0	0.608
2015	0.608	0	0	0	0	0	0	0	0.608
2016	0.608	0	0	0	0	0	0	0	0.608
2017	0.608	0	0	0	0	0	0	0	0.608
2018	0.608	0	0	0	0	0	0	0	0.608

Table 6.5 presents data on land converted to/remaining in the Coniferous Forest subcategory. Any piece of land converted to this subcategory remains in the relevant sub/category of land converted to Coniferous Forest for 20 years until it is finally transferred to the Coniferous Forest subcategory. Consequently, the area of each sub/category of land converted to Coniferous Forest increases for 20 years (from 1990 to 2010) and then increases or decreases according to the net outcome of balance between land converted to this subcategory since 1990 versus the land converted to this subcategory since 2010. This rule applies to all sub/categories considered in this NIR. Note that Broadleaved Forest, Annual Cropland, Woody Cropland, Woody Grassland and Wetlands (note that Wetlands are not shown in Table 6.5) land-use categories are not converted to the Coniferous Forest land-use category.

Table 6.5. Data on area of land remaining in the same land use subcategory (from Coniferous Forest to Coniferous Forest) and areas of land converted to Coniferous Forest subcategory from other land use sub/categories.

Year	Land converted to Coniferous Forest from:								Total area
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land	
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0.000	148.914	0.000	0.000	0.008	0.000	0.025	0.557	148.914

1991	0.000	148.905	0.000	0.000	0.008	0.000	0.025	0.557	149.494
1992	0.000	148.897	0.000	0.000	0.016	0.000	0.049	1.113	150.075
1993	0.000	148.888	0.000	0.000	0.024	0.000	0.074	1.670	150.656
1994	0.000	148.879	0.000	0.000	0.032	0.000	0.099	2.226	151.236
1995	0.000	148.871	0.000	0.000	0.040	0.000	0.123	2.783	151.817
1996	0.000	148.862	0.000	0.000	0.048	0.000	0.148	3.339	152.398
1997	0.000	148.854	0.000	0.000	0.056	0.000	0.173	3.896	152.978
1998	0.000	148.845	0.000	0.000	0.064	0.000	0.197	4.452	153.559
1999	0.000	148.836	0.000	0.000	0.072	0.000	0.222	5.009	154.139
2000	0.000	148.828	0.000	0.000	0.080	0.000	0.247	5.565	154.720
2001	0.000	148.819	0.000	0.000	0.089	0.000	0.271	6.122	155.301
2002	0.000	148.811	0.000	0.000	0.097	0.000	0.296	6.678	155.881
2003	0.000	148.802	0.000	0.000	0.105	0.000	0.321	7.235	156.462
2004	0.000	148.793	0.000	0.000	0.113	0.000	0.345	7.791	157.043
2005	0.000	148.785	0.000	0.000	0.121	0.000	0.370	8.348	157.623
2006	0.000	148.774	0.000	0.000	0.121	0.000	0.389	8.348	157.631
2007	0.000	148.763	0.000	0.000	0.121	0.000	0.408	8.348	157.639
2008	0.000	148.752	0.000	0.000	0.121	0.000	0.427	8.348	157.647
2009	0.000	148.741	0.000	0.000	0.121	0.000	0.445	8.348	157.655
2010	0.000	148.730	0.000	0.000	0.121	0.000	0.464	8.348	157.663
2011	0.000	149.309	0.000	0.000	0.113	0.000	0.458	7.791	157.671
2012	0.000	149.887	0.000	0.000	0.105	0.000	0.452	7.235	157.679
2013	0.000	150.466	0.000	0.000	0.097	0.000	0.447	6.678	157.687
2014	0.000	151.044	0.000	0.000	0.089	0.000	0.441	6.122	157.695
2015	0.000	151.622	0.000	0.000	0.080	0.000	0.435	5.565	157.703
2016	0.000	152.201	0.000	0.000	0.072	0.000	0.429	5.009	157.711
2017	0.000	152.779	0.000	0.000	0.064	0.000	0.423	4.452	157.719
2018	0.000	153.357	0.000	0.000	0.056	0.000	0.417	3.895	157.727

6.2.4. Methodological issues

Forest area is an area with vegetation cover that meets the national definition of forest. It includes stands of different age including areas transiently deprived of vegetation which are expected to revert to forest and lands recently afforested and reforested. All data collected by the Forest Department refer to the entire forest area. It includes also areas converted to forest in the IPCC 2006 sense. Consequently, all calculations involving biomass growth are performed on the entire forest area basis. However, estimates relating specifically to the conversion process (e.g. accumulation/release of carbon from soil) are calculated specifically for the relevant conversion areas.

The growing stock and annual increment for all subcategories included in this category are defined as follows[66]:

Growing stock = Volume over bark of all living trees more than 12 cm in diameter at breast height. Includes the stem from stump height up to a top diameter of 7cm. It does not include branches.

66 FAO. Forest Data Reporting Package for 2015. Cyprus

Annual increment = Average annual volume of gross increment over the given reference period less that of natural losses on all trees, measured to minimum diameters as defined for "Growing stock". The annual increment when expressed on the per hectare basis is averaged over the entire net area of forest in current year that is the area of forest remaining forest plus the areas converted to forest minus areas converted from forest to other uses in that year. Note: annual increment includes volume of trees harvested in that year.

National data on growing stock and annual increment are presented in Table 6.6.

Table 6.6. National data on growing stock and annual increment

Year	Growing stock	Coniferous Forest	Broadleaved Forest
	m3/ha	m3/ha/year	m3/ha/year
1990	45.96	0.5799	n.a.*
2000	45.90	0.5405	n.a.
2003		0.6976	n.a.
2004		0.6976	n.a.
2005	48.50	0.6954	n.a.
2006		0.6954	n.a.
2007		0.6954	n.a.
2008		0.8445	2.0000
2009		0.9431	2.0000
2010	57.39	0.9435	2.0000
2011		1.1687	2.0000
2012	61.06	1.1688	2.0000
2015		1.1691	2.0000
2016		1.1691	2.0000
2017		1.1691	2.0000
2018		1.1691	2.0000

*- Data not available

Data provided in Table 6.6 were interpolated and extrapolated to cover the entire period 1990 to the reported year.

National data on the growing stock and volume increment are averaged over the entire net area of forest in current year (that is the area of forest remaining forest plus the areas converted to forest minus areas converted from forest to other uses in that year).

National data on the volume of harvest is expressed as volume under bark. The volume of bark is assumed as 12 % of the harvested volume based on forest expert advice. The annual harvest when expressed on the per hectare basis is averaged over the entire net area of forest in current year (that is the area of forest remaining forest plus the areas converted to forest minus areas converted from forest to other uses in that year).

In Cyprus, salvage loggings are part of forest harvest however, data on salvage logging are also published separately from data on forest harvest. Salvage logging are included in calculation of emissions from harvest. Consequently, they do not appear in calculation of emissions from wildfires.

The root/shoot ratio for all forest is 0.28 (read from Table 6.4.4 for subtropical dry forest, based on the ERT advice).

The carbon fraction of wood is 0.47 tC/t d.m. (based on the ERT advice).

The biomass conversion factors were read Table 6.4.5 (p. 4.51) for Mediterranean dry tropical, subtropical climatic zone and growing stock level 41 – 100 m3/ha. These factors are presented in Table 6.7.

Table 6.7. Numerical data for BCEF values used in carbon source/sink calculations.

Forest type	BCEF	Value used in calculations

Broadleaved Forest	$BCEF_S$	0.8 t biomass/m3 wood volume
	$BCEF_I$	0.55 t biomass/m3 wood volume
	$BCEF_R$	0.89 t biomass/m3 wood volume
Coniferous Forest	$BCEF_S$	0.6 t biomass/m3 wood volume
	$BCEF_I$	0.45 t biomass/m3 wood volume
	$BCEF_R$	0.67 t biomass/m3 wood volume

Forest fires

Combustion factor Cf=0.45 (default all other temperate forests, Table 6.2.6 p.2.48) is used in all calculations relating to forest fires. All forest fires are reported under the land use category Forest remaining Forest.

Land converted to forest land

All emissions/removals relating to change in carbon stocks in above- and below-ground biomass are estimated under the Forest remaining Forest section. This is due to national data specificity as explained earlier. Consequently, the Land converted to Forest Land section covers only changes in carbon stocks in dead organic matter (includes dead wood and litter) and carbon stocks in soils.

A default 20-year transition period is used in calculations regarding changes in biomass and soil organic carbon. It is assumed that all other carbon pools (litter and dead wood) reach equilibrium values in the year of transition. The assumption is based on expert judgement.

It is further assumed that conversion of land to forest land does not lead to non-CO2 GHG emissions because in the Cyprus situation such conversion does not require fertilization, the use of fire, drying of wetlands, etc.

Change in carbon in dead organic matter

Following the Tier 1 approach it is assumed that dead organic matter pool is zero in all non-forest land-use categories. For Forest Land land-use category, the default values of 28.2 t C/ha and 20.3 t C/ha for broadleaved and coniferous forest types, respectively, are used (Table 6.2.2, p. 2.27, warm temperate dry climate).

Change in carbon stocks in soils

The reference stocks in soil organic carbon are read from Table 6.2.3 of the 2006 IPCC Guidelines (p. 2.31). All non-wetland soils in Cyprus are considered to be high activity clay soils and the default value of 38 t C/ha is used (Table 6.2.3, warm temperate dry climate). For wetland soils, the default value of 88 t C/ha is used (Table 6.2.3, warm temperate dry climate).

Tier 1 approach is implemented hence, the stock change factors for input, management and disturbance regime, are equal to 1. Consequently, the reference default value of 38 t C/ha is used in all calculations relating to changes in soil carbon in mineral soils.

Dead wood carbon stocks are assumed zero before and after conversion (default data are not available).

Default values for carbon stocks in litter in mature forests are read from Table 6.2.2, p. 2.27 for subtropical climate, i.e. 2.8 tC/ha for broadleaved forests and 4.1 tC/ha for coniferous forests.

All calculations are performed using the IPCC generic equations.

6.2.5. Uncertainties and time-series consistency

Uncertainty analysis will be performed when area data of resolution comparable to the area threshold used in the forest definition (0.3 ha) will be available.

Uncertainties are mainly affected by the lack of precise data on area of land converted to/from forest, area and net annual increment in private forests and to a lesser extent by potentially imprecise assessment of net annual increment in deciduous forest managed by the State Forest administration.

Time series for the land-use categories Forest Land remaining Forest Land and Land converted to Forest (for Coniferous and Broadleaved Forest together) are presented in Figure 6.2 and Figure 6.3.

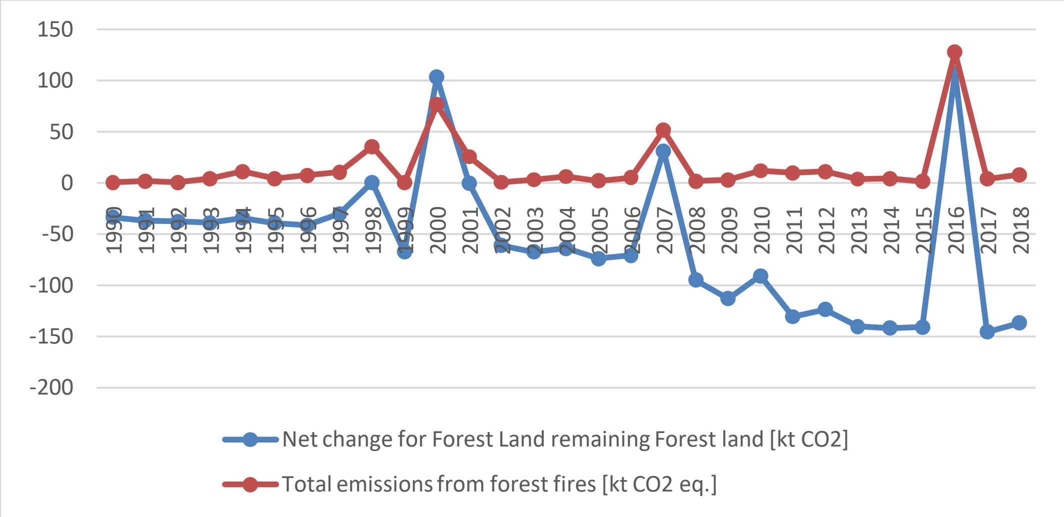

Figure 6.2. Forest Land remaining Forest Land: Net change in CO2 (blue line) and CO2 eq. emissions from forest fires (red line) during the period 1990 – 2018.

Figure 6.2 presents data that are consistent in time. A trend of increasing sink in Forest remaining Forest is clearly distinguishable. The trend is transiently broken in years of exceptional extent of forest fires.

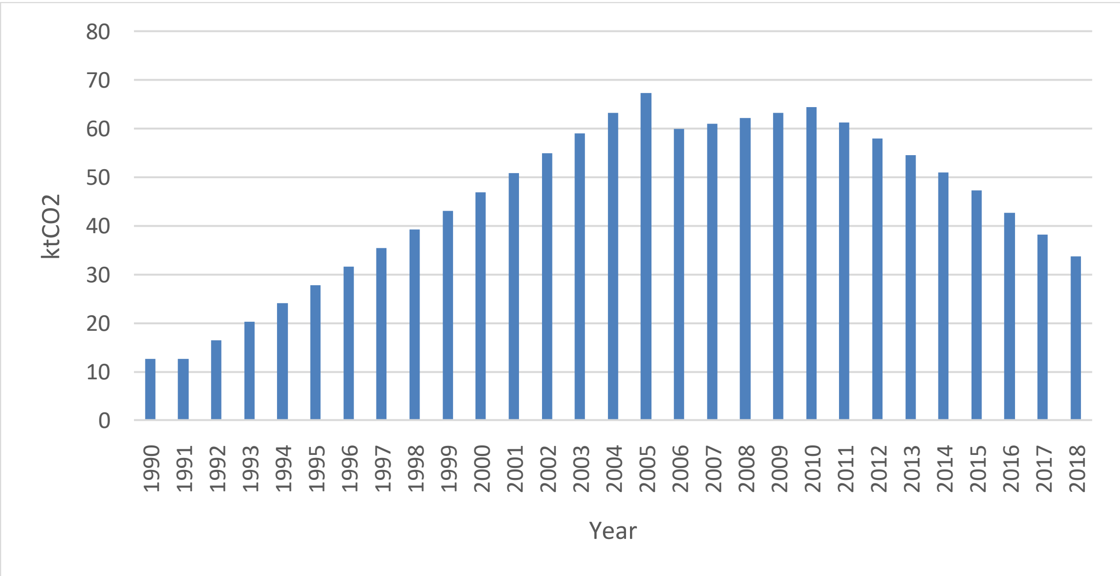

Figure 6.3. Land converted to Forest: Net change in CO2 (blue line) during the period 1990 – 2018

Figure 6.3 presents data that are consistent in time. A trend of increasing sink in land converted to Forest until 2005 is clearly distinguishable. The trend is not retained after 2005 because the annual area of land converted to forest rapidly decreases due to unavailability of land for further forestation.

Figure 6.4 presents the total input from the Forest remaining Forest and Land converted to Forest to the GHG sink/source in the LULUCF sector.

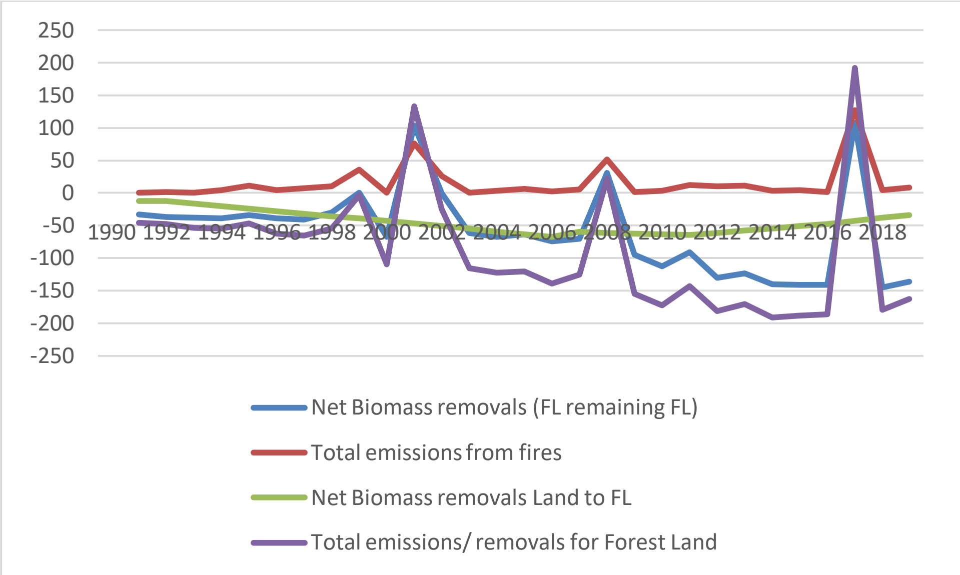

Figure 6.4. Forest remaining Forest and Land converted to Forest: net CO2 emissions/removals during the period 1990 – 2018

6.2.6. Category-specific QA/QC and verification

The following category specific QA/QC and verification approaches were implemented during preparation of this NIR:

- Check of correctness/plausibility of activity data and emission factors used in calculations and their units;
- Check of plausibility of input data;
- Check of completeness of data;
- Check of plausibility of results;
- Check of references and assumptions applied in processing of the data;
- Check of the correctness of all equations for estimation of the GHG fluxes
- Check of the consistency of the total area of the lands under the effective control of the Republic of Cyprus in all years of the reported period.

6.2.7. Category-specific recalculations

Change of BCEFI (biomass conversion and expansion factor for increment) from 0.645 tC/m3 to the default value 0.450 tC/m3 (Table 6.4.5, p. 4.51, value for Mediterranean, dry tropical and subtropical coniferous forest).

Use of interpolated and extrapolated data provided in Table 6.6 to cover the entire period 1990 to the reported year instead of using an average (0.844 m3/ha/yr) for the entire period (coniferous forest).

Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.

6.2.8. Category-specific planned improvements

1. The interpretation of the satellite images and related the CORINE land cover data used for calculation of LUC matrixes should be further continued until a consistency with the annual land use data is met. Net area changes calculated using the CORINE land use change data (resolution 5 ha) should be equal (within the defined error range) to net area changes calculated from the CORINE annual land use data set (resolution 25 ha).

2. An approach should be developed to obtain a numerical assessment of land use changes involving individual areas from 0.3 ha to 5 ha and their impact on the numerical estimates of land use changes obtained at the 5 ha resolution. The national definition of forest requires assessment of land use changes at the resolution of 0.3 ha. This may be achieved by means of establishing a correlation between the area of land use changes detected at the resolution of 5 ha and "true" area of land use changes estimated based on the threshold of 0.3 ha.

6.3. Cropland (4B)

6.3.1. Description

6.3.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

6.3.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting". Table 6.8 presents data on lands converted to Annual Cropland. Note that Forest and Woody Grassland land-use categories are not converted to Annual Cropland. Table 6.9 presents data on lands converted to Woody Cropland. Note that Broadleaved Forest land-use category is not converted to Woody Cropland. Wetlands are not converted to both Annual and Woody Cropland (not shown in Table 6.8 and Table 6.9).

Table 6.8. Data on area of land remaining in the same land use subcategory (from Annual Cropland to Annual Cropland) and areas of land converted to Annual Cropland subcategory from other land use sub/categories. Note that any piece of land after remaining for 20 years in the transitional land use sub/category is transferred to the final land use sub/category.

Year	Land converted to Annual Cropland from:								Total area
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land	
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0.000	0.000	128.077	0.001	0.088	0.000	0.000	0.000	128.166
1991	0.000	0.000	127.599	0.001	0.088	0.000	0.000	0.000	127.688
1992	0.000	0.000	127.121	0.002	0.175	0.000	0.000	0.000	127.298
1993	0.000	0.000	126.643	0.003	0.263	0.000	0.000	0.000	126.909
1994	0.000	0.000	126.164	0.005	0.350	0.000	0.000	0.000	126.519

1995	0.000	0.000	125.686	0.006	0.438	0.000	0.000	0.000	126.130
1996	0.000	0.000	125.208	0.007	0.525	0.000	0.000	0.000	125.740
1997	0.000	0.000	124.730	0.008	0.613	0.000	0.000	0.000	125.351
1998	0.000	0.000	124.251	0.009	0.701	0.000	0.000	0.000	124.961
1999	0.000	0.000	123.773	0.010	0.788	0.000	0.000	0.000	124.571
2000	0.000	0.000	123.295	0.012	0.876	0.000	0.000	0.000	124.183
2001	0.000	0.000	122.817	0.013	0.963	0.000	0.000	0.000	123.793
2002	0.000	0.000	122.338	0.014	1.051	0.000	0.000	0.000	123.403
2003	0.000	0.000	121.860	0.015	1.138	0.000	0.000	0.000	123.013
2004	0.000	0.000	121.382	0.016	1.226	0.000	0.000	0.000	122.624
2005	0.000	0.000	120.904	0.017	1.314	0.000	0.000	0.000	122.235
2006	0.000	0.000	120.826	0.029	1.314	0.000	0.001	0.008	122.178
2007	0.000	0.000	120.749	0.041	1.314	0.000	0.002	0.017	122.123
2008	0.000	0.000	120.671	0.052	1.314	0.000	0.003	0.025	122.065
2009	0.000	0.000	120.594	0.064	1.314	0.000	0.004	0.034	122.010
2010	0.000	0.000	120.517	0.075	1.314	0.000	0.005	0.042	121.953
2011	0.000	0.000	120.528	0.086	1.226	0.000	0.007	0.050	121.897
2012	0.000	0.000	120.539	0.096	1.138	0.000	0.008	0.059	121.840
2013	0.000	0.000	120.551	0.107	1.051	0.000	0.009	0.067	121.785
2014	0.000	0.000	120.562	0.117	0.963	0.000	0.010	0.075	121.727
2015	0.000	0.000	120.573	0.128	0.876	0.000	0.011	0.084	121.672
2016	0.000	0.000	120.585	0.138	0.788	0.000	0.012	0.092	121.615
2017	0.000	0.000	120.597	0.167	2.102	0.000	0.013	0.100	122.979
2018	0.000	0.000	120.609	0.196	0.788	0.000	0.014	0.108	124.343

Table 6.9. Data on area of land remaining in the same land use subcategory (from Woody Cropland to Woody Cropland) and areas of land converted to Woody Cropland subcategory from other land use sub/categories. Note that any piece of land after remaining for 20 years in the transitional land use sub/category is transferred to the final land use sub/category.

Year	Land converted to Woody Cropland from:								Total area
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land	
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0.000	0.000	0.092	122.782	0.007	0.066	0.036	0.529	123.512
1991	0.000	0.000	0.092	122.385	0.007	0.066	0.036	0.529	123.115
1992	0.000	0.000	0.183	121.988	0.014	0.131	0.073	1.057	123.446
1993	0.000	0.000	0.275	121.591	0.020	0.197	0.109	1.586	123.778
1994	0.000	0.000	0.366	121.194	0.027	0.263	0.145	2.114	124.109
1995	0.000	0.001	0.458	120.797	0.034	0.328	0.182	2.643	124.443
1996	0.000	0.001	0.549	120.400	0.041	0.394	0.218	3.171	124.774
1997	0.000	0.001	0.641	120.003	0.048	0.460	0.255	3.700	125.108
1998	0.000	0.001	0.732	119.606	0.054	0.525	0.291	4.229	125.438
1999	0.000	0.001	0.824	119.209	0.061	0.591	0.327	4.757	125.770

2000	0.000	0.001	0.915	118.812	0.068	0.657	0.364	5.286	126.103
2001	0.000	0.001	1.007	118.415	0.075	0.722	0.400	5.814	126.434
2002	0.000	0.001	1.098	118.018	0.082	0.788	0.436	6.343	126.766
2003	0.000	0.002	1.190	117.621	0.088	0.854	0.473	6.872	127.100
2004	0.000	0.002	1.281	117.224	0.095	0.919	0.509	7.400	127.430
2005	0.000	0.002	1.373	116.827	0.102	0.985	0.546	7.929	127.764
2006	0.000	0.002	1.377	116.651	0.102	0.988	0.546	7.929	127.595
2007	0.000	0.002	1.380	116.475	0.102	0.992	0.546	7.929	127.426
2008	0.000	0.002	1.384	116.299	0.102	0.995	0.546	7.929	127.257
2009	0.000	0.002	1.388	116.124	0.102	0.999	0.546	7.929	127.090
2010	0.000	0.002	1.392	115.948	0.102	1.002	0.546	7.929	126.921
2011	0.000	0.002	1.304	116.501	0.095	0.940	0.509	7.400	126.751
2012	0.000	0.002	1.216	117.054	0.088	0.877	0.473	6.872	126.582
2013	0.000	0.001	1.129	117.608	0.082	0.815	0.436	6.343	126.414
2014	0.000	0.001	1.041	118.161	0.075	0.753	0.400	5.814	126.245
2015	0.000	0.001	0.953	118.714	0.068	0.691	0.364	5.286	126.077
2016	0.000	0.001	0.865	119.267	0.061	0.628	0.327	4.757	125.906
2017	0.000	0.001	0.777	119.820	0.054	0.565	0.290	4.228	125.735
2018	0.000	0.001	0.689	120.373	0.047	0.502	0.253	3.699	125.564

The decreasing tendency in the area of cropland in Cyprus is consistent with international data provided e.g. by the World Bank[67].

There is no conversion of Wetlands to Cropland.

6.3.4. Methodological issues

Tier 1 method following the guidance contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was applied due to the lack of national data (except activity data). In particular, all emission factors are default IPCC data read from the 2006 IPCC Guidelines.

Annual Cropland remaining Annual Cropland

By definition this land-use category contains no woody vegetation. Due to the lack of data on changes in management in Annual Cropland, it is assumed that the management remains constant since before 1990 hence, the annual vegetation component does not affect the GHG sinks and sources on annual basis. It is further assumed that soil organic carbon remains unchanged following the lack of changes in the management of these lands.

Use of fire is not a part of management in lands classified as Annual Cropland.

Lands converted to Annual Cropland

Lands converted Annual Cropland are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. Tier 1 approach was implemented to calculate GHG sinks and sources resulting from the conversion.

Use of fire is not a part of management in lands classified as Lands converted to Annual Cropland.

[67] http://www.factfish.com/statistic-country/cyprus/permanent+crops+area+of+total+area

Woody Cropland remaining Woody Cropland

Woody Cropland differs from the Annual Cropland due to the presence of the woody vegetation (as detected using the CORINE land cover data). However, there is no national data on stock and net annual increment of this vegetation. Consequently, the default data provided in Table 6.5.1 (2006 IPCC Guidelines, p. 5.9) have been used in the GHG sink/source estimation for this land-use category.

It is further assumed that dead wood, litter and soil organic carbon remain unchanged following the lack of changes in the management of lands reported under this land-use category.

Use of fire is not a part of management in lands classified as Woody Cropland. Due to the lack of data it is assumed that wild fires do not occur in Woody Cropland (this assumption is further justified by the fact that woody vegetation is sparse in this land what prevents initiation and propagation of fire).

Lands converted to Woody Cropland

Lands converted Woody Cropland are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. Tier 1 approach was implemented to calculate GHG sinks and sources following the conversion.

It is assumed that there is no dead wood in Lands converted to Woody Cropland however, Woody cropland contains litter that amounts to 10% of litter present in forest (based on the default data). These assumptions are based on expert judgement.

Use of fire is not a part of management in lands classified as Lands converted to Woody Cropland.

Organic carbon in soil

The IPCC 2006 default reference value for soil organic C stocks in high activity clay mineral soils (warm temperate dry climate region) SOCREF = 38 t C/ha (Table 6.2.3, pg.2.31, Vol.4, IPCC 2006) is selected for all calculations involving soil carbon in Annual Cropland and Woody Cropland.

Table 6.10 presents the default relative soil organic carbon stock change factors used in calculations.

Table 6.10. The IPCC default relative soil organic carbon stock change factors.

	Relative stock change factor	Error	Remarks on the default values read from Table 6.5.5, p.5.17
Annual CL	Land use FLU= 0.58	+/- 61%	tropical dry moisture regime, long term annual cultivation
Annual CL	Tillage FMG= 1.0	NA	full level tillage
Annual CL	Input FI= 1.0	NA	medium level residue return for tropical dry climate
Woody CL	Land use FLU= 1.0	+/- 50%	all temperature regimes, long term perennial tree crops
Woody CL	Tillage FMG= 1.0	NA	reduced level tillage
Woody CL	Input FI= 1.04	+/- 13%	high level w/o manure residue return for tropical dry climate

6.3.5. Uncertainties and time-series consistency

Uncertainty analysis will be performed when area data of resolution comparable to the area threshold used in the forest definition (0.3 ha) will be available.

Uncertainties are mainly affected by the lack of precise data on area of land converted to/from Annual Cropland and Woody Cropland and area and net annual increment in Woody Cropland. The applicability of default data for woody vegetation stock, growth and harvest (provided in Table 6.5.1 of the 2006 IPCC Guidelines) should be further examined. In particular, the default data result in stock estimates that are greater than similar estimates for forest which may not be true.

All GHG sink/source estimates for Croplands are highly affected by uncertainties in activity data and emission factors (uncertain CORINE data and the use of default data). Greater availability of national data on this land-use category could potentially decrease uncertainties in the estimates.

Time series for the land-use categories Woody Cropland remaining Woody Cropland, Land converted to Annual Cropland and Land converted to Woody Cropland are presented in Figure 6.5.

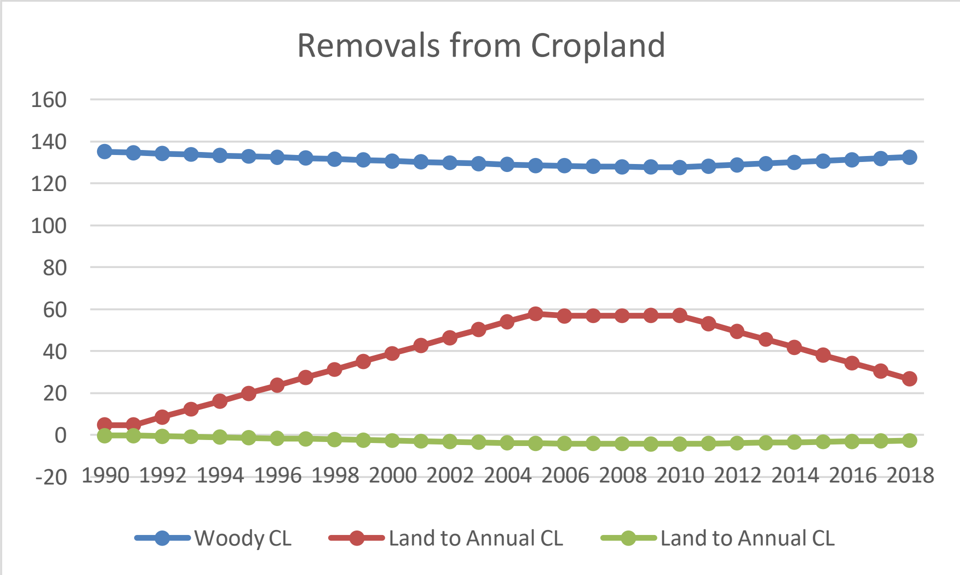

Figure 6.5. Woody Cropland remaining Woody Cropland, Land converted to Annual Cropland and Land converted to Woody Cropland: CO2 emissions/removals during the period 1990 – 2018 in KtCO2.

Time series presented in Figure 6.5 are consistent. The changes in 2005 and 2010 reflect changes in data (the CORINE data are available for 2000, 2006 and 2012 only, the remaining data are interpolated or extrapolated) or the specificity of the 2006 IPCC guidelines (the end of the first 20-year transition period occurs in 2010).

6.3.6. Category-specific QA/QC and verification

See para 6.2.6 above.

6.3.7. Category-specific recalculations

Not applicable (the results of calculations are reported for the first time).

6.3.8. Category-specific planned improvements

See para 6.2.8 above.

6.4. Grassland (4C)

6.4.1. Description

6.4.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

6.4.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting".

Table 6.11 presents numerical data on the area of Grassland remaining Grassland in the period 1990 - 2016.

Table 6.11. Data on area of land remaining in the same land-use subcategory (Grass Grassland remaining Grass Grassland) and areas of land converted to Grass Grassland subcategory from other land-use sub/categories. Note that there is no conversion of any land to Grass Grassland.

Year	Land converted to Grass Grassland from:							
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0	0	0	0	30.977	0	0	0
1991	0	0	0	0	30.524	0	0	0
1992	0	0	0	0	30.071	0	0	0
1993	0	0	0	0	29.617	0	0	0
1994	0	0	0	0	29.164	0	0	0
1995	0	0	0	0	28.711	0	0	0
1996	0	0	0	0	28.258	0	0	0
1997	0	0	0	0	27.804	0	0	0
1998	0	0	0	0	27.351	0	0	0
1999	0	0	0	0	26.898	0	0	0
2000	0	0	0	0	26.444	0	0	0
2001	0	0	0	0	25.991	0	0	0
2002	0	0	0	0	25.538	0	0	0
2003	0	0	0	0	25.085	0	0	0
2004	0	0	0	0	24.631	0	0	0
2005	0	0	0	0	24.178	0	0	0
2006	0	0	0	0	24.123	0	0	0
2007	0	0	0	0	24.068	0	0	0
2008	0	0	0	0	24.013	0	0	0
2009	0	0	0	0	23.958	0	0	0
2010	0	0	0	0	23.903	0	0	0
2011	0	0	0	0	23.848	0	0	0
2012	0	0	0	0	23.793	0	0	0
2013	0	0	0	0	23.738	0	0	0
2014	0	0	0	0	23.683	0	0	0
2015	0	0	0	0	23.628	0	0	0

Year	Land converted to Grass Grassland from:							
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
2016	0	0	0	0	23.573	0	0	0
2017	0	0	0	0	23.518	0	0	0
2018	0	0	0	0	23.463	0	0	0

According to the available data there is no conversion of Land to Grass Grassland.

Table 6.12 presents numerical data on the area of Woody Grassland remaining Woody Grassland and area of Lands converted to Woody Grassland in the period 1990 -2016. Note that the conversion of Land to Woody Grassland was detected only since 2006.

Table 6.12. Data on area of land remaining in the same land use subcategory (from Woody Grassland to Woody Grassland) and areas of land converted to Woody Grassland subcategory from other land use sub/categories.

Year	Land converted to Woody Grassland from:							
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0	0	0	0	0	121.948	0	0
1991	0	0	0	0	0	121.045	0	0
1992	0	0	0	0	0	120.143	0	0
1993	0	0	0	0	0	119.240	0	0
1994	0	0	0	0	0	118.337	0	0
1995	0	0	0	0	0	117.434	0	0
1996	0	0	0	0	0	116.532	0	0
1997	0	0	0	0	0	115.629	0	0
1998	0	0	0	0	0	114.726	0	0
1999	0	0	0	0	0	113.824	0	0
2000	0	0	0	0	0	112.921	0	0
2001	0	0	0	0	0	112.018	0	0
2002	0	0	0	0	0	111.115	0	0
2003	0	0	0	0	0	110.213	0	0
2004	0	0	0	0	0	109.310	0	0
2005	0	0	0	0	0	108.407	0	0
2006	0	0	0	0	0	108.334	0.006	0.058
2007	0	0	0	0	0	108.261	0.013	0.116
2008	0	0	0	0	0	108.188	0.019	0.174
2009	0	0	0	0	0	108.115	0.025	0.232
2010	0	0	0	0	0	108.042	0.032	0.290
2011	0	0	0	0	0	107.970	0.038	0.348
2012	0	0	0	0	0	107.897	0.044	0.406
2013	0	0	0	0	0	107.824	0.051	0.464
2014	0	0	0	0	0	107.751	0.057	0.522
2015	0	0	0	0	0	107.678	0.063	0.580
2016	0	0	0	0	0	107.605	0.070	0.638
2017	0	0	0	0	0	107.532	0.076	0.696
2018	0	0	0	0	0	107.459	0.082	0.754

There is no conversion of Wetlands to Grassland.

6.4.4. Methodological issues

Tier 1 method following the guidance contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was applied due to the lack of national data (except activity data). In particular, all emission factors are default IPCC data read from the 2006 IPCC Guidelines.

Grass Grassland remaining Grass Grassland

By definition this land-use category contains no woody vegetation. Due to the lack of data on changes in management in Grass Grassland, it is assumed that the management remains constant since before 1990 hence, the annual vegetation component does not affect the GHG sinks and sources on annual basis. It is further assumed that soil organic carbon remains unchanged following the lack of changes in the management of these lands.

Use of fire is not a part of management in lands classified as Grass Grassland.

Lands converted to Grass Grassland

According to the available data there is no conversion of Land to Grass Grassland.

Woody Grassland remaining Woody Grassland

Woody Grassland differs from the Grass Grassland due to the presence of the woody vegetation (as detected using the CORINE land cover data). However, there is no national data on stock and net annual increment of this vegetation. Consequently, the default data provided in Table 6.5.1 (2006 IPCC Guidelines, p. 5.9) have been used to estimate the GHG sink/source for this land-use category.

It is further assumed that dead wood, litter and soil organic carbon remain unchanged following the lack of changes in the management of lands reported under this land-use category.

Use of fire is not a part of management in lands classified as Woody Grassland. Due to the lack of data, it is further assumed that wild fires do not occur in Woody Grassland (this assumption is further justified by the fact that woody vegetation is sparse in this land what prevents initiation and propagation of fire).

Lands converted to Woody Grassland

Lands converted Woody Grassland are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. Tier 1 approach was implemented to calculate GHG sinks and sources following the conversion. However, the conversion of Land to Woody Grassland was detected only since 2006 (see Table 6.12).

It is assumed that there is no dead wood in Lands converted to Woody Grassland however, litter in Woody Grassland amounts to 10% of litter present in forest (based on the default data). These assumptions are based on expert judgement.

Use of fire is not a part of management in lands classified as Lands converted to Woody Grassland.

Organic carbon in soil

The IPCC 2006 default reference value for soil organic C stocks for high activity clay mineral soils (warm temperate dry climate region) SOCREF = 38 t C/ha (Table 6.2.3, pg.2.31, Vol.4, IPCC 2006) is selected for all calculations involving soil carbon in Grass Grassland and Woody Grassland. All relative stock change factors were read from Table 6.5.5, p. 5.17, Vol.4, IPCC 2006. All these factors are equal to 1 for Cyprian conditions.

All IPCC default relative soil carbon stock change factors for Grass Grassland and Woody Grassland are equal to 1 (Table 6.6.2, p. 6.16, vol.4, IPPC 2006).

6.4.5. Uncertainties and time-series consistency

Uncertainty analysis will be performed when area data of resolution comparable to the area threshold used in the forest definition (0.3 ha) will be available. Uncertainties are mainly affected by the lack of precise data on area of land converted to/from Grass Grassland and no data on area of land converted to/from Woody Grassland before 2006. Additionally, there is no national data on the net annual increment in Woody Grassland. The applicability of default data for woody vegetation stock, growth and harvest (provided in Table 6.5.1 of the 2006 IPCC Guidelines) should be further examined. In particular, the default data result in stock estimates that are greater than similar estimates for forest which may not be true.

All GHG sink/source estimates for Grasslands are highly affected by uncertainties in activity data and emission factors (uncertain CORINE data and the use of default data). Greater availability of national data on this land-use category could potentially decrease uncertainties in the estimates. In particular, it seems unlikely that there is no conversion of Land to Grass Grassland since 1990 and no conversion of Land to Woody Grassland before 2006. The fact that such conversion was detected after 2006 increases probability that similar conversions might have occurred also earlier.

Figure 6.6 presents consistent data series for CO2 removals in Woody Grassland remaining Woody Grassland during the period 1990 – 2017. The significant decrease in the removals before 2006 and stabilization of them result from changes in the area of this land-use category (compare area data contained in Table 6.11 and Table 6.12).

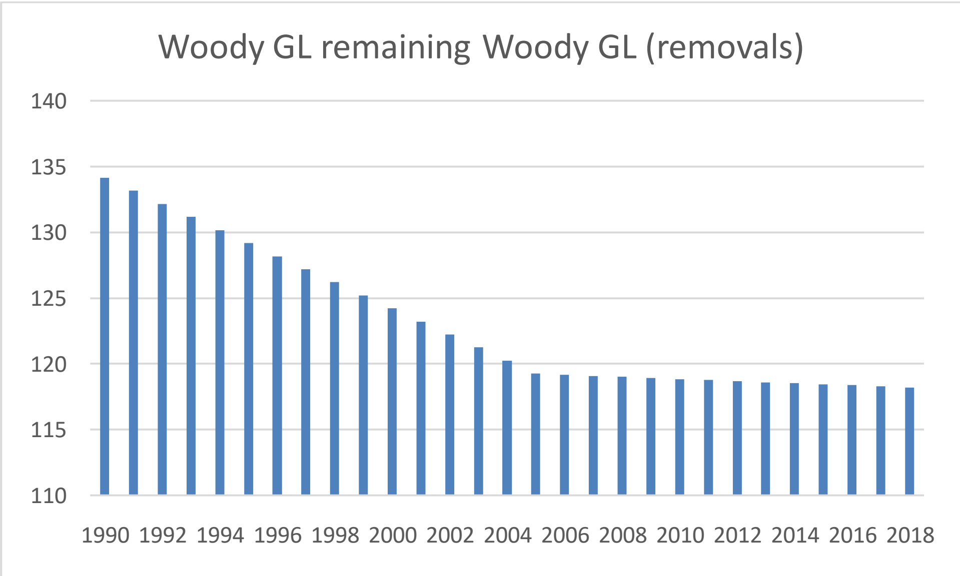

Figure 6.6. Woody Grassland remaining Woody Grassland: CO2 removals during the period 1990 – 2018 in KtCO2.

6.4.6. Category-specific QA/QC and verification, if applicable

See para 6.2.6 above.

6.4.7. Category-specific recalculations, if applicable, including changes made in response to the review process

Not applicable (the results of calculations are reported for the first time).

6.4.8. Category-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

See para 6.2.8 above.

6.5. Wetland (4D)

6.5.1. Description

6.5.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

6.5.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting".

Table 6.1 provides data on area of Wetlands remaining Wetlands and Lands converted to Wetlands reported annually during the period 1990 – 2016.

Table 6.1. Data on area of land remaining in the same land use category (from Wetland to Wetland) and areas of land converted to Wetland category from other land use sub/categories. Note that any piece of land after remaining for 20 years in the transitional land use category is transferred to the final land use category.

Year	Land converted to Wetlands from:								
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Wet-lands	Settle-ments	Other Land
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0	0	0	0	0	0	2.5780	0	0.0804
1991	0	0	0	0	0	0	2.5780	0	0.0804
1992	0	0	0	0	0	0	2.5780	0	0.1608
1993	0	0	0	0	0	0	2.5780	0	0.2412
1994	0	0	0	0	0	0	2.5780	0	0.3215
1995	0	0	0	0	0	0	2.5780	0	0.4019
1996	0	0	0	0	0	0	2.5780	0	0.4823
1997	0	0	0	0	0	0	2.5780	0	0.5627
1998	0	0	0	0	0	0	2.5780	0	0.6431
1999	0	0	0	0	0	0	2.5780	0	0.7235
2000	0	0	0	0	0	0	2.5780	0	0.8038

Year	Land converted to Wetlands from:								
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Wet-lands	Settle-ments	Other Land
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
2001	0	0	0	0	0	0	2.5780	0	0.8842
2002	0	0	0	0	0	0	2.5780	0	0.9646
2003	0	0	0	0	0	0	2.5780	0	1.0450
2004	0	0	0	0	0	0	2.5780	0	1.1254
2005	0	0	0	0	0	0	2.5780	0	1.2058
2006	0	0.0059	0	0	0	0	2.5780	0.0086	1.2086
2007	0	0.0119	0	0	0	0	2.5780	0.0172	1.2114
2008	0	0.0178	0	0	0	0	2.5780	0.0259	1.2141
2009	0	0.0238	0	0	0	0	2.5780	0.0345	1.2169
2010	0	0.0297	0	0	0	0	2.5780	0.0431	1.2197
2011	0	0.0357	0	0	0	0	2.6584	0.0517	1.1422
2012	0	0.0416	0	0	0	0	2.7388	0.0603	1.0646
2013	0	0.0475	0	0	0	0	2.8192	0.0690	0.9870
2014	0	0.0535	0	0	0	0	2.8996	0.0776	0.9094
2015	0	0.0594	0	0	0	0	2.9800	0.0862	0.8318
2016	0	0.0654	0	0	0	0	3.0603	0.0948	0.7542
2017	0	0.0714	0	0	0	0	3.6833	0.1034	0.6766
2018	0	0.0774	0	0	0	0	43.063	0.1120	0.5990

Note that Broadleaved Forest, Annual Cropland, Woody Cropland, Grass Grassland and Woody Grassland land-use categories are not converted to Wetlands.

6.5.4. Methodological issues

Tier 1 method following the guidance contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was applied due to the lack of national data (except activity data). In particular, all emission factors are default IPCC data read from the 2006 IPCC Guidelines.

Wetlands remaining Wetlands

In Cypriot conditions this land-use category contains no woody vegetation. According to the available data there is no peatlands and organic soils in Cyprus.

Due to the lack of data on changes in management in Wetlands, it is assumed that the management remains constant since before 1990. Consequently, it is assumed that soil organic carbon remains constant following the lack of changes in the management of these lands. Therefore, the Wetlands remaining Wetlands land-use category does not affect the GHG sinks and sources on annual basis.

Use of fire is not a part of management in lands classified as Wetlands.

Lands converted to Wetlands

Lands converted Wetlands are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. Tier 1 approach was implemented to calculate GHG sinks and sources following the conversion. It is assumed that there is no woody vegetation, dead wood and litter in Lands converted to Woody Grassland. These assumptions are based on expert judgement.

Use of fire is not a part of management in lands classified as Lands converted to Wetlands.

Organic carbon in soil

The reference stock in soil organic C is read from Table 6.2.3 of the 2006 IPCC Guidelines. For wetland soils, the default value of 88 t C/ha is used (Table 6.2.3, warm temperate dry climate).

Tier 1 approach is implemented hence, the stock change factors for input, management and disturbance regime, are equal to 1. Consequently, the default value of 88 t C/ha is used in all calculations relating to soil carbon in Wetland mineral soils. Note that there are no organic soils in Cyprus.

6.5.5. Uncertainties and time-series consistency

Uncertainty analysis will be performed when area data of resolution comparable to the area threshold used in the forest definition (0.3 ha) will be available.

All GHG sink/source estimates for Wetlands are highly affected by uncertainties in activity data and emission factors (uncertain CORINE data and the use of default data). Greater availability of national data on this land-use category could potentially decrease uncertainties in the estimates.

The applicability of default data for organic carbon in soil should be further examined.

In particular, it seems unlikely that there is no conversion of Coniferous Forest and Settlements to Wetlands before 2006. The fact that such conversion was detected after 2006 increases probability that similar conversions might have occurred also earlier. Additionally, the lack of conversion of Broadleaved Forest, Annual Cropland, Woody Cropland, Grass Grassland and Woody Grassland requires further research.

Figure 6.7 presents consistent data series for CO2 removals in Lands converted to Wetlands during the period 1990 – 2018. The increase in the removals before 2006, stabilization in the period 2006 – 2010 followed by a decrease result from changes in the area of this land-use category (compare area data contained in Table 6.13).

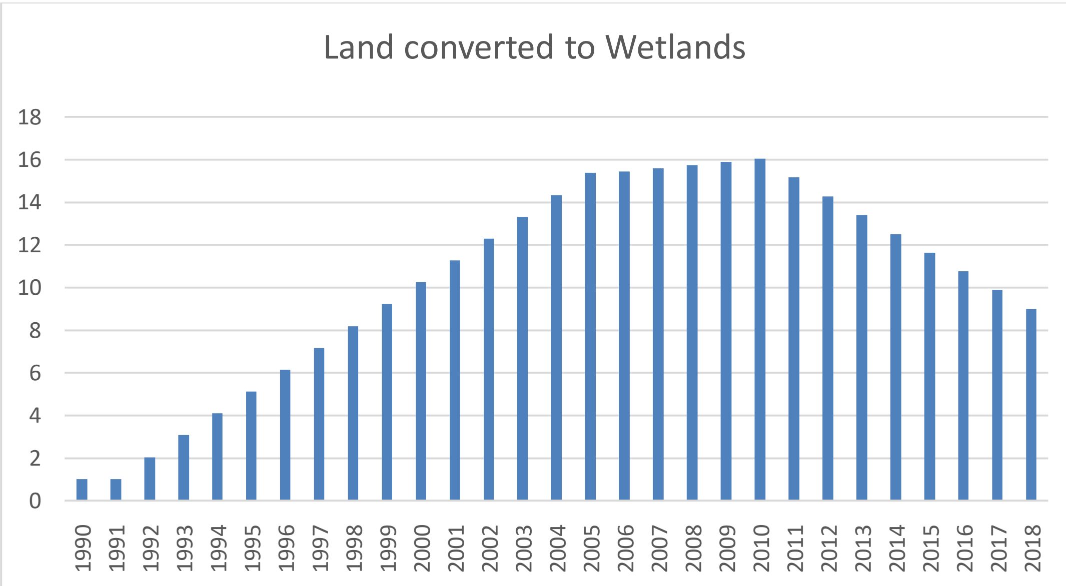

Figure 6.7. Lands converted to Wetlands: CO2 removals during the period 1990 – 2018.

6.5.6. Category-specific QA/QC and verification

See para 6.2.6 above.

6.5.7. Category-specific recalculations

Not applicable (the results of calculations are reported for the first time).

6.5.8. Category-specific planned improvements

See para 6.2.8 above.

6.6. Settlements (4E)

6.6.1. Description

6.6.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

6.6.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting". Table 6.14 provides data on area of Settlements remaining Settlements and Lands converted to Settlements reported annually during the period 1990 – 2016.

Table 6.14. Data on area of land remaining in the same land use subcategory (from Settlements to Settlements) and areas of land converted to Settlements category from other land use sub/categories. Note that any piece of land after remaining for 20 years in the transitional land use sub/category is transferred to the final land use sub/category.

Year	Land converted to Settlements from:							
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settlements	Other Land
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0.001	0.009	0.318	0.396	0.117	0.197	386.951	0.000
1991	0.001	0.009	0.318	0.396	0.117	0.197	386.341	0.000
1992	0.003	0.017	0.636	0.792	0.234	0.394	385.730	0.001
1993	0.004	0.025	0.954	11.876	0.350	0.590	385.120	0.001
1994	0.005	0.034	12.721	15.835	0.467	0.787	384.509	0.001
1995	0.006	0.042	15.901	19.793	0.584	0.984	383.899	0.002
1996	0.008	0.051	19.081	23.752	0.701	11.806	383.289	0.002
1997	0.009	0.059	22.262	27.711	0.818	13.774	382.678	0.002
1998	0.010	0.068	25.442	31.669	0.935	15.741	382.068	0.002
1999	0.012	0.076	28.622	35.628	10.513	17.709	381.458	0.003
2000	0.013	0.085	31.802	39.587	11.681	19.677	380.847	0.003
2001	0.014	0.093	34.983	43.546	12.849	21.644	380.237	0.003
2002	0.016	0.102	38.163	47.504	14.017	23.612	379.626	0.004
2003	0.017	0.110	41.343	51.463	15.185	25.580	379.016	0.004
2004	0.018	0.119	44.523	55.422	16.353	27.547	378.406	0.004
2005	0.019	0.127	47.704	59.380	17.521	29.515	377.795	0.005
2006	0.019	0.127	48.440	60.807	17.652	30.210	377.437	0.005

2007	0.019	0.127	49.176	62.234	17.784	30.906	377.079	0.005
2008	0.019	0.127	49.912	63.661	17.915	31.601	376.721	0.005
2009	0.019	0.127	50.648	65.089	18.046	32.297	376.363	0.005
2010	0.019	0.127	51.384	66.516	18.177	32.992	376.005	0.005
2011	0.018	0.119	48.939	63.984	17.141	31.720	386.022	0.004
2012	0.017	0.110	46.495	61.452	16.104	30.448	396.039	0.004
2013	0.016	0.102	44.051	58.921	15.067	29.176	406.057	0.004
2014	0.014	0.093	41.607	56.389	14.030	27.903	416.074	0.003
2015	0.013	0.085	39.160	53.860	12.990	26.630	426.090	0.003
2016	0.012	0.076	36.720	51.330	11.960	25.360	436.110	0.003
2017	0.011	0.067	34.280	48.800	10.930	24.090	446.130	0.003
2018	0.010	0.058	31.840	46.270	9.900	22.820	456.150	0.003

Note that all land-use categories (except Wetlands) are converted to Settlements. The total area of Settlements continuously increases during the period 1990 – 2017.

6.6.4. Methodological issues

Tier 1 method following the guidance contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was applied due to the lack of national data (except activity data). In particular, all emission factors are default IPCC data read from the 2006 IPCC Guidelines.

In Cypriot conditions Settlements land-use category contains all developed land, including transportation infrastructure and human settlements of any size. In particular, it contains: industrial and commercial units, urban areas, port areas, airports, construction, mineral extraction and waste dump sites. Urban areas contain densely and sparsely populated areas (e.g. cities and villages). The category also includes lands covered with woody vegetation typical for inhabited areas that were not classified as Forest, Woody Cropland and Woody Grassland. It also includes lands containing annual vegetation present in urban areas.

Settlements remaining Settlements

Due to the lack of data on changes in management in Settlements remaining Settlements, it is assumed that the management remains constant since before 1990 hence, this land-use category does not affect the GHG sinks and sources on annual basis. It is further assumed that soil organic carbon remains unchanged following the lack of changes in the management of these lands.

Use of fire is not a part of management in lands classified as Settlements.

Lands converted to Settlements

Lands converted Settlements are subject to changes in woody vegetation, dead wood, litter and soil organic carbon. Tier 1 approach was implemented to calculate GHG sinks and sources following the conversion. It is assumed that there is no dead wood and carbon stocks in litter amount to 5% of the stocks in litter found in Forest land-use category. These assumptions are based on expert judgement.

Use of fire is not a part of management in lands classified as Lands converted to Settlements.

Organic carbon in soil

Cyprus does not yet have available data on the magnitude of the change in the soil organic carbon in Settlements hence, a method based on the default approach is applied. The IPCC 2006 default reference value for soil organic C stocks for high activity clay mineral soils (warm temperate dry climate region) SOCREF = 38 t C/ha (Table 6.2.3, pg.2.31, Vol.4, IPCC 2006) is selected for all calculations involving soil carbon in Lands converted to Settlements.

Due to the diverse structure of lands classified as settlements calculation of a product of the relative stock change factors is performed using the following approach:

Step 1: Calculation of the average product of the relative stock change factors FLU, FMG and FI for lands to be converted to Settlements.

Almost all lands converted to Settlements originate from Annual CL (approx. 30%), Woody CL (approx. 39%), Grass GL (approx. 11%) and Woody GL (approx. 19%). The default values of the relative stock change factors FLU, FMG and FI for these land-use categories are available from Table 6.5.5, p. 5.17, Vol.4, IPCC 2006. Table 6.15 presents calculation of the average product of the relative stock change factors FLU, FMG and FI for lands to be converted to Settlements.

Table 6.15. Calculation of the average product of FLU, FMG and FI applicable to Lands to be converted to Settlements

Land converted to Settlements	Share	Land use FLU	Tillage FMG	Input FI	Product
Annual CL	30%	0.58	1	1	0.175
Woody CL	39%	1	1	1.04	0.403
Grass GL	11%	1	1	1	0.108
Woody GL	19%	1	1	1	0.193
Average product FLU, FMG and FI					0.879

Step 2: Calculation of the average product of the relative stock change factors FLU, FMG and FI for Settlements remaining Settlements (or 20 years after the conversion to Settlements).

In order to estimate GHG sink/source in soil organic carbon attributed to the conversion of lands to Settlements a numerical value of the product of the relative stock change factors FLU, FMG and FI that characterizes the soil organic carbon for Settlements remaining Settlements. As the first approximation, it is assumed that the Settlement remaining Settlement area consists in 60% of area that is paved over, 20 % of area that is turfgrass, and 20 % of area that has cultivated soil and is wooded. This approximation is based on expert judgement.

An approach proposed in Chapter 8.3.3.2, p. 8.24, Vol. 4, IPCC 2006 is applied to calculate an average value of the product of FLU, FMG and FI applicable to settlements at equilibrium (20 years after conversion). In particular, it is assumed that in the paved areas 20% of the soil carbon is lost (relative to the pre-conversion state, p. 8.24). For the turfgrass the relative stock change factor FMG= 1.17 (for improved grassland in tropical climate zone – Table 6.6.2, p. 6.16), and for the wooded and cultivated soil the relative stock change factor FMG= 1.17 (no-till FMG value from Table 6.5.5, p. 5.17, with FI equal to 1) were applied. Details of the calculation are presented in Table 6.16.

Table 6.16. Calculation of the average product of FLU, FMG and FI applicable to Settlements remaining Settlements

Land cover within Settlements	Average product FLU, FMG and FI for Lands converted to Settlements (see **Error! eference source not found.**)	Share	FMG for lands under specific land cover within Settlements	Product
Area that is paved over (and equivalent)	0.879	60%	0.8	0.422
Turfgrass	0.879	20%	1.17	0.206
Wooded and cultivated soil	0.879	20%	1.17	0.206
Average product FLU, FMG and FI for Settlements				0.834

The final value of the product of FLU, FMG and FI applicable to settlements in equilibrium (Settlements remaining Settlements) is 0.834. Consequently, the soil carbon stock in Settlements is 0.834*38 t C/ha = 31.692 t C/ha.

6.6.5. Uncertainties and time-series consistency

Uncertainty analysis will be performed when area data of resolution comparable to the area threshold used in the forest definition (0.3 ha) will be available. The character of conversions to/from the Other Land land-use category suggest that it contains more diversified lands than

All GHG sink/source estimates for Settlements are highly affected by uncertainties in activity data and emission factors (uncertain CORINE data and the use of default data). Greater availability of national data on this land-use category could potentially decrease uncertainties in the estimates.

The applicability of default data for organic carbon in soil should be further examined.

In particular, it seems unlikely that there is no conversion of Coniferous Forest and Settlements to Wetlands before 2006. The fact that such conversion was detected after 2006 increases probability that similar conversions might have occurred also earlier. Additionally, the lack of conversion of Broadleaved Forest, Annual Cropland, Woody Cropland, Grass Grassland and Woody Grassland requires further research.

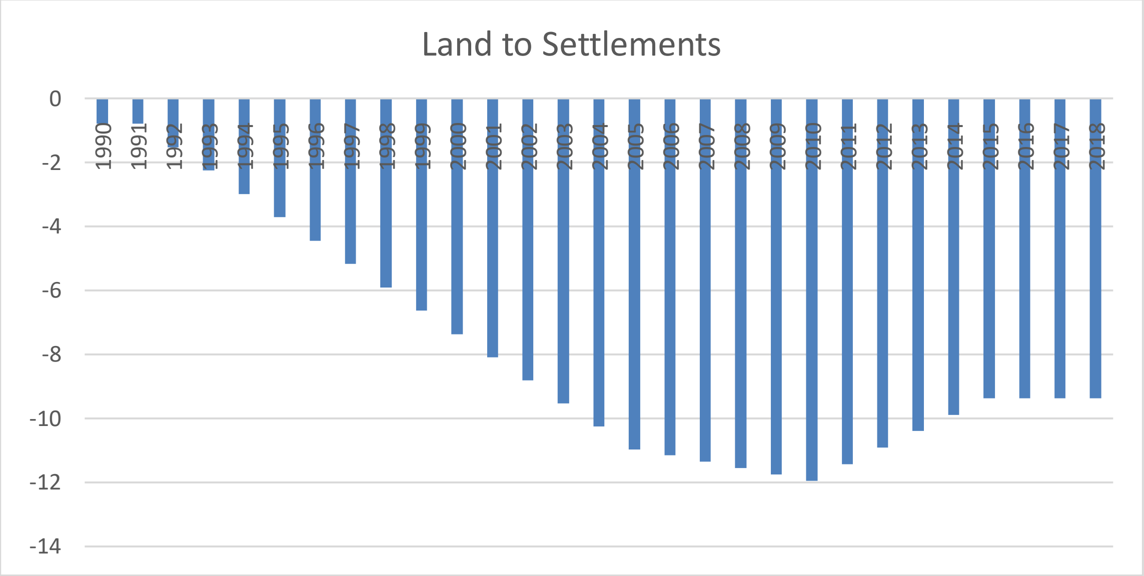

Figure 6.8. Lands converted to Settlements: CO2 emissions during the period 1990 – 2018 in KtCO2

Figure 6.8 presents consistent data series for CO2 emissions in Lands converted to Wetlands during the period 1990 – 2018. The changes in the emissions result from changes in the area of this land-use category (compare area data contained in Table 6.14).

6.6.6. Category-specific QA/QC and verification, if applicable

See para 6.2.6 above.

6.6.7. Category-specific recalculations, if applicable, including changes made in response to the review process

Not applicable (the results of calculations are reported for the first time).

6.6.8. Category-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

See para 6.2.8 above.

6.7. Other Land (4F)

6.7.1. Description

This land-use category includes bare soil, rock, beaches, dunes and sand plains and all land areas that couldn't be classified into any of the other five land-use categories by means of interpretation of the CORINE land cover data. It also allows the total of identified land areas to match the national area, i.e. to retain the entire Cyprus area unchanged among the reported years.

6.7.2. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach for representing land areas and land use databases are described in Chapter 6.1.1 "Information on approaches used for representing land areas and on land-use databases used for the inventory preparation".

6.7.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Land-use definitions are provided in Chapter 6.1.2.2 "The land-use categories for greenhouse gas inventory reporting".

The Other Land land-use category is characterized by increased dynamics of lands converted to and from the category. In particular, majority of pieces of land converted to this category do not remain in it for a prolonged time (expert judgement, see Table 6.17). However, it may happen that some pieces of land stay longer in the category but the currently available CORINE land cover data do not allow for distinguishing the share of land that stays permanently in this category. Consequently, it was assumed that any piece of land converted to this category is reported under it without any transition period. This assumption may be abandoned when more precise data on land dynamics in this category is available.

Table 6.17. Comparison of land use conversion from/to Other Land category (data in relation to the total converted land during the period 1990 -2017)

Land use sub/category	Conversion	
	from Other Land to:	to Other Land from:
Broadl. Forest		2.42%
Coniferous Forest	45.86%	0.33%
Annual Cropland	0.48%	6.77%
Woody Cropland	43.56%	1.46%
Grass Grassland		25.89%

Woody Grassland	3.29%	63.07%
Wetland	6.78%	
Settlements	0.03%	0.07%

Data presented in Table 6.17 apparently suggest that the Other Land land-use category serves as an intermediate step in conversion from Grass Grassland and Woody Grassland to Wood Cropland and Coniferous Forest. The 1990 area of Other Land is too low to allow for all conversions from the Other Land remaining Other Land to various land-use categories in the period 1990 – 2017 hence, if all these conversions are real, they should occur to a great extent on the expense of lands converted to Other Land during that period.

Table 6.18. Data on area of land remaining in the same land use category (from Other Land to Other Land) and areas of land converted to Other Land category from other land use sub/categories. Note that the rule that any piece of land after remaining for 20 years in the transitional land use sub/category is transferred to the final land use sub/category is not implemented for this category due to high dynamics of lands in this category.

Year	Land converted to Other Land from:							
	Broadl. Forest	Conif. Forest	Annual CL	Woody CL	Grass GL	Woody GL	Settle-ments	Other Land
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0.025	0.000	0.069	0.000	0.234	0.640	0.000	5.835
1991	0.025	0.000	0.069	0.000	0.234	0.640	0.000	5.637
1992	0.025	0.000	0.069	0.000	0.234	0.640	0.000	5.439
1993	0.025	0.000	0.069	0.000	0.234	0.640	0.000	5.241
1994	0.025	0.000	0.069	0.000	0.234	0.640	0.000	5.043
1995	0.025	0.000	0.069	0.000	0.234	0.640	0.000	4.844
1996	0.025	0.000	0.069	0.000	0.234	0.640	0.000	4.646
1997	0.025	0.000	0.069	0.000	0.234	0.640	0.000	4.448
1998	0.025	0.000	0.069	0.000	0.234	0.640	0.000	4.250
1999	0.025	0.000	0.069	0.000	0.234	0.640	0.000	4.052
2000	0.025	0.000	0.069	0.000	0.234	0.640	0.000	3.854
2001	0.025	0.000	0.069	0.000	0.234	0.640	0.000	3.656
2002	0.025	0.000	0.069	0.000	0.234	0.640	0.000	3.458
2003	0.025	0.000	0.069	0.000	0.234	0.640	0.000	3.259
2004	0.025	0.000	0.069	0.000	0.234	0.640	0.000	3.061
2005	0.025	0.000	0.069	0.000	0.234	0.640	0.000	2.863
2006	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.762
2007	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2008	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2009	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2010	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2011	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2012	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2013	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2014	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2015	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2016	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2017	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761
2018	0.000	0.005	0.000	0.022	0.042	0.000	0.001	3.761

Note that area of land converted to the Other Land land-use category is insignificant (except the land converted form Grass Grassland and Woody Grassland) when compared to the area of Other Land remaining Other Land land-use category.

6.7.4 Methodological issues

Tier 1 method following the guidance contained in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was applied due to the lack of national data (except activity data). In particular, all emission factors are default IPCC data read from the 2006 IPCC Guidelines (or derived from the IPCC default data).

In Cypriot conditions Other Land land-use category contains a diversified group of lands described in para 6.7.1 above).

Other Land remaining Other land

Due to the lack of data on changes in management in Other Land remaining Other Land, it is assumed that the management remains constant since before 1990 hence, this land-use category does not affect the GHG sinks and sources on annual basis. It is assumed that lands falling into the Other Land land-use category do not contain woody and annual vegetation, dead wood and litter. These assumptions are based on expert judgement. It is further assumed that soil organic carbon remains unchanged following the lack of changes in the management of these lands.

Use of fire is not a part of management in lands classified as Other Land.

Lands converted to Other Land

Lands converted Other Land lose all woody vegetation, dead wood and litter. These lands are also subject to changes in soil organic carbon. Tier 1 approach was implemented to calculate GHG sinks and sources following the conversion.

Use of fire is not a part of management in lands classified as Lands converted to Settlements.

Organic carbon in soil

Cyprus does not yet have available data on soil organic carbon in lands falling into the Other Land land-use category. However, taking into account land-use categories that are converted to and from the Other Land it is clear that assumption that the organic carbon stock is zero for lands belonging to this category does not hold. Note that Other Land in Cyprus includes beaches, dunes, sand plains and bare rock but also a balance area allowing the reported area remain unchanged among the reported years. It is also important to note that lands classified as Other Land are converted to Coniferous Forest and Woody Cropland (see Table 6.17 above). Consequently, an approach developed for the estimation of the average product of FLU, FMG and FI applicable to Settlements remaining Settlements (see Chapter 6.6.4 above) was implemented for the estimation of the average product of FLU, FMG and FI applicable to Other Land remaining Other Land. Table 6.19 presents details of the calculations.

Table 6.19. Calculation of the average product of FLU, FMG and FI applicable to Other Land remaining Other Land

Land converted to Other Land	Share	Land use FLU	Tillage FMG	Input FI	Product
Broadl. F	2.4%	1	1	1	0.024
Coniferous F	0.3%	1	1	1	0.003
Annual CL	6.8%	0.58	1	1	0.039
Woody CL	1.5%	1	1	1.04	0.015
Grass GL	25.9%	1	1	1	0.259
Woody GL	63.1%	1	1	1	0.631
Settlements	0.1%	0.834			0. 001
Average product FLU, FMG and FI					**0.972**

CORINE land cover data did not allow for precise estimation of the share of rock, beaches, dunes and sand plains in the entire area of the Other Land land-use category hence, it was assumed that the share equals 0.5 (expert judgement). Finally, the average product of Land use FLU*Tillage FMG*Input FI =0.972/2=0.486.

6.7.5. Uncertainties and time-series consistency

Uncertainty analysis will be performed when area data of resolution comparable to the area threshold used in the forest definition (0.3 ha) will be available. The character of conversions to/from the Other Land land-use category suggest that it contains more diversified lands than bare soil, rock, beaches, dunes and sand plains. Use of more advanced information on land use may allow for attribution of significant part of the current Other Land land-use category to other categories.

In general, GHG sink/source estimates for Other Land are highly affected by uncertainties in activity data and emission factors (uncertain CORINE data and the use of default data). Greater availability of national data on this land-use category could potentially decrease uncertainties in the estimates.

The applicability of default data for organic carbon in soil should be further examined.

Figure 6.9 presents data series for CO2 emissions in Lands converted to Other Land during the period 1990 – 2015. The estimates of the CO2 emission are affected by the assumption that any piece of land converted to this land-use category is reported under it without any transition period. The rapid change in the emission occurring in 2005 is a clear consequence of this assumption. It is likely that the change is an artefact and does not represent the actual transition of CO2 emissions during the period 1990 – 2018 however, it is entirely consistent with the approach applied for estimation of these emissions.

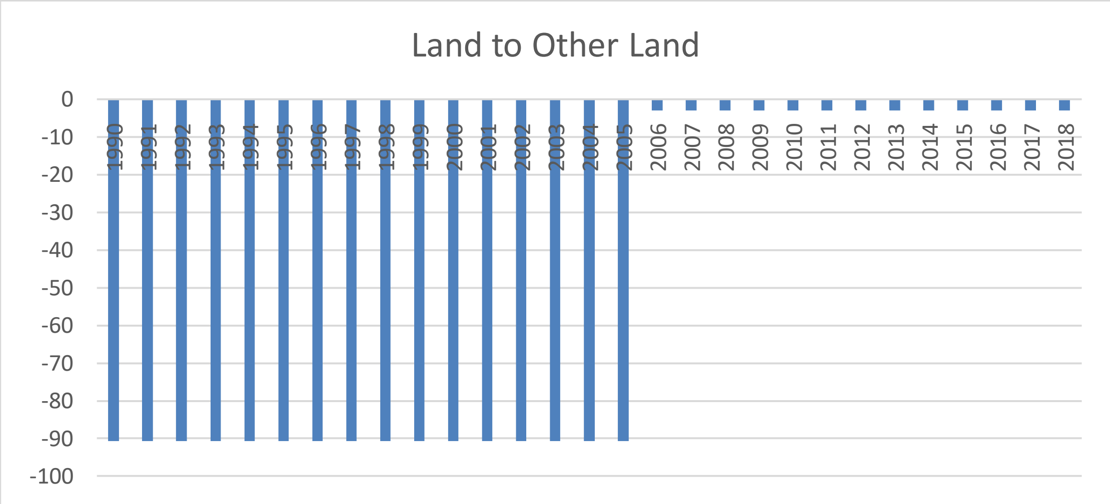

Figure 6.9. Lands converted to Other Land: CO2 emissions during the period 1990 – 2018 in KtCO2.

6.7.6. Category-specific QA/QC and verification

See para 6.2.6 above.

6.7.7. Category-specific recalculations

Not applicable (the results of calculations are reported for the first time).

6.7.8. Category-specific planned improvements

See para 6.2.8 above.

6.8. Harvested Wood Products (4G)

6.8.1. Description

Harvested Wood Products (HWP) include all wood material (including bark) that leaves harvest sites. Slash and other material left at harvest sites are regarded as dead organic matter in the associated land-use category.

In Cyprus, all domestically produced HWP originate only from harvest occurring in Forest Land land-use category.

6.8.2. Information on approaches used and on databases used for the inventory preparation

All calculations of the HWP contribution under the Convention are performed using the IPCC Harvested Wood Products (HWP) Model as developed by Kim Pingoud and further modified by the authors of Chapter 12 of Volume 4 of the 2006 IPCC Guidelines. The model referred to as "HWP Worksheet (Zipped MS-Excel file)" is available from the IPCC website at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html. All relevant data were collected from the FAO database "Forestry Production and Trade" (Last update: December 14, 2016) available at http://www.fao.org/faostat/en/#data/FO.

6.8.3. Category specific definitions and the classification systems used

Definitions contained in "FAO Forest Products Definitions"[68]are used in this inventory.

6.8.4. Methodological issues

The annual change in HWP carbon stocks in Cyprus are judged to be significant however, due to a limited availability of the country specific data and following the guidance contained in decision tree presented in Figure 6.12.1 (page 12.10 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories) Tier 1 approach was selected to calculate an estimate of HWP Contribution. In particular, the following elements of the IPCC approach are applied (page 12.6):

1. All CO2 released from HWP is included in the AFOLU Sector;

2. CO2 released from wood burnt for energy in the Energy Sector is not included in the Energy Sector totals (although CO2 emissions from biofuels are reported as a memo item for QA/QC purposes). CH4 and other gases from HWP used for energy is included in the Energy Sector;

3. CO2 released from HWP in SWDS is not included in the Waste Sector totals although CH4 emissions from HWP are included.

6.8.4.1. Data for the calculation of an estimate of HWP Contribution under the Convention

All relevant data were collected from the FAO database "Forestry Production and Trade" (Last update: December 14, 2016)[69]. Table 6.20 lists the FAO items and their codes that were the source of numerical data for all calculations in this chapter.

[68] available at: http://www.fao.org/forestry/34572-0902b3c041384fd87f2451da2bb9237.pdf

[69] available at http://www.fao.org/faostat/en/#data/FO

Table 6.20. The FAO items and their codes that were the source of numerical data for all calculations relating to the HWP GHG contribution.

Item	Item Code
Roundwood	1861
Sawnwood	1872
Wood-Based Panels	1873
Paper+Paperboard	1876
Wood Pulp plus Rec. Paper (aggregated items)	1875 (wood pulp) 1669 (recycled paper)
Industrial Roundwood	1865
Other Industrial Roundwood	1871
Chips and particles	1619
Wood charcoal	1630
Wood residues	1620

The FAO data for wood pulp production in Cyprus were not complete for the period 1992 – 2015. The missing data (referred to as estimates in Table 6.21) were obtained in the following way: (i) Estimates for 2000 and 2001 were assumed to amount to 10,000 tonnes based on the data from the period 1992 – 1997; (ii) All other estimates were calculated via proportional interpolation/extrapolation however, if data for production are lower than data for export then it is assumed that production is equal to export (to avoid a negative balance of the pulp production and export).

Table 6.21. Wood pulp production in Cyprus 1992 – 2018 (FAO data and estimates calculated based on them)

Year	Data / Estimate	Pulp production	Pulp production adjusted to the export data
		tonne	tonne
1992	Data	10000	10000
1993	Data	10000	10000
1994	Data	10000	10000
1995	Data	10000	10000
1996	Data	10000	10000
1997	Data	10000	10000
1998	Estimate	10000	10000
1999	Estimate	10000	10000
2000	Estimate	10000	11050
2001	Estimate	10000	11410
2002	Data	11000	11380
2003	Estimate	13450	13450
2004	Estimate	14675	14675
2005	Data	15900	15900
2006	Data	16860	16860
2007	Data	23295	23295
2008	Data	25760	25760
2009	Estimate	35461	35461
2010	Data	45162	45166
2011	Estimate	44239	44239
2012	Data	43316	43317
2013	Estimate	42558	44969
2014	Data	41800	41800
2015	Estimate	41042	42243
2016	Data	43627	43627
2017	Data	47255	47255
2018	Data	50322	50322

Estimates for wood pulp production the period 1961 – 1991 were assumed to be zero, unless data for pulp export were provided by the FAO. In such situation, it was assumed that pulp production is equal to pulp export.

Default half-lives for the estimation of "products in use" carbon pools and associated fraction retained each year were read from Table 6.12.7 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (see Table 6.22).

Table 6.22. The default half-fives and associated decay rates for solid wood products and paper products

	Solid wood products	Paper products
Half-life (years)	30 yr	2 yr
Decay rate k (k = ln(2)/ half-life)	0.023 yr^{-1}	0.347 yr^{-1}

Conversion factors used in the calculation of the HWP contribution were read from Table 6.12.4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The factors are presented in Table 6.23.

Table 6.23. Conversion factors used in the calculation of the HWP contribution

Conversion factor	Value
Sawn wood, other industrial roundwood	0.260 tC/m3*
Wood-based panels	0.294 tC/m3
Paper products	0.450 tC/adt
Charcoal	0.765 tC/adt
Bark	1.12 $tC_{overrbark}/t\ C_{underbark}$

* Average for temperate species and tropical species

An IPCC default estimated growth rate of HWP consumption prior to 1961 for Europe was used (0.0151 yr-1)

6.8.4.2. Calculation of an estimate of HWP Contribution under the Convention

All calculations of the HWP contribution under the Convention are performed using the IPCC Harvested Wood Products (HWP) Model as developed by Kim Pingoud and further modified by the authors of Chapter 12 of Volume 4 of the 2006 IPCC Guidelines. The model referred to as "HWP Worksheet (Zipped MS-Excel file)" is available from the IPCC website at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html.

Cyprus has selected the Production Approach (described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, page 12.29 onwards) to be used for the UNFCCC reporting purposes. The Production Approach (PA) estimates changes in carbon stocks in the forest pool (in Cyprus, all domestically produced HWP originate only from harvest occurring in Forest Land land-use category) of the reporting country and the wood products pool containing products made from wood harvested in the reporting country. The wood products pool also includes products made from wood collected at domestic harvest that are exported and stored in uses in other countries.

The Production Approach involves equations: (i) 12.1 (to estimate the first-order decay); (ii) 12.3 (to estimate HWP products produced annually from domestic harvest); and (iii) 12.A.6 (to estimate HWP contribution from the production approach) of volume 4 of the 2006 IPCC Guidelines. The estimation of HWP contribution from the production approach using equation 12.A.6 is explained below:

HWP Contribution to AFOLU Net CO2 emissions PA = −44/12 ● (H - ↑CHWP DH)

and ↑C HWP DH = H - ΔC HWP IU DH - ΔC HWP SWDS DH

where:

H = Harvest of wood to be used for HWP (including fuelwood)

ΔCHWP IU DH = Annual change in carbon stock in HWP in use (Variable 2A),

ΔCHWP SWDS DH = Annual change in carbon stock in HWP in solid waste disposal sites where the wood in the products came from domestic harvest (Variable 2B)

The annual change in carbon stock in HWP in use (Variable 2A) is estimated in this chapter while the annual change in carbon stock in HWP in solid waste disposal sites where the wood in the products came from domestic harvest (Variable 2B) should be estimated under the Waste sector. Numerical values of estimated variables 2A and 2B for the period 2010 – 2016 are presented in Table 6.24.

Table 6.24. Numerical values of estimated variables 2A and 2B

kt C	2010	2011	2012	2013	2014	2015	2016	2017	2018
Variable 2A	-7.201	-7.196	-7.112	-7.067	-6.862	-6.811	-6.740	-6.638	-6.578
Variable 2B	0.494	0.517	0.682	0.557	0.553	0.485	0.319	0.200	0.210

The HWP CRF Table 6requires calculation of HWP produced and consumed domestically and HWP produced and exported separately for solid wood and paper products. The share of HWP produced and consumed domestically (HWP domestic prod/con) is calculated by means of the following formula:

$$\text{HWP domestic prod/con} = (\text{Sawnwood}_{\text{production}} - \text{Sawnwood}_{\text{export}})/(\text{Sawnwood}_{\text{production}})$$

Where:

Sawnwood = FAO Item Code 1872 (Sawnwood)

The coefficient HWP domestic prod/con is multiplied by the relevant data for HWP from domestic harvest to obtain numerical values for HWP from domestic harvest consumed domestically. The remaining HWP from domestic harvest (not consumed domestically) are assumed to be exported.

Note: According to the FAO data Cyprus does not produce paper or paper board hence domestic consumption of domestically produced paper is zero.

6.8.5. Uncertainties and time-series consistency

The HWP Contribution to LULUCF emissions/removals reveals trend from 1990 to about 1999 was averaging around 5 k t CO2 per year and then stabilization of emissions at the level close to 25 k t CO2 per year. Figure 6.10 presents consistent data series of HWP contribution to LULUCF emissions or removals as appropriate.

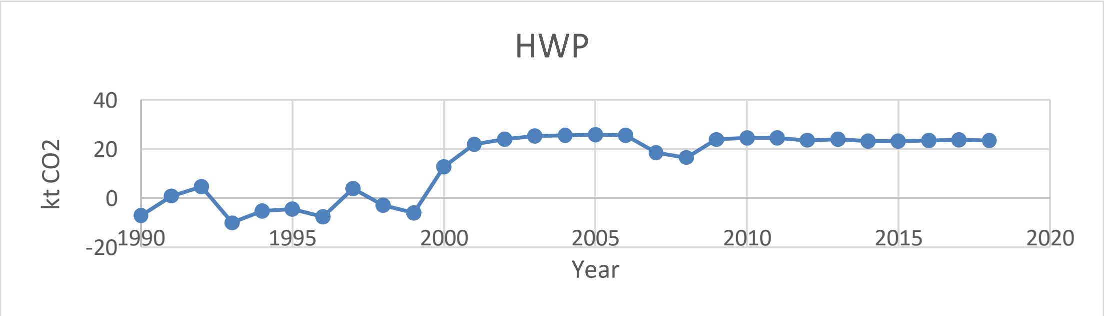

Figure 6.10. HWP Contribution to LULUCF emissions/removals. Note: negative numbers denote removals; positive numbers denote emissions.

6.8.6. Category-specific QA/QC and verification

Not applicable. All data are read from the FAO website.

6.8.7. Category-specific recalculations

Not applicable (the results of calculations are reported for the first time).

6.8.8. Category-specific planned improvements

Not applicable. All data are read from the FAO website. The methodology implements the IPCC proposed approach. No other approaches are available.

Chapter 7.
Waste (CRF sector 5)

7.1. Overview of sector

Disposal and treatment of industrial and municipal wastes can produce emissions of GHG. Typically, CH_4 emissions from SWDS are the largest source of greenhouse gas emissions in the Waste Sector. CH_4 emissions from wastewater treatment and discharge may also be important.

Solid wastes can be disposed of through landfilling, recycling, incineration or waste-to-energy. Incineration and waste-to-energy technologies are not implemented for the management of municipal solid waste in Cyprus. This chapter will deal with CH_4 and N_2O emissions resulting from solid waste disposal, biological treatment of solid waste and wastewater treatment and discharge. The most important gas produced in this source category is methane (CH_4). Emissions from incineration and open burning of waste are reported as NO as incineration does not take place in Cyprus.

7.1.1. Emissions trends

Emissions from the Waste Sector in 2018 contributed 6.5% of the total emissions without LULUCF, 62.4% to the total methane emissions of the country without LULUCF and 5.7% to the total N_2O emissions without LULUCF. In 2018, 87.5% of the waste sector emissions are from solid waste disposal, 1.0% from biological treatment of solid waste and 11.5% from waste water treatment and discharge. The emissions from waste have changed considerably between 1990 and 2018 due to changes that are taking place in the waste and wastewater management practices of the country. Recycling and composting have been reducing the amount of waste disposal on land since 2010.

Table 7.1. Total GHG emissions (in Gg CO_2 eq) from waste, 1990-2018

Gg CO_2 eq.	**1990**	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**
Total waste	**386.7**	**467.1**	**496.5**	**512.6**	**556.6**	**569.1**	**574.3**
A. Solid waste disposal	258.3	326.5	370.6	420.4	475.7	494.0	502.6
B. Biological treatment of solid waste	0.0	0.0	0.0	1.4	7.5	5.68	5.68
C. Incineration and open burning of waste	NO	NO	NO	NO	NO	NO	NO
D. Wastewater treatment and discharge	128.38	140.62	125.89	90.78	73.35	69.37	66.05
E. Other	NO	NO	NO	NO	NO	NO	NO
CH_4 (Gg)	15.0	18.1	19.3	19.8	21.5	22.0	22.2
N_2O (Gg)	0.04	0.05	0.05	0.06	0.07	0.06	0.06
Total (Gg CO_2 eq.)	**386.7**	**467.1**	**496.5**	**512.6**	**556.6**	**569.1**	**574.3**

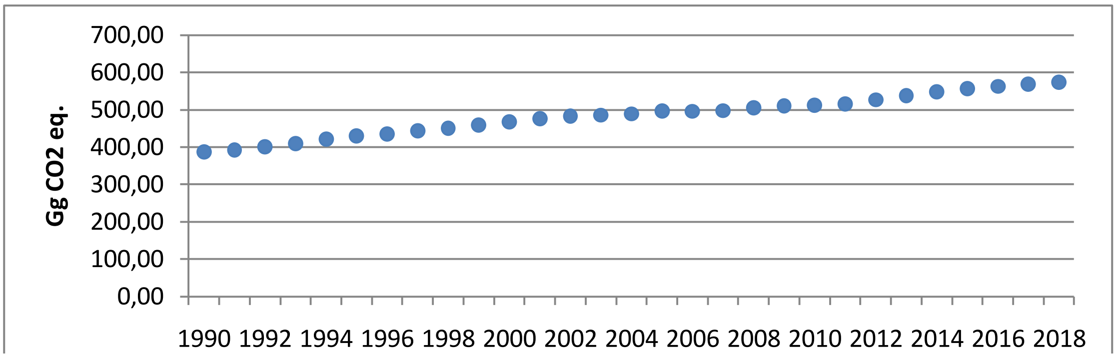

Figure 7.1. GHG emissions from waste for the period 1990-2018

7.1.2. Methodology

The calculation of GHG emissions from Waste is based on the methodologies and emission factors suggested by the IPCC Guidelines. Data used for the estimation of the emissions was obtained from the National Statistical Service. Tier 2 method with default IPCC 2006 emission factors and parameters is implemented for Solid Waste Disposal (5A) and Tier 1 for Biological Treatment of Solid Waste (5B) and Wastewater Treatment and Discharge (5D). Unfortunately, data for 2018 were unavailable at the time preparing this report due to incomplete and insufficient information necessary to properly reflect statistical quantities of waste that were processed from some of the solid waste disposal sides (SWDS). For this reason, the same data as 2017 were used for estimating emissions from Solid Waste Disposal (5A) and Biological Treatment of Solid Waste (5B).

The methodologies and emission factors used are summarised in Table 7.2.

Table 7.2. Waste– methodologies and emission factors applied

Category-Classification		Gas	EF	Method
5A1.a	Solid Waste Disposal - Managed waste disposal sites- Anaerobic	CH_4	D	T2
5A1.a	Solid Waste Disposal - Managed waste disposal sites- Anaerobic	CO_2	NA	NA
5A2.	Solid Waste Disposal - Unmanaged waste disposal sites	CH_4	D	T2
5A2.	Solid Waste Disposal - Unmanaged waste disposal sites	CO_2	NA	NA
5B1a	Biological treatment of solid waste – Composting- municipal solid waste	CH_4/N_2O	D	T1
5D1.	Wastewater Treatment and Discharge - Domestic wastewater	CH_4/N_2O	CS	T1
5D2.	Wastewater Treatment and Discharge - Industrial wastewater	CH_4	D	T1
5D2.	Wastewater Treatment and Discharge - Industrial wastewater	N_2O	OTH	OTH

T1: IPCC methodology Tier 1; D: IPCC default methodology and emission factor; OTH: other methodology – EMEP/CORINAIR 2007

Key categories

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

Uncertainty

The uncertainty analysis is presented in Section 1.5.

Completeness

Table 7.3 gives an overview of the IPCC source categories included in this chapter and presents the status of emissions estimates from all sub-sources in the sector of waste.

Table 7.3. Waste – completeness

	CO_2	CH4	N2O
5A. Solid Waste Disposal	NA	✓	NA
5B. Biological Treatment of Solid Waste		✓	✓
5D. Wastewater Treatment and Discharge		✓	✓

NA: Not applicable

7.2. Solid Waste Disposal (5A)

Treatment and disposal of municipal, industrial and other solid waste produces significant amounts of methane (CH_4). In addition to CH_4, solid waste disposal sites (SWDS) also produce biogenic carbon dioxide (CO_2) and non-methane volatile organic compounds (NMVOCs) as well as smaller amounts of nitrous oxide (N_2O), nitrogen oxides (NO_x) and carbon monoxide (CO). In Cyprus, as in many other industrialised countries, waste management has changed much over the last decade. Waste minimisation and recycling/reuse policies have been introduced to reduce the amount of waste generated, and increasingly, alternative waste management practices to solid waste disposal on land have been implemented to reduce the environmental impacts of waste management.

Decomposition of organic material derived from biomass sources (e.g., crops, wood) is the primary source of CO_2 released from waste. These CO_2 emissions are not included in national totals, because the carbon is of biogenic origin and net emissions are accounted for under the LULUCF Sector.

Municipal solid waste management in Cyprus

In Cyprus, household waste collected by local authorities or individuals and disposed of in sites of different characteristics. In 2005[70] five disposal sites were in operation, of which none met the standards for landfills in accordance with the requirements of the relevant EU Directives. The landfills in Nicosia and Limassol operated with controlled drop while the other three sites operate under semi-controlled deposition conditions. These sites have been categorised as deep unmanaged for the purposes of inventory preparation.

Until 2010 they were also in operation 113 sites of uncontrolled disposal of household and other solid waste. These sites have been categorised as shallow unmanaged. Most active UWDS have been active for more than 25 years while the smallest portion of the active UWDS were active for less than 5 years (Figure 7.2). Approximately half of UWDS (48%) started their operation during 1990-2000, while a significant number became operational during 1980-1990. Before 1970 only two sites operated of which one was closed in mid 1990s while the other is still in operation (Figure 7.3).

[70] In 2005 a census of all the solid waste disposal sites took place in Cyprus through the study “Παροχή συμβουλευτικών υπηρεσιών για την ετοιμασία στρατηγικού σχεδίου, περιβαλλοντικής και τεχνοοικονομικής μελέτης και εγγράφων προσφορών για την αποκατάσταση και μετέπειτα φροντίδα των χώρων ανεξέλεγκτης απόρριψης απορριμμάτων στην Κύπρο" ("Consultancy services for the preparation of the strategic plan, environmental and techno-economic studies and tender documents for the rehabilitation and aftercare of uncontrolled waste disposal sites in Cyprus")

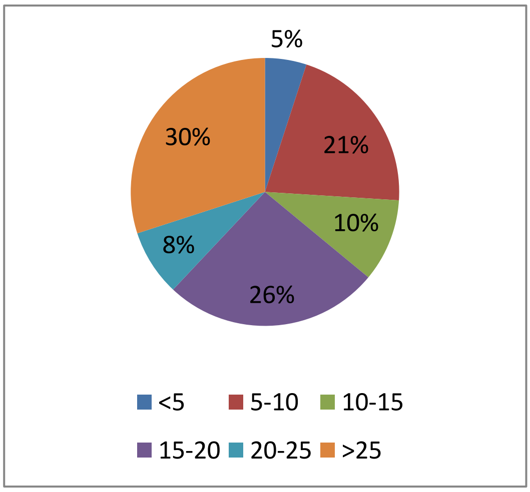

Figure 7.2. Years of activity of active Uncontrolled Waste Disposal Sites

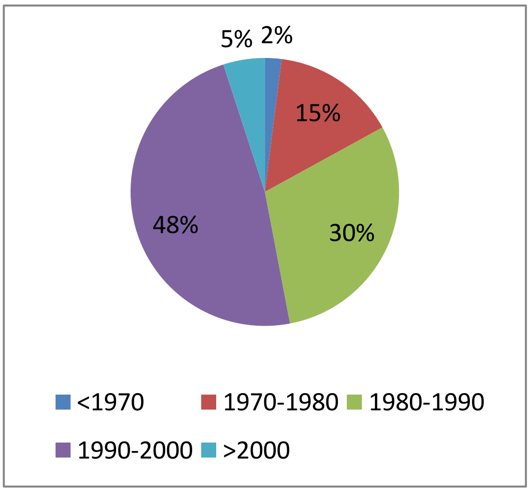

Figure 7.3. Starting year of activity for all Uncontrolled Waste Disposal Sites

The situation started changing in 2006 when the first managed waste disposal site started its operation in Pafos. Then the second managed waste disposal site started its operation in 2010, serving the districts of Larnaca and Ammochostos. For Limassol and Nicosia, the new farcicalities are under construction and all the municipal solid wastes produced are transferred to the existing deep unmanaged sites.

[71]The national municipal waste Management Plant of 2015-2021 (MWMP) contains quantitative and qualitative targets and enumerates specific measures and actions to be taken in order for the EU targets to be reached. One of the quantitative target is that no more than 95,000 tonnes of biodegradable waste to be disposed in landfills (represents the 35% target of the 1999/31/EC directive). Also the Legal Measures will be focused on the:

- Development of local waste prevention and management schemes
- Mandatory obligation for establishing separate collection systems by local authorities,
- Establishment of extended producer responsibility (EPR) in streams other than packaging waste,
- Establishment of a landfill tax/levy,
- Banning the disposal of certain waste streams from entering into landfills (e.g. green waste, high calorific value waste, etc.)

The adaptations of the strategy that are envisaged:

- One Sanitary Landfill and one Residual Sanitary Landfill (supplementing MBT unit at Koshi) were constructed and operated (both meet the requirements of directive 99/31/EC). The MBT unit was constructed and operated from 01/04/2010 servicing Larnaca - Ammochostos districts. The Plant was designed in a way that a high separation of recycled and biodegradable material is achieved. Another I.W.M.P (Integrated Waste Management Plant) servicing Limassol district is expected to be operated by the year 2018.
- The construction of the Green Point Network (22 collection points for the depositing of various waste streams out of households – bulky waste, green, textile, furniture, weee, etc.) is competed. The 4 Green Points, servicing Paphos district are operated and the rest expected to be operated by 2018.
- Separate collection at source was promoted at households, from the existing collective system for the packing waste servicing also and all types of paper, created under the packaging directive while

[71] Athena Papanastasiou, Environment Officer, Waste Management Unit, Department of Environment, Tel.: +357 22 866231, E-mail: apapanastasiou@environment.moa.gov.cy

the competent authority promotes the separate collection from other household streams such as other organic waste eg. food and green waste.

- The construction works for the rehabilitation/restoration of the old non approved landfills, which are closed at Paphos and Larnaca - Ammochostos districts, were completed. The preparation of studies/documents regarding the rehabilitation/restoration of the 20 non sanitary landfills of Nicosia district and the 44 sanitary landfills of Limassol district, will be completed within 2018 and after that the construction works will begin.

A comprehensive study was undertaken in 2005 for the elaboration of a Strategic Plan, an Environmental study and a Feasibility study for the restoration and management of landfills. The purpose of the study was to record all landfills, assess their status and level of risk, create a restoration priority list based on pollution risk assessments, undertake the appropriate environmental studies as well as feasibility studies for the restoration of the prioterized landfills. These studies were a necessary step for the restoration of all landfills recorded.

Two (2) landfills are still active in Cyprus but arrangements are made in order to be closed and restored. According to recent data, these two landfills are feeded with approximately 155.000 ton and 200.000 ton of municipality waste each year respectively (reference year 2012).

Sixty two (62) non sanitary landfills are planned to be restored appropriately within the following years. According to the preliminary study contacted in 2005, these landfills contain approximately 597.269 m3 of solid waste excluding 2 major landfills that have not been closed yet.

Fifty three (53) landfills have been restored the last five years and are being monitored. During their restoration a total of 4.902.000 m3 of solid waste were reallocated and properly buried using composite liners and leakage collection systems.

The EU landfill directive is fully harmonized in the national legislation but not fully implemented. Cyprus didn't manage to seize of the operation of non-compliant landfills by 2009. Also Cyprus has rehabilitated only 46% of its closed landfills.

Emission trends

Methane emissions were calculated using the Tier 2 method proposed by the IPCC 2006 guidelines using the IPCCWasteModel excel spreadsheet provided with the 2006 IPCC guidelines. Unfortunately, data for 2018 were unavailable at the time preparing this report due to incomplete and insufficient information necessary to properly reflect statistical quantities of waste that were processed from some of the solid waste disposal sides (SWDS). For this reason, the same data as 2017 were used for estimating emissions.

Carbon dioxide emissions occur during flaring of biogas released from the decomposition of waste. These emissions should not be included in the total GHG emissions of this source as they are of biogenic origin. Nevertheless, recovery and flaring of biogas do not occur in Cyprus and is therefore reported as NO.

CH_4 emissions from solid waste disposal on land in 2018 accounted for 90.5% of total GHG emissions from Waste, 5.7% of total national emissions without LULUCF and 56.5% of the total CH_4 emissions without LULUCF. Total emissions increased by 94.5% between 1990 and 2018. Emissions from Solid Waste Disposal Sites are presented in Table 7.4 and Figure 7.4.

Table 7.4. Total GHG emissions from solid waste disposal sites for the period 1990 – 2018

Gg CH_4	**1990**	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**
A. Solid waste disposal	10.60	13.24	14.97	16.94	19.13	19.86	20.20
1. Managed waste disposal sites	NO	NO	NO	0.55	2.57	3.21	3.51
2. Unmanaged waste disposal sites	10.60	13.24	14.97	16.39	16.56	16.65	16.69
3. Uncategorised waste disposal sites	NO	NO	NO	NO	NO	NO	NO
A. Solid waste disposal (Gg CO2 eq.)	**265.0**	**330.9**	**374.3**	**423.5**	**478.5**	**496.5**	**505.0**

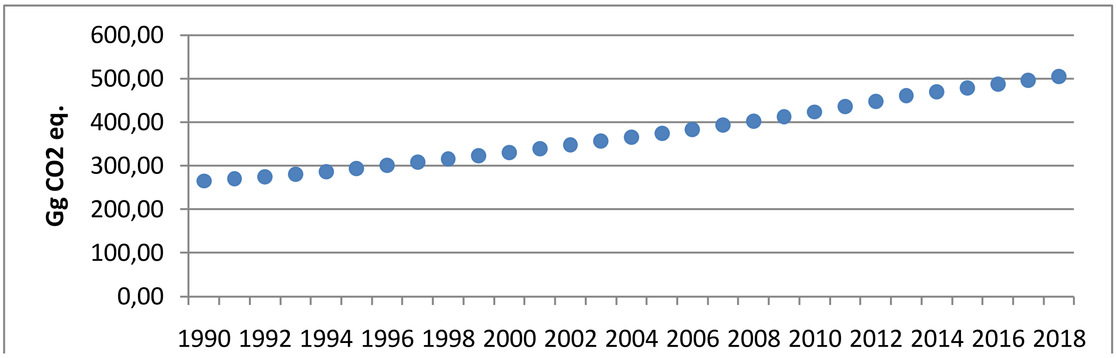

Figure 7.4. Total GHG emissions from solid waste disposal sites for the period 1990 – 2018

7.2.1. Methodological issues

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) outlines three methods to estimate CH_4 emissions from solid waste disposal sites: (a) the Tier 1 method based on the IPCC First Order Decay method (FOD), (b) the Tier 2 method using the IPCC FOD method, some default parameters and good quality country specific activity data and (c) the Tier 3 method using good quality country specific activity data and either the FOD IPCC FOD method with country specific key parameters or measurement derived county-specific parameters. According to the 2006 IPCC Guidelines, is a good practice to use the FOD method in order to account for time dependence of the emissions. Tier 2 methodology was implemented for the estimation of emissions from land disposal of solid waste through the use of the IPCCWasteModel excel spreadsheet. The parameters are set to Southern Europe region, the DOC is calculated based on waste by composition and the methane generation constant is the default for dry temperate.

Total municipal solid waste (MSW_T)

Data on total MSW production and annual per capita production are available for the period 1996-2016 from the National Statistical Service. The data for the period 1990-1995 was obtained using the linear trend equation of 1996-2008 that was obtained from plotting the annual per capita production against time as shown in Figure 7.5. The years 2009 to 2016 were excluded from the trend, because during those years there are considerable changes in (a) the economy of the country and (b) the waste management practices of the country, which resulted in a decrease of the waste production. The total municipal solid waste production (MSW_T) was then estimated by multiplying the annual per capita production by the total population at the end of the year.

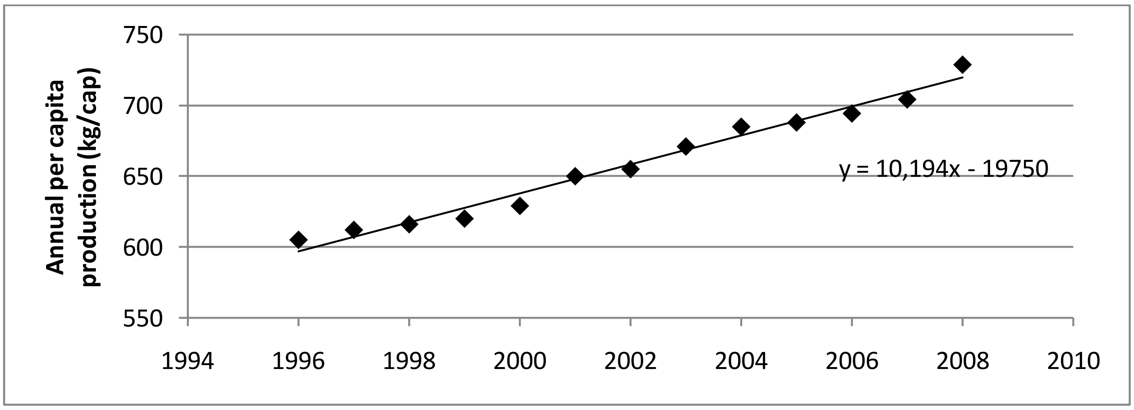

Figure 7.5. Plot used to estimate the annual per capita production for 1990-1995 (kg/cap)

The total population used, the annual per capita production and the resulting municipal solid waste production for the whole reporting period, are presented in Table 7.5. Population data is according to national statistics published annually by the Statistical Service[72]. Total MSW of 2015 was revised according to revised data provided by the Statistical Service.

The population reported by the Statistical Service and used for the purposes of the GHG inventory of Cyprus is the population for the areas under the effective control of the Republic of Cyprus[73]. The reduction in population during the period 2012-2015 has been caused by negative net migration due to the economic crisis experienced during that period.

Table 7.5. Total population, annual per capita production (kg/cap), total MSW production (1000t)

	Total population	Annual per capita production (kg/cap)	Total MSW production (1000t)
1990	587100	536.1	314.7
1991	603100	546.3	329.4
1992	619200	556.4	344.6
1993	632900	566.6	358.6
1994	645400	576.8	372.3
1995	656300	587.0	385.3
1996	666300	605.0	400.1
1997	675200	612.0	410.5
1998	682900	616.0	418.2
1999	690500	620.0	425.8
2000	697500	629.0	436.1
2001	705500	650.0	456.1
2002	713700	655.0	464.6
2003	722900	671.0	481.4
2004	733000	685.0	498.1
2005	744000	688.0	507.9
2006	757900	694.0	521.0
2007	776400	704.0	539.8
2008	796900	729.0	572.7
2009	819100	730.0	589.1
2010	839800	690.0	571.4
2011	862000	674.0	571.9
2012	865900	657.0	567.6
2013	858000	618.0	533.0
2014	847000	613.0	523.2
2015	848300	642.0	541.2
2016	854800	642.0	545.4
2017	864200	636	547.4
2018	875900	636	547.4

Determining Historical Waste per Capita Data

Please refer to Annex 3.2 for the methodology used to estimate Historical Waste per Capita Data.

Fraction of MSW disposed at SWDS (MSW_F)

Data on MSW disposed at SWDS is available for the period 1996-2017 from the National Statistical

[72] The 2017 publication, which includes data for the years 1996-2016 is available at http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/ACC6EE0E5A63FE79C225703C001EC792/$file/POP-DISTRICT-A96_16-EN-281117.xls?OpenElement; contact person for population statistics at the Statistical Service is Loukia Makri, +357 22602150, lmakri@cystat.mof.gov.cy

[73] http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/4756DB2E6CAEB256C22581E200378EA0?OpenDocument&sub=1&sel=1&e=&print

Service[74]. Unfortunately, data for 2018 were unavailable at the time preparing this report due to incomplete and insufficient information necessary to properly reflect statistical quantities of waste that were processed from some of the solid waste disposal sides (SWDS). For this reason, the same data as 2017 were used for estimating emissions. For the period 1990-1995 it was assumed that the fraction of waste disposed to SWDS is the same as 1996. The MSW_F and the corresponding mass of MSW disposed to disposal sites are presented in Table 7.6. In Table 7.6 data on other waste management practices are also presented for years that data is available. MSW to disposal sites for 1950-1989 is assumed 100%.

Table 7.6. Fraction of MSW disposed at SWDS (MSW_F), mass of MSW disposed to disposal sites (1000t) and other practices

	Composting (1000t)*	Recycling (1000t)	MSW to disposal sites (1000t)	MSW to disposal sites
1990			305.97	97.2%
1991			320.29	97.2%
1992			334.98	97.2%
1993			348.66	97.2%
1994			361.94	97.2%
1995			387.00	97.2%
1996		11.12	389.00	97.2%
1997		12.54	398.00	96.9%
1998		12.17	406.00	97.1%
1999		12.76	413.00	97.0%
2000		13.11	423.00	97.0%
2001		14.1	442.00	96.9%
2002		14.61	450.00	96.9%
2003		14.73	466.63	96.9%
2004		16.48	481.59	96.7%
2005		18.61	489.30	96.3%
2006		21.5	499.49	95.9%
2007		27.59	512.19	94.9%
2008		42.09	530.59	92.7%
2009		49.39	539.67	91.6%
2010	7.89	61.09	489.97	85.7%
2011	14.95	72.22	460.96	80.6%
2012	22.98	69.65	451.28	79.5%
2013	19.62	69.78	422.82	79.3%
2014	29.58	70.05	397.85	76.0%
2015	43.86	72.11	403.00	74.5%
2016	43.49	73.25	409.96	75.2%
2017	33.12	78.21	414.33	75.7%
2018	33.12	78.21	414.33	75.7%

* includes Compost for backfilling

Assumptions for allocation have been based on the information provided by the Solid Waste Management Unit of the Department of Environment[75], presented below (Table 7.7). Managed-semi-aerobic is not used in Cyprus. The categorisation is based on the disposal of the waste according to their origin; i.e. urban or rural. Based on this categorisation, the amount of waste disposed per type of disposal site was estimated using the urban and rural population of each district at the end of the year (Table 7.8) and the waste generation per capita (Table 7.5). The resulting amount of waste generated per district and type of waste disposal site is presented in Table 7.9. The resulting total quantities of municipal solid waste disposed per type of waste disposal site and the population served per technology

[74] The 2017 publication, which includes data for the years 1996-2016 is available at http://www.cystat.gov.cy/mof/cystat/statistics.nsf/energy_environment_82main_gr/energy_environment_82main_gr?OpenForm&sub=2&sel=2; contact person for population statistics at the Statistical Service is Marilena Kythreotou, +357 22602137, mkythreotou@cystat.mof.gov.cy

[75] Mrs. Elena Christodoulidou, Environment Officer, Solid Waste Management Unit, Department of Environment, tel. +357 22866248, email echristodoulidou@environment.moa.gov.cy

are presented in Table 7.10. Managed-semi-aerobic is not used in Cyprus and therefore not included in the table.

Table 7.7. Allocation of waste to types waste disposal sites

	Deep unmanaged	Shallow unmanaged	Managed-anaerobic
Nicosia	all urban until 2011; all from 2012	all rural until 2011	
Ammochostos	all urban until 2009	all rural until 2009	all from 2010
Larnaca	all urban until 2009	all rural until 2009	all from 2010
Limassol	all urban until 2011; all from 2012	all rural until 2011	
Pafos	all urban until 2005	all rural until 2005	all from 2006

Table 7.8. Urban and Rural population of Cyprus per district at the end of the year (1000s)

	1990	1991	1992	1993	1994	1995	1996	1997
Regional Population								
Nicosia	238.6	244.9	251.3	256.3	260.8	264.6	268	271
Ammochostos	30.3	31.0	31.7	32.7	33.6	34.4	35.1	35.8
Larnaca	98.0	100.8	103.5	105.8	107.8	109.6	111.2	112.6
Limassol	168.7	173.6	178.6	182.4	185.8	188.8	191.5	193.9
Pafos	51.5	52.8	54.1	55.7	57.4	58.9	60.5	61.9
TOTAL	587.1	603.1	619.2	632.9	645.4	656.3	666.3	675.2
Urban Population								
Nicosia	171.6	177.0	182.5	186.4	189.9	193	195.7	198.2
Ammochostos	0.0	0.0	0	0.0	0	0	0	0
Larnaca	58.3	60.5	62.6	64.1	65.4	66.6	67.6	68.6
Limassol	130.6	135.4	140.3	143.6	146.6	149.2	151.7	153.8
Pafos	30.2	31.8	33.5	35.0	36.6	38.1	39.7	41.2
TOTAL	390.7	404.7	418.9	429.1	438.5	446.9	454.7	461.8
Rural population								
Nicosia	67.0	67.9	68.8	69.9	70.9	71.6	72.3	72.8
Ammochostos	30.3	31.0	31.7	32.7	33.6	34.4	35.1	35.8
Larnaca	39.7	40.3	40.9	41.7	42.4	43.0	43.6	44.0
Limassol	38.1	38.2	38.3	38.8	39.2	39.6	39.8	40.1
Pafos	21.3	21.0	20.6	20.7	20.8	20.8	20.8	20.7
TOTAL	196.4	198.4	200.3	203.8	206.9	209.4	211.6	213.4

	1998	1999	2000	2001	2002	2003	2004	2005
Regional Population								
Nicosia	273.4	275.8	277.9	280.3	283.5	286.2	289.7	293.5
Ammochostos	36.5	37.1	37.8	38.5	39.1	39.6	40.1	40.8
Larnaca	113.9	115.1	116.2	117.5	119.3	120.8	122.8	124.8
Limassol	195.8	197.8	199.5	201.6	204.6	205.7	208.1	210.8
Pafos	63.3	64.7	66.1	67.6	68.6	70.6	72.3	74.1
TOTAL	682.9	690.5	697.5	705.5	715.1	722.9	733.0	744.0
Urban Population								
Nicosia	200.2	202.3	204.1	206.2	208.9	210.3	212.8	215.4
Ammochostos	0	0	0	0.0	0	0	0	0
Larnaca	69.5	70.3	71.1	72.0	73.2	73.5	74.4	75.4
Limassol	155.7	157.5	159.2	161.2	163.9	163.1	164.3	165.7
Pafos	42.7	44.2	45.7	47.3	48.3	49.5	50.7	52
TOTAL	468.1	474.3	480.1	486.7	494.3	496.4	502.2	508.5
Rural population								
Nicosia	73.2	73.5	73.8	74.1	74.6	75.9	76.9	78.1
Ammochostos	36.5	37.1	37.8	38.5	39.1	39.6	40.1	40.8
Larnaca	44.4	44.8	45.1	45.5	46.1	47.3	48.4	49.4
Limassol	40.1	40.3	40.3	40.4	40.7	42.6	43.8	45.1
Pafos	20.6	20.5	20.4	20.3	20.3	21.1	21.6	22.1
TOTAL	214.8	216.2	217.4	218.8	220.8	226.5	230.8	235.5

	2006	2007	2008	2009	2010	2011	2012	2013
Regional Population								
Nicosia	298.4	305.1	312.6	320.6	328	336.0	336.9	333.8
Ammochostos	41.6	42.7	43.8	45.1	46.3	47.6	47.9	47.4
Larnaca	127.4	130.8	134.5	138.5	142.3	146.3	147.2	145.9
Limassol	214.3	219	224.4	230.2	235.5	241.3	241.9	239.7
Pafos	76.2	78.8	81.6	84.7	87.7	90.8	92	91.2
TOTAL	757.9	776.4	796.9	819.1	839.8	862.0	865.9	858
Urban Population								
Nicosia	219	223.7	229.1	234.9	240.2	245.9	246.4	244.1
Ammochostos	0	0	0	0	0	0	0	0
Larnaca	76.6	78.4	80.3	82.4	84.3	86.4	86.7	85.9
Limassol	167.7	170.7	174.1	177.8	181.1	184.6	184.1	182.4
Pafos	53.5	55.3	57.3	59.5	61.6	63.9	64.9	64.3
TOTAL	516.8	528.1	540.8	554.6	567.2	580.8	582.1	576.7
Rural population								
Nicosia	79.4	81.4	83.5	85.7	87.8	90.1	90.5	89.7
Ammochostos	41.6	42.7	43.8	45.1	46.3	47.6	47.9	47.4
Larnaca	50.8	52.4	54.2	56.1	58.0	59.9	60.5	60
Limassol	46.6	48.3	50.3	52.4	54.4	56.7	57.8	57.3
Pafos	22.7	23.5	24.3	25.2	26.1	26.9	27.1	26.9
TOTAL	241.1	248.3	256.1	264.5	272.6	281.2	283.8	281.3
	2014	**2015**	**2016**	**2017**	**2018**			
Regional Population								
Nicosia	329.5	330	332.2	335.9	341.7			
Ammochostos	46.8	46.9	47	47.5	48.2			
Larnaca	144	144.2	144.9	146.5	147.0			
Limassol	236.6	237	239.4	242.0	244.9			
Pafos	90.1	90.2	91.3	92.3	94.1			
TOTAL	847	848.3	854.8	864.2	875.9			
Urban Population								
Nicosia	241	241.4	244.2	246.9	252.9			
Ammochostos	0	0	0	0	0			
Larnaca	84.8	84.9	85.7	86.6	87.0			
Limassol	180	180.3	182.6	184.6	187.0			
Pafos	63.5	63.6	64.4	65.1	66.9			
TOTAL	569.3	570.2	576.9	583.2	593.8			
Rural population								
Nicosia	88.5	88.6	88	89.0	88.8			
Ammochostos	46.8	46.9	47	47.5	48.2			
Larnaca	59.2	59.3	59.2	59.9	60.0			
Limassol	56.6	56.7	56.8	57.4	57.9			
Pafos	26.6	26.6	26.9	27.2	27.2			
TOTAL	277.7	278.1	277.9	281.0	282.1			

Table 7.9. Amount of waste generated per district and type of waste disposal site (kt)

	1990	1991	1992	1993	1994	1995	1996	1997
Nicosia								
deep unmanaged	89.4	94.0	98.7	102.7	106.5	110.1	115.1	117.6
shallow unmanaged	34.9	36.1	37.2	38.5	39.8	40.9	42.5	43.2
managed-anaerobic	0	0	0	0	0	0	0	0
Ammochostos								
deep unmanaged	0	0	0	0	0	0	0	0
shallow unmanaged	15.8	16.5	17.1	18.0	18.8	19.6	20.6	21.2
managed-anaerobic	0	0	0	0	0	0	0	0
Larnaca								
deep unmanaged	30.4	32.1	33.9	35.3	36.7	38.0	39.8	40.7

shallow unmanaged	20.7	21.4	22.1	23.0	23.8	24.5	25.6	26.1
managed-anaerobic	0	0	0	0	0	0	0	0
Limassol								
deep unmanaged	68.1	71.9	75.9	79.1	82.2	85.2	89.2	91.3
shallow unmanaged	19.9	20.3	20.7	21.4	22.0	22.6	23.4	23.8
managed-anaerobic	0	0	0	0	0	0	0	0
Pafos								
deep unmanaged	15.7	16.9	18.1	19.3	20.5	21.7	23.4	24.4
shallow unmanaged	11.1	11.2	11.1	11.4	11.7	11.9	12.2	12.3
managed-anaerobic	0	0	0	0	0	0	0	0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Nicosia								
deep unmanaged	119.7	121.7	124.5	129.9	132.5	136.8	140.9	142.8
shallow unmanaged	43.8	44.2	45.0	46.7	47.3	49.4	50.9	51.8
managed-anaerobic	0	0	0	0	0	0	0	0
Ammochostos								
deep unmanaged	0	0	0	0	0	0	0	0
shallow unmanaged	21.8	22.3	23.1	24.3	24.8	25.8	26.6	27.0
managed-anaerobic	0	0	0	0	0	0	0	0
Larnaca								
deep unmanaged	41.6	42.3	43.4	45.4	46.4	47.8	49.3	50.0
shallow unmanaged	26.6	26.9	27.5	28.7	29.2	30.8	32.1	32.7
managed-anaerobic	0	0	0	0	0	0	0	0
Limassol								
deep unmanaged	93.1	94.7	97.1	101.5	104.0	106.1	108.8	109.8
shallow unmanaged	24.0	24.2	24.6	25.4	25.8	27.7	29.0	29.9
managed-anaerobic	0	0	0	0	0	0	0	0
Pafos								
deep unmanaged	25.5	26.6	27.9	29.8	30.6	32.2	33.6	34.5
shallow unmanaged	12.3	12.3	12.4	12.8	12.9	13.7	14.3	14.6
managed-anaerobic	0	0	0	0	0	0	0	0
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Nicosia								
deep unmanaged	145.7	149.4	154.7	157.1	142.1	133.6	176.0	163.7
shallow unmanaged	52.8	54.4	56.4	57.3	51.9	48.9	0	0
managed-anaerobic	0	0	0	0	0	0	0	0
Ammochostos								
deep unmanaged	0	0	0	0	0	0	0	0
shallow unmanaged	27.7	28.5	29.6	30.2	0	0	0	0
managed-anaerobic	0	0	0	0	27.4	25.9	25.0	23.2
Larnaca								
deep unmanaged	51.0	52.4	54.2	55.1	0	0	0	0
shallow unmanaged	33.8	35.0	36.6	37.5	0	0	0	0
managed-anaerobic	0	0	0	0	84.2	79.5	76.9	71.5
Limassol								
deep unmanaged	111.6	114.0	117.6	118.9	107.1	100.3	126.4	117.5
shallow unmanaged	31.0	32.3	34.0	35.0	32.2	30.8	0	0
managed-anaerobic	0	0	0	0	0	0	0	0
Pafos								
deep unmanaged	0	0	0	0	0	0	0	0
shallow unmanaged	0	0	0	0	0	0	0	0
managed-anaerobic	50.7	52.6	55.1	56.6	51.9	49.3	48.1	44.7
	2014	**2015**	**2016**	**2017**	**2018**			
Nicosia								
deep unmanaged	153.6	157.8	160.3	161.7	164.5			

shallow unmanaged	0	0	0	0	0			
managed-anaerobic	0	0	0	0	0			
Ammochostos								
deep unmanaged	0	0	0	0	0			
shallow unmanaged	0	0	0	0	0			
managed-anaerobic	21.8	22.4	22.7	22.9	23.2			
Larnaca								
deep unmanaged	0	0	0	0	0			
shallow unmanaged	0	0	0	0	0			
managed-anaerobic	67.1	68.9	69.9	70.5	70.8			
Limassol								
deep unmanaged	110.3	113.3	115.5	116.5	117.9			
shallow unmanaged	0	0	0	0	0			
managed-anaerobic	0	0	0	0	0			
Pafos								
deep unmanaged	0	0	0	0	0			
shallow unmanaged	0	0	0	0	0			
managed-anaerobic	42.0	43.1	44.1	44.4	45.3			

Table 7.10. Allocation of population and waste to types waste disposal sites

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Population (10^6)								
Un-managed, deep	0.391	0.405	0.419	0.429	0.439	0.447	0.455	0.462
Un-managed, shallow	0.196	0.198	0.200	0.204	0.207	0.209	0.212	0.213
Managed, anaerobic	0	0	0	0	0	0	0	0
TOTAL	0.587	0.603	0.619	0.633	0.645	0.656	0.666	0.675
Waste production (Gg)								
Un-managed, deep	203.6	214.9	226.6	236.4	245.9	255.1	267.4	274.0
Un-managed, shallow	102.4	105.4	108.4	112.3	116.0	119.5	124.5	126.6
Managed, anaerobic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	306.0	320.3	335.0	348.7	361.9	374.6	391.9	400.6
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Population (10^6)								
Un-managed, deep	0.468	0.474	0.480	0.487	0.494	0.496	0.502	0.509
Un-managed, shallow	0.215	0.216	0.217	0.219	0.221	0.227	0.231	0.236
Managed, anaerobic	0	0	0	0	0	0	0	0
TOTAL	0.683	0.691	0.698	0.706	0.715	0.723	0.733	0.744
Waste production (Gg)								
Un-managed, deep	280.0	285.3	292.9	306.6	313.6	322.9	332.6	337.0
Un-managed, shallow	128.5	130.0	132.6	137.8	140.1	147.3	152.9	156.1
Managed, anaerobic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	408.4	415.3	425.5	444.4	453.7	470.2	485.5	493.1
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Population (10^6)								
Un-managed, deep	0.463	0.473	0.484	0.495	0.421	0.431	0.579	0.574
Un-managed, shallow	0.218	0.225	0.232	0.239	0.142	0.147	0	0
Managed, anaerobic	0.076	0.079	0.082	0.085	0.276	0.285	0.287	0.285
TOTAL	0.758	0.776	0.797	0.819	0.840	0.862	0.866	0.858
Waste production (Gg)								
Un-managed, deep	308.3	315.8	326.6	331.1	249.3	233.9	302.3	281.2
Un-managed, shallow	145.3	150.2	156.6	160.0	84.1	79.8	0.0	0.0
Managed, anaerobic	50.7	52.6	55.1	56.6	163.5	154.7	150.0	139.5
TOTAL	504.3	518.6	538.2	547.8	496.8	468.3	452.3	420.6
	2014	**2015**	**2016**	**2017**	**2018**			
Population (10^6)								

Un-managed, deep	0.566	0.567	0.572	0.578	0.587			
Un-managed, shallow	0	0	0	0	0			
Managed, anaerobic	0.281	0.281	0.283	0.286	0.289			
TOTAL	0.847	0.848	0.855	0.864	0.876			
Waste production (Gg)								
Un-managed, deep	263.9	271.1	275.8	278.2	282.4			
Un-managed, shallow	0	0	0	0	0			
Managed, anaerobic	130.9	134.5	136.7	137.8	139.3			
TOTAL	394.8	405.5	412.5	416.0	421.7			

Composition of MSW disposed at SWDS

Data on the composition of waste to disposal sites is available for the period 1996 to 2017. For the period 1990-1995 it is assumed that the composition is the same as 1996. The breakdown on the organic matter to food waste and non-food/garden waste has been provided from the Statistical Service and is assumed constant for all the years: 86% of organic matter is food waste and the remaining 14% is non-food/garden waste[76]. The resulting composition of MSW disposed at SWDS is presented in Table 7.11. Composition of waste for 1950-1989 is assumed the same as 1990.

Table 7.11. Composition of MSW disposed at SWDS

	Paper	Textiles	Wood	Food waste	Garden	Plastics, other inert
1990	28%	6%	2%	39%	6%	19%
1991	28%	6%	2%	39%	6%	19%
1992	28%	6%	2%	39%	6%	19%
1993	28%	6%	2%	39%	6%	19%
1994	28%	6%	2%	39%	6%	19%
1995	28%	6%	2%	39%	6%	19%
1996	28%	6%	2%	39%	6%	19%
1997	28%	6%	2%	39%	6%	19%
1998	27%	6%	2%	39%	6%	19%
1999	27%	6%	2%	39%	6%	19%
2000	27%	6%	2%	39%	6%	19%
2001	27%	6%	2%	39%	6%	19%
2002	27%	6%	2%	39%	6%	19%
2003	27%	6%	2%	38%	6%	20%
2004	27%	6%	2%	38%	6%	20%
2005	27%	6%	2%	38%	6%	20%
2006	26%	6%	2%	38%	6%	21%
2007	24%	7%	2%	39%	6%	21%
2008	23%	7%	2%	41%	7%	20%
2009	23%	7%	2%	42%	7%	19%
2010	27%	8%	3%	44%	7%	12%
2011	28%	9%	3%	45%	7%	7%
2012	28%	10%	3%	45%	7%	6%
2013	26%	10%	3%	47%	8%	7%
2014	27%	11%	3%	49%	8%	2%
2015	27%	11%	3%	49%	8%	2%
2016	27%	11%	3%	48%	8%	3%
2017	27%	11%	3%	48%	8%	4%
2018	27%	11%	3%	48%	8%	4%

Total non-municipal solid waste

In addition to the municipal solid waste production data presented above, data has been obtained for the following additional solid waste categories: Animal and vegetal wastes, Paper and cardboard wastes,

[76] Mrs. Marilena Kythreotou, +357 22602137, mkythreotou@cystat.mof.gov.cy (tel. communication 25/10/2013)

Wood wastes, Textile wastes and Industrial effluent sludges. Data was obtained from the National Statistical Service[77]. The Statistical Service has collected the data for the purposes of compliance with Regulation (EC) No 2150/2002 of 25 November 2002 on waste statistics, by the application of the methodologies presented in the relevant manuals published by EUROSTAT[78].

The available data for the pre-mentioned categories is presented in Table 7.12.

Table 7.12. Total waste disposal – landfilled for non-municipal solid waste (in tonnes)

Category	2004	2006	2008	2010	2012	2014	2016
Industrial effluent sludges	:	:	:	299	177	539	672
Wood wastes	:	:	:	17481	10589	8769	5415
Textile wastes	:	:	:	30962	14	13	13
Animal and vegetal wastes	60704	67565	107059	50678	17941	11913	10434

The first reference year for which data for Generation and Treatment of Waste is available, is 2004 in accordance with the provisions of the Waste Statistics Regulation (EC) No 2150/2002. No data are available for Cyprus before 2004. The methodology applied is may differ between years, due to the amendment of the Regulation (data 2010 and onwards) and moreover due to improved methods of reporting waste following Eurostat's recommendations. Data revisions were applied from 2012 onwards.

An estimation of the activity data for the years 2013 and 2015 was made by obtaining the average of the years before and after; i.e. 2012 and 2014, 2014 and 2016 respectively.

An extrapolation of the trend available from the years 2012-2016 was used to estimate activity data for 2017 and 2018.

To estimate the activity data for the years prior to 2012 going back to the year 1950 (see Annex 3.2), the annual change of the Gross Domestic Product at Constant market prices of 2005 was used, as published by the Statistical Service in the Statistical Abstract[79] (Table 7.13 for the period 1990-2011).

Table 7.13. Gross Domestic Product (GDP) at Constant market prices of 2005 (1990-2011)

	1990	1991	1992	1993	1994	1995	1996	1997
GDP (€mn)	7650	7704	8428	8487	8988	10191	10355	10603
Annual change		0.7%	9.4%	0.7%	5.9%	13.4%	1.6%	2.4%
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
GDP (€mn)	11139	11663	12330	12773	13186	13556	14180	14731
Annual change	5.1%	4.7%	5.7%	3.6%	3.2%	2.8%	4.6%	3.9%
	2006	**2007**	**2008**	**2009**	**2010**	**2011**		
GDP (€mn)	15397	16156	16747	16407	16631	16698		
Annual change	4.5%	4.9%	3.7%	-2.0%	1.4%	0.4%		

The resulting waste production per waste stream obtained from the application of the assumptions and methods presented above is presented in Table 7.14 for the complete time series.

[77] Ms. Marilena Kythreotou, Statistical Officer A', tel. +357 22 602317, mkythreotou@cystat.mof.gov.cy

[78] Manual on waste statistics, available at http://ec.europa.eu/eurostat/product?code=KS-RA-13-015&language=en; Waste generation and treatment (ESMS metadata file — env_wasgt_esms), available at http://ec.europa.eu/eurostat/cache/metadata/en/env_wasgt_esms.htm

[79] Available at http://www.cystat.gov.cy/mof/cystat/statistics.nsf/All/9707F78B64756B8AC225809700377869/$file/ABSTRACT-2014-EN-281215.pdf?OpenElement

Table 7.14. Solid waste production per waste stream 1990-2018 (in tonnes)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Industrial effluent sludges	79	79	88	88	94	108	110	113
Wood wastes	4716	4749	5242	5279	5609	6476	6582	6744
Textile wastes	6	6	7	7	7	9	9	9
Animal and vegetal wastes	7990	8046	8881	8944	9504	10973	11153	11426
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Industrial effluent sludges	119	125	132	137	142	146	153	159
Wood wastes	7103	7453	7906	8200	8474	8719	9140	9509
Textile wastes	9	10	10	11	11	12	12	13
Animal and vegetal wastes	12034	12628	13395	13893	14358	14773	15485	16111
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Industrial effluent sludges	166	175	182	178	181	181	177	358
Wood wastes	9959	10476	10873	10657	10804	10848	10589	9679
Textile wastes	13	14	14	14	14	14	14	14
Animal and vegetal wastes	16874	17750	18423	18056	18306	18380	17941	14927
	2014	**2015**	**2016**	**2017**	**2018**			
Industrial effluent sludges	539	605.5	672	815	958			
Wood wastes	8769	7092	5415	4249	3084			
Textile wastes	13	13	13	13	12			
Animal and vegetal wastes	11913	11173.5	10434	9695	8955			

Reservations and reflections on the methodology applied

(a) The backcasting of the waste production using a purely economic indicator shows the weakness that it does not represent the changes in the waste management practices that have been occurring after 2004 that Cyprus joined the European Union.

(b) During the period 1990-2000 Cyprus had considerably higher industrial activity than today, which started reducing during the late 1990s. During the start of 2000s and especially after Cyprus joined the European Union, the economy of Cyprus focuses more on services. These conditions cannot be represented in the backcasting with the GDP applied.

However, given the information available, this is the only methodology that can be applied to complete the series. Attempts will be made to improve the estimation of waste production through the examination of other available data and methods for future submission.

Allocation of waste to types of waste disposal sites

For the allocation of solid waste estimated to different types of waste disposal sites, it was decided to use the Number of Establishments by Economic Activity NACE (Rev. 2) and District for the year 2017, published by the Statistical Service in 2018[80] (Table 7.15).

[80] Available at https://www.mof.gov.cy/mof/cystat/statistics.nsf/All/8E65F57AC6EB3259C22583590036DE1F/$file/ESTABLISMENTS_NACE2_DISTRICT-2017-041218.pdf?OpenElement

Table 7.15. Number of Establishments by Economic Activity NACE (Rev. 2) and District for the year 2017 associated with the production Industrial effluent sludges, Wood wastes, Textile wastes and Animal and vegetal wastes

Number of Establishments by Economic Activity NACE (Rev. 2) and District (2017)	**Nicosia**	**Ammochostos**	**Larnaca**	**Limassol**	**Pafos**	**TOTAL**
WOOD WASTES						
16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	264	51	164	297	85	
31091 Manufacture of wooden furniture	80	5	25	29	10	
43321 Installation of non self-manufactured doors, windows, kitchens, frames and the like of wood or other materials	25	6	9	29	9	
46731 Wholesale of wood	28	4	8	16	5	
47524 Retail sale of wood	10	2	4	7	2	
TOTAL wood	**407**	**68**	**210**	**378**	**111**	**1174**
contribution of district to total	**35%**	**6%**	**18%**	**32%**	**9%**	
TEXTILE WASTES						
13 Manufacture of textiles	52	4	23	22	7	
46161 Agents involved in the sale of textiles, clothing, fur, footwear and leather goods	8	0	4	8	0	
4641 Wholesale of textiles	32	1	7	18	0	
4751 Retail sale of textiles in specialized stores	43	6	19	48	13	
46411 Wholesale of textiles (e.g fabrics, yarn, household linen, sewing thread, etc.)	32	1	7	18	0	
47511 Retail sale of fabrics	13	1	3	15	4	
TOTAL textile	**180**	**13**	**63**	**129**	**24**	**409**
contribution of district to total	**44%**	**3%**	**15%**	**32%**	**6%**	
ANIMAL AND VEGETAL WASTES						
014 Animal production	343	70	363	190	110	
0162 Support activities for animal production	2	0	0	2	0	
104 Manufacture of vegetable and animal oils and fats	13	3	10	3	6	
103 Processing and preserving of fruit and vegetables	14	1	8	18	4	
104 Manufacture of vegetable and animal oils and fats	13	3	10	3	6	
105 Manufacture of dairy products	30	7	25	33	9	
10611 Production of flour from cereals and vegetables	4	1	1	2	0	
4631 Wholesale of fruit and vegetables	57	18	39	46	18	
4721 Retail sale of fruit and vegetables in specialized stores	58	8	36	35	10	
0113 Growing of vegetables and melons, roots and tubers	155	387	321	134	117	
TOTAL Animal and vegetal products	**689**	**498**	**813**	**466**	**280**	**2746**
contribution of district to total	**25%**	**18%**	**30%**	**17%**	**10%**	
INDUSTRIAL EFFLUENT SLUDGES						
total establishments	**39966**	**6865**	**16308**	**30444**	**11436**	**105019**
contribution of district to total	**38%**	**7%**	**16%**	**29%**	**11%**	

Assumptions for allocation have been based on the information provided by the Solid Waste Management Unit of the Department of Environment, which is the same as for municipal solid waste (see Table 7.7). The categorization is based on the disposal of the waste according to their origin; i.e. urban or rural. All waste generated by industrial activities are assumed as urban waste and this transferred to either deep unmanaged of managed-anaerobic sites.

The resulting amount of waste generated per district is presented in Table 7.16, while the total quantities of solid waste disposed per type of waste and waste disposal site are presented in Table 7.17.

Table 7.16. Amount of non-municipal solid waste generated per district (tonnes)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Nicosia								
Industrial effluent sludges	30.0	30.2	33.3	33.6	35.7	41.2	41.9	42.9
Wood wastes	1635	1635	1635	1635	1635	1635	1635	1635
Textile wastes	3	3	3	3	3	3	3	3
Animal and vegetal wastes	2005	2005	2005	2005	2005	2005	2005	2005
Ammochostos								
Industrial effluent sludges	5.2	5.2	5.7	5.8	6.1	7.1	7.2	7.4
Wood wastes	273	273	273	273	273	273	273	273
Textile wastes	0	0	0	0	0	0	0	0
Animal and vegetal wastes	1449	1449	1449	1449	1449	1449	1449	1449
Larnaca								
Industrial effluent sludges	12.2	12.3	13.6	13.7	14.6	16.8	17.1	17.5
Wood wastes	843	849	938	944	1003	1158	1177	1206
Textile wastes	1	1	1	1	1	1	1	1
Animal and vegetal wastes	2365	2382	2629	2648	2814	3249	3302	3383
Limassol								
Industrial effluent sludges	22.8	23.0	25.4	25.6	27.2	31.4	31.9	32.7
Wood wastes	1518	1529	1688	1700	1806	2085	2119	2171
Textile wastes	2	2	2	2	2	3	3	3
Animal and vegetal wastes	1356	1365	1507	1518	1613	1862	1893	1939
Pafos								
Industrial effluent sludges	8.6	8.6	9.5	9.6	10.2	11.8	12.0	12.3
Wood wastes	446	449	496	499	530	612	622	638
Textile wastes	0	0	0	0	0	1	1	1
Animal and vegetal wastes	815	820	906	912	969	1119	1137	1165
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Nicosia								
Industrial effluent sludges	45.2	47.4	50.3	52.2	53.9	55.5	58.1	60.5
Wood wastes	1635	1635	1635	1635	1635	1635	1635	1635
Textile wastes	3	3	3	3	3	3	3	3
Animal and vegetal wastes	2005	2005	2005	2005	2005	2005	2005	2005
Ammochostos								
Industrial effluent sludges	7.8	8.1	8.6	9.0	9.3	9.5	10.0	10.4
Wood wastes	273	273	273	273	273	273	273	273
Textile wastes	0	0	0	0	0	0	0	0
Animal and vegetal wastes	1449	1449	1449	1449	1449	1449	1449	1449
Larnaca								
Industrial effluent sludges	18.4	19.3	20.5	21.3	22.0	22.6	23.7	24.7
Wood wastes	1271	1333	1414	1467	1516	1560	1635	1701

Textile wastes	1	2	2	2	2	2	2	2
Animal and vegetal wastes	3563	3739	3966	4113	4251	4374	4585	4770
Limassol								
Industrial effluent sludges	34.4	36.1	38.3	39.7	41.1	42.2	44.3	46.1
Wood wastes	2287	2400	2545	2640	2728	2807	2943	3062
Textile wastes	3	3	3	3	4	4	4	4
Animal and vegetal wastes	2042	2143	2273	2358	2437	2507	2628	2734
Pafos								
Industrial effluent sludges	12.9	13.6	14.4	14.9	15.4	15.9	16.6	17.3
Wood wastes	672	705	747	775	801	824	864	899
Textile wastes	1	1	1	1	1	1	1	1
Animal and vegetal wastes	1227	1288	1366	1417	1464	1506	1579	1643
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Nicosia								
Industrial effluent sludges	63.4	66.6	69.2	67.8	68.7	69.0	67.4	136.2
Wood wastes	1635	1635	1635	1635	1635	1635	1635	1635
Textile wastes	3	3	3	3	3	3	3	3
Animal and vegetal wastes	2005	2005	2005	2005	2005	2005	2005	2005
Ammochostos								
Industrial effluent sludges	10.9	11.4	11.9	11.6	11.8	11.9	11.6	23.4
Wood wastes	273	273	273	273	273	273	273	273
Textile wastes	0	0	0	0	0	0	0	0
Animal and vegetal wastes	1449	1449	1449	1449	1449	1449	1449	1449
Larnaca								
Industrial effluent sludges	25.9	27.2	28.2	27.7	28.0	28.2	27.5	55.6
Wood wastes	1781	1874	1945	1906	1933	1940	1894	1731
Textile wastes	2	2	2	2	2	2	2	2
Animal and vegetal wastes	4996	5255	5454	5346	5420	5442	5312	4419
Limassol								
Industrial effluent sludges	48.3	50.8	52.7	51.6	52.4	52.6	51.3	103.8
Wood wastes	3207	3373	3501	3431	3479	3493	3409	3116
Textile wastes	4	4	5	4	5	5	4	4
Animal and vegetal wastes	2864	3012	3126	3064	3107	3119	3045	2533
Pafos								
Industrial effluent sludges	18.1	19.1	19.8	19.4	19.7	19.7	19.3	39.0
Wood wastes	942	990	1028	1008	1022	1026	1001	915
Textile wastes	1	1	1	1	1	1	1	1
Animal and vegetal wastes	1721	1810	1878	1841	1867	1874	1829	1522
	2014	**2015**	**2016**	**2017**	**2018**			
Nicosia								
Industrial effluent sludges	205.1	230.4	255.7	310.1	364.4			
Wood wastes	1635	1635	1635	1635	1635			
Textile wastes	3	3	3	3	3			
Animal and vegetal wastes	2005	2005	2005	2005	2005			
Ammochostos								
Industrial effluent sludges	35.2	39.6	43.9	53.3	62.6			
Wood wastes	273	273	273	273	273			
Textile wastes	0	0	0	0	0			

Animal and vegetal wastes	1449	1449	1449	1449	1449			
Larnaca								
Industrial effluent sludges	83.7	94.0	104.4	126.5	148.7			
Wood wastes	1569	1269	969	760	552			
Textile wastes	2	2	2	2	2			
Animal and vegetal wastes	3527	3308	3089	2870	2651			
Limassol								
Industrial effluent sludges	156.3	175.5	194.8	236.2	277.6			
Wood wastes	2823	2283	1744	1368	993			
Textile wastes	4	4	4	4	4			
Animal and vegetal wastes	2022	1896	1771	1645	1520			
Pafos								
Industrial effluent sludges	58.7	65.9	73.2	88.7	104.3			
Wood wastes	829	671	512	402	292			
Textile wastes	1	1	1	1	1			
Animal and vegetal wastes	1215	1139	1064	989	913			

Table 7.17. Total quantities of solid waste disposed per type of waste and waste disposal site (tonnes)

	1990	1991	1992	1993	1994	1995	1996	1997
Deep unmanaged								
Industrial effluent sludges	78.8	79.4	87.6	88.2	93.8	108.3	110.0	112.7
Wood wastes	4715.5	4735.3	5028.8	5050.8	5247.7	5763.8	5827.1	5923.1
Textile wastes	6.2	6.3	6.6	6.6	6.9	7.5	7.5	7.7
Animal and vegetal wastes	7989.5	8021.6	8495.6	8531.2	8849.3	9683.1	9785.3	9940.5
Managed anaerobic								
Industrial effluent sludges	NO	NO	NO	NO	NO	NO	NO	NO
Wood wastes	NO	NO	NO	NO	NO	NO	NO	NO
Textile wastes	NO	NO	NO	NO	NO	NO	NO	NO
Animal and vegetal wastes	NO	NO	NO	NO	NO	NO	NO	NO
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Deep unmanaged								
Industrial effluent sludges	118.7	124.6	132.1	137.1	141.6	145.7	152.8	158.9
Wood wastes	6136.9	6345.6	6615.0	6790.2	6953.3	7099.2	7349.6	7569.4
Textile wastes	7.9	8.1	8.5	8.7	8.9	9.0	9.3	9.6
Animal and vegetal wastes	10285.8	10623.1	11058.3	11341.3	11604.9	11840.5	12245.1	12600.2
Managed anaerobic								
Industrial effluent sludges	NO	NO	NO	NO	NO	NO	NO	NO
Wood wastes	NO	NO	NO	NO	NO	NO	NO	NO
Textile wastes	NO	NO	NO	NO	NO	NO	NO	NO
Animal and vegetal wastes	NO	NO	NO	NO	NO	NO	NO	NO
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Deep unmanaged								
Industrial effluent sludges	148.3	156.0	162.0	158.7	121.1	121.6	118.7	240.0
Wood wastes	6895.9	7154.8	7353.8	7245.5	5113.5	5127.6	5044.2	4751.2
Textile wastes	9.1	9.4	9.7	9.6	7.2	7.3	7.2	7.0
Animal and vegetal wastes	11312.9	11720.8	12034.2	11863.6	5111.2	5123.8	5049.3	4537.8
Managed anaerobic								
Industrial effluent sludges	18.1	19.1	19.8	19.4	59.5	59.8	58.3	118.0
Wood wastes	941.6	990.5	1028.0	1007.6	3227.3	3239.3	3168.4	2919.6
Textile wastes	0.8	0.8	0.8	0.8	3.2	3.2	3.2	3.1
Animal and vegetal wastes	1720.6	1809.9	1878.5	1841.1	8735.3	8764.9	8590.1	7390.4
	2014	**2015**	**2016**	**2017**	**2018**			

Deep unmanaged								
Industrial effluent sludges	361.4	406.0	450.5	546.3	642.1			
Wood wastes	4458.2	3918.2	3378.3	3002.9	2627.6			
Textile wastes	6.8	6.8	6.8	6.7	6.6			
Animal and vegetal wastes	4026.3	3900.8	3775.3	3649.8	3524.3			
Managed anaerobic								
Industrial effluent sludges	177.6	199.5	221.5	268.5	315.6			
Wood wastes	2670.8	2212.3	1753.7	1435.0	1116.3			
Textile wastes	3.0	3.0	3.0	2.9	2.8			
Animal and vegetal wastes	6190.7	5896.4	5602.0	5307.7	5013.3			

Estimation of CH_4 from waste disposal on land

For the purpose of estimation of emissions, the default IPCC parameters have been used assuming that waste streams have the same characteristics as MSW component and the IPCC waste model excel template. Therefore the quantities presented in Table 7.17 have been added to the quantities of the MSW in the model.

Degradable organic carbon (DOC) has been estimated using the following equation (equation 3.7, volume 5, pg. 3.13 of IPCC 2006 guidelines using default carbon content values (0.15 for food waste, 0.43 for wood, 0.24 for textiles and 0.05 for Sewage sludge)).

$$DOC = \Sigma_i (DOC_i * W_i)$$

Fraction of degradable organic carbon which decomposes (DOC_F) is assumed as 0.5, which is the default value proposed by the 2006 IPCC guidelines (pg. 3.13, volume 5).

The CH_4 fraction F value used is according to the default proposed by the IPCC guidelines, i.e. 0.5. The oxidation factor (OX) used is according to the defaults proposed by the IPCC guidelines (Table 3.2, pg. 3.15, vol. 5, 2006 IPCC guidelines); i.e. 0 for deep unmanaged and 0.1 for managed anaerobic. No methane is recovered from SWDS in Cyprus therefore recovery (R) is assumed 0.

The defaults used by the IPCC waste model for Methane generation rate constant (k) are according to dry temperate climate; i.e. 0.06 for food waste, 0.02 for wood and straw and 0.04 for textiles.

According to the consultations with the Waste Management Unit of the Department of Environment, and according to the 2006 IPCC Guidelines, all SWDS not meeting the criteria of managed SWDS and which have depth smaller than 5m classified as unmanaged disposal sites, and therefore be assumed shallow. The value for the methane correction factor for shallow unmanaged disposal sites is assumed to be 0.4, and is according to the default IPCC2006 guidelines (pg. 3.14, volume 5). Moreover, all SWDS not meeting the criteria of managed SWDS and which have depth greater than or equal to 5m classified as unmanaged disposal sites, and assumed deep. The value for the methane conversion factor for deep unmanaged disposal sites is assumed to be 0.8, and is according to the default IPCC2006 guidelines (pg. 3.14, volume 5).

Other parameters used for the calculation of methane emissions by the IPCC waste model are Delay time of 6 months, Fraction of methane (F) in developed gas of 0.5 and Conversion factor, C to CH of 41.33.

The resulting CH_4 emissions for the total solid waste including both municipal and non-municipal solid wastes, as estimated by the IPCC Waste Model are presented in Table 7.18.

7.2.2. Uncertainties and time-series consistency

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

7.2.3. Category-specific QA/QC and verification

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

7.2.4. Category-specific recalculations

Emissions from solid waste management (5A) were recalculated for the time series 1990-2017, in order to include non-municipal solid wastes to the total solid waste. The resulting CH_4 emissions for the total solid waste including both municipal and non-municipal solid wastes, as estimated by the IPCC Waste Model are presented in Table 7.18.

Table 7.18. Revised total solid waste CH_4 emissions (Gg) – recalculation in red

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Un-managed, deep	8.52	8.68	8.85	9.05	9.25	9.47	9.71	9.96
Un-managed, shallow	2.08	2.11	2.15	2.18	2.22	2.26	2.31	2.36
Un-managed, total	10.60	10.79	11.00	11.23	11.48	11.73	12.02	12.32
Managed, anaerobic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	10.60	10.79	11.00	11.23	11.48	11.73	12.02	12.32
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Un-managed, deep	10.22	10.48	10.74	11.01	11.30	11.60	11.89	12.20
Un-managed, shallow	2.41	2.45	2.50	2.55	2.60	2.65	2.71	2.77
Un-managed, total	12.62	12.93	13.24	13.55	13.90	14.25	14.61	14.97
Managed, anaerobic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	12.62	12.93	13.24	13.55	13.90	14.25	14.61	14.97
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Un-managed, deep	12.50	12.71	12.91	13.13	13.36	13.42	13.47	13.70
Un-managed, shallow	2.83	2.88	2.92	2.97	3.02	2.99	2.97	2.83
Un-managed, total	15.33	15.58	15.83	16.10	16.39	16.42	16.44	16.53
Managed, anaerobic	0.00	0.14	0.28	0.42	0.55	1.03	1.48	1.89
TOTAL	15.33	15.72	16.11	16.52	16.94	17.44	17.91	18.43
	2014	**2015**	**2016**	**2017**	**2018**			
Un-managed, deep	13.85	13.98	14.14	14.29	14.44			
Un-managed, shallow	2.70	2.58	2.47	2.36	2.25			
Un-managed, total	16.56	16.56	16.60	16.65	16.69			
Managed, anaerobic	2.25	2.57	2.90	3.21	3.51			
TOTAL	18.80	19.13	19.50	19.86	20.20			

Impact of recalculations

The impact of recalculations to the total CH_4 emissions from solid waste management ranges from 0.26 Gg CH_4 in 1990 to 0.82 Gg CH_4 in 2017, which corresponds to 6.6 to 20.4 Gg CO2 eq. respectively as shown in Figure 7.6. The impact to total waste sector emissions ranges from 1.8% in 1990 to 3.8% in 2017, while the impact to the total national emissions excluding LULUCF ranges from 0.1% in 1990 to 0.2% in 2017.

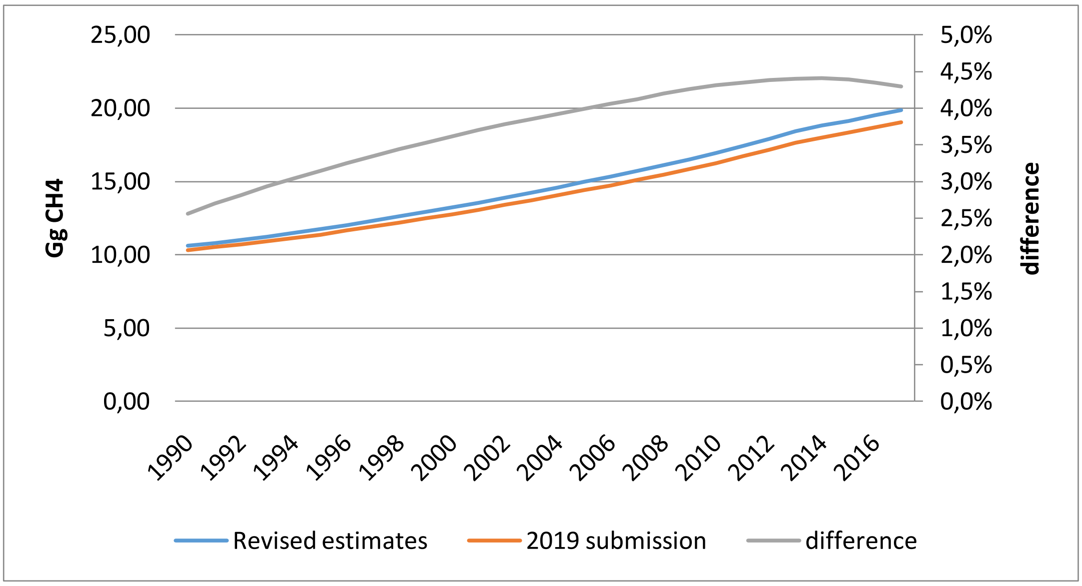

Figure 7.6. Impact of recalculations to the total CH_4 emissions from solid waste management ranges

7.2.5. Category-specific planned improvements

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

7.3. Biological Treatment of Solid Waste (5B)

Composting and anaerobic digestion of organic waste, such as food waste, garden (yard) and park waste and sludge, is common both in developed and developing countries. In Cyprus there is no anaerobic digestion of Solid Waste, therefore it is reported as NO. Composting is an aerobic process and a large fraction of the degradable organic carbon (DOC) in the waste material is converted into carbon dioxide (CO_2). CH_4 is formed in anaerobic sections of the compost, but it is oxidised to a large extent in the aerobic sections of the compost.

Unfortunately, data for 2018 were unavailable at the time preparing this report due to incomplete and insufficient information necessary to properly reflect statistical quantities of waste that were processed from some of the solid waste disposal sides (SWDS). For this reason, the same data as 2017 were used for estimating emissions. Emissions from biological treatment of solid waste in 2018 accounted for 1% of total GHG emissions from Waste, 0.06% of total national emissions without LULUCF. 100% of the emissions are from composting; anaerobic treatment is not applied for solid waste in Cyprus. The emissions from biological treatment are presented in Table 7.19 and Figure 7.7.

Table 7.19. Emissions from biological treatment of solid waste, 1990-2018

	1990	2000	2005	2010	2015	2017	2018
CH_4 (Gg)	NO	NO	NO	0.03	0.18	0.13	0.13
N_2O (Gg)	NO	NO	NO	0.0019	0.0105	0.0080	0.008
Total (Gg CO2 eq.)	NO	NO	NO	1.4	7.5	5.68	5.68

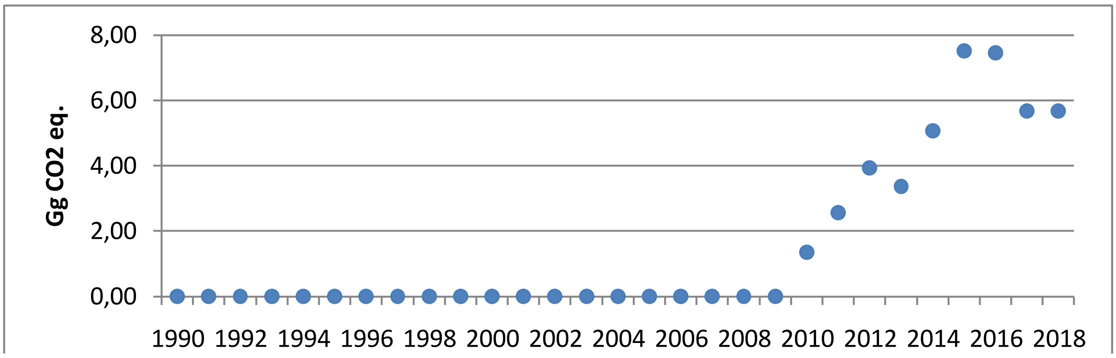

Figure 7.7. Emissions from Composting 1990-2018

7.3.1. Methodological issues

The estimation of CH_4 and N_2O emissions from biological treatment of solid waste according to the 2006 IPCC Guidelines (chapter 4, vol. 5) involves following steps:

Step 1. Activity data

Collect data on the amount and type of solid waste which is treated biologically. The amount of solid waste composted has already been presented in Table 7.6 and is according to the national statistics on production and management of municipal solid waste[81]. Activity data includes the amount of composting material that is used for backfilling.

Step 2. Estimation of emissions

The CH_4 and N_2O emissions of the biological treatment have been estimated using the default method, i.e. equations 4.1 and 4.2 of 2006 IPCC guidelines (volume 5, page 4.5). The emission factor for N_2O emissions is assumed 0.24 g/kg wet waste as proposed in the corrigendum of the 2006 guidelines dated July 2015, while the CH_4 emission factor as 4 g/kg wet waste (IPCC2006, vol.5, pg. 4.6, table 4.1).

Step 3. Subtraction of recovered gas

According to the guidelines, the amount of recovered gas from the amount of CH_4 generated to estimate net annual CH_4 emissions should be subtracted. No recovery takes place in Cyprus therefore amount of recovered gas is 0.

7.3.2. Uncertainties and time-series consistency

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

7.3.3. Category-specific QA/QC and verification

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

[81] The 2017 publication, which includes data for the years 1996-2016 is available at http://www.cystat.gov.cy/mof/cystat/statistics.nsf/energy_environment_82main_gr/energy_environment_82main_gr?OpenForm&sub=2&sel=2; contact person for population statistics at the Statistical Service is Marilena Kythreotou, +357 22602137, mkythreotou@cystat.mof.gov.cy

7.3.4. Category-specific recalculations

No recalculations to report

7.3.5. Category-specific planned improvements

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

7.4. Incineration and Open Burning of Waste (5C)

Incineration and Open Burning of Waste do not take place in Cyprus and are therefore reported as NO. Fire Prevention of Outdoors Law of 1988 (220/1988) as amended by 109(I)2002 prohibits any open burning of waste or any other material by the population, including waste.

However, according to the Statistical Service[82] in 2014, 4.45 kt of partly stabilised biodegradable waste that has been generated during sorting have been incinerated for energy recovery in the cement kiln. The emissions of this activity have been considered in the energy sector, source category 1A2f, Non-Metallic Minerals.

7.5. Wastewater Treatment and Discharge (5D)

Wastewater can be a source of methane (CH_4) when treated or disposed anaerobically. It can also be a source of nitrous oxide (N_2O) emissions. Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on site (uncollected), sewered to a centralized plant (collected) or disposed untreated nearby or via an outfall. In Cyprus there is no disposal of untreated wastewater nearby or via an outfall. Wastewater treatment systems and discharge pathways in Cyprus are presented in Figure 7.8.

[82] Statistical Service, 2017, Generation and treatment of municipal solid waste, available at http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/ADFFD39B594E2B42C2256D41001F2DBB/$file/MUNICIPAL_SOLID_WASTE-A93_16-EN-281117.xls?OpenElement

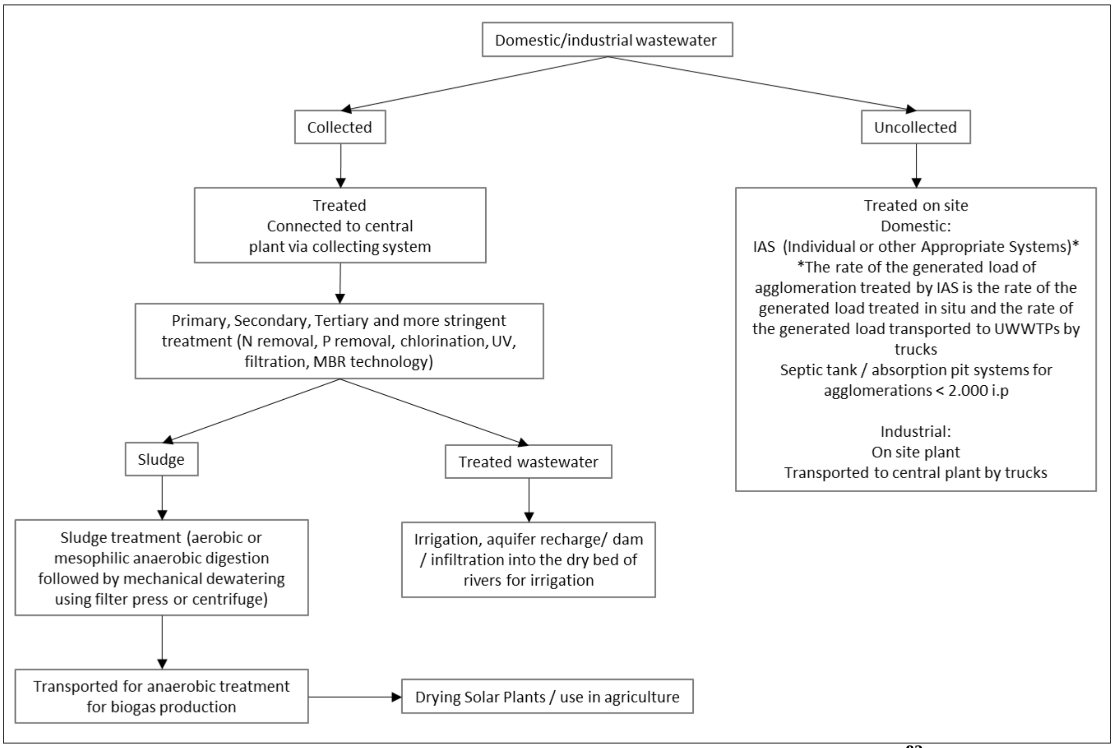

Figure 7.8. Wastewater treatment systems and discharge pathways in Cyprus[83]

Emissions from Wastewater treatment and discharge accounted for 11.5% of the total GHG emissions from Waste sector in 2018 and 0.75% of total national emissions without LULUCF. The emissions from Wastewater treatment and discharge between 1990 and 2018 decreased by 48.5% mainly due to the shift from septic tanks to centralised aerobic treatment systems for the treatment of domestic wastewater. The emissions from these sources are presented in Table 7.20 and Figure 7.9.

Table 7.20. Emissions from Wastewater treatment and discharge (5D) 1990-2018

	1990	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**
D. Wastewater treatment and discharge	**128.38**	**140.62**	**125.89**	**90.78**	**73.35**	**69.38**	**66.05**
1. Domestic wastewater	103.88	112.39	99.76	63.23	44.62	38.34	35.01
2. Industrial wastewater	24.51	28.23	26.13	27.55	28.73	31.04	31.04
CH_4 (Gg)	4.64	5.04	4.47	2.98	2.28	2.11	1.97
N_2O (Gg)	0.04	0.05	0.05	0.06	0.05	0.06	0.06
Total (Gg CO_2 eq.)	**128.38**	**140.62**	**125.89**	**90.78**	**73.35**	**69.38**	**66.05**

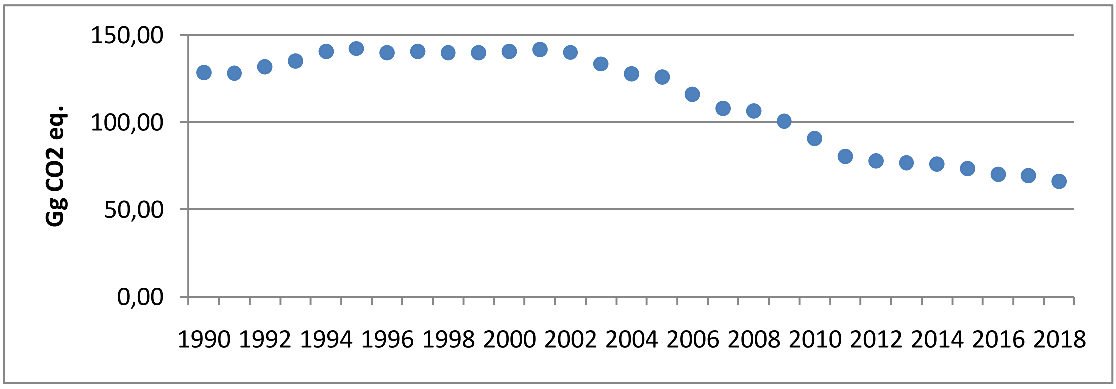

Figure 7.9. Total emissions from Wastewater treatment and discharge (5D) 1990-2018

[83] Stella Perikenti, Environment Officer, National expert on urban wastewater management, Pollution Control Unit, Department of Environment (+35726804573, sperikenti@environment.moa.gov.cy)

7.5.1. Domestic Wastewater Treatment and Discharge (5D1)

According to the 2006 IPCC Guidelines, Domestic wastewater is defined as "wastewater from household water use, while industrial wastewater is from industrial practices only"[84]. Sewers in Cyprus are closed and underground, which is believed that is not a significant source of CH_4. The most wastewater treatment methods and pathways in Cyprus are presented in Figure 7.8. All information presented regarding urban wastewater has been obtained from Ms. Stella Perikenti (Pollution Control Unit, Department of Environment) and Ms. Lia Georgiou (Division of Waste Water and Reuse, Water Development Department).

To meet regulatory standards, many large industrial facilities pre-treat their wastewater before releasing it into the sewage system. Domestic wastewater is also treated in on-site septic systems. These are advanced systems that may treat wastewater from one household. They consist of an anaerobic underground tank and a drainage field for the treatment of effluent from the tank. This used to be a common practice in the 1990s which gradually reduced due to the construction of the wastewater collection systems and treatment stations (Figure 7.10). 10% of wastewater disposed in septic tanks is collected by authorised wastewater collectors and transported to aerobic wastewater treatment plants. Some industrial wastewater may be discharged into municipal sewer lines where it combines with domestic wastewater provided that the organic load of the wastewater is reduced to the limits set in the wastewater disposal permit issued by the Department of Environment.

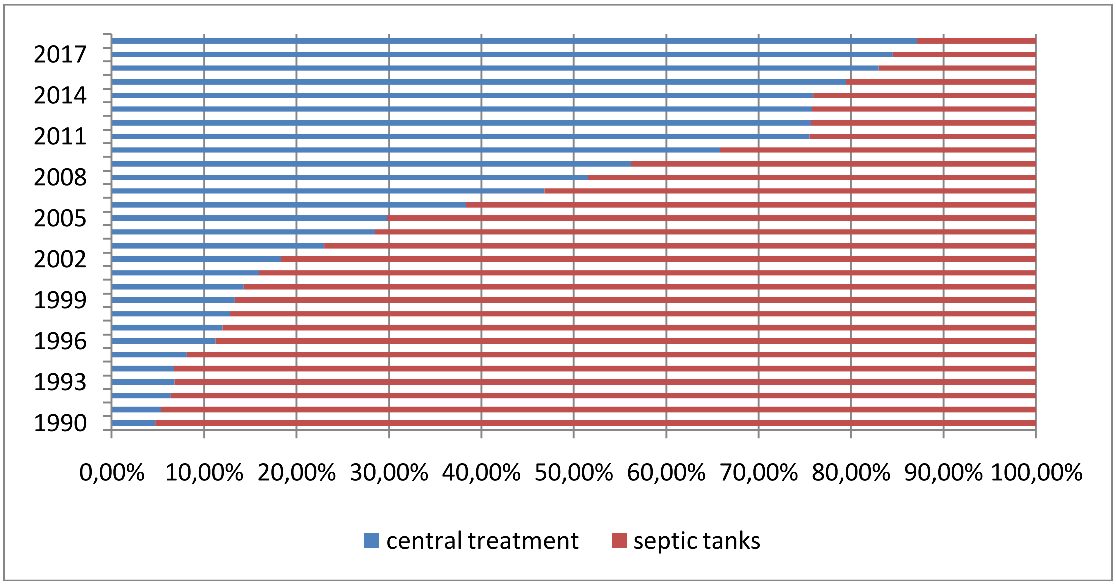

Figure 7.10. Domestic Wastewater treatment in Cyprus 1990-2018

Centralised wastewater treatment methods can be classified as primary, secondary, and tertiary treatment. In primary treatment, physical barriers remove larger solids from the wastewater. Remaining particulates are then allowed to settle. Secondary treatment consists of a combination of biological processes that promote biodegradation by micro-organisms. Tertiary treatment processes are used to further purify the wastewater of pathogens, contaminants, and remaining nutrients such as nitrogen and phosphorus compounds. This is achieved using one or a combination of processes that can include biological processes, advanced filtration, carbon adsorption, UV and disinfection. Details on the technologies used in Cyprus are presented in Table 7.21.

Table 7.21. Wastewater treatment technologies implemented in Cyprus for the treatment of urban wastewaters

[84] 2006 IPCC Guidelines, 2015 Corrigendum, Volume 5, pg. 6.6

Wastewater treatment plant	Capacity	Primary	Secondary	Tertiary	N Removal	P Removal	UV	Chlorination	Sand Filtration	MBR Technology
Kakopetria	2200	√	√							
Paralimni	68750	√	√	√	√	√		√	√	
Ayia Napa	56250	√	√	√	√	√		√	√	
Livadhia Refugee Camp	2000	√	√	√				√	√	
Larnaca	70000	√	√	√	√			√	√	
Kyperounda	3500	√	√	√				√	√	
Platres	3500	√	√	√				√	√	
Agros	5250	√	√	√				√	√	
Limassol	272000	√	√	√	√	√		√	√	
Paphos	162500	√	√	√	√	√		√	√	
Dhali	5000	√	√	√				√	√	
Mia Milia	160000	√	√							
Central Vathia Gonia	45765	√	√	√				√	√	
Anthoupolis-A	7200	√	√	√				√		
Anthoupolis-B	130000	√	√	√	√	√				√
Vathia-Gonia-A	201667	√	√	√	√	√	√			√
Pelendri	3000	√	√	√				√	√	
Lythrodontas	3500	√	√	√				√	√	
Mia Milia B	269117	√	√	√	√	√				√
Astromeritis	14767	√	√	√				√	√	

Sludge is produced in all of the primary, secondary and tertiary stages of treatment. Sludge that is produced in primary treatment consists of solids that are removed from the wastewater and is not accounted for in this category. Sludge produced in secondary and tertiary treatment results from biological growth in the biomass, as well as the collection of small particles. This sludge is treated further before it can be safely disposed of. Methods of sludge treatment include aerobic and anaerobic stabilisation (digestion), centrifugation, composting, and drying. The majority of treated sludge produced by the wastewater treatment plants in Cyprus is used in agriculture (Table 7.22). Table 7.23 shows the load entering the UWWTPs currently in operation in population equivalent.

CH_4 emissions and N_2O emissions from this source are presented in Table 7.24 and Figure 7.11.

Table 7.22. Utilisation of treated sludge produced by the wastewater treatment plants in Cyprus (t of dry matter/yr)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Sludge production	8035	7974	9163	7083	6815	6533	6123	6160	6695	6850	7166	8406
Sludge used in agriculture	5745	6515	7903	5294	3912	2756	2924	1391	936	1436	1075	937
Sludge transported for anaerobic treatment for biogas production			620		2478			4061		4380	1044	1281
Sludge stored at the plants					425			621		309	781	1062
Incineration			640							608	788	266

Sludge transported for composting											3425	4705
Others (green areas)										117	53	155

Table 7.23. Load entering the Urban Waste Water Treatment Plants (UWWTP) (p.e.)

UWW Name or IAS	2007	2009	2011	2014	2016
Kakopetria	1200	1200	1200	1200	1200
Paralimni	68487	62700	52665	53500	68750
Ayia Napa			37500	37500	56250
Livadhia Refugee Camp	2000	2000	2000	2000	2000
Larnaca	39090	68000	70000	70000	70000
Kyperounda	2068	2068	2200	2200	2200
Platres	1820	1820	2000	2000	2000
Agros	2400	2400	2500	2500	2500
Limassol	131178	130000	182926	193417	225989
Paphos	50000	85300	123925	119611	120100
Dhali	4710	4710	5000	Not operated	Not operated
Mia Milia	140000	140000	140000	Not operated	Not operated
Central Vathia Gonia	9240	13900	20068	1230	14857
Anthoupolis-A	4800	Not operated	Not operated	Not operated	Not operated
Anthoupolis-B	Not operated	26500	37706	34132	35983
Vathia-Gonia-A	Not operated	Not operated	39781	57252	63187
Pelendri	Not operated	2200	2200	2200	2200
Lythrodontas	Not operated	2100	3500	3500	3500
Mia Milia B	Not operated	Not operated	Not operated	157116	156330
IAS	9240	13900	26328	16219	34117
Astromeritis	Not operated	Not operated	Not operated	Not operated	7700

Table 7.24. Total emissions from Domestic wastewater 1990-2018

	1990	2000	2005	2010	2015	2016	2017	2018
CH_4 (Gg)	3.68	3.93	3.43	1.88	1.14	0.95	0.88	0.74
N_2O (Gg)	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.06
Total (Gg CO_2 eq.)	103.88	112.39	99.76	63.23	44.62	40.01	38.34	35.01

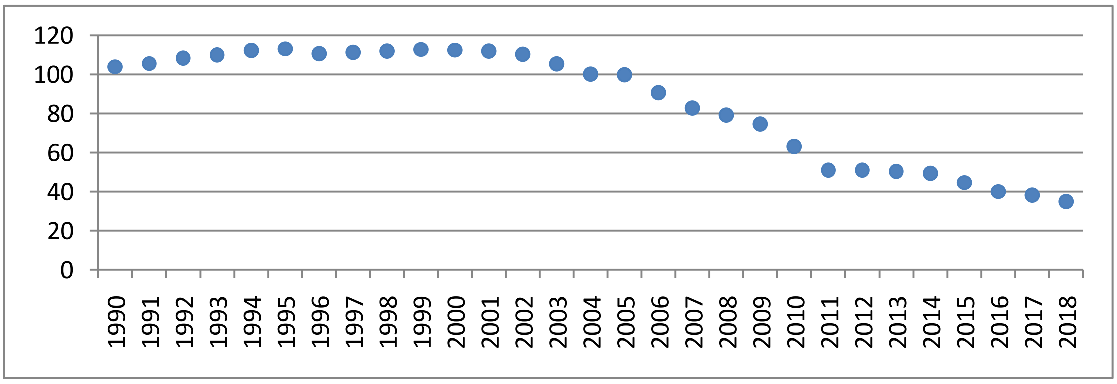

Figure 7.11. Total emissions from Domestic wastewater (5D1) 1990-2018

7.5.1.1. Methodological Issues

<u>Methane emissions from wastewater</u>

Emissions are a function of the amount of organic waste generated and an emission factor that characterises the extent to which this waste generates CH_4. Three tier methods for CH_4 from this category. Tier 2 methodology is applied for estimation of Methane emissions from wastewater in Cyprus.

The steps for inventory preparation for CH_4 from domestic wastewater are as follows:

Step 1: Use Equation 6.3 (2006 IPCC Guidelines, vol. 5, pg. 6.13) to estimate total organically degradable carbon in wastewater (TOW).

BOD is country specific and according to Ms. Stella Perikenti 60 g/person/day should be used[85]. Country population has already been presented in Table 7.5. I is assumed 1 for waste disposed in septic tanks (assuming default for uncollected; IPCC2006, vol.5, pg. 6.14), eqn.6.3 and 1.25 for wastewater treated in central wastewater treatment stations (assuming default for collected; IPCC2006, vol.5, pg. 6.14). Distribution of wastewater to septic tanks and central treatment stations (Ui) is presented in Table 7.25, along with the estimated TOW for the whole period.

Ui has been recalculated after meetings with representatives of the Water Development Department (responsible department for the construction and management of the Urban Wastewater Treatment Units)[86] and the Pollution Prevention Unit of the Department of Environment on completion of the time series. Data on population equivalents served by wastewater treatment plants (on the basis of the actual BOD loads) was available for the years 1992-2005 from the Statistical Service[87] and for 2007, 2009, 2011 and 2014 from the Pollution Control Unit of the Department of Environment. 1990-1991 has been estimated from the trend of 1992-2005 ($y=0.0417e^{0.1204x}$, $R^2 = 0.9706$), 2006, 2008, 2010, 2012, 2013 average of the years before and after and 2015-2017 linear trend of 2011-2014 ($y=0.0014x+0.7539$, $R^2 =1$). The population served by septic tanks has been estimated by subtracting the connected population from 100%.

Table 7.25. Distribution of wastewater to septic tanks and central treatment stations Ui and estimated TOW

	1990	1991	1992	1993	1994	1995	1996
Septic							
Ui	95.3%	94.7%	93.6%	93.2%	93.3%	91.9%	88.8%
TOW (kt BOD/yr)	12.25	12.51	12.69	12.92	13.19	13.21	12.96
Treatment							
Ui	4.7%	5.3%	6.4%	6.8%	6.7%	8.1%	11.2%
TOW (kt BOD/yr)	0.76	0.88	1.08	1.18	1.18	1.46	2.04

	1997	1998	1999	2000	2001	2002	2003
Septic							
Ui	88.0%	87.2%	86.7%	85.7%	84.1%	81.7%	77.0%
TOW (kt BOD/yr)	13.01	13.04	13.11	13.09	12.99	12.77	12.19
Treatment							
Ui	12.0%	12.8%	13.3%	14.3%	15.9%	18.3%	23.0%
TOW (kt BOD/yr)	2.22	2.39	2.51	2.73	3.07	3.58	4.55

	2004	2005	2006	2007	2008	2009	2010
Septic							
Ui	71.5%	70.2%	61.7%	53.1%	48.5%	43.8%	34.2%
TOW (kt BOD/yr)	11.48	11.44	10.24	9.04	8.46	7.86	6.28

[85] Stella Perikenti, Environment Officer, National expert on urban wastewater management, Pollution Control Unit, Department of Environment (+35726804573, sperikenti@environment.moa.gov.cy)

[86] Lia Georgiou, Senior Sanitary Engineer, Division of Waste Water and Reuse, Water Development Department (+357 22609186-185, lgeorgiou@wdd.moa.gov.cy)

[87] resident population connected to wastewater collecting system and wastewater treatment plants, 2007, available at http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/CB1FB8138D95CBB5C22573210044E253/$file/WASTEWATER_TREATMENT-EN-240707.xls?OpenElement

Treatment							
Ui	28.5%	29.8%	38.3%	46.9%	51.5%	56.2%	65.8%
TOW (kt BOD/yr)	5.72	6.07	7.95	9.96	11.24	12.59	15.14

	2011	2012	2013	2014	2015	2016	2017
Septic							
Ui	24.5%	24.3%	24.2%	24.1%	20.5%	17%	15.5%
TOW (kt BOD/yr)	4.62	4.61	4.55	4.46	3.81	3.18	2.94
Treatment							
Ui	75.5%	75.7%	75.8%	75.9%	79.5%	83%	84.5%
TOW (kt BOD/yr)	17.82	17.94	17.80	17.61	18.45	19.42	19.99

	2018						
Septic							
Ui	12.84%						
TOW (kt BOD/yr)	2.46						
Treatment							
Ui	87.16%						
TOW (kt BOD/yr)	20.90						

Step 2: Select the pathway and systems according to country activity data. Use Equation 6.2 (2006 IPCC Guidelines, vol. 5, pg. 6.12) to obtain the emission factor for each domestic wastewater treatment/discharge pathway or system.

Bo is considered as 0.6 $kgCH_4$/kgBOD (default proposed by IPCC, 2006 guidelines, vol.5, pg. 6.12, table 6.2). MCFj is 0.5 for septic tanks and 0 for central wastewater treatment units, as recommended by IPCC (2006 guidelines, vol.5, pg. 6.13, table 6.3). 0 was chosen for MCF for WWTP since the information available indicated that they are well managed:

According to further investigation from TERT during the 2017 annual review of the issue it was found that the European Commission published a database on all waste water treatment plants which shows the status of compliance of those plants with EU legislation. This source also contains information on the Cypriot plants[88]. According to this website, all but one of the Cypriot waste water treatment plants are fully compliant with UWWTD (Urban Waste Water Treatment Directive) standards. Most important is the compliance on DOC5. DOC5 is the biodegradable part of the organic load into the waste water treatment plant. All experts in the TERT agree that when a plant is overloaded or not well managed, an increase in DOC5 is expected, before an increased methane emissions becomes apparent. The single plant that is not compliant with legislation in Cyprus still does comply with the DOC5-criterion. For the TERT the information provided on this website seems to prove that all Cypriot waste water treatment plants are well-managed and therefore a MCF=0 for collected waste water is justified. This is independent EU information demonstrating compliance of wastewater treatment plants in Cyprus, justifying an MCF of 0.

The resulting EF are 0.3 $kgCH_4$/kgBOD for septic and 0 $kgCH_4$/kgBOD for centralised treatment.

Step 3: Use Equation 6.1 (2006 IPCC Guidelines, vol. 5, pg. 6.11) to estimate emissions, adjust for possible sludge removal and/or CH_4 recovery and sum the results for each pathway/system. CH_4 Emissions (Table 7.27) have been estimated using the parameters listed in Table 7.26.

Table 7.26. Parameters used for the estimation of CH4 emissions from wastewater treatment

Parameter	Value
Total organics in wastewater in inventory year, kg BOD/yr (TOW)	Table 7.25
Fraction of population in income group i in inventory year (Ui)	Table 7.25
Degree of utilisation of treatment/discharge pathway or system, j, for	100%

[88] http://uwwtd.oieau.fr/Cyprus/uwwtps/compliance

each income group (Ti,j) fraction i in inventory year	
EFj = emission factor, kg CH_4 / kg BOD	Septic: 0.3 kgCH_4/kgBOD Centralised treatment: 0 kgCH_4/kgBOD
R = amount of CH_4 recovered in inventory year, kg CH_4/yr	0

Table 7.27. CH_4 emissions from domestic wastewater treatment 1990-2018

	1990	1991	1992	1993	1994	1995	1996
CH_4 – septic (t)	3676	3752	3808	3875	3956	3963	3887
CH_4 – centralized (t)	0	0	0	0	0	0	0
Total (t)	3676	3752	3808	3875	3956	3963	3887

	1997	1998	1999	2000	2001	2002	2003
CH_4 – septic (t)	3904	3912	3933	3927	3898	3831	3657
CH_4 – centralized (t)	0	0	0	0	0	0	0
Total (t)	3904	3912	3933	3927	3898	3831	3657

	2004	2005	2006	2007	2008	2009	2010
CH_4 – septic (t)	3443	3431	3071	2711	2539	2359	1885
CH_4 – centralized (t)	0	0	0	0	0	0	0
Total (t)	3443	3431	3071	2711	2539	2359	1885

	2011	2012	2013	2014	2015	2016	2017
CH_4 – septic (t)	1386	1384	1364	1339	1144	955	881
CH_4 – centralized (t)	0	0	0	0	0	0	0
Total (t)	1386	1384	1364	1339	1333	1335	1341

	2018						
CH_4 – septic (t)	739						
CH_4 – centralized (t)	0						
Total (t)	739						

Nitrous oxide emissions from wastewater

The activity data that are needed for estimating N_2O emissions are nitrogen content in the wastewater effluent, country population and average annual per capita protein generation (Table 7.28). Per capita protein generation consists of intake (consumption) which has been obtained from the Food and Agriculture Organization[89], multiplied by factors to account for additional 'non-consumed' protein and for industrial protein discharged into the sewer system. Food (waste) that is not consumed may be washed down the drain (e.g., as result of the use of garbage disposals in some developed countries) and also, bath and laundry water can be expected to contribute to nitrogen loadings. Wastewater from industrial or commercial sources that is discharged into the sewer may contain protein (e.g., from grocery stores and butchers).

The total nitrogen in the effluent is estimated using equation 6.8 (pg. 6.25, vol. 5, 2006 IPCC guidelines) where human population is are presented in Table 7.5 and annual per capita protein consumption as presented in Table 7.28. Data is not available after 2007 and therefore considered constant for the remaining years, due to an unclear trend. Default fraction of nitrogen in protein (FNPR) of 0.16, kg N/kg protein, default factor for non-consumed protein added to the wastewater for developed countries (FNON-CON) of 1.4, default factor for industrial and commercial co-discharged protein into the sewer system (FIND-COM) of 1.25 and default nitrogen removed with sludge (NSLUDGE) of 0.

Table 7.28. Annual per capita protein consumption and resulting NEFFLUENT (kg/person/yr)

	1990	1991	1992	1993	1994	1995	1996

[89] FAOSTAT, 2009, Food consumption, Dietary Protein Consumption (g/person/day), available from http://www.fao.org/filead min/templates/ess/documents/food_security_statistics/FoodConsumptionNutrients_en.xls

Protein consumption (kg/person/yr)	35.4	35.4	35.4	36.1	36.1	36.9	36.9
NEFFLUENT (kg N/yr)	5116938	5010457	5620729	5595673	5672550	5962866	5765676

	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Protein consumption (kg/person/yr)	36.9	37.2	37.2	37.6	37.6	37.6	36.3
NEFFLUENT (kg N/yr)	5825439	6038437	6146569	6068449	6147425	6181677	5920774

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Protein consumption (kg/person/yr)	36.3	35.0	35.0	35.0	35.0	35.0	35.0
NEFFLUENT (kg N/yr)	6034959	5971170	5908449	6418466	6660423	6626644	6884229

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Protein consumption (kg/person/yr)	35.0	35.0	35.0	35.0	35.0	35.0	35.0
NEFFLUENT (kg N/yr)	6952568	6984024	6920305	6831584	6842069	6894495	6970312

	2018						
Protein consumption (kg/person/yr)	35.0						
NEFFLUENT (kg N/yr)	7064680						

After the collection of the information presented above regarding wastewater treatment, it appeared that emissions from advanced centralised wastewater treatment plants should also be estimated and subtracted from the overall emissions. Thus, the emissions have been estimated using the overall emission factor to estimate N_2O emissions from such plants of 3.2 g N_2O/person/year, recommended in the 2006 IPCC Guidelines (Box 6.1, pg. 6.26, vol. 5). The population used is the population presented in Table 7.5. The resulting emissions are presented in Table 7.29. The amount of nitrogen associated with these emissions (NWWT, Table 7.29) have been back calculated and subtracted from the NEFFLUENT. The NWWT is calculated by multiplying N2OPLANTS by 28/44.

The resulting N_2O emissions from wastewater are also presented in Table 7.29.

Table 7.29. N_2O emissions from advanced centralised wastewater treatment plants, NWWT and resulting NEFFLUENT

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
N_2OPLANTS (t)	40.20	39.36	44.15	43.96	44.56	46.84	45.29
NWWT (kg N/yr)	1228	1261	1289	1314	1336	1357	1228
NEFFLUENT – NWWT (kg N/yr)	5009229	5619468	5594384	5671235	5961530	5764320	5009229
N_2O emissions (t)	40.20	39.36	44.15	43.96	44.56	46.84	45.29

	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
N_2OPLANTS (t)	45.76	47.43	48.28	47.67	48.29	48.56	46.51

NWWT (kg N/yr)	1375	1391	1406	1420	1437	1453	1472
NEFFLUENT – NWWT (kg N/yr)	5824064	6037046	6145163	6067029	6145988	6180224	5919302
N_2O emissions (t)	45.76	47.43	48.28	47.67	48.29	48.56	46.51

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
$N_2OPLANTS$ (t)	47.41	46.90	46.41	50.42	52.32	52.05	54.08
NWWT (kg N/yr)	1493	1515	1543	1581	1623	1668	1710
NEFFLUENT – NWWT (kg N/yr)	6033466	5969655	5906906	6416885	6658800	6624976	6882518
N_2O emissions (t)	47.41	46.90	46.41	50.42	52.32	52.05	54.08

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
$N_2OPLANTS$ (t)	54.61	54.86	54.36	53.66	53.75	54.16	54.75
NWWT (kg N/yr)	1755	1763	1747	1725	1727	1741	1760
NEFFLUENT – NWWT (kg N/yr)	6950813	6982261	6918558	6829859	6840341	6892755	6968552
N_2O emissions (t)	54.61	54.86	54.36	53.66	53.75	54.16	54.75

	2018						
$N_2OPLANTS$ (t)	55.49						
NWWT (kg N/yr)	1784						
NEFFLUENT – NWWT (kg N/yr)	7062896						
N_2O emissions (t)	55.49						

7.5.1.2 Uncertainties and time-series consistency

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

7.5.1.3. Category-specific QA/QC and verification

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

7.5.1.4. Category-specific recalculations

Emissions of CH_4 from domestic wastewater were recalculated for the period 2015-2017 due to updated data of the population served by a sewer and aerobic treatment systems or addressed by IAS (Individual Appropriate Systems) during 2016. These recalculations causes a decrease in emissions of CH_4 of -14.16% for 2015, -28.48% for 2016 and -34.31% for 2017.

7.5.1.5. Category-specific planned improvements

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

7.5.2. Industrial wastewater (5D2)

The principal factor that determines methane generation potential of wastewater is the amount of organic material in the wastewater stream. For industrial wastewater, this is indicated by the Chemical Oxygen Demand (COD). COD indicates the total amount of carbon, biodegradable and non-biodegradable, that is available for oxidation. According to IPCC guidelines, industrial production should be grouped according to their methane production potential. The main groups are paper and pulp manufacture, slaughterhouses, alcohol, beer, starch, organic chemicals and others (vegetable oil production, textiles, rubber, petroleum refineries, fruits and vegetables). The industrial activities taking place in Cyprus are predominately food and drink industries.

Regarding the treatment of wastewaters produced by the manufacturing processes implemented, the following apply:

- Alcohol - Cyprus has one installation producing alcohol and its wastewater is treated by anaerobic digestion, subsequently by further aerobic treatment and the final effluent is discharged into the local municipal sewerage system.
- Beer - Wastewater derived by two brewery installations, are also treated by anaerobic digestion and subsequently by further aerobic treatment. One is discharging the final effluent into the local municipal sewerage system and the other is using the effluent for irrigation.
- Dairy products - Wastewater derived by one dairy installation are treated by anaerobic digestion and subsequently by further aerobic treatment and the final effluent is discharged into the local municipal sewerage system.
- Meat and Poultry - Wastewater derived by meat and poultry installations are treated by anaerobic digestion plans treating mainly pig slurry and subsequently by further aerobic treatment and their final disposal to evaporation lagoons.
- Vegetable oils - Cyprus has several olive oil mills. A portion of the produced wastewater is treated by anaerobic digestion plans treating mainly pig slurry. In addition, during the process of producing biodiesel from used cooking oils, glycerol is produced and it is mainly treated by anaerobic digestion.
- Veg., fruits and juices – soft drinks. Cyprus has one installation that is treating wastewater and other waste deriving from vegetables, fruits, juices and soft drinks production by anaerobic digestion.

Emissions from industrial wastewater increased by 27% between 1990 and 2018 (Table 7.30, Figure 7.12). Emission estimates from this source have been revised due to availability of new data for 2017.

Table 7.30. Total emissions from industrial wastewater 1990-2018

	1990	2000	2005	2010	2015	2017	2018
CH_4 (t)	967.9	1115.2	1033.8	1091.1	1138.2	1229.6	1229.3
N_2O (t)	1.042	1.175	0.958	0.926	0.914	0.991	0.991
Total (Gg CO2 eq.)	**24.20**	**27.88**	**25.84**	**27.28**	**28.46**	**30.74**	**30.74**

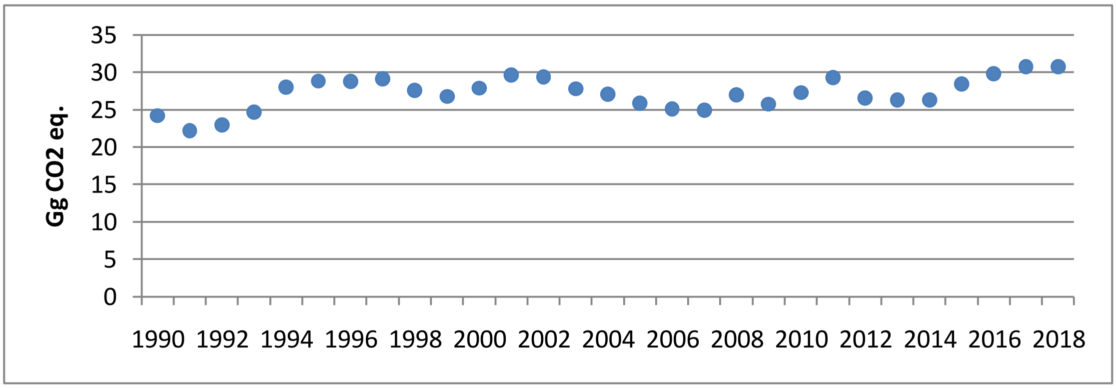

Figure 7.12. Emissions from industrial wastewater 1990-2018

7.5.2.1. Methodological Issues

Methane emissions

According to the IPCC guidelines, to estimate total emissions from wastewater, the selected emissions factors are multiplied by the associated organic wastewater production and summed. The amount of CH_4 recovered and thus not emitted into the atmosphere for each handling method should be subtracted: no methane recovery takes place in Cyprus therefore recovery is assumed 0. The sum of the emissions for each handling method provides the total CH_4 emissions from industrial wastewater. In equation form, the estimate of total CH_4 emissions from wastewater handling is as follows (equation 6.4, 2006 IPCC guidelines, volume 5 pg. 6.20):

$$CH_4\ Emissions=\Sigma[(TOW_i-S_i)*EF_i-R_i]$$

where CH_4 emissions is the total methane emissions from wastewater in kg CH_4, TOWi is the total organically degradable material in wastewater from industry i in kg COD/yr, Si is the organic component removed as sludge in inventory year, kg COD/yr, EFi is the emission factor for industry i in kg CH_4/kg COD and Ri is the total amount of methane recovered in kg CH_4/yr.

To estimate total organic wastewater (TOW) for a particular industry the following equation should be used (equation 6.6, IPCC2006 guidelines, volume 5, pg. 6.22):

$$TOWi = Pi\ x\ Wi\ x\ COD$$

where TOW is the total industrial organically material in wastewater for industry in kg COD/yr, P is the total industrial product for industrial sector W is the wastewater generated in m^3/tonne of product, COD is the chemical oxygen demand (industrial degradable organic component in kg COD/m^3 wastewater.

To estimate the emission factor for industrial wastewater, the following equation is proposed by the IPCC guidelines (Equation 6.5, IPCC2006 guidelines, volume 5,pg. 6.21):

$$EF_j = B_o\ x\ MCF_j$$

where EF_j is the emission factor (kg CH_4/kg DC) for each treatment (e.g. aerobic treatment, anaerobic digester for sludge, etc.), Bo is the maximum methane producing capacity (kg CH_4/kg DC), MCF_j is the methane conversion factor. Since no country specific data is available, Bo is considered 0.25 (2006 IPCC guidelines, volume 5, pg. 6.21).

In words, the methodology applied for the estimation of methane emissions from industrial wastewater is the following:
(a) Collection of data for industrial production (Table 7.31).
(b) Total industrial organic wastewater was estimated by multiplying the industrial production by the wastewater generation coefficients and by COD in Table 7.32 (2006 IPCC guidelines, volume 5, pg. 6.22, Table 6.8).
(c) Organically Degradable material (TOW) in Gg is the sum of the TOW of each industrial product divided by 1,000,000 (Table 7.33).
(d) The wastewater generated was categorised to anaerobic and aerobic treatment according to the assumptions of Table 7.34.
(e) Methane conversion factor was assumed 0.3 for aerobic treatment following a recommendation of the ERT during the in-country review of the 2016 submission. In the initial submission, the MCF used was 0 which is the default for centralised. 0.3, which is currently used is the default for not well managed, centralised, overloaded aerobic treatment (table 6.3, pg. 6.13, volume 5, 2006 IPCC guidelines). This change has been made until sufficient information is available for the wastewater treatment plants in Cyprus to justify the use of 0. 0.8 was used for anaerobic treatment, according to the 2006 IPCC guidelines (pg. 6.21, volume 5). Maximum producing capacity was assumed 0.25 kg CH_4 / kg according to the 2006 IPCC guidelines (pg. 6.21, volume 5). The resulting methane emission factor estimated according to waste stream is presented in Table 7.35.
(f) The emission factor for each waste streams was multiplied by the TOW (kg COD/ year) of the respective waste stream to estimate the annual emissions of methane per waste stream. The total CH_4 emissions are the sum of the CH_4 emitted per waste stream.

Data for industrial production

Detailed statistics on industrial production in Cyprus do not exist. Therefore data on industrial consumption is used instead. Another issue associated with the national statistics on industrial activity, is that the sales of industrial products for the year x-2 (which in this case is 2019) are completed and published in the summer after the inventory has to be submitted (which in this case is summer 2020). Therefore, the 2018 "production" is assumed to be equal to the 2017 "production". The industrial production data used is presented in Table 7.31.

Table 7.31. Industrial production 1990-2018 (Gg)

Gg product	1990	1991	1992	1993	1994	1995	1996
Alcohol	1.0	1.0	1.0	1.0	1.0	1.1	0.9
Beer	33.1	34.8	36.6	36.1	35.6	35.2	33.1
Soft drinks	46.6	50.5	54.7	55.4	56.2	56.9	57.5
Dairy products	60.7	64.6	68.8	71.2	73.9	76.7	81.1
Meat & poultry	64.4	63.1	67.7	76.0	80.9	81.0	88.0
Refinery	635.3	763.2	727.1	781.2	896.8	827.9	760.0
Soaps & detergents	12.1	12.9	13.8	10.9	9.8	9.5	9.0
Vegetable oils	21.7	24.9	28.6	27.5	26.5	25.7	28.1
Vegetables, fruits & juices	47.9	34.9	34.0	38.0	52.1	56.3	53.0
Wine	49.4	52.8	56.5	56.3	56.0	55.8	54.3

Gg product	1997	1998	1999	2000	2001	2002	2003
Alcohol	1.0	1.0	2.1	2.6	3.9	3.8	2.5
Beer	33.3	36.5	40.5	40.9	40.4	38.3	36.7
Soft drinks	58.3	59.3	60.0	60.9	62.7	62.3	62.1
Dairy products	81.4	86.3	84.1	83.3	89.5	92.4	93.2
Meat & poultry	97.0	93.7	69.5	80.5	87.8	90.0	92.4
Refinery	1042.7	1082.6	1140.4	1134.8	1115.1	1045.5	931.9
Soaps & detergents	7.1	7.2	7.2	7.0	7.8	8.1	6.2
Vegetable oils	26.3	22.7	23.2	21.8	20.1	21.3	19.4
Vegetables, fruits & juices	52.5	48.0	49.0	49.9	51.6	48.7	44.2
Wine	42.0	30.9	43.2	37.4	34.5	37.5	35.5

Gg product	2004	2005	2006	2007	2008	2009	2010
Alcohol	1.9	1.3	1.2	1.0	0.9	0.7	0.7
Beer	37.1	37.7	37.4	39.8	42.7	35.7	34.3
Soft drinks	60.5	66.6	58.3	62.5	62.9	59.4	57.9
Dairy products	93.9	96.3	99.5	97.8	112.1	104.1	106.0
Meat & poultry	93.4	95.5	94.0	94.5	102.1	99.1	105.6
Refinery	269.2	0.0	0.0	0.0	0.0	0.0	0.0
Soaps & detergents	7.4	6.1	6.2	6.3	6.8	6.9	7.1
Vegetable oils	19.6	19.3	19.1	18.1	18.2	16.3	16.9
Vegetables, fruits & juices	42.1	37.6	34.4	35.4	40.6	40.4	45.5
Wine	31.7	29.8	26.5	20.2	15.9	12.4	11.1

Gg product	2011	2012	2013	2014	2015	2016	2017
Alcohol	0.6	0.7	0.7	0.6	0.57	0.61	0.65
Beer	32.2	33.0	32.9	32.8	34.18	37.55	39.43
Soft drinks	54.6	35.6	26.0	10.8	11.13	14.46	14.57
Dairy products	109.3	106.2	100.9	99.8	100.12	103.73	108.45
Meat & poultry	103.6	96.0	83.6	79.7	82.43	84.72	87.47
Refinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soaps & detergents	6.7	7.1	6.5	7.3	6.79	8.20	7.30
Vegetable oils	15.7	14.3	12.2	12.6	12.06	11.72	13.97
Vegetables, fruits & juices	56.5	48.0	54.5	57.9	68.46	72.93	74.90
Wine	14.2	10.9	11.5	11.0	8.95	8.45	9.27

Gg product	2018						
Alcohol	0.65						
Beer	39.43						
Soft drinks	14.57						
Dairy products	108.45						
Meat & poultry	87.47						
Refinery	0.0						
Soaps & detergents	7.30						
Vegetable oils	13.97						
Vegetables, fruits & juices	74.90						
Wine	9.27						

<u>Industrial organic wastewater</u>

Wastewater production was estimated by multiplying the industrial production by the wastewater generation coefficients in Table 7.32 (volume 5, pg. 6.22, Table 6.8). Information in the 2006 guidelines is not available for soft drinks, soaps & detergents and COD of vegetable oils. For these categories, the values recommended in the 2000 IPCC Good Practice Guide (pg.5.22) are used.

Table 7.32. Wastewater generation coefficient (m^3 /t product) and COD concentration (kg COD/m^3) according to industrial product

	Wastewater generation (m^3/t)	COD (kg/m^3)
Alcohol	24	11
Beer	6.3	2.9
Soft drinks	2 [a]	2 [a]
Dairy products	7	2.7
Meat& poultry	13	4.1
Refinery	0.6	1.0
Soaps& detergents	3.0 [a]	0.9 [a]
Vegetable oils	3.1	0.9 [a]
Vegetables, fruits & juices	20.0	5.0
Wine	23.0	1.5

[a] 2000 IPCC Good Practice Guide, pg. 5.22

<u>Total organic wastewater</u>

Total organically degradable material in wastewater in kg COD/year per industrial product was then estimated by multiplying the industrial production by the wastewater generated and by the COD coefficient of each industrial product in Table 7.32 (2006 IPCC guidelines, p.6.22). The sum of the TOW of each industrial product divided by 10^6 is presented in Table 7.33.

Table 7.33. Total organically degradable material (Gg), 1990-2018

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gg DC	12.61	11.55	11.96	12.85	14.64	15.07	15.04	15.22	14.40	13.98

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gg DC	14.58	15.49	15.38	14.53	13.72	13.08	12.53	12.42	13.51	12.86

	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Gg DC	13.68	14.75	13.28	13.14	13.16	14.31	15.02	15.53	15.53	

<u>Categorisation of wastewater treatment to aerobic and anaerobic</u>

The wastewater generated was categorised to anaerobic and aerobic treatment according to the assumptions of Table 7.34. The assumptions were prepared in collaboration with the Pollution Prevention Unit of the Department of Environment.

<u>Methane emission factor</u>

Methane conversion factor was assumed 0 for aerobic treatment and 0.8 for anaerobic treatment, according to the 2006 IPCC guidelines (volume 5, pg. 6.21, Table 6.7). Maximum producing capacity was assumed 0.25 kg CH_4 / kg COD according to the 2006 IPCC guidelines (pg. 6.21, volume 5). The resulting methane emission factor estimated according to waste stream is presented in Table 7.35.

The aggregate MCF for all waste streams was multiplied by the total annual organic wastewater generation (kg COD/ year) to estimate the annual emissions of methane.

Table 7.34. Treatment of waste by anaerobic treatment according to industrial production, 1990-2018

	1990	1991	1992	1993	1994	1995	1996
alcohol	2.0%	2.1%	2.1%	2.0%	1.9%	1.9%	2.2%
beer	20%	19%	18%	18%	19%	19%	20%
soft drinks	1.00%	0.92%	0.85%	0.84%	0.83%	0.82%	0.81%
dairy products	0	0	0	0	0	0	0
meat & poultry	0	0	0	0	0	0	0
refinery	0	0	0	0	0	0	0
soaps & detergents	0	0	0	0	0	0	0
vegetable oils	0	0	0	0	0	0	0
veg., fruits & juices	1.0%	1.4%	1.4%	1.3%	0.9%	0.9%	0.9%
wine	0	0	0	0	0	0	0

	1997	1998	1999	2000	2001	2002	2003
alcohol	2.1%	2.0%	1.0%	0.8%	0.5%	0.5%	0.8%
beer	20%	18%	16%	16%	16%	17%	18%
soft drinks	0.80%	0.79%	0.78%	0.76%	0.74%	0.75%	0.75%
dairy products	0	0	0	0	0	0	0
meat & poultry	0	0	0	0	0	0	0
refinery	0	0	0	0	0	0	0
soaps & detergents	0	0	0	0	0	0	0
vegetable oils	0	0	0	0	0	0	0
veg., fruits & juices	0.9%	1.0%	1.0%	1.0%	0.9%	1.0%	1.1%
wine	0	0	0	0	0	0	0

	2004	2005	2006	2007	2008	2009	2010
alcohol	1.1%	1.5%	1.8%	2.1%	2.3%	2.8%	2.8%
beer	18%	18%	18%	17%	15%	19%	19%
soft drinks	0.77%	0.70%	0.80%	0.75%	0.74%	0.78%	0.80%
dairy products	0	0	5.00%	5.09%	4.44%	4.78%	4.69%
meat & poultry	5.00%	4.89%	4.97%	4.95%	4.57%	4.71%	4.42%
refinery	0	0	0	0	0	0	0
soaps & detergents	0	0	0	0	0	0	0
vegetable oils	0	0	0.5%	0.5%	0.5%	0.6%	0.5%
veg., fruits & juices	1.1%	1.3%	1.4%	1.4%	1.2%	1.2%	1.1%
wine	0	0	0	0	0	0	0

	2011	2012	2013	2014	2015	2016	2017
alcohol	3.5%	3.1%	3.1%	3.2%	3.6%	3.4%	3.1%
beer	21%	20%	20%	20%	19%	18%	17%
soft drinks	0.85%	1.31%	1.79%	4.31%	4.19%	3.22%	3.20%
dairy products	4.55%	4.69%	4.93%	4.99%	4.97%	4.80%	4.59%
meat & poultry	4.51%	4.86%	5.59%	5.86%	5.67%	5.51%	5.34%
refinery	0	0	0	0	0	0	0
soaps & detergents	0	0	0	0	0	0	0
vegetable oils	0.6%	0.6%	0.7%	0.7%	0.7%	0.8%	0.6%
veg., fruits & juices	0.8%	1.0%	0.9%	0.8%	0.7%	0.7%	0.6%
wine	0	0	0	0	0	0	0

	2018						
alcohol	3.1%						
beer	17%						
soft drinks	3.20%						
dairy products	4.59%						
meat & poultry	5.34%						
refinery	0						
soaps & detergents	0						
vegetable oils	0.6%						
veg., fruits & juices	0.6%						
wine	0						

Table 7.35. Methane emission factor estimated according to waste stream (kg CH_4/kg COD), 1990-2018

	1990	1991	1992	1993	1994	1995	1996
alcohol	0.078	0.078	0.078	0.078	0.077	0.077	0.078
beer	0.100	0.099	0.098	0.098	0.098	0.099	0.100
soft drinks	0.076	0.076	0.076	0.076	0.076	0.076	0.076
dairy products	0.075	0.075	0.075	0.075	0.075	0.075	0.075
meat & poultry	0.075	0.075	0.075	0.075	0.075	0.075	0.075
refinery	0.075	0.075	0.075	0.075	0.075	0.075	0.075
soaps & detergents	0.075	0.075	0.075	0.075	0.075	0.075	0.075
vegetable oils	0.075	0.075	0.075	0.075	0.075	0.075	0.075
veg., fruits & juices	0.076	0.077	0.077	0.077	0.076	0.076	0.076
wine	0.075	0.075	0.075	0.075	0.075	0.075	0.075

	1997	1998	1999	2000	2001	2002	2003
alcohol	0.078	0.078	0.076	0.076	0.076	0.076	0.076
beer	0.100	0.098	0.095	0.095	0.095	0.097	0.098
soft drinks	0.076	0.076	0.076	0.076	0.076	0.076	0.076
dairy products	0.075	0.075	0.075	0.075	0.075	0.075	0.075
meat & poultry	0.075	0.075	0.075	0.075	0.075	0.075	0.075
refinery	0.075	0.075	0.075	0.075	0.075	0.075	0.075
soaps & detergents	0.075	0.075	0.075	0.075	0.075	0.075	0.075
vegetable oils	0.075	0.075	0.075	0.075	0.075	0.075	0.075
veg., fruits & juices	0.076	0.076	0.076	0.076	0.076	0.076	0.076
wine	0.075	0.075	0.075	0.075	0.075	0.075	0.075

	2004	2005	2006	2007	2008	2009	2010
alcohol	0.076	0.077	0.077	0.078	0.078	0.079	0.078
beer	0.097	0.097	0.097	0.096	0.094	0.098	0.099
soft drinks	0.076	0.076	0.076	0.076	0.076	0.076	0.076
dairy products	0.075	0.075	0.081	0.081	0.081	0.081	0.081
meat & poultry	0.081	0.081	0.081	0.081	0.081	0.081	0.081
refinery	0.075	0.075	0.075	0.075	0.075	0.075	0.075
soaps & detergents	0.075	0.075	0.075	0.075	0.075	0.075	0.075
vegetable oils	0.075	0.075	0.076	0.076	0.076	0.076	0.076
veg., fruits & juices	0.076	0.077	0.077	0.077	0.076	0.076	0.076
wine	0.075	0.075	0.075	0.075	0.075	0.075	0.075

	2011	2012	2013	2014	2015	2016	2017
alcohol	0.079	0.079	0.079	0.079	0.080	0.079	0.079
beer	0.101	0.100	0.100	0.100	0.099	0.097	0.096
soft drinks	0.076	0.077	0.077	0.080	0.080	0.079	0.079
dairy products	0.081	0.081	0.081	0.081	0.081	0.081	0.081
meat & poultry	0.081	0.081	0.082	0.082	0.082	0.082	0.082
refinery	0.075	0.075	0.075	0.075	0.075	0.075	0.075

soaps & detergents	0.075	0.075	0.075	0.075	0.075	0.075	0.075
vegetable oils	0.076	0.076	0.076	0.076	0.076	0.076	0.076
veg., fruits & juices	0.076	0.076	0.076	0.076	0.076	0.076	0.076
wine	0.075	0.075	0.075	0.075	0.075	0.075	0.075

	2018						
alcohol	0.079						
beer	0.096						
soft drinks	0.079						
dairy products	0.081						
meat & poultry	0.082						
refinery	0.075						
soaps & detergents	0.075						
vegetable oils	0.076						
veg., fruits & juices	0.076						
wine	0.075						

Estimation of N_2O emissions

The nitrous oxide emissions were estimated by multiplying the total annual industrial wastewater production (Table 7.36) by the default emission factor of 0.25 g N_2O/m^3 wastewater according to EMEP/CORINAIR 2007 methodology[90].

Table 7.36. Total industrial wastewater production (1000 m^3/year), 1990-2018

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Alcohol	24	24	23	24	25	26	22	23
Beer	208	219	231	227	225	222	208	210
Soft drinks	93	101	109	111	112	114	115	117
Dairy products	425	452	481	499	517	537	568	570
Meat & poultry	837	820	880	987	1052	1052	1145	1261
Refinery	381	458	436	469	538	497	456	626
Soaps &detergents	36	39	41	33	29	29	27	21
Vegetable oils	67	77	89	85	82	80	87	82
Veg., fruits & juices	959	698	680	759	1041	1127	1060	1050
Wine	1136	1215	1300	1295	1289	1283	1250	965

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Alcohol	24	50	61	94	92	59	46	32
Beer	230	255	257	255	242	231	234	238
Soft drinks	119	120	122	125	125	124	121	133
Dairy products	604	589	583	626	647	652	657	674
Meat & poultry	1218	903	1047	1142	1170	1202	1214	1242
Refinery	650	684	681	669	627	559	161	0
Soaps &detergents	22	22	21	23	24	19	22	18
Vegetable oils	70	72	68	62	66	60	61	60
Veg., fruits & juices	961	980	999	1031	974	884	842	751
Wine	711	993	860	793	863	817	730	685

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Alcohol	28	24	21	17	18	14	16	16
Beer	236	251	269	225	216	203	208	207
Soft drinks	117	125	126	119	116	109	71	52
Dairy products	696	684	785	729	742	765	743	706

[90] EMEP/CORINAIR Emission Inventory Guidebook – 2007, Group 9: Waste treatment and disposal; 091001 - Waste water treatment in industry, EEA Technical report No 16/2007, available at https://www.eea.europa.eu/publications/EMEPCORINAIR5/B9101vs1.pdf, table 2, pg. B9101-2

Meat & poultry	1222	1228	1327	1289	1373	1347	1248	1086
Refinery	0	0	0	0	0	0	0	0
Soaps &detergents	19	19	21	21	21	20	21	20
Vegetable oils	59	56	56	50	52	49	44	38
Veg., fruits & juices	687	708	812	808	911	1129	960	1090
Wine	609	465	366	285	254	327	250	265

	2014	**2015**	**2016**	**2017**	**2018**			
Alcohol	15	14	15	16	16			
Beer	206	215	237	248	248			
Soft drinks	22	22	29	29	29			
Dairy products	698	701	726	759	759			
Meat & poultry	1037	1072	1101	1137	1137			
Refinery	0	0	0	0	0			
Soaps &detergents	22	20	25	22	22			
Vegetable oils	39	37	36	43	43			
Veg., fruits & juices	1157	1369	1459	1498	1498			
Wine	253	206	194	213	213			

7.5.2.2 Uncertainties and time-series consistency

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

7.5.2.3. Category-specific QA/QC and verification

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

7.5.2.4. Category-specific recalculations

Emissions from Industrial Wastewater Treatment and Discharge (5D2) were recalculated for 2017 due to revision of the activity data of solid waste production by the Statistical Service. Emissions increased for the particular year from 29.78 to 30.74 Gg CO_2 eq. which corresponds to an increase of emissions by 3.2%.

7.5.2.5. Category-specific planned improvements

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

7.6. Other (5E)

Not occurring.

Chapter 8.
Other (CRF sector 6)

Not applicable

Chapter 9.
Indirect CO_2 and N_2O emissions

Any indirect CO_2 and N_2O emissions estimated have been reported in the appropriate chapters of the inventory.

Chapter 10.
Recalculations and improvements

10.1. Explanations and justifications for recalculations

The recalculations made are driven by the results of the various review processes, QC checks and internal audits and the ERT reviews of the annual submissions of Cyprus by the nominated experts from the UNFCCC. In the 2018 submission, several recalculations were implemented as a result of the following:

- Changes or refinements in methods: A methodological change occurs when an inventory agency uses a different tier to estimate emissions from a source category (e.g. for key source categories) or when it moves from a tier described in the IPCC Guidelines to a national method. Methodological changes are often driven by the development of new and different data sets. A methodological refinement occurs when an inventory agency uses the same tier to estimate emissions but applies it using a different data source or a different level of aggregation.
- Inclusion of new sources: A new source is defined as a source for which estimates (all or some gases) did not exist in previous inventories either due to lack of data or because it has just been identified.
- Allocation: Changes in allocation of emissions to different sectors or sources/sub-sources.
- Correction of errors: This case concerns errors during calculating emissions (e.g. transcript errors) or while filling in the required information in the CRF tables. Inconsistencies resolving is also included in this category.
- Updated activity data.

10.2. Implications for emission levels

The justification of the recalculations made in the present submission as far as the preparation of GHG inventory is concerned has been presented in details in Chapters 3 – 7. In Table 10.1 the effect of the recalculations made on the total GHG emissions in Cyprus excluding LULUCF on a per sector basis is presented.

Table 10.1. Comparison of NIR2020 to NIR2019, in kt CO2 eq.

NIR2019	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
1. Energy	3969.76	4503.12	4831.86	5010.05	5222.93	5132.14
2. IPPU	841.14	814	875.5	940.17	980.12	956.68
3. Agriculture	471.23	475.23	509.71	540.53	529.97	580.14
4. LULUCF	-251.19	-247.48	-255.07	-271.55	-256.02	-277.01
5. Waste	386.73	391.53	400.54	409.98	421.82	430.14
Total (incl. LULUCF)	5417.66	5936.41	6362.54	6629.17	6898.81	6822.09
Total (excl. LULUCF)	5668.85	6183.89	6617.61	6900.72	7154.83	7099.1
NIR2020	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
1. Energy	3972.22	4505.77	4834.55	5012.6	5225.87	5135.14
2. IPPU	853.25	828.32	911.33	975.58	1021.15	992.65
3. Agriculture	471.41	475.42	509.94	540.73	530.09	580.26
4. LULUCF	-218.97	-212.04	-218.38	-233.56	-222.81	-238.77
5. Waste	386.73	391.53	400.54	409.98	421.82	430.14
Total (incl. LULUCF)	5464.64	5989	6437.99	6705.31	6976.13	6899.41
Total (excl. LULUCF)	5683.61	6201.04	6656.37	6938.87	7198.94	7138.18
Difference						
1. Energy	*0.06%*	*0.06%*	*0.06%*	*0.05%*	*0.06%*	*0.06%*

2. IPPU	*1.44%*	*1.76%*	*4.09%*	*3.77%*	*4.19%*	*3.76%*
3. Agriculture	*0.04%*	*0.04%*	*0.05%*	*0.04%*	*0.02%*	*0.02%*
4. LULUCF	*-12.83%*	*-14.32%*	*-14.38%*	*-13.99%*	*-12.97%*	*-13.80%*
5. Waste	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
Total (incl. LULUCF)	*0.87%*	*0.89%*	*1.19%*	*1.15%*	*1.12%*	*1.13%*
Total (excl. LULUCF)	*0.26%*	*0.28%*	*0.59%*	*0.55%*	*0.62%*	*0.55%*
NIR2019	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1. Energy	5428.9	5553.38	5901.29	6160.12	6376.29	6270.82
2. IPPU	1020.17	991.14	951.11	970.26	997.87	985.43
3. Agriculture	562.15	548.52	562.79	545.7	552.35	601.49
4. LULUCF	-284.56	-254.78	-180.35	-358.72	68.99	-186.44
5. Waste	435.17	443.67	450.63	458.42	467.1	476.37
Total (incl. LULUCF)	7161.84	7281.94	7685.46	7775.78	8462.6	8147.66
Total (excl. LULUCF)	7446.4	7536.72	7865.81	8134.5	8393.61	8334.1
NIR2020	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1. Energy	5432	5556.56	5901.11	6166.68	6379.48	6274.09
2. IPPU	1055.38	1027.88	989.74	1011.33	1053.93	1044.36
3. Agriculture	562.35	548.51	562.8	545.6	552.17	601.53
4. LULUCF	-244.44	-225.59	-181.67	-292.4	-35.02	-186.76
5. Waste	435.17	443.67	450.63	458.42	467.1	476.37
Total (incl. LULUCF)	7240.47	7351.02	7722.62	7889.64	8417.67	8209.58
Total (excl. LULUCF)	7484.91	7576.61	7904.29	8182.04	8452.69	8396.34
Difference						
1. Energy	*0.06%*	0.06%	0.00%	0.11%	0.05%	0.05%
2. IPPU	*3.45%*	3.71%	4.06%	4.23%	5.62%	5.98%
3. Agriculture	*0.04%*	0.00%	0.00%	-0.02%	-0.03%	0.01%
4. LULUCF	*-14.10%*	-11.46%	0.73%	-18.49%	-150.76%	0.17%
5. Waste	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%
Total (incl. LULUCF)	*1.10%*	0.95%	0.48%	1.46%	-0.53%	0.76%
Total (excl. LULUCF)	*0.52%*	0.53%	0.49%	0.58%	0.70%	0.75%
NIR2019	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1. Energy	6430.31	6824.45	6958.11	7136	7319.03	7641
2. IPPU	1025.86	1036.65	1121.16	1178.66	1191.09	1214.8
3. Agriculture	620.89	602.75	583.45	532.98	548.14	539.92
4. LULUCF	-337.46	-351.98	-347.27	-377.01	-452.23	-208.26
5. Waste	483.35	485.69	488.88	496.47	495.78	497.63
Total (incl. LULUCF)	8222.96	8597.56	8804.33	8967.11	9101.81	9685.1
Total (excl. LULUCF)	8560.42	8949.54	9151.6	9344.12	9554.04	9893.36
NIR2020	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1. Energy	6433.31	6825.51	6961.8	7139.78	7322.73	7645.05
2. IPPU	1092.02	1105.82	1197.75	1218.04	1231.32	1258.23
3. Agriculture	620.83	602.56	583.21	532.83	547.99	539.87
4. LULUCF	-276.67	-284.99	-283.64	-303.27	-381.73	-239.88
5. Waste	483.35	485.69	488.88	496.47	495.78	497.63
Total (incl. LULUCF)	8352.84	8734.59	8948	9083.86	9216.1	9700.91
Total (excl. LULUCF)	8629.51	9019.58	9231.64	9387.13	9597.83	9940.79
Difference						
1. Energy	0.05%	0.02%	0.05%	0.05%	0.05%	0.05%
2. IPPU	6.45%	6.67%	6.83%	3.34%	3.38%	3.58%
3. Agriculture	-0.01%	-0.03%	-0.04%	-0.03%	-0.03%	-0.01%
4. LULUCF	-18.01%	-19.03%	-18.32%	-19.56%	-15.59%	15.18%
5. Waste	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Total (incl. LULUCF)	1.58%	1.59%	1.63%	1.30%	1.26%	0.16%
Total (excl. LULUCF)	0.81%	0.78%	0.87%	0.46%	0.46%	0.48%
NIR2019	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**

1. Energy	7807.12	7726.29	7495.37	7202.01	6716.01	5794.37
2. IPPU	1212.78	1043.38	933.62	877.65	836.83	1064.41
3. Agriculture	515.83	509.15	531.62	520.91	497.58	462.82
4. LULUCF	-512.05	-541.59	-488.52	-565	-544.7	-579.74
5. Waste	505.63	510.21	512.56	516.17	526.63	538.04
Total (incl. LULUCF)	9529.31	9247.45	8984.65	8551.74	8032.36	7279.9
Total (excl. LULUCF)	10041.36	9789.04	9473.17	9116.74	8577.06	7859.64
NIR2020	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1. Energy	7811.11	7732.24	7502.1	7209.8	6719.15	5799.68
2. IPPU	1259.59	1094.86	969.23	925.44	885.96	1113.3
3. Agriculture	515.55	508.93	531.37	520.55	497.06	462.29
4. LULUCF	-417.75	-429.02	-398.11	-434.67	-421.38	-439.78
5. Waste	505.63	510.21	512.56	516.17	526.63	538.04
Total (incl. LULUCF)	9674.14	9417.22	9117.15	8737.28	8207.43	7473.53
Total (excl. LULUCF)	10091.89	9846.24	9515.26	9171.95	8628.81	7913.31
Difference						
1. Energy	0.05%	0.08%	0.09%	0.11%	0.05%	0.09%
2. IPPU	3.86%	4.93%	3.81%	5.45%	5.87%	4.59%
3. Agriculture	-0.05%	-0.04%	-0.05%	-0.07%	-0.10%	-0.11%
4. LULUCF	-18.42%	-20.79%	-18.51%	-23.07%	-22.64%	-24.14%
5. Waste	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Total (incl. LULUCF)	1.52%	1.84%	1.47%	2.17%	2.18%	2.66%
Total (excl. LULUCF)	0.50%	0.58%	0.44%	0.61%	0.60%	0.68%
NIR2019	**2014**	**2015**	**2016**	**2017**		
1. Energy	5957.5	6080.77	6480.13	6619.35		
2. IPPU	1279.73	1221.35	1225.4	1269.52		
3. Agriculture	448.15	457.27	481.54	494.73		
4. LULUCF	-577.02	-572.48	75.76	-534.01		
5. Waste	548.49	561.33	572.06	579.64		
Total (incl. LULUCF)	7656.86	7748.25	8834.89	8429.23		
Total (excl. LULUCF)	8233.88	8320.73	8759.13	8963.24		
NIR2020	**2014**	**2015**	**2016**	**2017**		
1. Energy	5962.93	6086.18	6485.62	6594.11		
2. IPPU	1329.63	1243.39	1262.44	1316.63		
3. Agriculture	447.69	456.87	481.13	494.24		
4. LULUCF	-435.67	-431.89	-49.78	-419.22		
5. Waste	548.49	556.62	562.55	569.09		
Total (incl. LULUCF)	7853.07	7911.16	8741.97	8554.86		
Total (excl. LULUCF)	8288.74	8343.05	8791.75	8974.08		
Difference						
1. Energy	0.09%	0.09%	0.08%	-0.38%		
2. IPPU	3.90%	1.80%	3.02%	3.71%		
3. Agriculture	-0.10%	-0.09%	-0.09%	-0.10%		
4. LULUCF	-24.50%	-24.56%	-165.71%	-21.50%		
5. Waste	0.00%	-0.84%	-1.66%	-1.82%		
Total (incl. LULUCF)	2.56%	2.10%	-1.05%	1.49%		
Total (excl. LULUCF)	0.67%	0.27%	0.37%	0.12%		

10.3. Implications for emission trends

Total GHG emissions of years 1990-2017 in the current submission are slightly higher than the emissions reported in the 2019 submission. The emission trends for the period 1990 –2017 according to the inventories submitted in 2019 (October, after Saturday paper corrections) and 2020 are shown in Figure 10.1 (LULUCF excluded). Emission trends for the period have not been affected significantly by the recalculations because in most cases the recalculations concerned the whole period.

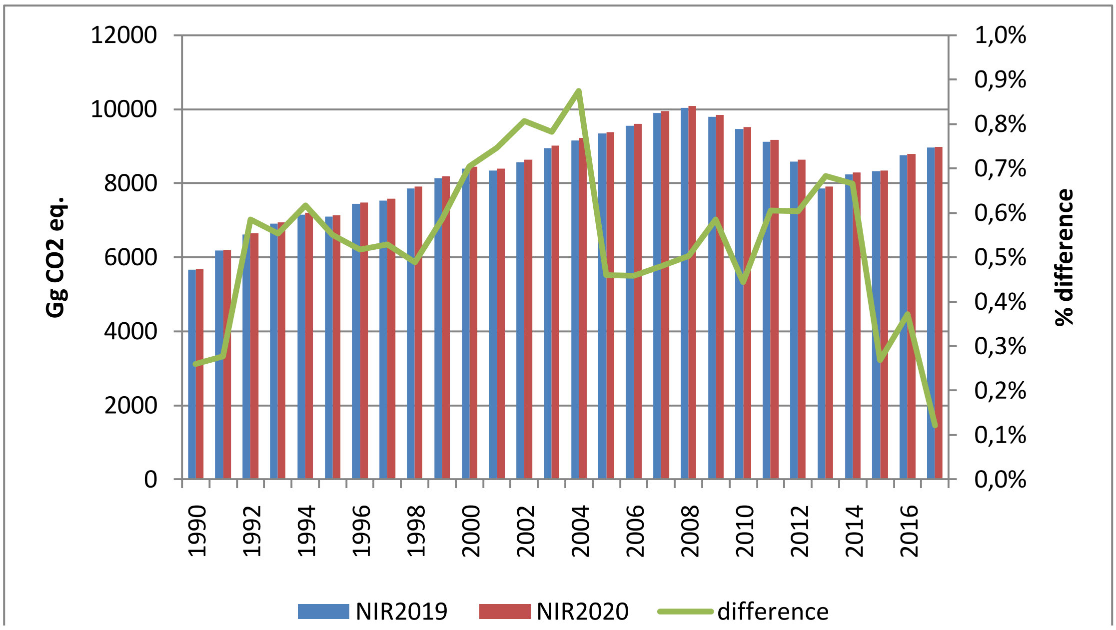

Figure 10.1. Comparison of NIR2019 to NIR2020, LULUCF excluded [kt CO2 eq.]

10.4. Planned improvements

An inventory improvement procedure is in place, which utilises:

- the recommendations from UNFCCC ERT reports,
- the annual QA/QC checks of the inventory by EU under the Monitoring Mechanism Regulation (MMR),
- the recommendations of 2017 comprehensive review of national greenhouse gas inventory data pursuant to Article 19(1) of Regulation (EU) No 525 (MMR),
- the findings of independent audits carried out by local experts at the end of each year,
- the output of key category analysis, uncertainty analysis and QA/QC procedures,

As a basis to prioritise, plan and materialize future improvements and recalculations. As mentioned above, details on the resulted recalculations and improvements planned per source/sink category have been presented in the respective chapters (Chapters 3 – 7).

Finally, it should be mentioned that the results and the proposals that will arise from the review of the present inventory, within the technical review process defined in relevant decisions of the Conference of the Parties, will be integrated in the plan for the improvement of the GHG emissions inventory.

Chapter 11.
KP-LULUCF

11.1. General information

GHG emissions and removals arising from land use, land use change and forestry activities reported under the Kyoto Protocol (incl. HWP) for the period 2013 – 2018 are presented in Table 11.1.

Table 11.1. GHG emissions (+) and removals (-) arising from land use, land use change and forestry activities reported under the Kyoto Protocol (incl. HWP) for the period 2013 – 2018

	Greenhouse gas emissions/removals [kt CO2eq]					
Activity	2013	2014	2015	2016	2017	2018
Afforestation/ Reforestation	-37.8	-43.0	-41.6	-36.8	-37.5	-35.3
Deforestation	0.7	0.6	0.5	0.4	0.3	0.2
Forest management	-142.3	-143.5	-139.0	-28.3	-144.9	-139.8

A weak decreasing trend in GHG emissions from deforestation is distinguishable. GHG removals from A/R and FM are almost stable during the reported period (except for 2016 due to forest wildfires).

It is noticeable that Forest Management Reference Level is lower than the actual removals estimated for the Forest Management Kyoto Protocol activity hence, the accountable input from Forest Management is source (and not sink).

11.1.1. Definition of forest and any other criteria

Cyprus has adopted the following definition of forest: Forest comprises of land covered by forest trees which covers at least 0.3 hectares, where the tree crown cover is at least 10 per cent and the minimum tree height is of 5 meters (at maturity).

The forest definition adopted by Cyprus is in line with the Forest National Law of 2012 (25 (I)/2012) and in accordance with the definitions used in the past for reporting to the Food and Agriculture Organization of the United Nations for its Global Forest Resource assessment (FAO FRA 2015). This definition is consistent with the guidance on adopting national definition of forest contained in Decision 16/CMP.1.

Forest Land contains all lands that meet the definition of forest. It also includes forest roads, cleared tracts, firebreaks and other small open areas within the forest as well as reforested areas or burnt areas or other areas that temporarily have low plant cover due to human intervention or natural causes, but does not include municipal parks and gardens. Note, that forest land contains only areas covered with trees that according to the Forest National Law of 2012 (25 (I)/2012) are considered forest trees.

According to the Forest National Law of 2012 (25 (I)/2012) all forests in Cyprus are managed. Natural forests in the sense of the Decision 2/CMP.7 do not exist in Cyprus. Therefore, there occurs no conversion from natural forests to plantations.

11.1.2. Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Cyprus has decided not to elect any voluntary activities under Article 3.4 of the KP.

11.1.3. Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The area of forest land reported for Afforestation/Reforestation, Deforestation and Forest Management under the Kyoto Protocol has the same basis as the area reported for land use changes from and to forests in the greenhouse gas inventory prepared under the Convention however, the time frame is different (under the KP ARD areas start in 1990). Note, that lands classified as ARD under the Kyoto Protocol may be reported under different land-use category under the Convention after the 20-year transition period. All land use changes to/from forests are considered to be direct human induced ARD. Afforestation and Reforestation activities are reported together.

Land-use category definitions and methods for sink/source assessment are implemented in a consistent way for the entire period since 1990.

11.1.4. Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Cyprus has decided not to elect any voluntary activities under Article 3.4 of the KP hence, mandatory FM is the only Art. 3.4 activity reported by Cyprus.

11.2. Land-related information

11.2.1. Spatial assessment unit used for determining the area of the units of land under Article 3.3

Land use data for Cyprus are sourced from the CORINE land cover (CLC) inventory (http://land.copernicus.eu/pan-european/corine-land-cover/view) data. More detailed information on the way the CORINE data were analyzed and interpreted is provided in Chapter 7.1.2.2 "The land-use categories for greenhouse gas inventory reporting" above.

Due to its representativeness and coverage the CORINE land cover data allow an unbiased reporting of the complete forest area, forest land remaining forest land and the change of land use from and to forests. At this moment, the CORINE land cover data constitute the only available database covering the entire Cyprus.

Table 11.2. Comparison of ARD and FM areas reported under KP and areas of forest land remaining forest land and LUC to/from forests reported under the Convention (k ha).

Year	Reporting under the Kyoto Protocol					Reporting under the Convention		
	Annual AR area	Total AR since 1990	Annual D area	Total D since 1990	Annual FM area	Forest remaining Forest area (annual)	Land converted to Forest	Land converted from Forest
							20-yr transition period	
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
1990	0.589	0.589	0.034	0.034	149.381	149.381	0.589	0.034
1991	0.589	1.178	0.034	0.069	149.312	149.312	1.178	0.069
1992	0.589	1.768	0.034	0.103	149.277	149.277	1.768	0.103
1993	0.589	2.357	0.034	0.138	149.243	149.243	2.357	0.138

1994	0.589	2.946	0.034	0.172	149.208	149.208	2.946	0.172
1995	0.589	3.535	0.034	0.207	149.174	149.174	3.535	0.207
1996	0.589	4.125	0.034	0.241	149.139	149.139	4.125	0.241
1997	0.589	4.714	0.034	0.276	149.105	149.105	4.714	0.276
1998	0.589	5.303	0.034	0.310	149.070	149.070	5.303	0.310
1999	0.589	5.892	0.034	0.345	149.036	149.036	5.892	0.345
2000	0.589	6.482	0.034	0.379	149.001	149.001	6.482	0.379
2001	0.589	7.071	0.034	0.414	148.967	148.967	7.071	0.414
2002	0.589	7.660	0.034	0.448	148.932	148.932	7.660	0.448
2003	0.589	8.249	0.034	0.483	148.898	148.898	8.249	0.483
2004	0.589	8.838	0.034	0.517	148.863	148.863	8.838	0.517
2005	0.589	9.428	0.034	0.552	148.829	148.829	9.428	0.552
2006	0.019	9.447	0.011	0.562	148.818	148.818	9.447	0.562
2007	0.019	9.465	0.011	0.573	148.807	148.807	9.465	0.573
2008	0.019	9.484	0.011	0.584	148.796	148.796	9.484	0.584
2009	0.019	9.503	0.011	0.595	148.786	148.786	9.503	0.595
2010	0.019	9.522	0.011	0.606	148.775	149.364	8.933	0.571
2011	0.019	9.541	0.011	0.617	148.764	149.942	8.362	0.548
2012	0.019	9.560	0.011	0.627	148.753	150.521	7.792	0.524
2013	0.019	9.578	0.011	0.638	148.742	151.099	7.221	0.500
2014	0.019	9.597	0.011	0.649	148.731	151.678	6.651	0.477
2015	0.019	9.616	0.011	0.660	148.721	152.256	6.081	0.453
2016	0.019	9.635	0.011	0.671	148.710	152.834	5.510	0.430
2017	0.019	9.654	0.011	0.682	148.699	153.413	4.940	0.406
2018	0.019	9.673	0.011	0.693	148.688	153.991	4.369	0.382

Lands actually reported under the Kyoto Protocol are marked in bold.

11.2.2 Methodology used to develop the land transition matrix

Land transition matrix was developed using the CORINE land cover change data further processed to obtain consistency with the CORINE land cover data on annual basis. The processing included direct changes in the Other Land category to allow the total area of the lands under control of the Government remain unchanged in all reported years.

The CORINE land cover data are available for the years 2000, 2006 and 2012. It was assumed that annual changes in land use observed during the period 2000 – 2006 approximate the changes occurring in the period 1990 – 2006. It was also assumed that annual changes in land use observed during the period 2006 – 2012 approximate the changes occurring in the period 2007 – 2018. The land use change matrixes for the period 1990 – 2006 and 2007 – 2018 are contained in Table 11.3 and Table 11.4, respectively.

Table 11.3. The annual land use change matrix for the year 1990/1991 (changes representative for the period 1990 – 2006).

From\To	Broadl. F	Conif. F	Annual CL	Woody CL	Grass GL	Woody GL	Wet-land	Settle-ments	Other Land	Total initial area
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
Broadl. F	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	1.02
Conif. F	0.00	148.91	0.00	0.00	0.00	0.00	0.00	0.01	0.00	148.91
Annual CL	0.00	0.00	127.60	0.09	0.00	0.00	0.00	0.32	0.07	128.08

Woody CL	0.00	0.00	0.00	122.39	0.00	0.00	0.00	0.40	0.00	122.78
Grass GL	0.00	0.01	0.09	0.01	30.52	0.00	0.00	0.12	0.23	30.98
Woody GL	0.00	0.00	0.00	0.07	0.00	121.05	0.00	0.20	0.64	121.95
Wetland	0.00	0.00	0.00	0.00	0.00	0.00	2.58	0.00	0.00	2.58
Settlements	0.00	0.02	0.00	0.04	0.00	0.00	0.00	38.63	0.00	38.70
Other Land	0.00	0.56	0.00	0.53	0.00	0.00	0.08	0.00	5.64	6.80
Total final area	1.00	149.49	127.69	123.11	30.52	121.05	2.66	39.67	6.60	601.80

Table 11.4. The annual land use change matrix for the year 2007/2008 (changes representative for the period 2007 – 2018).

From\To	Broadl. F	Conif. F	Annual CL	Woody CL	Grass GL	Woody GL	Wet-land	Settle-ments	Other Land	Total initial area
	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha	k ha
Broadl. F	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61
Conif. F	0.00	158.19	0.00	0.00	0.00	0.00	0.01	0.00	0.00	158.20
Annual CL	0.00	0.00	121.77	0.00	0.00	0.00	0.00	0.07	0.00	121.85
Woody CL	0.00	0.00	0.01	127.92	0.00	0.00	0.00	0.14	0.02	128.09
Grass GL	0.00	0.00	0.00	0.00	23.67	0.00	0.00	0.01	0.04	23.72
Woody GL	0.00	0.00	0.00	0.00	0.00	107.43	0.00	0.07	0.00	107.50
Wetland	0.00	0.00	0.00	0.00	0.00	0.00	3.86	0.00	0.00	3.86
Settlements	0.00	0.02	0.00	0.00	0.00	0.01	0.01	54.28	0.00	54.32
Other Land	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.00	3.56	3.63
Total final area	0.61	158.21	121.79	127.93	23.67	107.50	3.88	54.58	3.63	601.80

11.2.3. Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Maps reflecting the approximate location of land cover changes as detected using the CORINE land cover data base are used for identification of individual land cover change however, reporting is performed on the level of the entire land under the Government control.

11.3. Activity-specific information

11.3.1. Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1. Description of the methodologies and the underlying assumptions used

The methodologies and assumptions used for calculation of the GHG estimates under the Kyoto Protocol Art. 3.3 are identical with those for LUCs from and to forests used for similar calculations under the Convention. However, the areas of the activities under the KP differ from the areas of subcategories under the Convention as they follow the KP specific rules explained in the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

As the first step in estimating carbon stock change and GHG emissions and removals, areas of land subjected KP activities are calculated by year. In each case, the calculations involve areas of the relevant land-use categories conversions and areas remaining in the same land-use category as reported under the Convention.

Afforestation/Reforestation (AR)

Lands to be reported as AR under the Kyoto Protocol include all lands that were converted from non-forest land-use categories to forest land-use category since 1990 irrespectively of their fate after the conversion with exception to deforestation. All forest lands subjected to deforestation are always reported as D under the KP.

In Cyprus, analysis of land use change matrixes revealed that the following land use categories (reported under the Convention) are converted to forest: Grass Grassland, Settlements and Other Land. Under the Convention lands converted to forest turn into Forest remaining Forest 20 years after the conversion however, under the KP these lands shall be continuously reported under AR.

As discussed in Chapter 7.7.3 (in particular see Table 7.17), lands classified as Other Land reveal increased dynamics and quick turn-over of lands converted to and from the Other Land. The land-use categories that mostly contribute to the Other Land land-use category are Woody Grassland and Grass Grassland. Therefore, conversions of Other Land land-use category to forest was replaced by conversion of Woody Grassland and Grass Grassland to forest in proportion equal to their presence in the Other Land land-use category. This replacement results in closer to reality approximation of carbon stock changes and GHG emission and removal in lands to be reported as AR under the KP.

If initially afforested/reforested land remains in Forest land-use category for at least 20 years then it is reclassified to Forest remaining Forest (referred to as Secondary classification in Table 11.5) for the purpose of reporting under the Convention however, it shall be reported as AR under the Kyoto Protocol. Table 11.5 presents numerical data on area of lands to be reported as AR under the KP.

Deforestation (D)

Lands to be reported as D under the Kyoto Protocol include all lands that were converted from forest land-use category to non-forest land-use categories since 1990 irrespectively of their fate after the conversion.

In Cyprus, analysis of land use change matrixes revealed that lands classified as Broadleaved Forest are converted to Settlements and Other Land while lands classified as Coniferous Forest are converted to Woody Cropland, Wetland, Settlements and Other Land. If initially converted land remains in these land-use categories for at least 20 years then it is reclassified to Woody Cropland remaining Woody Cropland, Wetland remaining Wetland, Settlements remaining Settlements and Other Land remaining Other Land (referred to as Secondary classification in Table 11.6) for the purpose of reporting under the Convention. However, all these lands are reported as Deforestation under the Kyoto Protocol. Table 11.6 presents numerical data on land-use categories to be reported as Deforestation under the Kyoto Protocol.

Forest management (FM)

All land under the forest land-use category is considered as managed. Consequently, lands to be reported as FM under the Kyoto Protocol include Broadleaved Forest remaining Broadleaved Forest and Coniferous Forest remaining Coniferous Forest land-use categories reported under the Convention since 1990 to the reported year of the second commitment period of the KP. It means that lands containing the FM activity shall not contain any lands converted to Forest since 1990. Table 11.7 presents numerical data on area of land-use categories under the Convention to be reported as FM under the KP.

Table 11.5. Land-use category conversions occurring under the Convention to be reported as AR under the KP (Non-forest land-use categories converted to forest land-use categories)

<table>
<tr><td rowspan="5">Year</td><td rowspan="5">Total AR</td><td colspan="4">Conversion from non-forest land-use categories under the Convention:</td><td>Secondary classification</td></tr>
<tr><td rowspan="2">Grass Grassland</td><td rowspan="2">Settlements</td><td colspan="2">Other Land consisting of:</td><td rowspan="3">Coniferous F. remaining Coniferous F.</td></tr>
<tr><td>Woody GL</td><td>Grass GL</td></tr>
<tr><td colspan="4">to Coniferous Forest land-use category under the Convention</td></tr>
<tr><td>ha</td><td>ha</td><td>ha</td><td>ha</td><td>ha</td></tr>
<tr><td>1990</td><td>589.2</td><td>8.0</td><td>24.7</td><td>407.5</td><td>109.1</td><td></td></tr>
</table>

1991	1178.5	16.1	49.3	815.0	218.2	
1992	1767.7	24.1	74.0	1222.6	327.3	
1993	2356.9	32.2	98.7	1630.1	436.4	
1994	2946.2	40.2	123.3	2037.6	545.5	
1995	3535.4	48.3	148.0	2445.1	654.6	
1996	4124.6	56.3	172.7	2852.7	763.7	
1997	4713.9	64.4	197.4	3260.2	872.8	
1998	5303.1	72.4	222.0	3667.7	981.9	
1999	5892.3	80.5	246.7	4075.2	1091.0	
2000	6481.6	88.5	271.4	4482.7	1200.1	
2001	7070.8	96.6	296.0	4890.3	1309.3	
2002	7660.0	104.6	320.7	5297.8	1418.4	
2003	8249.3	112.7	345.4	5705.3	1527.5	
2004	8838.5	120.7	370.0	6112.8	1636.6	
2005	9427.7	128.8	394.7	6520.3	1745.7	
2006	9446.5	128.8	413.5	6520.3	1745.7	
2007	9465.4	128.8	432.4	6520.3	1745.7	
2008	9484.2	128.8	451.2	6520.3	1745.7	
2009	9503.0	128.8	470.0	6520.3	1745.7	
2010	9521.9	128.8	488.9	6520.3	1745.7	
2011	9540.7	120.7	483.0	6112.8	1636.6	589.2
2012	9559.5	112.7	477.2	5705.3	1527.5	1178.5
2013	**9578.4**	**104.6**	**471.4**	**5297.8**	**1418.4**	**1767.7**
2014	**9597.2**	**96.6**	**465.5**	**4890.3**	**1309.3**	**2356.9**
2015	**9616.0**	**88.5**	**459.7**	**4482.7**	**1200.1**	**2946.2**
2016	**9634.9**	**80.5**	**453.9**	**4075.2**	**1091.0**	**3535.4**
2017	**9653.7**	**72.4**	**448.0**	**3667.7**	**981.9**	**4124.6**
2018	**9672.5**	**64.4**	**442.2**	**3260.2**	**872.8**	**4713.9**

Lands actually reported under the Kyoto Protocol are marked in bold.

Table 11.6. Land-use category conversions occurring under the Convention to be reported as D under the KP (Forest land-use categories converted to non-forest land-use categories)

Year	Total D	Conversion from forest land-use categories under the Convention:						Secondary classification:		
		Broadleaved Forest		Coniferous Forest				Woody CL remaining Woody CL	Settlements remaining Settlements	Other Land remaining Other Land
		To non-forest land-use categories under the Convention:								
		Settlements	Other Land	Woody CL	Wetland	Settlements	Other Land			
	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha
1990	34.5	1.3	24.6	0.1		8.5				
1991	68.9	2.6	49.2	0.2		17.0				
1992	103.4	3.9	73.7	0.4		25.4				
1993	137.9	5.2	98.3	0.5		33.9				
1994	172.3	6.4	122.9	0.6		42.4				
1995	206.8	7.7	147.5	0.7		50.9				
1996	241.3	9.0	172.1	0.8		59.3				
1997	275.8	10.3	196.7	1.0		67.8				
1998	310.2	11.6	221.2	1.1		76.3				
1999	344.7	12.9	245.8	1.2		84.8				
2000	379.2	14.2	270.4	1.3		93.3				
2001	413.6	15.5	295.0	1.4		101.7				
2002	448.1	16.8	319.6	1.6		110.2				
2003	482.6	18.1	344.2	1.7		118.7				
2004	517.0	19.3	368.7	1.8		127.2				
2005	551.5	20.6	393.3	1.9		135.6				
2006	562.4	20.6	393.3	1.9	5.9	135.6	4.9			
2007	573.2	20.6	393.3	1.9	11.9	135.6	9.8			
2008	584.1	20.6	393.3	1.9	17.8	135.6	14.7			
2009	594.9	20.6	393.3	1.9	23.8	135.6	19.6			

2010	605.8	20.6	393.3	1.9	29.7	135.6	24.5			
2011	616.6	19.3	368.8	1.8	35.7	127.2	29.4	0.1	9.8	24.6
2012	627.5	18.1	344.2	1.7	41.6	118.7	34.3	0.2	19.5	49.2
2013	**638.3**	**16.8**	**319.6**	**1.6**	**47.5**	**110.2**	**39.2**	**0.4**	**29.3**	**73.7**
2014	**649.2**	**15.5**	**295.0**	**1.4**	**53.5**	**101.7**	**44.1**	**0.5**	**39.1**	**98.3**
2015	**660.0**	**14.2**	**270.5**	**1.3**	**59.4**	**93.3**	**49.0**	**0.6**	**48.8**	**122.9**
2016	**670.9**	**12.9**	**245.9**	**1.2**	**65.4**	**84.8**	**53.9**	**0.7**	**58.6**	**147.5**
2017	**681.7**	**11.6**	**221.3**	**1.1**	**71.3**	**76.3**	**58.8**	**0.8**	**68.4**	**172.1**
2018	**692.6**	**10.3**	**196.7**	**1.0**	**77.2**	**67.8**	**63.7**	**1.0**	**78.1**	**196.7**

Lands actually reported under the Kyoto Protocol are marked in bold.

Table 11.7. Forest land-use categories remaining Forest land-use categories under the Convention to be reported as FM under the KP

Year	Total FM	Broadleaved F remaining Broadleaved F	Coniferous F remaining Coniferous F
	ha	ha	ha
2011	148174.7	607.6	147567.1
2012	147574.6	607.6	146967.0
2013	**146974.5**	**607.6**	**146366.9**
2014	**146374.4**	**607.6**	**145766.9**
2015	**145774.3**	**607.6**	**145166.8**
2016	**145174.3**	**607.5**	**144566.7**
2017	**144574.1**	**607.5**	**143966.6**
2018	**143973.9**	**607.5**	**143366.5**

Lands actually reported under the Kyoto Protocol are marked in bold.

Cyprus has decided **not to elect** any among the following approaches allowed by Decision 2/CMP.7 for including in reporting/accounting under the KP[91]:

- Possibility to exclude from the accounting of Afforestation and Reforestation and Forest Management (either annually or at the end of second commitment period) emissions from natural disturbances that in any single year exceed a Forest Management background level.
- Possibility to include in the accounting of Forest Management under Article 3.4 anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from the harvest and conversion of forest plantations, accounted for under Forest Management, to non-forest land.

Consequently, GHG removals/emissions reported under the Convention from lands to be reported under the KP are in fact GHG removals/emissions to be reported under the KP.

11.3.1.2. Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

All carbon pools are included.

No forests are fertilized in Cyprus hence, all GHG emissions relating to fertilization are reported as not occurring “NO”.

11.3.1.3. Information on whether or not indirect and natural GHG emissions and removals have been factored out

Due to unavailability of the UNFCCC approved approaches for factoring out the indirect and natural GHG emissions/removals these have not been implemented in this report.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

This is the first submission hence no recalculations are reported.

11.3.1.5 Uncertainty estimates

Uncertainty analysis will be performed when area data of resolution comparable to the area threshold used in the forest definition (0.3 ha) will be available. All remarks on uncertainties included in Chapter 7 (LULUCF) are applicable to this chapter as well.

[91] Details of these approaches are presented in the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

11.3.1.6 Information on other methodological issues

The methodologies used to estimate emissions/removals from ARD activities are identical to methodologies used for reporting under the Convention.

11.3.1.7 The year of the onset of an activity, if after 2008

All activities covered by this report are reported since 1 January 2013.

11.4. Article 3.3

11.4.1. Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and are direct human-induced

Land use data for Cyprus leading to identification of the A/R/D activities are sourced from the CORINE land cover (CLC) inventory data[92] (http://land.copernicus.eu/pan-european/corine-land-cover/view) which contains information on the timing of collection of the relevant images. This fact guarantees that activities reported under Article 3.3 approximately began on or after 1 January 1990. However, the earliest data available from the CORINE database cover year 2000 and all numerical data for the preceding years are obtained by extrapolation back the land use changes observed in the period 2000 – 2006.

In Cyprus, all ARD activities are human induced.

11.4.2. Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

The national definition of forest as contained in the Forest National Law of 2012 (25 (I)/2012) includes under forest all areas that are temporarily un-stocked (e.g. harvested area, disturbances) but expected to revert to forest. Any land use change involving the decrease of forest area requires an administrative permission and lack of such permission ensures that all temporarily un-stocked areas will revert to forest.

11.4.3. Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

State Forests are legally obliged to reintroduce forest into any area under their control that has lost forest cover. Private forest owners are required to obtain an administrative permission to change land use from forest to non-forest one. Consequently, the annual deforestation rate is about 25 ha/year in the period 1990 – 2018.

92

11.5. Article 3.4

11.5.1. Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Land use data for Cyprus leading to identification of the FM activities are sourced from the CORINE land cover (CLC) inventory (http://land.copernicus.eu/pan-european/corine-land-cover/view) data which contains information on the timing of collection of the relevant images. This fact guarantees that activities under Article 3.4 have occurred since 1 January 1990. However, the earliest data available from the CORINE database cover year 2000 and all numerical data for the preceding years are obtained by extrapolation back the land use changes observed in the period 2000 – 2006.

In Cyprus, all FM activities are human induced.

11.5.2. Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

Cyprus has decided not to elect any voluntary activities under the KP.

11.5.3. Information relating to Forest Management

Cyprus has a well-established tradition in Forest Management which is characterized by a relevant forest policy that focuses on forest protection and biodiversity conservation in parallel to wood production, resulting e.g. in progressively decreasing volume of harvest. The Forest National Law of 2012 (25 (I)/2012) promotes sustainable management of forests allowing for balancing the relevant ecological, economic and social functions of forests. Therefore, Cyprus decided to use a broad definition of Forest Management under the Kyoto Protocol.

11.6. Other information

11.6.1. Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

A key category is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Whenever the term key category is used, it includes both source and sink categories.

Key category analysis requires disaggregation of sinks and sources. Table 11.8, Table 11.9 and Table 11.10 present disaggregation applied for AR, D and FM KP activities, respectively.

Table 11.8. Afforestation/Reforestation - disaggregation by land-use categories

	Initial land-use category	Converted to / remaining	Final land-use category
1	Grass Grassland	converted to:	Coniferous Forest
2	Settlements		Coniferous Forest
3	Other Land		Coniferous Forest
4	Coniferous F.	remaining	Coniferous Forest

Table 11.9. Deforestation - disaggregation by land-use categories

	Initial land-use category	Converted to / remaining	Final land-use category
1	Broadleaved Forest	converted to:	Settlements
2			Other Land
3	Coniferous Forest	converted to:	Woody CL
4			Wetland
5			Settlements
6			Other Land
7	Woody CL	remaining	Woody CL
8	Settlements		Settlements
9	Other Land		Other Land

Table 11.10. Forest Management - disaggregation by land-use categories

	Initial land-use category	Converted to / remaining	Final land-use category
1	Broadleaved Forest	remaining	Broadleaved Forest
2	Coniferous Forest		Coniferous Forest

Table 11.11. Key category analysis for the KP LUUCF activities. For the purposes of reporting the signs for removals are always negative (-) and for emissions positive (+).

IPCC Category Code	IPCC Category	GHG	Latest Year (2018) Estimate (LYE)	Absolute value of LYE	Level Assessment (LA)	Cumulative Total of LA
			kt CO2 eq	kt CO2 eq		
3 B 1 a(1)	Coniferous Forest Land Remaining Coniferous Forest Land	CO2	-141,029	141,029	0,8053	0,8053
3 B 1 b ii (1)(2)	Woody Grassland Converted to Coniferous Forest Land	CO2	-16,568	16,568	0,0946	0,8999
3 B 1 b iv (1)	Settlements Converted to Coniferous Forest Land	CO2	-8,553	8,553	0,0488	0,9487
3 B 6	Grass Grassland to Coniferous Forest	CO2	-4,501	4,501	0,0257	0,9744
3 B 1 a(2)	Deciduous Forest land Remaining Deciduous Forest Land	CO2	1,255	1,255	0,0072	0,9988
3 B 4 b	Coniferous Forest Converted to Wetlands	CO2	-1,174	1,174	0,0067	0,9811
3 B 6 b i (2)	Deciduous Forest Land Converted to Other Land	CO2	0,806	0,806	0,0046	0,9857
3 B 6 b i (1)	Coniferous Forest Land Converted to Other Land	CO2	0,708	0,708	0,0040	0,9898
3 B 1 b ii (1)(1)	Grass Grassland Converted to Coniferous Forest Land	CO2	-0,332	0,332	0,0019	0,9917

3 B 5 b i (1)	Coniferous Forest Land Converted to Settlements	CO_2	-0,188	0,188	0,0011	0,9999
3 B 5 b i (2)	Deciduous Forest Land Converted to Settlements	CO_2	0,015	0,015	0,0001	1,0000
3 B 2 b i (1)(2)	Coniferous Forest Land Converted to Woody Cropland	CO_2	-0,002	0,002	0,0000	1,0000
	Total			175,130	1,0000	

11.7. Information relating to Article 6

Cyprus does not participate in the implementation of Article 6 of the KP.

11.8. Calculation of an estimate of HWP Contribution under the KP

In Cyprus, transparent and verifiable activity data for the specified categories (paper, wood panels and sawn wood) are available from the FAO Stat data base (for details see para 11.8.2) hence, accounting of Harvested Wood Products shall be on the basis of the change in the Harvested Wood Products pool during the second commitment period, estimated using the first-order decay function with default half-lives provided in the Decision 2/CMP.7[93]. Therefore, the estimation of the HWP contribution under the KP is calculated following the guidance contained in the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (page 2.109 onwards).

11.8.1. Initial steps to estimate the HWP contribution

The approach for the FMRL construction by Cyprus is a linear extrapolation of historical emissions data (1990–2008) of forest land remaining forest land. Numerical values for the FMRL are: (i) Applying first-order decay function for HWP = –0.157 Mt CO_2 eq/year; (ii) Assuming instantaneous oxidation of HWP = –0.164 Mt CO_2 eq/year.

The approach used to establish the FMRL for Cyprus was assessed by the UNFCCC experts as consistent and transparent methodology in which net emissions are projected from the limited information available (FCCC/TAR/2011/EU).

11.8.2. Data for the calculation of an estimate of HWP Contribution under the Kyoto Protocol

Decision 2/CMP.7 limits the mandatory accounting to HWP originating from domestic forests which are accounted for under Article 3, paragraphs 3 and 4. Imported HWP, irrespective of their origin, are excluded. For Cyprus, Article 3, paragraph 3 activities cover afforestation, reforestation and deforestation (ARD) while Article 3, paragraph 4 covers only forest management as Cyprus decided not to elect any other activities on the voluntary basis.

FAOSTAT provides data on Forestry Production and Trade in Cyprus for the period 1961 – 2018 and these data were used for all calculations presented below. More detailed information about collection and processing of the data are provided in Chapter 7.8.4.1 Data for the calculation of an estimate of HWP Contribution under the Convention.

[93] Table 1, p. O8, 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

Country specific data on half-lives on harvested wood products are not available hence, the default half-lives provided in Decision 2/CMP.7, paragraph 29 (two years for paper, 25 years for wood panels and 35 years for sawn-wood) are applied in all calculations relating to HWP.

In Cyprus, all forests are considered as managed. Data on the total forest area and the areas of afforestation/reforestation, deforestation and forest management located in land under the Government control are presented in Table 11.12 (below).

Table 11.12. Estimation of AR, D and FM area since 1990 (Government Controlled Area)

Year	Total area of forest [ha]	Total AR since 1990 [ha]	Total D since 1990 [ha]	Annual FM area [ha]
Data	Data	Data	Data	Estimate
1990	149935	589	34	149381
1991	150490	1178	69	149312
1992	151045	1768	103	149277
1993	151600	2357	138	149243
1994	152154	2946	172	149208
1995	152709	3535	207	149174
1996	153264	4125	241	149139
1997	153819	4714	276	149105
1998	154373	5303	310	149070
1999	154928	5892	345	149036
2000	155483	6482	379	149001
2001	156038	7071	414	148967
2002	156592	7660	448	148932
2003	157147	8249	483	148898
2004	157702	8838	517	148863
2005	158257	9428	552	148829
2006	158265	9447	562	148818
2007	158273	9465	573	148807
2008	158281	9484	584	148796
2009	158289	9503	595	148786
2010	158297	9522	606	148775
2011	158305	9541	617	148175
2012	158313	9560	627	147575
2013	**158321**	**9578**	**638**	**146975**
2014	**158329**	**9597**	**649**	**146374**
2015	**158337**	**9616**	**660**	**145774**
2016	**158345**	**9635**	**671**	**145174**
2017	**158353**	**9654**	**682**	**144574**
2018	**158361**	**9673**	**693**	**143974**

Deforestation in Cyprus is minor in extent (less than 35 ha annually) and occurs predominantly in private forests that are usually degraded before the final removal of tree cover hence, wood stock in areas to be deforested is low and of poor quality. In particular, the wood has no industrial value (according to forest expert judgement). Such wood is usually burned as a part of fire wood. Consequently, it is assumed that wood harvested from deforestation does not enter the HWP pool in Cyprus.

AR lands in Cyprus are not subject to harvest because market value of wood contained in these lands is too low (the oldest AR forest is 25 years old in 2015).

Consequently, all wood suitable for transformation into HWP is harvested from forests subject to FM, hence all HWP categories produced in Cyprus originate from forests that are accounted for by the country. Data on production of HWP by the KP categories are presented in Table 11.13.

Table 11.13. Production of HWP by the KP categories in Cyprus.

Year	Sawn-wood	Wood-based Panels	Paper + Paperboard
	m3	m3	metric-t
1990	22000	13800	0
1991	16430	11400	0
1992	14160	12100	0
1993	17160	22000	0
1994	14900	22000	0
1995	14900	21000	0
1996	15600	21000	0
1997	13600	20100	0
1998	11290	19300	0
1999	11750	20500	0
2000	8740	12200	0
2001	8600	4200	0
2002	7460	2600	0
2003	5645	2340	0
2004	4953	1900	0
2005	4255	1718	0
2006	3850	2500	0
2007	8717	2534	0
2008	9657	2312	0
2009	4571	1396	0
2010	3971	1067	0
2011	2909	480	0
2012	2628	12	0
2013	2241	8	0
2014	2390	5	0
2015	1865	10	0
2016	1718	6	0
2017	1146	7	0
2018	1267	7	0

Data on production export and import of sawn wood, wood-based panels and paper products were collected from the FAOStat data base for the period 1961- 2018 and extended back to the year 1900 using the guidance contained in the IPCC 2006 Guidelines.

Fraction of feedstock originating from domestic production (that is harvested on the FM land) for the period 1961 – 2018 was calculated using the FAOStat database while the fraction of feedstock originating from domestic production for the period 1900 – 1960 is assumed to be equal the respective average for the period 1961 – 2016 for all HWP categories (sawn wood, wood panels and paper).

Default conversion factors were read from Table 11.2.8.1 (sawn wood – 0.229 Mg C/m3; Wood-based panels – 0.269 Mg C/m3; and paper and paperboard – 0.386 Mg C/Mg) and default half-lives of HWP categories were read from Table 11.2.8.2 contained in the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (page 2.122 and 2.123, respectively).

Export of HWP from Cyprus is negligible, hence they do not significantly affect these calculations.

Initial stocks, gains and losses of the KP HWP categories for the period 2013 – 2018 are presented in Table 11.14 (below).

Table 11.14. Initial stocks, gains and losses of the KP HWP categories for the period 2013 – 2018 (all data in kt C)

2013	Initial stock(6)	Gains(7)	Losses(7)
sawn wood			
domestically consumed	242,38	0,49	4,76
exported	0,00	0,00	0,00
panels			
domestically consumed	59,29	0,00	1,62
exported	0,00	0,00	0,00
paper and paper board			
domestically consumed	0,03	0,00	0,01
exported	0,00	0,00	0,00

2014	Initial stock(6)	Gains(7)	Losses(7)
sawn wood			
domestically consumed	238,12	0,53	4,67
exported	0,00	0,00	0,00
panels			
domestically consumed	57,67	0,00	1,58
exported	0,00	0,00	0,00
paper and paper board			
domestically consumed	0,02	0,00	0,01
exported	0,00	0,00	0,00

2015	Initial stock(6)	Gains(7)	Losses(7)
sawn wood			
domestically consumed	233,97	0,39	4,59
exported	0,00	0,00	0,00
panels			
domestically consumed	56,10	0,00	1,53
exported	0,00	0,00	0,00
paper and paper board			
domestically consumed	0,01	0,00	0,00
exported	0,00	0,00	0,00

2016	Initial stock(6)	Gains(7)	Losses(7)
sawn wood			
domestically consumed	229,77	0,39	4,51
exported	0,00	0,00	0,00

panels			
domestically consumed	54,57	0,00	1,49
exported	0,00	0,00	0,00
paper and paper board			
domestically consumed	0,01	0,00	0,00
exported	0,00	0,00	0,00

2017	**Initial stock(6)**	**Gains(7)**	**Losses(7)**
sawn wood			
domestically consumed	225,65	0,25	4,43
exported	0,00	0,00	0,00
panels			
domestically consumed	53,07	0,00	1,45
exported	0,00	0,00	0,00
paper and paper board			
domestically consumed	0,01	0,00	0,00
exported	0,00	0,00	0,00

2018	**Initial stock(6)**	**Gains(7)**	**Losses(7)**
sawn wood			
domestically consumed	221,47	0,24	4,35
exported	0,00	0,00	0,00
panels			
domestically consumed	51,62	0,00	1,41
exported	0,00	0,00	0,00
paper and paper board			
domestically consumed	0,00	0,00	0,00
exported	0,00	0,00	0,00

For the calculations of the Harvested Wood Products the worksheet provided with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories have been implemented.

Chapter 12.
Information on accounting of Kyoto units

Information regarding Kyoto Protocol units should be included in the NIR in accordance with decision 15/CMP.1, annex, paragraphs 12–17, in conjunction with decision 3/CMP.11, and annex II to decision 3/CMP.11.

The standard electronic format (SEF) for providing information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs for the year 2018 for Cyprus' registry is submitted together with this report. The SEF reporting software has been used for this purpose. Cyprus national registry is still not connected to the ITL. Therefore, until 31.12.2017 no transactions have taken place to and from Cyprus' account.

The joint assigned amount of the EU, its Member States and Iceland for the second commitment period of the Kyoto Protocol is equal to the percentage inscribed for the Union, its Member States and Iceland in the third column of Annex B to the Kyoto Protocol as replaced by the Doha Amendment (80 %) of its base year emissions multiplied by eight. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The Agreement between the EU, its Member States and Iceland, concerning Iceland's participation in the joint fulfilment of commitments by the EU, its Member States and Iceland for the second commitment period of the Kyoto Protocol sets out the terms governing Iceland's participation[94]. The emission levels define the Member States' and Iceland's assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the 'Climate and Energy package'[95]. This assigned amount of the EU is determined in line with the terms of the joint fulfilment agreement, as described in the EU's initial report and will be established upon the completion of the initial review, still ongoing at the moment of this submission.

[94] OJ L 207, 4.8.2015, p. 17

[95] Directive 2009/29/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community and Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, OJ L 140, 5.6. 2009.

Chapter 13.
Information on changes in national system

The national inventory arrangements and the QA/QC procedures have been restructured in 2017, to meet the requirements of CMP and COP Decisions relevant to national systems and QA/QC. The most important change is that the legal framework defining the roles-responsibilities and the co-operation between the DoE Inventory team and the designated contact points of the competent Ministries was formalized by Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities, concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

Chapter 14.
Information on changes in national registry

The information regarding the National Registry that should be included in the NIR in accordance decision 5/CMP.1 and the annex to decision 13/CMP.1 in conjunction with decision 3/CMP.11 and other relevant provisions and standards are presented in the following table.

Cyprus national registry is still not connected to the ITL.

Ref:	Category	Subject	Question	Response
1	Registry	Organization & system	Country or organization?	Cyprus
1.1			By what name is your organization known?	Department of Environment Ministry of Agriculture, Rural Development and Environment
1.2			By what name is your Registry system known?	CY Union Registry
1.3		Location	Where / in which nation is your Registry located? (Please provide your full address for correspondence)	Postal Address: Department of Environment 1498, Nicosia, Cyprus Offices: 20-22 28th Oktovriou Ave., Engomi, 2414, Nicosia, Cyprus
1.4		Time zone:	Please state GMT +/- hours.	Standard Time is 2 hours ahead of Greenwich Mean Time (GMT+2).
1.5		Days/hours of operation	Please indicate periods when the system will be operational, including uptime / downtime.	
1.6		Calendar constraints	Please identify critical dates/periods (e.g. service deadlines, holidays/reduced service, etc.)	
2.1	Personnel	Primary (Business) contact:	Please provide the following details for your business Registry System Administrator. This is the person responsible for day-to-day operation of the Registry: • Name • Role / Job title • Telephone number • Email address • Level of training / expertise in registry system (e.g. developer, administrator, user) • Competence level in English (e.g. native, fluent, proficient, etc.)	• Name: Dr. Theodoulos MESIMERIS • Role / Job title: Senior Environment Officer /Head of Climate Action Unit/ National Administrator • Telephone number: +357 22408948 • Email address tmesimeris@environment.moa.gov.cy • Level of training / expertise in registry system (e.g. developer, administrator, user): National Administrator • Competence level in English (e.g. native, fluent, proficient, etc.): Proficient user
2.2		Secondary (Technical) contact:	Please provide the following details for your technical support. This is the person responsible for technical support of your infrastructure and networking operation of the Registry: • Name • Role / Job title	

			• Telephone number • Email address • Level of training / expertise in registry system (e.g. developer, administrator, user) • Competence level in English (e.g. native, fluent, proficient, etc.)	
2.3		Other possible contacts?	How many other members of staff are regularly involved on a frequent basis?	Two other members of staff are regularly involved on a frequent basis. Person 1: • Name: Nicoletta Kythreotou • Role / Job title: Environment Officer • Telephone number: +357 22408947 • Email address: nkythreotou@environment.moa.gov.cy • Level of training / expertise in registry system (e.g. developer, administrator, user): National Administrator (2) • Competence level in English (e.g. native, fluent, proficient, etc.): Proficient user Person 2: • Name: Niki Papaki • Role / Job title: Environment Technician • Telephone number: +357 22408946 • Email address: npapaki@environment.moa.gov.cy • Level of training / expertise in registry system (e.g. developer, administrator, user): National Administrator (3) • Competence level in English (e.g. native, fluent, proficient, etc.): Independent user

Chapter 15.
Information on minimising adverse impacts in accordance with article 3, paragraph 14

15.1. Introduction

Article 3, paragraph 14, of the Kyoto Protocol requires that Annex I Parties shall strive to meet their commitments under Article 3, paragraph 1 of the Kyoto Protocol in such a way as to minimize adverse social environmental and economic impacts on developing country Parties, particularly those Parties identified in Article 4, paragraphs 8 and 9, of the Convention. Information on how commitments under Article 3, paragraph 14, are being implemented is to be prioritised under a number of actions as set down in section H of the annex to guidelines for the preparation of supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol (Decision 15/CMP.1). These requirements are addressed in this chapter.

15.2. Context

As a Member State of the European Union, Cyprus commitments under the Kyoto Protocol are being implemented under Decision 2005/166/EC, governing joint fulfilment under Article 4, and Decision 280/2004/EC, which covers specific emissions monitoring and reporting requirements. In this context, the minimization of adverse impacts on developing countries is also largely dictated by the European Commission’s policy on climate change and by its policies and programmes affecting developing countries. Regulation at the European level also controls or influences market conditions, fiscal incentives, tax and duty exemptions and subsidies in all economic sectors in Member States.

The impact assessment of new policy initiatives has been established in the European Union, which allows their potential adverse social, environmental and economic impacts on various stakeholders, including developing country Parties, to be identified and limited at an early stage within the legislative process. Impact Assessment Guidelines specifically address impacts on third countries and also issues related to international relations. This provides a framework in which Member States like Cyprus can also ensure a high level of protection of the environment and contribute to the integration of environmental considerations into the preparation and adoption of specified plans and programmes with a view to promoting sustainable development.

15.3. Specific Elements

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

The current paragraph includes information on the means used by the country in order to enhance the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies that run counter to the objectives of the Convention and on the application of market instruments.

Cyprus, as a Member of the EU, supports and makes the necessary steps to implement the EU Common Agricultural Policy. In the specific policy environmental concerns have been gradually incorporated. Such examples are the including "decoupled" direct payments which have replaced price support; environmental cross compliance; a substantial increase in budget for rural development. As part of

2008 Common Agriculture Policy Health Check, additional part of direct aid has been shifted to climate change, renewable energy, water management, biodiversity, innovation; - transparency of agricultural subsidies has improved. It is important to note that in the other areas most subsidies are within the competence of the country.

The energy market liberalisation (National Laws 122(I)/2003 and 183(I)/2004) has been an important step to create an original internal energy market and can be considered as a mean to address market imperfections and to reflect externalities. The existence of a competitive internal energy market is a strategic instrument both in terms of giving local consumers a choice between different companies supplying gas and electricity at reasonable prices, but also in terms of making the market accessible for all suppliers, especially the smallest and those investing in renewable forms of energy.

At the same time, Cyprus participates in the EU Emissions Trading Scheme, which constitutes an important market instrument to implement the objectives of the Convention and Article 3, paragraph 1 of the Kyoto Protocol which aims at creating the right incentives for forward looking low carbon investment decisions by reinforcing a clear, undistorted and long-term carbon price signal.

Finally, the taxation on energy products and electricity, as defined by the Directive 2003/96/EC, contribute to establishment of rules for the taxation of energy products used as motor or heating fuel, taxes on energy consumption, and common minimum levels of taxation. The Directive has been transposed into Cyprus legislation with Law 91(I)/2004.

(b) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort

Cyprus considers important that EU remains committed to the climate change mitigation, through the international funding. Therefore, Cyprus has already contributed through the direct funding of the EU, with the amount of 1.2 million € for two projects in Nepal and eastern Caribbean. In the fulfilment of the requirements of Article 16 of Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC, Cyprus submits reports including information regarding funding provided by the Republic of Cyprus to developing countries. No private funding, technology and capacity building have been provided to developing countries since 2013 due to the fact that Cyprus is implementing a macroeconomic adjustment program in order to improve key sectors of the economy as well as its public finances, pursuant to the provisions of the Memorandum of Understanding.

Annexes
to the national inventory report

Annex 1: Key categories

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

In that context, a “key source category” is one that is prioritised within the national inventory system because its estimate has a significant influence on a country’s total inventory of direct greenhouse gases in terms of the absolute level of emissions (level assessment) or/and to the trend of emissions (trend assessment).

As far as possible, key source categories should receive special consideration in terms of two important inventory aspects.

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

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

The determination of the key categories without LULUCF for the Greek inventory system is based on the application of the Tier 1 methodology described in the 2006 IPCC Guidelines, adopting the categorization of sources that is presented in the GLs. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms. It should be noted that, according to the 2006 IPCC GLs the trend is estimated on the basis of the base year (1990). The methodology for the determination of key categories with LULUCF is the same as for the one for key sources without LULUCF.

The key categories analysis has been performed for the years 1990 and 2017 on both level and trend analysis basis. Any differences between the key categories in the time-series are due to the fluctuation of the trend in specific categories and refer to trend analysis.

Table A1.1.Key categories analysis without LULUCF – Level assessment for 2018

IPCC Source category	Direct GHG	2018 estimate (Gg CO2 eq.)	Level assessment	Cumulative total of level assessment
1A1a. Public electricity and heat production	CO_2	3342.359900	0.3824225068	38.24%
1A3b. Road transportation	CO_2	2051.238091	0.2346963332	61.71%
2A1. Cement production	CO_2	918.9477000	0.1051431604	72.23%
1A2f. Non-metallic minerals	CO_2	419.551723	0.0480038136	77.03%
5A2. Unmanaged waste disposal sites	CH_4	417.1767540	0.0477320770	81.80%
1A4b. Residential	CO_2	284.479968	0.0325493202	85.05%

2F1. Refrigeration and air conditioning	**HFCs[(1)]**	**162.8645362**	**0.0186344577**	**86.92%**
3D. Agricultural soils(2) (3) (4)	**N_2O**	**119.1676610**	**0.0136347961**	**88.28%**
1A4a. Commercial/institutional	**CO_2**	**108.655021**	**0.0124319722**	**89.52%**
3A1a. Dairy cattle	**CH_4**	**98.6078568**	**0.0112824067**	**90.65%**
5A1. Managed waste disposal sites	**CH_4**	**87.8035352**	**0.0100462096**	**91.66%**
1A4c. Agriculture/forestry/fishing	**CO_2**	**78.7840367**	**0.0090142264**	**92.56%**
1A2e. Food processing, beverages and tobacco	**CO_2**	**65.513744**	**0.0074958804**	**93.31%**
3A2. Sheep	**CH_4**	**62.1976000**	**0.0071164575**	**94.02%**
2G3. N2O from product uses	**N_2O**	**60.8218000**	**0.0069590427**	**94.72%**
3A1b. Non-dairy cattle	**CH_4**	**55.4168250**	**0.0063406221**	**95.35%**
1A2g. Other (*please specify*)	**CO_2**	**51.927549**	**0.0059413899**	**95.94%**
3B3. Swine	CH_4	31.7423760	0.0036318647	96.31%
3A4a. Goats	CH_4	31.3015000	0.0035814210	96.67%
5D2. Industrial wastewater	CH_4	30.7408318	0.0035172711	97.02%
3B5. Indirect N_2O emissions	N_2O	27.5132076	0.0031479763	97.33%
1A5a. Stationary	CO_2	19.3567725	0.0022147422	97.55%
5D1. Domestic wastewater	CH_4	18.4749080	0.0021138420	97.77%
5D1. Domestic wastewater	N_2O	16.5372675	0.0018921431	97.95%
3A3. Swine	CH_4	13.5769500	0.0015534327	98.11%
2A4. Other process uses of carbonates	CO_2	12.8582000	0.0014711956	98.26%
1A3b. Road transportation	N_2O	12.501466	0.0014303791	98.40%
3B4a. Goats	N_2O	10.9571820	0.0012536870	98.53%
3B2. Sheep	N_2O	9.0364183	0.0010339191	98.63%
2D3. Other	CO_2	8.9990200	0.0010296401	98.73%
3B1a. Dairy cattle	CH_4	8.2094550	0.0009393005	98.83%
1A2c. Chemicals	CO_2	7.816436	0.0008943325	98.91%
1A1a. Public electricity and heat production	N_2O	7.709666	0.0008821162	99.00%
3B1a. Dairy cattle	N_2O	6.8331290	0.0007818255	99.08%
3B4d. Poultry	N_2O	5.9159439	0.0006768840	99.15%
2D1. Lubricant use	CO_2	4.6140000	0.0005279196	99.20%
1A5b. Mobile	CO_2	4.5153108	0.0005166279	99.25%
2F3. Fire protection	HFCs[(1)]	4.2749167	0.0004891228	99.30%
1A4b. Residential	CH_4	4.2578406	0.0004871690	99.35%
3B1b. Non-dairy cattle	CH_4	4.2560992	0.0004869697	99.40%
3B3. Swine	N_2O	3.8321346	0.0004384610	99.44%
1A3b. Road transportation	CH_4	3.668416	0.0004197288	99.49%
2F4. Aerosols	HFCs[(1)]	3.4982090	0.0004002543	99.53%
1A2f. Non-metallic minerals	N_2O	3.427695	0.0003921863	99.56%
3B1b. Non-dairy cattle	N_2O	3.3654305	0.0003850622	99.60%
5B1. Composting	CH_4	3.3125000	0.0003790060	99.64%
1A1a. Public electricity and heat production	CH_4	3.233920	0.0003700152	99.68%

2A2. Lime production	CO_2	3.1784000	0.0003636627	99.71%
1A2d. Pulp, paper and print	CO_2	2.601671	0.0002976751	99.74%
3B4d. Poultry	CH_4	2.4810968	0.0002838794	99.77%
5B1. Composting	N_2O	2.3691000	0.0002710651	99.80%
1A2b. Non-ferrous metals	CO_2	2.187089	0.0002502400	99.82%
3B2. Sheep	CH_4	2.1769160	0.0002490760	99.85%
1A3d. Domestic navigation	CO_2	2.144380	0.0002453533	99.87%
1A2f. Non-metallic minerals	CH_4	2.023575	0.0002315312	99.90%
1A4a. Commercial/institutional	CH_4	1.323102	0.0001513852	99.91%
2F2. Foam blowing agents	HFCs[(1)]	1.2773518	0.0001461506	99.93%
3B4a. Goats	CH_4	1.2520600	0.0001432568	99.94%
1A4b. Residential	N_2O	0.9391919	0.0001074594	99.95%
1A3a. Domestic aviation	CO_2	0.888586	0.0001016693	99.96%
1A4c. Agriculture/forestry/fishing	CH_4	0.3106253	0.0000355408	99.97%
3A4c. Mules and Asses	CH_4	0.3005000	0.0000343823	99.97%
5D2. Industrial wastewater	N_2O	0.2954306	0.0000338023	99.97%
1A4a. Commercial/institutional	N_2O	0.256058	0.0000292973	99.98%
3H. Urea application	CO_2	0.2234467	0.0000255661	99.98%
1A2e. Food processing, beverages and tobacco	N_2O	0.203155	0.0000232444	99.98%
1A4c. Agriculture/forestry/fishing	N_2O	0.1886410	0.0000215837	99.98%
3F. Field burning of agricultural residues	CH_4	0.1769911	0.0000202508	99.98%
2G1. Electrical equipment	SF_6	0.1653081	0.0000189140	99.99%
1A1c. Manufacture of solid fuels and other energy industries	N_2O	0.133003	0.0000152178	99.99%
3A4b. Horses	CH_4	0.1273500	0.0000145710	99.99%
1A2g. Other (*please specify*)	N_2O	0.122528	0.0000140192	99.99%
1A2e. Food processing, beverages and tobacco	CH_4	0.106245	0.0000121562	99.99%
1A1c. Manufacture of solid fuels and other energy industries	CH_4	0.083685	0.0000095750	99.99%
3B4c. Mules and Asses	N_2O	0.0721133	0.0000082510	99.99%
1A5a. Stationary	CH_4	0.0653063	0.0000074721	99.99%
2D2. Paraffin wax use	CO_2	0.0589435	0.0000067441	100.00%
3F. Field burning of agricultural residues	N_2O	0.0546968	0.0000062582	100.00%
1A2g. Other (*please specify*)	CH_4	0.050866	0.0000058200	100.00%
1A5a. Stationary	N_2O	0.0467070	0.0000053441	100.00%
1A2c. Chemicals	N_2O	0.038651	0.0000044223	100.00%
1A3d. Domestic navigation	N_2O	0.033633	0.0000038482	100.00%
3B4c. Mules and Asses	CH_4	0.0330550	0.0000037821	100.00%
3B4b. Horses	N_2O	0.0282974	0.0000032377	100.00%
1A2c. Chemicals	CH_4	0.020842	0.0000023847	100.00%
3B4b. Horses	CH_4	0.0165555	0.0000018942	100.00%
1A5b. Mobile	CH_4	0.0157878	0.0000018064	100.00%
2G4. Other	CO_2	0.0130200	0.0000014897	100.00%

1A5b. Mobile	N_2O	0.0112914	0.0000012919	100.00%
1A3a. Domestic aviation	N_2O	0.007407	0.0000008475	100.00%
1A2d. Pulp, paper and print	N_2O	0.004390	0.0000005023	100.00%
1A3d. Domestic navigation	CH_4	0.002822	0.0000003228	100.00%
1A2d. Pulp, paper and print	CH_4	0.002017	0.0000002308	100.00%
1A2b. Non-ferrous metals	N_2O	0.001837	0.0000002102	100.00%
1A2b. Non-ferrous metals	CH_4	0.001122	0.0000001283	100.00%
1A3a. Domestic aviation	CH_4	0.000155	0.0000000178	100.00%

Table A1.2.Key categories analysis with LULUCF – Level assessment for 2018

IPCC Source category	Direct GHG	2018 estimate (Gg CO2 eq.)	Level assessment	Cumulative total of level assessment
1A1a. Public electricity and heat production	**CO_2**	**3342.359900**	**0.3587416085**	**35.87%**
1A3b. Road transportation	**CO_2**	**2051.238091**	**0.2201631405**	**57.89%**
2A1. Cement production	**CO_2**	**843.3490000**	**0.0905181925**	**66.94%**
1A2f. Non-metallic minerals	**CO_2**	**419.551723**	**0.0450312547**	**71.45%**
5A2. Unmanaged waste disposal sites	**CH_4**	**417.1767540**	**0.0447763449**	**75.92%**
2F1. Refrigeration and air conditioning	**HFCs(1)**	**288.0897503**	**0.0309212004**	**79.02%**
1A4b. Residential	**CO_2**	**284.479968**	**0.0305337559**	**82.07%**
4B1. Cropland remaining cropland	**CO_2**	**132.4103000**	**0.0142118400**	**83.49%**
4A1. Forest land remaining forest land	**CO_2**	**129.7118383**	**0.0139222091**	**84.88%**
3D. Agricultural soils(2) (3) (4)	**N_2O**	**119.1676610**	**0.0127904833**	**86.16%**
4C1. Grassland remaining grassland	**CO_2**	**118.2048081**	**0.0126871385**	**87.43%**
1A4a. Commercial/institutional	**CO_2**	**108.655021**	**0.0116621424**	**88.60%**
3A1a. Dairy cattle	**CH_4**	**98.6078568**	**0.0105837618**	**89.65%**
5A1. Managed waste disposal sites	**CH_4**	**87.8035352**	**0.0094241142**	**90.60%**
1A4c. Agriculture/forestry/fishing	**CO_2**	**78.7840367**	**0.0084560349**	**91.44%**
1A2e. Food processing, beverages and tobacco	**CO_2**	**65.513744**	**0.0070317101**	**92.15%**
2G3. N2O from product uses	**N_2O**	**64.9126248**	**0.0069671909**	**92.84%**
3A2. Sheep	**CH_4**	**62.1976000**	**0.0066757823**	**93.51%**
3A1b. Non-dairy cattle	**CH_4**	**55.4168250**	**0.0059479893**	**94.10%**
1A2g. Other (*please specify*)	**CO_2**	**51.927549**	**0.0055734789**	**94.66%**
4A2. Land converted to forest land	**CO_2**	**33.7369747**	**0.0036210513**	**95.02%**
3B3. Swine	**CH_4**	**31.7423760**	**0.0034069673**	**95.36%**
3A4a. Goats	**CH_4**	**31.3015000**	**0.0033596473**	**95.70%**
5D2. Industrial wastewater	CH_4	30.7408318	0.0032994698	96.03%
3B5. Indirect N_2O emissions	N_2O	27.5132076	0.0029530430	96.33%
2D3. Other	CO_2	25.5366575	0.0027408962	96.60%
4G. Harvested wood products (5)	CO_2	24.1208439	0.0025889343	96.86%
4B2. Land converted to cropland	CO_2	21.3593606	0.0022925393	97.09%

4E2. Land converted to settlements	CO_2	20.0862053	0.0021558892	97.30%
1A5a. Stationary	CO_2	19.3567725	0.0020775978	97.51%
5D1. Domestic wastewater	**CH_4**	18.4749080	0.0019829457	97.71%
5D1. Domestic wastewater	N_2O	16.5372675	0.0017749752	97.89%
2A4. Other process uses of carbonates	CO_2	14.7390636	0.0015819707	98.05%
3A3. Swine	CH_4	13.5769500	0.0014572389	98.19%
1A3b. Road transportation	N_2O	12.501466	0.0013418052	98.33%
3B4a. Goats	N_2O	10.9571820	0.0011760544	98.44%
3B2. Sheep	N_2O	9.0364183	0.0009698953	98.54%
4D2. Land converted to wetlands	CO_2	9.0057914	0.0009666081	98.64%
3B1a. Dairy cattle	CH_4	8.209455	0.0008811358	98.72%
1A2c. Chemicals	CO_2	7.816436	0.0008389524	98.81%
1A1a. Public electricity and heat production	N_2O	7.709666	0.0008274926	98.89%
3B1a. Dairy cattle	N_2O	6.833129	0.0007334122	98.96%
4C2. Land converted to grassland	CO_2	6.5172265	0.0006995059	99.03%
4F2. Land converted to other land	CO_2	6.5144541	0.0006992083	99.10%
3B4d. Poultry	N_2O	5.9159439	0.0006349691	99.17%
2A2. Lime production	CO_2	5.3347575	0.0005725893	99.23%
2D1. Lubricant use	CO_2	4.5181048	0.0004849365	99.27%
1A5b. Mobile	CO_2	4.5153108	0.0004846366	99.32%
2F3. Fire protection	HFCs(1)	4.2749167	0.0004588346	99.37%
1A4b. Residential	CH_4	4.2578406	0.0004570018	99.41%
3B1b. Non-dairy cattle	CH_4	4.2560992	0.0004568149	99.46%
3B3. Swine	N_2O	3.8321346	0.0004113100	99.50%
1A3b. Road transportation	CH_4	3.668416	0.0003937378	99.54%
2F4. Aerosols	HFCs(1)	3.4982090	0.0003754692	99.58%
1A2f. Non-metallic minerals	N_2O	3.427695	0.0003679008	99.61%
3B1b. Non-dairy cattle	N_2O	3.3654305	0.0003612178	99.65%
5B1. Composting	CH_4	3.3125000	0.0003555367	99.69%
1A1a. Public electricity and heat production	CH_4	3.233920	0.0003471026	99.72%
1A2d. Pulp, paper and print	CO_2	2.601671	0.0002792421	99.75%
3B4d. Poultry	CH_4	2.4810968	0.0002663007	99.78%
5B1. Composting	N_2O	2.3691000	0.0002542798	99.80%
1A2b. Non-ferrous metals	CO_2	2.187089	0.0002347443	99.82%
3B2. Sheep	CH_4	2.1769160	0.0002336524	99.85%
1A3d. Domestic navigation	CO_2	2.144380	0.0002301602	99.87%
1A2f. Non-metallic minerals	CH_4	2.023575	0.0002171940	99.89%
1A4a. Commercial/institutional	CH_4	1.323102	0.0001420109	99.91%
2F2. Foam blowing agents	HFCs(1)	1.2773518	0.0001371005	99.92%
3B4a. Goats	CH_4	1.2520600	0.0001343859	99.93%
1A4b. Residential	N_2O	0.9391919	0.0001008052	99.94%
1A3a. Domestic aviation	CO_2	0.888586	0.0000953736	99.95%

4A1. Forest land remaining forest land	CH_4	0.7462892	0.0000801006	99.96%
1A4c. Agriculture/forestry/fishing	CH_4	0.3106253	0.0000333400	99.96%
3A4c. Mules and Asses	CH_4	0.3005000	0.0000322532	99.97%
5D2. Industrial wastewater	N_2O	0.2954306	0.0000317091	99.97%
4A1. Forest land remaining forest land	N_2O	0.2616402	0.0000280823	99.97%
1A4a. Commercial/institutional	N_2O	0.256058	0.0000274831	99.98%
3H. Urea application	CO_2	0.2234467	0.0000239829	99.98%
1A2e. Food processing, beverages and tobacco	N_2O	0.203155	0.0000218050	99.98%
1A4c. Agriculture/forestry/fishing	N_2O	0.1886410	0.0000202472	99.98%
3F. Field burning of agricultural residues	CH_4	0.1769911	0.0000189968	99.99%
2G1. Electrical equipment	SF_6	0.1653081	0.0000177428	99.99%
1A1c. Manufacture of solid fuels and other energy industries	N_2O	0.133003	0.0000142755	99.99%
3A4b. Horses	CH_4	0.1273500	0.0000136687	99.99%
1A2g. Other (*please specify*)	N_2O	0.122528	0.0000131511	99.99%
1A2e. Food processing, beverages and tobacco	CH_4	0.106245	0.0000114035	99.99%
1A1c. Manufacture of solid fuels and other energy industries	CH_4	0.083685	0.0000089821	99.99%
3B4c. Mules and Asses	N_2O	0.0721133	0.0000077401	99.99%
1A5a. Stationary	CH_4	0.0653063	0.0000070094	99.99%
2D2. Paraffin wax use	CO_2	0.0616810	0.0000066203	100.00%
1B2c. Venting and flaring	CO_2	0.0604927	0.0000064928	100.00%
3F. Field burning of agricultural residues	N_2O	0.0546968	0.0000058707	100.00%
1A2g. Other (*please specify*)	CH_4	0.050866	0.0000054596	100.00%
1A5a. Stationary	N_2O	0.0467070	0.0000050132	100.00%
1A2c. Chemicals	N_2O	0.038651	0.0000041485	100.00%
1A3d. Domestic navigation	N_2O	0.033633	0.0000036099	100.00%
3B4c. Mules and Asses	CH_4	0.0330550	0.0000035479	100.00%
3B4b. Horses	N_2O	0.0282974	0.0000030372	100.00%
1A2c. Chemicals	CH_4	0.020842	0.0000022370	100.00%
3B4b. Horses	CH_4	0.0165555	0.0000017769	100.00%
1A5b. Mobile	CH_4	0.0157878	0.0000016945	100.00%
2G4. Other	CO_2	0.0118300	0.0000012697	100.00%
1A5b. Mobile	N_2O	0.0112914	0.0000012119	100.00%
1A3a. Domestic aviation	N_2O	0.007407	0.0000007950	100.00%
1A2d. Pulp, paper and print	N_2O	0.004390	0.0000004712	100.00%
1A3d. Domestic navigation	CH_4	0.002822	0.0000003028	100.00%
1A2d. Pulp, paper and print	CH_4	0.002017	0.0000002165	100.00%
1A2b. Non-ferrous metals	N_2O	0.001837	0.0000001971	100.00%
1A2b. Non-ferrous metals	CH_4	0.001122	0.0000001204	100.00%
1A3a. Domestic aviation	CH_4	0.000155	0.0000000167	100.00%

Table A1.3.Key categories analysis without LULUCF – Level assessment for 1990

IPCC Source category	Direct GHG	1990 estimate (Gg CO2 eq.)	Level assessment	Cumulative total of level assessment
1A1a. Public electricity and heat production	**CO_2**	**1675.770000**	**0.2990542273**	**29.9%**
1A3b. Road transportation	**CO_2**	**1186.010542**	**0.2116528319**	**51.1%**
2A1. Cement production	**CO_2**	**667.664000**	**0.1191498485**	**63.0%**
1A2f. Non-metallic minerals	**CO_2**	**379.826700**	**0.0677830372**	**69.8%**
1A4b. Residential	**CO_2**	**299.704000**	**0.0534845165**	**75.1%**
5A2. Unmanaged waste disposal sites	**CH_4**	**264.959926**	**0.0472841654**	**79.8%**
5D1. Domestic wastewater	**CH_4**	**91.895500**	**0.0163994687**	**81.5%**
1A1b. Petroleum refining	**CO_2**	**85.718200**	**0.0152970814**	**83.0%**
2F1. Refrigeration and air conditioning	**HFCs**	**79.600350**	**0.0142053033**	**84.4%**
1A4a. Commercial/institutional	**CO_2**	**75.212000**	**0.0134221680**	**85.8%**
1A2e. Food processing, beverages and tobacco	**CO_2**	**72.570570**	**0.0129507843**	**87.1%**
3A2. Sheep	**CH_4**	**58.000000**	**0.0103505524**	**88.1%**
1A4c. Agriculture/forestry/fishing	**CO_2**	**55.484000**	**0.0099015526**	**89.1%**
3A1a. Dairy cattle	**CH_4**	**55.350000**	**0.0098776392**	**90.1%**
3B3. Swine	**CH_4**	**54.552500**	**0.0097353191**	**91.1%**
3D. Agricultural soils	**N_2O**	**48.134152**	**0.0085899149**	**91.9%**
2G3. N2O from product uses	**N_2O**	**47.880107**	**0.0085445786**	**92.8%**
1A2g. Other	**CO_2**	**47.869907**	**0.0085427583**	**93.6%**
3A1b. Non-dairy cattle	**CH_4**	**45.985000**	**0.0082063819**	**94.4%**
2A4. Other process uses of carbonates	**CO_2**	**44.076000**	**0.0078657060**	**95.2%**
1A3a. Domestic aviation	**CO_2**	**26.045000**	**0.0046479334**	**95.7%**
3A4a. Goats	CH_4	25.750000	0.0045952883	96.2%
3B5. Indirect N_2O emissions	N_2O	24.377503	0.0043503555	96.6%
5D2. Industrial wastewater	CH_4	24.197500	0.0043182326	97.0%
1A3b. Road transportation	N_2O	23.582144	0.0042084175	97.4%
5D1. Domestic wastewater	N_2O	11.979600	0.0021378531	97.7%
1A5a. Stationary	CO_2	10.995000	0.0019621435	97.9%
3A3. Swine	CH_4	10.422500	0.0018599764	98.0%
3B4a. Goats	N_2O	8.969800	0.0016007308	98.2%
3B2. Sheep	N_2O	8.433400	0.0015050060	98.3%
3B4d. Poultry	N_2O	7.867200	0.0014039632	98.5%
3B3. Swine	N_2O	7.748000	0.0013826910	98.6%
2D3. Other	CO_2	7.447653	0.0013290917	98.8%
1A3b. Road transportation	CH_4	6.856323	0.0012235644	98.9%
3B1a. Dairy cattle	CH_4	5.919000	0.0010562917	99.0%
2A2. Lime production	CO_2	5.332600	0.0009516441	99.1%
3B1a. Dairy cattle	N_2O	5.066000	0.0009040672	99.2%
1A2b. Non-ferrous metals	CO_2	4.910000	0.0008762278	99.3%
1A2d. Pulp, paper and print	CO_2	4.820700	0.0008602915	99.3%

1A1a. Public electricity and heat production	N_2O	3.874000	0.0006913455	99.4%
3B1b. Non-dairy cattle	CH_4	3.622370	0.0006464401	99.5%
3B1b. Non-dairy cattle	N_2O	3.267342	0.0005830827	99.5%
1A2c. Chemicals	CO_2	2.199000	0.0003924287	99.6%
1A3d. Domestic navigation	CO_2	2.198000	0.0003922502	99.6%
3B4d. Poultry	CH_4	2.102500	0.0003752075	99.7%
3B2. Sheep	CH_4	2.030000	0.0003622693	99.7%
1A4b. Residential	CH_4	1.904500	0.0003398729	99.7%
3H. Urea application	CO_2	1.815000	0.0003239009	99.8%
1A1a. Public electricity and heat production	CH_4	1.650000	0.0002944554	99.8%
3F. Field burning of agricultural residues	CH_4	1.550718	0.0002767376	99.8%
1A2f. Non-metallic minerals	N_2O	1.435168	0.0002561169	99.8%
3A4c. Mules and Asses	CH_4	1.256500	0.0002242322	99.9%
2D1. Lubricant use	CO_2	1.120000	0.0001998727	99.9%
3B4a. Goats	CH_4	1.025000	0.0001829192	99.9%
1A2f. Non-metallic minerals	CH_4	0.759025	0.0001354539	99.9%
1A4b. Residential	N_2O	0.697320	0.0001244422	99.9%
3F. Field burning of agricultural residues	N_2O	0.478883	0.0000854604	99.9%
1B2a. Oil	CH_4	0.404930	0.0000722629	99.9%
1A4a. Commercial/institutional	CH_4	0.374750	0.0000668771	99.9%
5D2. Industrial wastewater	N_2O	0.310516	0.0000554140	100.0%
3B4c. Mules and Asses	N_2O	0.301546	0.0000538133	100.0%
1A3a. Domestic aviation	N_2O	0.217093	0.0000387419	100.0%
3A4b. Horses	CH_4	0.207000	0.0000369408	100.0%
1A4c. Agriculture/forestry/fishing	CH_4	0.183500	0.0000327470	100.0%
1A2e. Food processing, beverages and tobacco	N_2O	0.151980	0.0000271220	100.0%
1A4a. Commercial/institutional	N_2O	0.139524	0.0000248991	100.0%
3B4c. Mules and Asses	CH_4	0.138228	0.0000246678	100.0%
1A1c. Manufacture of solid fuels and other energy industries	N_2O	0.133504	0.0000238248	100.0%
1A4c. Agriculture/forestry/fishing	N_2O	0.128617	0.0000229527	100.0%
1A2g. Other	N_2O	0.113538	0.0000202617	100.0%
1A1b. Petroleum refining	N_2O	0.107280	0.0000191450	100.0%
1B2c. Venting and flaring	CH_4	0.091250	0.0000162843	100.0%
1A1c. Manufacture of solid fuels and other energy industries	CH_4	0.084000	0.0000149905	100.0%
1A2e. Food processing, beverages and tobacco	CH_4	0.066000	0.0000117782	100.0%
2D2. Paraffin wax use	CO_2	0.063498	0.0000113316	100.0%
1A1b. Petroleum refining	CH_4	0.055500	0.0000099044	100.0%
1A2g. Other	CH_4	0.047850	0.0000085392	100.0%
3B4b. Horses	N_2O	0.044700	0.0000079771	100.0%
2G4. Other	CO_2	0.041210	0.0000073542	100.0%
1A5a. Stationary	CH_4	0.037000	0.0000066029	100.0%
1A3d. Domestic navigation	N_2O	0.034568	0.0000061689	100.0%

3B4b. Horses	CH_4	0.027000	0.0000048184	100.0%
1A5a. Stationary	N_2O	0.026522	0.0000047331	100.0%
2G1. Electrical equipment	SF_6	0.025767	0.0000045983	100.0%
1A2d. Pulp, paper and print	N_2O	0.011145	0.0000019889	100.0%
1A2b. Non-ferrous metals	N_2O	0.005960	0.0000010636	100.0%
1A2c. Chemicals	N_2O	0.005364	0.0000009572	100.0%
1A2d. Pulp, paper and print	CH_4	0.004675	0.0000008343	100.0%
1A3a. Domestic aviation	CH_4	0.004550	0.0000008120	100.0%
1A2b. Non-ferrous metals	CH_4	0.003250	0.0000005800	100.0%
1A3d. Domestic navigation	CH_4	0.002900	0.0000005175	100.0%
1A2c. Chemicals	CH_4	0.002250	0.0000004015	100.0%

Table A1.4.Key categories analysis with LULUCF – Level assessment for 1990

IPCC Source category	Direct GHG	1990 estimate (Gg CO2 eq.)	Level assessment	Cumulative total of level assessment
1A1a. Public electricity and heat production	CO_2	**1675.770000**	**0.2781913670**	**27.8%**
1A3b. Road transportation	CO_2	**1186.010542**	**0.1968873377**	**47.5%**
2A1. Cement production	CO_2	**667.664000**	**0.1108376214**	**58.6%**
1A2f. Non-metallic minerals	CO_2	**379.826700**	**0.0630543027**	**64.9%**
1A4b. Residential	CO_2	**299.704000**	**0.0497532868**	**69.9%**
5A2. Unmanaged waste disposal sites	CH_4	**264.959926**	**0.0439854896**	**74.3%**
4B1. Cropland remaining cropland	CO_2	**135.060200**	**0.0224210850**	**76.5%**
4C1. Grassland remaining grassland	CO_2	**134.142940**	**0.0222688124**	**78.7%**
4F2. Land converted to other land	CO_2	**95.534942**	**0.0158595726**	**80.3%**
5D1. Domestic wastewater	CH_4	**91.895500**	**0.0152553959**	**81.9%**
1A1b. Petroleum refining	CO_2	**85.718200**	**0.0142299142**	**83.3%**
2F1. Refrigeration and air conditioning	**HFCs**	**79.600350**	**0.0132143016**	**84.6%**
1A4a. Commercial/institutional	CO_2	**75.212000**	**0.0124858000**	**85.8%**
1A2e. Food processing, beverages and tobacco	CO_2	**72.570570**	**0.0120473013**	**87.0%**
3A2. Sheep	CH_4	**58.000000**	**0.0096284689**	**88.0%**
1A4c. Agriculture/forestry/fishing	CO_2	**55.484000**	**0.0092107925**	**88.9%**
3A1a. Dairy cattle	CH_4	**55.350000**	**0.0091885475**	**89.9%**
3B3. Swine	CH_4	**54.552500**	**0.0090561560**	**90.8%**
3D. Agricultural soils	N_2O	**48.134152**	**0.0079906584**	**91.6%**
2G3. N2O from product uses	N_2O	**47.880107**	**0.0079484848**	**92.4%**
1A2g. Other	CO_2	**47.869907**	**0.0079467915**	**93.1%**
3A1b. Non-dairy cattle	CH_4	**45.985000**	**0.0076338817**	**93.9%**
2A4. Other process uses of carbonates	CO_2	**44.076000**	**0.0073169723**	**94.6%**
4A1. Forest land remaining forest land	CO_2	**32.867621**	**0.0054562908**	**95.2%**
1A3a. Domestic aviation	CO_2	**26.045000**	**0.0043236805**	**95.6%**
3A4a. Goats	CH_4	25.750000	0.0042747082	96.0%
3B5. Indirect N_2O emissions	N_2O	24.377503	0.0040468625	96.5%

5D2. Industrial wastewater	CH_4	24.197500	0.0040169806	96.9%
1A3b. Road transportation	N_2O	23.582144	0.0039148266	97.2%
4A2. Land converted to forest land	CO_2	12.657145	0.0021011884	97.5%
5D1. Domestic wastewater	N_2O	11.979600	0.0019887104	97.7%
1A5a. Stationary	CO_2	10.995000	0.0018252589	97.8%
3A3. Swine	CH_4	10.422500	0.0017302193	98.0%
3B4a. Goats	N_2O	8.969800	0.0014890593	98.2%
3B2. Sheep	N_2O	8.433400	0.0014000126	98.3%
3B4d. Poultry	N_2O	7.867200	0.0013060188	98.4%
3B3. Swine	N_2O	7.748000	0.0012862306	98.6%
2D3. Other	CO_2	7.447653	0.0012363706	98.7%
1A3b. Road transportation	CH_4	6.856323	0.0011382051	98.8%
3B1a. Dairy cattle	CH_4	5.919000	0.0009826018	98.9%
2A2. Lime production	CO_2	5.332600	0.0008852547	99.0%
3B1a. Dairy cattle	N_2O	5.066000	0.0008409970	99.1%
1A2b. Non-ferrous metals	CO_2	4.910000	0.0008150997	99.1%
1A2d. Pulp, paper and print	CO_2	4.820700	0.0008002752	99.2%
1A1a. Public electricity and heat production	N_2O	3.874000	0.0006431153	99.3%
4B2. Land converted to cropland	CO_2	3.851576	0.0006393928	99.4%
3B1b. Non-dairy cattle	CH_4	3.622370	0.0006013427	99.4%
4G. Harvested wood products	CO_2	3.271830	0.0005431502	99.5%
3B1b. Non-dairy cattle	N_2O	3.267342	0.0005424052	99.5%
1A2c. Chemicals	CO_2	2.199000	0.0003650518	99.6%
1A3d. Domestic navigation	CO_2	2.198000	0.0003648858	99.6%
3B4d. Poultry	CH_4	2.102500	0.0003490320	99.6%
3B2. Sheep	CH_4	2.030000	0.0003369964	99.7%
1A4b. Residential	CH_4	1.904500	0.0003161624	99.7%
3H. Urea application	CO_2	1.815000	0.0003013047	99.7%
4E2. Land converted to settlements	CO_2	1.755169	0.0002913723	99.8%
1A1a. Public electricity and heat production	CH_4	1.650000	0.0002739133	99.8%
3F. Field burning of agricultural residues	CH_4	1.550718	0.0002574316	99.8%
1A2f. Non-metallic minerals	N_2O	1.435168	0.0002382495	99.8%
3A4c. Mules and Asses	CH_4	1.256500	0.0002085892	99.9%
2D1. Lubricant use	CO_2	1.120000	0.0001859291	99.9%
3B4a. Goats	CH_4	1.025000	0.0001701583	99.9%
4D2. Land converted to wetlands	CO_2	1.024691	0.0001701069	99.9%
1A2f. Non-metallic minerals	CH_4	0.759025	0.0001260043	99.9%
1A4b. Residential	N_2O	0.697320	0.0001157608	99.9%
3F. Field burning of agricultural residues	N_2O	0.478883	0.0000794985	99.9%
1B2a. Oil	CH_4	0.404930	0.0000672216	99.9%
1A4a. Commercial/institutional	CH_4	0.374750	0.0000622115	100.0%
5D2. Industrial wastewater	N_2O	0.310516	0.0000515482	100.0%
3B4c. Mules and Asses	N_2O	0.301546	0.0000500591	100.0%
1A3a. Domestic aviation	N_2O	0.217093	0.0000360392	100.0%

3A4b. Horses	CH_4	0.207000	0.0000343637	100.0%
1A4c. Agriculture/forestry/fishing	CH_4	0.183500	0.0000304625	100.0%
1A2e. Food processing, beverages and tobacco	N_2O	0.151980	0.0000252299	100.0%
1A4a. Commercial/institutional	N_2O	0.139524	0.0000231620	100.0%
3B4c. Mules and Asses	CH_4	0.138228	0.0000229469	100.0%
1A1c. Manufacture of solid fuels and other energy industries	N_2O	0.133504	0.0000221627	100.0%
1A4c. Agriculture/forestry/fishing	N_2O	0.128617	0.0000213514	100.0%
1A2g. Other	N_2O	0.113538	0.0000188482	100.0%
1A1b. Petroleum refining	N_2O	0.107280	0.0000178093	100.0%
1B2c. Venting and flaring	CH_4	0.091250	0.0000151482	100.0%
1A1c. Manufacture of solid fuels and other energy industries	CH_4	0.084000	0.0000139447	100.0%
1A2e. Food processing, beverages and tobacco	CH_4	0.066000	0.0000109565	100.0%
2D2. Paraffin wax use	CO_2	0.063498	0.0000105411	100.0%
1A1b. Petroleum refining	CH_4	0.055500	0.0000092134	100.0%
4A1. Forest land remaining forest land	CH_4	0.052758	0.0000087582	100.0%
1A2g. Other	CH_4	0.047850	0.0000079435	100.0%
3B4b. Horses	N_2O	0.044700	0.0000074206	100.0%
2G4. Other	CO_2	0.041210	0.0000068412	100.0%
1A5a. Stationary	CH_4	0.037000	0.0000061423	100.0%
1A3d. Domestic navigation	N_2O	0.034568	0.0000057386	100.0%
3B4b. Horses	CH_4	0.027000	0.0000044822	100.0%
1A5a. Stationary	N_2O	0.026522	0.0000044029	100.0%
2G1. Electrical equipment	SF_6	0.025767	0.0000042775	100.0%
4A1. Forest land remaining forest land	N_2O	0.018496	0.0000030705	100.0%
1A2d. Pulp, paper and print	N_2O	0.011145	0.0000018502	100.0%
1A2b. Non-ferrous metals	N_2O	0.005960	0.0000009894	100.0%
1A2c. Chemicals	N_2O	0.005364	0.0000008905	100.0%
1A2d. Pulp, paper and print	CH_4	0.004675	0.0000007761	100.0%
1A3a. Domestic aviation	CH_4	0.004550	0.0000007553	100.0%
1A2b. Non-ferrous metals	CH_4	0.003250	0.0000005395	100.0%
1A3d. Domestic navigation	CH_4	0.002900	0.0000004814	100.0%
1A2c. Chemicals	CH_4	0.002250	0.0000003735	100.0%

Table A1.5.Key categories analysis without LULUCF – Trend assessment for 2018

IPCC Source category	Direct GHG	1990 estimate	2018 estimate	Level assessment 2017	Trend assessment	% contribution to trend	Cumulative total of level assessment
1A1a. Public electricity and heat production	**CO_2**	**1675.770000**	**3342.3599**	**0.382423**	**0.045756**	**27.25%**	**27.25%**
1A4b. Residential	**CO_2**	**299.704000**	**284.4799682**	**0.032549**	**0.014077**	**8.38%**	**35.64%**
1A2f. Non-metallic minerals	**CO_2**	**379.826700**	**419.5517229**	**0.048004**	**0.013647**	**8.13%**	**43.76%**
2F1. Refrigeration and air conditioning	**HFCs[(1)]**	**0.000000**	**162.8645362**	**0.018634**	**0.011572**	**6.89%**	**50.66%**
2A1. Cement production	**CO_2**	**667.664000**	**918.9477**	**0.105143**	**0.011096**	**6.61%**	**57.27%**
1A3b. Road transportation	**CO_2**	**1186.010542**	**2051.238091**	**0.234696**	**0.010052**	**5.99%**	**63.25%**
5D1. Domestic wastewater	**CH_4**	**91.895500**	**18.47490796**	**0.002114**	**0.009202**	**5.48%**	**68.73%**
3D. Agricultural soils(2) (3) (4)	**N_2O**	**0.000000**	**119.167661**	**0.013635**	**0.008468**	**5.04%**	**73.78%**
5A1. Managed waste disposal sites	**CH_4**	**0.000000**	**87.80353521**	**0.010046**	**0.006239**	**3.72%**	**77.49%**
2A4. Other process uses of carbonates	**CO_2**	**44.076000**	**12.8582**	**0.001471**	**0.004129**	**2.46%**	**79.95%**
3B3. Swine	**CH_4**	**54.552500**	**31.74237602**	**0.003632**	**0.003986**	**2.37%**	**82.33%**
1A2g. Other (*please specify*)	**CO_2**	**0.000000**	**51.92754856**	**0.005941**	**0.003690**	**2.20%**	**84.52%**
1A2e. Food processing, beverages and tobacco	**CO_2**	**72.570570**	**65.51374377**	**0.007496**	**0.003648**	**2.17%**	**86.70%**
1A3a. Domestic aviation	**CO_2**	**26.045000**	**0.888586022**	**0.000102**	**0.002917**	**1.74%**	**88.43%**
3A2. Sheep	**CH_4**	**58.000000**	**62.1976**	**0.007116**	**0.002217**	**1.32%**	**89.75%**
1A3b. Road transportation	**N_2O**	**23.582144**	**12.50146551**	**0.001430**	**0.001810**	**1.08%**	**90.83%**
3A1b. Non-dairy cattle	**CH_4**	**45.985000**	**55.416825**	**0.006341**	**0.001324**	**0.79%**	**91.62%**
2G3. N2O from product uses	**N_2O**	**47.880107**	**60.8218**	**0.006959**	**0.001157**	**0.69%**	**92.31%**
1A4a. Commercial/institutional	**CO_2**	**75.212000**	**108.6550209**	**0.012432**	**0.000885**	**0.53%**	**92.84%**
3B5. Indirect N_2O emissions	**N_2O**	**24.377503**	**27.5132076**	**0.003148**	**0.000834**	**0.50%**	**93.33%**
1A4c. Agriculture/forestry/fishing	**CO_2**	**55.484000**	**78.7840367**	**0.009014**	**0.000750**	**0.45%**	**93.78%**
3A4a. Goats	**CH_4**	**25.750000**	**31.3015**	**0.003581**	**0.000722**	**0.43%**	**94.21%**
3A1a. Dairy cattle	**CH_4**	**55.350000**	**98.60785683**	**0.011282**	**0.000674**	**0.40%**	**94.61%**
3B3. Swine	**N_2O**	**7.748000**	**3.832134621**	**0.000438**	**0.000614**	**0.37%**	**94.98%**
5D2. Industrial wastewater	**CH_4**	**24.197500**	**30.74083175**	**0.003517**	**0.000584**	**0.35%**	**95.32%**
1A3b. Road transportation	**CH_4**	**6.856323**	**3.668416068**	**0.000420**	**0.000524**	**0.31%**	**95.64%**
3B4d. Poultry	N_2O	7.867200	5.915943871	0.000677	0.000480	0.29%	95.92%

1A2b. Non-ferrous metals	CO_2	4.910000	2.18708922	0.000250	0.000406	0.24%	96.16%
2A2. Lime production	CO_2	5.332600	3.1784	0.000364	0.000384	0.23%	96.39%
1A2d. Pulp, paper and print	CO_2	4.820700	2.60167071	0.000298	0.000367	0.22%	96.61%
3B2. Sheep	N_2O	8.433400	9.0364183	0.001034	0.000323	0.19%	96.80%
1A5b. Mobile	CO_2	0.000000	4.5153108	0.000517	0.000321	0.19%	96.99%
2F3. Fire protection	HFCs(1)	0.000000	4.274916723	0.000489	0.000304	0.18%	97.18%
1A2c. Chemicals	CO_2	2.199000	7.81643637	0.000894	0.000304	0.18%	97.36%
3B4a. Goats	N_2O	8.969800	10.95718201	0.001254	0.000248	0.15%	97.50%
2F4. Aerosols	HFCs(1)	0.000000	3.498209	0.000400	0.000249	0.15%	97.65%
5B1. Composting	CH_4	0.000000	3.3125	0.000379	0.000235	0.14%	97.79%
3A3. Swine	CH_4	10.422500	13.57695	0.001553	0.000228	0.14%	97.93%
2D3. Other	CO_2	7.447653	8.99902	0.001030	0.000213	0.13%	98.05%
2D1. Lubricant use	CO_2	1.120000	4.614	0.000528	0.000200	0.12%	98.17%
5D1. Domestic wastewater	N_2O	11.979600	16.53726745	0.001892	0.000196	0.12%	98.29%
3H. Urea application	CO_2	1.815000	0.223446667	0.000026	0.000192	0.11%	98.40%
5B1. Composting	N_2O	0.000000	2.3691	0.000271	0.000168	0.10%	98.50%
3F. Field burning of agricultural residues	CH_4	1.550718	0.176991104	0.000020	0.000165	0.10%	98.60%
3B1b. Non-dairy cattle	N_2O	3.267342	3.365430461	0.000385	0.000135	0.08%	98.68%
3A4c. Mules and Asses	CH_4	1.256500	0.3005	0.000034	0.000122	0.07%	98.76%
5A2. Unmanaged waste disposal sites	CH_4	264.959926	417.176754	0.047732	0.000673	0.40%	99.16%
1A5a. Stationary	CO_2	10.995000	19.3567725	0.002215	0.000117	0.07%	99.23%
3B1b. Non-dairy cattle	CH_4	3.622370	4.256099223	0.000487	0.000112	0.07%	99.29%
1A1a. Public electricity and heat production	N_2O	3.874000	7.709665841	0.000882	0.000105	0.06%	99.36%
1A3d. Domestic navigation	CO_2	2.198000	2.1443799	0.000245	0.000099	0.06%	99.41%
3B1a. Dairy cattle	N_2O	5.066000	6.833129	0.000782	0.000094	0.06%	99.47%
3B1a. Dairy cattle	CH_4	5.919000	8.209455	0.000939	0.000094	0.06%	99.53%
2F2. Foam blowing agents	HFCs(1)	0.000000	1.277351767	0.000146	0.000091	0.05%	99.58%
1A4b. Residential	CH_4	1.904500	4.257840612	0.000487	0.000085	0.05%	99.63%
1A2f. Non-metallic minerals	N_2O	1.435168	3.427695145	0.000392	0.000079	0.05%	99.68%
3B2. Sheep	CH_4	2.030000	2.176916	0.000249	0.000078	0.05%	99.72%
3B4d. Poultry	CH_4	2.102500	2.48109675	0.000284	0.000064	0.04%	99.76%

1A2f. Non-metallic minerals	CH_4	0.759025	2.02357507	0.000232	0.000057	0.03%	99.80%
1A4a. Commercial/institutional	CH_4	0.374750	1.323101775	0.000151	0.000051	0.03%	99.83%
3F. Field burning of agricultural residues	N_2O	0.478883	0.054696806	0.000006	0.000051	0.03%	99.86%
1A1a. Public electricity and heat production	CH_4	1.650000	3.233920235	0.000370	0.000041	0.02%	99.88%
3B4c. Mules and Asses	N_2O	0.301546	0.072113298	0.000008	0.000029	0.02%	99.90%
3B4a. Goats	CH_4	1.025000	1.25206	0.000143	0.000028	0.02%	99.92%
1A3a. Domestic aviation	N_2O	0.217093	0.007406955	0.000001	0.000024	0.01%	99.93%
3A4b. Horses	CH_4	0.207000	0.12735	0.000015	0.000015	0.01%	99.94%
5D2. Industrial wastewater	N_2O	0.310516	0.295430644	0.000034	0.000015	0.01%	99.95%
3B4c. Mules and Asses	CH_4	0.138228	0.033055	0.000004	0.000013	0.01%	99.96%
1A4b. Residential	N_2O	0.697320	0.939191948	0.000107	0.000013	0.01%	99.96%
2G1. Electrical equipment	SF_6	0.025767	0.165308094	0.000019	0.000009	0.01%	99.97%
1A2g. Other (*please specify*)	N_2O	0.000000	0.122527736	0.000014	0.000009	0.01%	99.97%
1A1c. Manufacture of solid fuels and other energy industries	N_2O	0.133504	0.13300336	0.000015	0.000006	0.00%	99.98%
2G4. Other	CO_2	0.041210	0.01302	0.000001	0.000004	0.00%	99.98%
1A1c. Manufacture of solid fuels and other energy industries	CH_4	0.084000	0.083685	0.000010	0.000004	0.00%	99.98%
1A2g. Other (*please specify*)	CH_4	0.000000	0.050866296	0.000006	0.000004	0.00%	99.98%
3B4b. Horses	N_2O	0.044700	0.02829737	0.000003	0.000003	0.00%	99.99%
2D2. Paraffin wax use	CO_2	0.063498	0.058943491	0.000007	0.000003	0.00%	99.99%
1A2e. Food processing, beverages and tobacco	N_2O	0.151980	0.203155436	0.000023	0.000003	0.00%	99.99%
1A4a. Commercial/institutional	N_2O	0.139524	0.256057746	0.000029	0.000002	0.00%	99.99%
1A2c. Chemicals	N_2O	0.005364	0.038650919	0.000004	0.000002	0.00%	99.99%
3B4b. Horses	CH_4	0.027000	0.0165555	0.000002	0.000002	0.00%	99.99%
1A3d. Domestic navigation	N_2O	0.034568	0.033632906	0.000004	0.000002	0.00%	99.99%
1A4c. Agriculture/forestry/fishing	N_2O	0.128617	0.188640973	0.000022	0.000001	0.00%	100.00%
1A2c. Chemicals	CH_4	0.002250	0.020842118	0.000002	0.000001	0.00%	100.00%
1A5b. Mobile	CH_4	0.000000	0.0157878	0.000002	0.000001	0.00%	100.00%
1A4c. Agriculture/forestry/fishing	CH_4	0.183500	0.31062525	0.000036	0.000001	0.00%	100.00%
1A2d. Pulp, paper and print	N_2O	0.011145	0.004390139	0.000001	0.000001	0.00%	100.00%
1A5b. Mobile	N_2O	0.000000	0.011291435	0.000001	0.000001	0.00%	100.00%
1A2b. Non-ferrous metals	N_2O	0.005960	0.001836759	0.000000	0.000001	0.00%	100.00%

1A3a. Domestic aviation	CH_4	0.004550	0.000155347	0.000000	0.000001	0.00%	100.00%
1A5a. Stationary	CH_4	0.037000	0.06530625	0.000007	0.000000	0.00%	100.00%
1A2d. Pulp, paper and print	CH_4	0.004675	0.002017103	0.000000	0.000000	0.00%	100.00%
1A2b. Non-ferrous metals	CH_4	0.003250	0.001121655	0.000000	0.000000	0.00%	100.00%
1A5a. Stationary	N_2O	0.026522	0.04670703	0.000005	0.000000	0.00%	100.00%
1A3d. Domestic navigation	CH_4	0.002900	0.002821553	0.000000	0.000000	0.00%	100.00%
1A2e. Food processing, beverages and tobacco	CH_4	0.066000	0.106245058	0.000012	0.000000	0.00%	100.00%
1A1b. Petroleum refining	CO_2	85.718200	0	0.000000	0.000000	0.00%	100.00%
1A1b. Petroleum refining	CH_4	0.055500	0	0.000000	0.000000	0.00%	100.00%
1A1b. Petroleum refining	N_2O	0.107280	0	0.000000	0.000000	0.00%	100.00%
1B2a. Oil	CH_4	0.404930	0	0.000000	0.000000	0.00%	100.00%

Table A1.6.Key categories analysis with LULUCF – Trend assessment for 2018

IPCC Source category	Direct GHG	1990 estimate	2018 estimate	Level assessment 2017	Trend assessment	% contribution to trend	Cumulative total of level assessment
1A1a. Public electricity and heat production	CO_2	**1675.770000**	**3342.3599**	**0.358744**	**0.045184**	**21.92%**	**21.92%**
2F1. Refrigeration and air conditioning	**HFCs(1)**	**0.000000**	**288.0897503**	**0.030921**	**0.019398**	**9.41%**	**31.33%**
2A1. Cement production	CO_2	**667.664000**	**843.349**	**0.090519**	**0.014877**	**7.22%**	**38.54%**
1A4b. Residential	CO_2	**299.704000**	**284.4799682**	**0.030534**	**0.013013**	**6.31%**	**44.86%**
1A2f. Non-metallic minerals	CO_2	**379.826700**	**419.5517229**	**0.045032**	**0.012518**	**6.07%**	**50.93%**
1A3b. Road transportation	CO_2	**1186.010542**	**2051.238091**	**0.220165**	**0.010817**	**5.25%**	**56.18%**
4F2. Land converted to other land	CO_2	**95.534942**	**6.514454122**	**0.000699**	**0.009815**	**4.76%**	**60.94%**
5D1. Domestic wastewater	CH_4	**91.895500**	**18.47490796**	**0.001983**	**0.008619**	**4.18%**	**65.12%**
3D. Agricultural soils(2) (3) (4)	N_2O	**0.000000**	**119.167661**	**0.012791**	**0.008024**	**3.89%**	**69.01%**
4C1. Grassland remaining grassland	CO_2	**134.142940**	**118.2048081**	**0.012687**	**0.006439**	**3.12%**	**72.13%**
5A1. Managed waste disposal sites	CH_4	**0.000000**	**87.80353521**	**0.009424**	**0.005912**	**2.87%**	**75.00%**
4B1. Cropland remaining cropland	CO_2	**135.060200**	**132.4103**	**0.014212**	**0.005581**	**2.71%**	**77.71%**
4A1. Forest land remaining forest land	CO_2	**32.867621**	**129.7118383**	**0.013922**	**0.005206**	**2.53%**	**80.23%**

2A4. Other process uses of carbonates	**CO_2**	**44.076000**	**14.73906361**	**0.001582**	**0.003738**	**1.81%**	**82.05%**
3B3. Swine	**CH_4**	**54.552500**	**31.74237602**	**0.003407**	**0.003718**	**1.80%**	**83.85%**
1A2g. Other (*please specify*)	**CO_2**	**0.000000**	**51.92754856**	**0.005574**	**0.003496**	**1.70%**	**85.55%**
1A2e. Food processing, beverages and tobacco	**CO_2**	**72.570570**	**65.51374377**	**0.007032**	**0.003378**	**1.64%**	**87.19%**
1A3a. Domestic aviation	**CO_2**	**26.045000**	**0.888586022**	**0.000095**	**0.002736**	**1.33%**	**88.51%**
3A2. Sheep	**CH_4**	**58.000000**	**62.1976**	**0.006676**	**0.002037**	**0.99%**	**89.50%**
1A3b. Road transportation	**N_2O**	**23.582144**	**12.50146551**	**0.001342**	**0.001689**	**0.82%**	**90.32%**
4G. Harvested wood products [5]	**CO_2**	**0.000000**	**24.12084392**	**0.002589**	**0.001624**	**0.79%**	**91.11%**
3A1b. Non-dairy cattle	**CH_4**	**45.985000**	**55.416825**	**0.005948**	**0.001204**	**0.58%**	**91.69%**
4E2. Land converted to settlements	**CO_2**	**1.755169**	**20.08620534**	**0.002156**	**0.001164**	**0.56%**	**92.26%**
4B2. Land converted to cropland	**CO_2**	**3.851576**	**21.35936058**	**0.002293**	**0.001025**	**0.50%**	**92.75%**
2D3. Other	**CO_2**	**7.447653**	**25.53665752**	**0.002741**	**0.000920**	**0.45%**	**93.20%**
4A2. Land converted to forest land	**CO_2**	**12.657145**	**33.7369747**	**0.003621**	**0.000913**	**0.44%**	**93.64%**
2G3. N2O from product uses	**N_2O**	**47.880107**	**64.9126248**	**0.006967**	**0.000768**	**0.37%**	**94.02%**
3B5. Indirect N_2O emissions	**N_2O**	**24.377503**	**27.5132076**	**0.002953**	**0.000764**	**0.37%**	**94.39%**
1A4a. Commercial/institutional	**CO_2**	**75.212000**	**108.6550209**	**0.011662**	**0.000757**	**0.37%**	**94.75%**
3A1a. Dairy cattle	**CH_4**	**55.350000**	**98.60785683**	**0.010584**	**0.000699**	**0.34%**	**95.09%**
3A4a. Goats	**CH_4**	**25.750000**	**31.3015**	**0.003360**	**0.000656**	**0.32%**	**95.41%**
1A4c. Agriculture/forestry/fishing	**CO_2**	**55.484000**	**78.7840367**	**0.008456**	**0.000651**	**0.32%**	**95.73%**
3B3. Swine	N_2O	7.748000	3.832134621	0.000411	0.000574	0.28%	96.01%
5D2. Industrial wastewater	CH_4	24.197500	30.74083175	0.003299	0.000527	0.26%	96.26%
4D2. Land converted to wetlands	CO_2	1.024691	9.00579137	0.000967	0.000496	0.24%	96.50%
1A3b. Road transportation	CH_4	6.856323	3.668416068	0.000394	0.000489	0.24%	96.74%
3B4d. Poultry	N_2O	7.867200	5.915943871	0.000635	0.000446	0.22%	96.96%
4C2. Land converted to grassland	CO_2	0.000000	6.517226474	0.000700	0.000439	0.21%	97.17%
1A2b. Non-ferrous metals	CO_2	4.910000	2.18708922	0.000235	0.000380	0.18%	97.35%
1A2d. Pulp, paper and print	CO_2	4.820700	2.60167071	0.000279	0.000342	0.17%	97.52%
1A5b. Mobile	CO_2	0.000000	4.5153108	0.000485	0.000304	0.15%	97.67%
3B2. Sheep	N_2O	8.433400	9.0364183	0.000970	0.000297	0.14%	97.81%
1A2c. Chemicals	CO_2	2.199000	7.81643637	0.000839	0.000290	0.14%	97.95%
2F3. Fire protection	HFCs[1]	0.000000	4.274916723	0.000459	0.000288	0.14%	98.09%

2F4. Aerosols	HFCs(1)	0.000000	3.498209	0.000375	0.000236	0.11%	98.20%
3B4a. Goats	N_2O	8.969800	10.95718201	0.001176	0.000225	0.11%	98.31%
5B1. Composting	CH_4	0.000000	3.3125	0.000356	0.000223	0.11%	98.42%
2A2. Lime production	CO_2	5.332600	5.3347575	0.000573	0.000213	0.10%	98.53%
3A3. Swine	CH_4	10.422500	13.57695	0.001457	0.000205	0.10%	98.62%
2D1. Lubricant use	CO_2	1.120000	4.5181048	0.000485	0.000184	0.09%	98.71%
3H. Urea application	CO_2	1.815000	0.223446667	0.000024	0.000180	0.09%	98.80%
5D1. Domestic wastewater	N_2O	11.979600	16.53726745	0.001775	0.000172	0.08%	98.88%
5A2. Unmanaged waste disposal sites	CH_4	264.959926	417.176754	0.044777	0.000349	0.17%	99.05%
5B1. Composting	N_2O	0.000000	2.3691	0.000254	0.000160	0.08%	99.13%
3F. Field burning of agricultural residues	CH_4	1.550718	0.176991104	0.000019	0.000155	0.07%	99.21%
3B1b. Non-dairy cattle	N_2O	3.267342	3.365430461	0.000361	0.000124	0.06%	99.27%
1A5a. Stationary	CO_2	10.995000	19.3567725	0.002078	0.000123	0.06%	99.33%
3A4c. Mules and Asses	CH_4	1.256500	0.3005	0.000032	0.000115	0.06%	99.38%
1A1a. Public electricity and heat production	N_2O	3.874000	7.709665841	0.000827	0.000103	0.05%	99.43%
3B1b. Non-dairy cattle	CH_4	3.622370	4.256099223	0.000457	0.000102	0.05%	99.48%
1A3d. Domestic navigation	CO_2	2.198000	2.1443799	0.000230	0.000092	0.04%	99.53%
2F2. Foam blowing agents	HFCs(1)	0.000000	1.277351767	0.000137	0.000086	0.04%	99.57%
3B1a. Dairy cattle	N_2O	5.066000	6.833129	0.000733	0.000084	0.04%	99.61%
3B1a. Dairy cattle	CH_4	5.919000	8.209455	0.000881	0.000083	0.04%	99.65%
1A4b. Residential	CH_4	1.904500	4.257840612	0.000457	0.000082	0.04%	99.69%
1A2f. Non-metallic minerals	N_2O	1.435168	3.427695145	0.000368	0.000077	0.04%	99.73%
3B2. Sheep	CH_4	2.030000	2.176916	0.000234	0.000071	0.03%	99.76%
3B4d. Poultry	CH_4	2.102500	2.48109675	0.000266	0.000059	0.03%	99.79%
1A2f. Non-metallic minerals	CH_4	0.759025	2.02357507	0.000217	0.000055	0.03%	99.81%
1A4a. Commercial/institutional	CH_4	0.374750	1.323101775	0.000142	0.000049	0.02%	99.84%
3F. Field burning of agricultural residues	N_2O	0.478883	0.054696806	0.000006	0.000048	0.02%	99.86%
4A1. Forest land remaining forest land	CH_4	0.052758	0.746289154	0.000080	0.000045	0.02%	99.88%
1A1a. Public electricity and heat production	CH_4	1.650000	3.233920235	0.000347	0.000041	0.02%	99.90%
3B4c. Mules and Asses	N_2O	0.301546	0.072113298	0.000008	0.000028	0.01%	99.92%
3B4a. Goats	CH_4	1.025000	1.25206	0.000134	0.000026	0.01%	99.93%

1A3a. Domestic aviation	N_2O	0.217093	0.007406955	0.000001	0.000023	0.01%	99.94%
4A1. Forest land remaining forest land	N_2O	0.018496	0.261640197	0.000028	0.000016	0.01%	99.95%
3A4b. Horses	CH_4	0.207000	0.12735	0.000014	0.000014	0.01%	99.95%
5D2. Industrial wastewater	N_2O	0.310516	0.295430644	0.000032	0.000013	0.01%	99.96%
3B4c. Mules and Asses	CH_4	0.138228	0.033055	0.000004	0.000013	0.01%	99.97%
1A4b. Residential	N_2O	0.697320	0.939191948	0.000101	0.000012	0.01%	99.97%
2G1. Electrical equipment	SF_6	0.025767	0.165308094	0.000018	0.000008	0.00%	99.98%
1A2g. Other (*please specify*)	N_2O	0.000000	0.122527736	0.000013	0.000008	0.00%	99.98%
1A1c. Manufacture of solid fuels and other energy industries	N_2O	0.133504	0.13300336	0.000014	0.000005	0.00%	99.98%
2G4. Other	CO_2	0.041210	0.01183	0.000001	0.000004	0.00%	99.98%
1A2g. Other (*please specify*)	CH_4	0.000000	0.050866296	0.000005	0.000003	0.00%	99.99%
1A1c. Manufacture of solid fuels and other energy industries	CH_4	0.084000	0.083685	0.000009	0.000003	0.00%	99.99%
3B4b. Horses	N_2O	0.044700	0.02829737	0.000003	0.000003	0.00%	99.99%
2D2. Paraffin wax use	CO_2	0.063498	0.061681004	0.000007	0.000003	0.00%	99.99%
1A2e. Food processing, beverages and tobacco	N_2O	0.151980	0.203155436	0.000022	0.000003	0.00%	99.99%
1A4a. Commercial/institutional	N_2O	0.139524	0.256057746	0.000027	0.000002	0.00%	99.99%
1A2c. Chemicals	N_2O	0.005364	0.038650919	0.000004	0.000002	0.00%	99.99%
3B4b. Horses	CH_4	0.027000	0.0165555	0.000002	0.000002	0.00%	100.00%
1A3d. Domestic navigation	N_2O	0.034568	0.033632906	0.000004	0.000001	0.00%	100.00%
1A4c. Agriculture/forestry/fishing	CH_4	0.183500	0.31062525	0.000033	0.000001	0.00%	100.00%
1A2c. Chemicals	CH_4	0.002250	0.020842118	0.000002	0.000001	0.00%	100.00%
1A4c. Agriculture/forestry/fishing	N_2O	0.128617	0.188640973	0.000020	0.000001	0.00%	100.00%
1A5b. Mobile	CH_4	0.000000	0.0157878	0.000002	0.000001	0.00%	100.00%
1A2d. Pulp, paper and print	N_2O	0.011145	0.004390139	0.000000	0.000001	0.00%	100.00%
1A5b. Mobile	N_2O	0.000000	0.011291435	0.000001	0.000001	0.00%	100.00%
1A2b. Non-ferrous metals	N_2O	0.005960	0.001836759	0.000000	0.000001	0.00%	100.00%
1A3a. Domestic aviation	CH_4	0.004550	0.000155347	0.000000	0.000000	0.00%	100.00%
1A5a. Stationary	CH_4	0.037000	0.06530625	0.000007	0.000000	0.00%	100.00%
1A2d. Pulp, paper and print	CH_4	0.004675	0.002017103	0.000000	0.000000	0.00%	100.00%
1A5a. Stationary	N_2O	0.026522	0.04670703	0.000005	0.000000	0.00%	100.00%
1A2b. Non-ferrous metals	CH_4	0.003250	0.001121655	0.000000	0.000000	0.00%	100.00%

1A3d. Domestic navigation	CH_4	0.002900	0.002821553	0.000000	0.000000	0.00%	100.00%
1A2e. Food processing, beverages and tobacco	CH_4	0.066000	0.106245058	0.000011	0.000000	0.00%	100.00%
1A1b. Petroleum refining	CO_2	85.718200	0	0.000000	0.000000	0.00%	100.00%
1A1b. Petroleum refining	CH_4	0.055500	0	0.000000	0.000000	0.00%	100.00%
1A1b. Petroleum refining	N_2O	0.107280	0	0.000000	0.000000	0.00%	100.00%
1B2a. Oil	CH_4	0.404930	0	0.000000	0.000000	0.00%	100.00%

Annex 2: Assessment of uncertainty

A2.1: Description of methodology used for identifying uncertainties

Uncertainty analysis constitutes a key activity in the annual inventory cycle. The realisation of such an analysis is foreseen in the reporting guidelines under the Convention and represents a specific function to be performed by a National System (Decision 24/CP.19).

Uncertainty information is not intended to dispute the validity of the inventory estimates, but to help prioritize efforts to improve the accuracy of inventories and guide decisions on methodological choice. This will be achieved with the correct application of the analytic calculating methods at least for the key categories.

There are two methods for the uncertainty estimation suggested by the 2006 IPCC Guidelines; a basic method (Tier 1) which is mandatory and an analytic one (Tier 2).

The Tier 2 methodology is based on Monte Carlo analysis. The principle of Monte Carlo analysis is to select random values of emission factor and activity data from within their individual probability density functions, and to calculate the corresponding emission values. This procedure is repeated many times, and the results of each calculation run build up the overall emission probability density function. Monte Carlo analysis can be performed at the source category level, for aggregations of source categories or for the inventory as a whole. This analysis is suitable for a composite system such as the calculation of GHG emissions in national level. but its application requires significant resources and time.

The application of the Tier 1 methodology for uncertainty analysis is based on the following equations.

A. Uncertainty of total emissions

$$u_{i,g} = \sqrt{u_{AD,i}^2 + u_{EF,i,g}^2}$$

$$U_{i,g} = \frac{u_{i,g} \cdot E_{i,g}}{\sum_{i,g} E_{i,g}}$$

$$U_{tot} = \sqrt{\sum_{i,g} U_{i,g}^2}$$

where. i is the index referring to emission sources, g is the index referring to GHG, ui.g is the combined uncertainty for emissions of g-gas and i-source, uAD.i is the uncertainty of activity data of the i-source, uEF.i.g is the uncertainty of the emission factor of g-gas and i-source, Ui.g is the uncertainty of the calculated emissions of g-gas and i-source, Ei.g are the emissions of g-gas and i-source and Utot is the uncertainty of total emissions. Uncertainty estimations on activity data (uAD.i) and on the emission factors (uEF.i.g) are based on IPCC defaults using expert judgement and reasoning details and detailed explanation regarding their choice for each sector is presented in reasoning details and detailed explanation regarding their choice for each sector is presented in Table A2.1.

B. Uncertainty in trend in emissions

$$A_{i,g} = \frac{0{,}01 \cdot E_{i,g,t} + \sum_{i,g} E_{i,g,t} - \left(0{,}01 \cdot E_{i,g,0} + \sum_{i,g} E_{i,g,0}\right)}{0{,}01 \cdot E_{i,g,0} + \sum_{i,g} E_{i,g,0}} \cdot 100 - \frac{\sum_{i,g} E_{i,g,t} - \sum_{i,g} E_{i,g,0}}{\sum_{i,g} E_{i,g,0}} \cdot 100$$

$$B_{i,g} = \frac{E_{i,g,t}}{\sum_{i,g} E_{i,g,0}}$$

$$TREF_{i,g} = A_{i,g} \cdot u_{EF,i,g}$$

$$TRAD_i = B_{i,g} \cdot u_{AD,i} \cdot \sqrt{2}$$

$$U_{TR} = \sqrt{\sum_{i,g} TREF_{i,g}^2 + TRAD_{i,g}^2}$$

where, t is the index referring to the inventory year, 0 is the index referring to the base year, Ai,g is the difference (%) of emissions of g-gas and i-source in response to a 1% increase of emissions in the base year and inventory year, Ei,g,t emissions of g-gas and i-source in the inventory year, Ei,g, 0 emissions of g-gas and i-source in the base year, Bi,g the difference (%) of emissions of g-gas and i-source in response to a 1% increase of emissions in the inventory year, TREFi,g the contribution of EF uncertainty of g-gas and i-source to the uncertainty in the trend of emissions, TRADi the contribution of AD uncertainty i-source to the uncertainty in the trend of emissions and UTR is the uncertainty in the trend of emissions.

The uncertainty analysis for the Cyprus' GHG inventory is based on Tier 1 methodology with 1990 as base year for CO2, CH4, N2O and 1995 for F-gases emissions.

Moreover:

- For the estimation of uncertainties per gas, a combination of the information provided by the IPCC and critical evaluation of information from indigenous sources was applied.
- 100% of emissions are used for the uncertainty analysis.
- The uncertainty analysis was carried out both without and with the LULUCF sector.

In Tables A2.2 and A2.3, the analytical calculations of the emissions estimates uncertainty are presented, without the sector of LULUCF for 1990 and 2018.

Table A2.1.Reasoning for activity data and emission factor uncertainty value

IPCC Source category	**Reasoning for activity data uncertainty**	**Reasoning for emission factor uncertainty**
Stationary Combustion	5% corresponds to the IPCC default uncertainty range for AD obtained from national energy balances. After 2005 that AD are cross-checked with PS AD from verified EUETS reports (source specific QA/QC), the uncertainty of AD is reduced to 3%.	• CO2: According to IPCC guidelines the use of default carbon content per fuel corresponds to 95% confidence intervals and the % uncertainty is estimated < 5%. 1990-2004 5%; PS data from verified EU-ETS reports are used for the calculation of EFs for the majority of fuels after 2005. We estimate the EF uncertainty to be 3%. • CH4: In IPCC guidelines is mentioned that the default uncertainty for stationary combustion EF is 50-150%. We select the mean 100%. • N2O: Although in IPCC GPG is mentioned that EF from Table 2.16 may be expected to limit uncertainties to within an order of magnitude. In order to be conservative we select 300% as uncertainty.
Road transport	5% corresponds to the IPCC default	IPCC defaults are used: 5% for CO2; 40% for

IPCC Source category	Reasoning for activity data uncertainty	Reasoning for emission factor uncertainty
	uncertainty range for AD obtained from national energy balances.	CH_4 and 50% for N_2O
Navigation	Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range.	IPCC defaults are used: 5% for CO_2; 100% for CH_4 and 300% for N_2O
Civil Aviation	Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range.	IPCC defaults are used: 5% for CO_2; 100% for CH_4 and 300% for N_2O
Not specified - Mobile	Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range.	IPCC defaults are used: 5% for CO_2; 100% for CH_4 and 300% for N_2O
Oil and Natural gas	Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range.	In IPCC guidelines is mentioned that the EF used may be expected to limit uncertainties to within an order of magnitude. However, in order to be conservative the value 300% is selected for all gases
Cement Production	Plant level production data (2%).	Plant level production data (2%)
Lime Production	Plant level production data (2%).	In IPCC guidelines is mentioned that the EF used may be expected to range between 1-5%. In order to be conservative the value 5% is selected.
Other process uses of carbonates	Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range.	In IPCC guidelines is mentioned that the EF used may be expected to range between 1-5%. In order to be conservative the value 5% is selected.
Non-Energy Products from Fuels and Solvent Use	Activity data obtained from national energy balance. 5% corresponds to the IPCC default uncertainty range.	In IPCC guidelines is mentioned that the EF used may be expected to range between 1-5%. In order to be conservative the value 5% is selected.
Refrigeration and Air Conditioning Equipment	Activity data obtained from national statistics (population, inventory of fluorinated and ozone depleting containing equipment): 5%	Expert judgement; 500%
Foam Blowing	Activity data obtained from national statistics (population): 5%	Expert judgement; 500%
Fire Extinguishers	Activity data obtained from national statistics (population): 5%	Expert judgement; 500%
Aerosols/MDIs	Activity data obtained from national statistics (population): 5%	Expert judgement; 500%
SF_6 from electrical equipment	Activity data obtained from national statistics (population): 5%	Expert judgement; 500%
N_2O from product uses	Uncertainty given by Statistical Service for the population data: 5%	Expert judgement; 500%
Enteric fermentation	Uncertainty given by Statistical Service for the livestock population data: 5%	30-50% proposed by 2006 IPCC guidelines; However, in order to be conservative the value 50% is selected.
Manure management	Uncertainty given by Statistical Service for the livestock population data: 5%	Conservative IPCC values: 30% for CH_4 and 100% for N_2O
Indirect N_2O emissions	Uncertainty given by Statistical Service for the livestock population	Conservative IPCC values: 50% for N_2O

IPCC Source category	Reasoning for activity data uncertainty	Reasoning for emission factor uncertainty
	data: 20%	
Agricultural soils – direct emissions	Uncertainty given by Statistical Service for the livestock population data: 20%	In IPCC guidelines is mentioned that the EF used may be expected to range between 3-30%. In order to be conservative the value 30% is selected.
Agricultural soils – indirect emissions	Uncertainty given by Statistical Service for the livestock population data: 20%	50% (According to Good Practice Guidance. Page 4.75)
Field burning of agricultural Residues	Uncertainty given by Statistical Service for the livestock population data: 20%	20% (According to Good Practice Guidance. Page 4.82. Table 4.20)
Urea application	Uncertainty given by Statistical Service for the livestock population data: 20%	50% (According to Good Practice Guidance)
Solid waste disposal	IPCC proposes 10-30%. 30% chosen as Cyprus is a country collecting data on regular basis	Estimated based on information from 2006 IPCC guidelines (vol. 5, pg. 3.27, table 3.5) using highest values to be conservative: 30%
Composting	IPCC proposes 10-30%. 30% chosen as Cyprus is a country collecting data on regular basis	Estimated based on information from 2006 IPCC guidelines using highest values to be conservative: 100%
Wastewater handling	Domestic: 30% Industrial: 100%	Estimated 30% based on information in 2006 IPCC guidelines

Table A2.2.Analytical calculations of uncertainty, without LULUCF 1990

Member State:	Cyprus
Reporting year:	1990

IPCC category/Group	Gas	Base year emissions or removals	1990 emissions or removals	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty (2)	Uncertainty in trend in national emissions introduced by activity data uncertainty (3)	Uncertainty introduced into the trend in total national emissions
1A1a. Public electricity and heat production	CH4	0.06600000	0.07	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	2.48444E-13
1A1b. Petroleum refining	CH4	0.00222000	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	2.81091E-16
1A1c. Manufacture of solid fuels and other energy industries	CH4	0.00336000	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	6.43901E-16
1A2b. Non-ferrous metals	CH4	0.00013000	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	9.6389E-19
1A2c. Chemicals	CH4	0.00009000	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	4.61983E-19
1A2d. Pulp, paper and print	CH4	0.00018700	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	1.99445E-18
1A2e. Food processing, beverages and tobacco	CH4	0.00264000	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	3.9751E-16
1A2f. Non-metallic minerals	CH4	0.03036100	0.03	2%	100%	1.0002	0.0000		0.0000	0.0000	0.0000	8.41187E-15
1A2g. Other	CH4	0.00191400	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	2.08941E-16
1A3a. Domestic aviation	CH4	0.00018200	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	1.88922E-18
1A3b. Road transportation	CH4	0.27500243	0.28	5%	40%	0.4031	0.0000		0.0000	0.0000	0.0000	4.31334E-12
1A3d. Domestic navigation	CH4	0.00011600	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	7.67461E-19
1A4a. Commercial/institutional	CH4	0.01499000	0.01	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	1.28157E-14
1A4b. Residential	CH4	0.07618000	0.08	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	3.30996E-13
1A4c. Agriculture/forestry/fishing	CH4	0.00734000	0.01	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	3.07279E-15
1A5a. Stationary	CH4	0.00148000	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	1.24929E-16
1B2a. Oil	CH4	0.01619720	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	3.53338E-16
3A1a. Dairy cattle	CH4	2.21400000	2.21	5%	50%	0.5025	0.0000		0.0002	0.0000	0.0000	2.79573E-10
3A1b. Non-dairy cattle	CH4	1.83940000	1.84	5%	50%	0.5025	0.0000		0.0002	0.0000	0.0000	1.92971E-10
3A2. Sheep	CH4	2.32000000	2.32	5%	50%	0.5025	0.0000		0.0002	0.0000	0.0000	3.06985E-10
3A3. Swine	CH4	0.41690000	0.42	5%	50%	0.5025	0.0000		0.0000	0.0000	0.0000	9.91298E-12

3A4a. Goats	CH4	1.03000000	1.03	5%	50%	0.5025	0.0000		0.0001	0.0000	0.0000	6.05083E-11
3A4b. Horses	CH4	0.00828000	0.01	5%	50%	0.5025	0.0000		0.0000	0.0000	0.0000	3.91022E-15
3A4c. Mules and Asses	CH4	0.05026000	0.05	5%	50%	0.5025	0.0000		0.0000	0.0000	0.0000	1.44074E-13
3B1a. Dairy cattle	CH4	0.23676000	0.24	5%	30%	0.3041	0.0000		0.0000	0.0000	0.0000	3.19711E-12
3B1b. Non-dairy cattle	CH4	0.14490000	0.14	5%	30%	0.3041	0.0000		0.0000	0.0000	0.0000	1.19751E-12
3B2. Sheep	CH4	0.08120000	0.08	5%	30%	0.3041	0.0000		0.0000	0.0000	0.0000	3.76056E-13
3B3. Swine	CH4	2.18210000	2.18	5%	30%	0.3041	0.0000		0.0002	0.0000	0.0000	2.71575E-10
3B4a. Goats	CH4	0.04100000	0.04	5%	30%	0.3041	0.0000		0.0000	0.0000	0.0000	9.58756E-14
3B4b. Horses	CH4	0.00108000	0.00	5%	30%	0.3041	0.0000		0.0000	0.0000	0.0000	6.65255E-17
3B4c. Mules and Asses	CH4	0.00552910	0.01	5%	30%	0.3041	0.0000		0.0000	0.0000	0.0000	1.74361E-15
3B4d. Poultry	CH4	0.08410000	0.08	5%	30%	0.3041	0.0000		0.0000	0.0000	0.0000	4.03397E-13
3F. Field burning of agricultural residues	CH4	0.06202870	0.06	20%	20%	0.2828	0.0000		0.0000	0.0000	0.0000	3.51112E-12
5A2. Unmanaged waste disposal sites	CH4	10.33370040	10.33	30%	30%	0.4243	0.0000		0.0011	0.0000	0.0005	2.19258E-07
5D1. Domestic wastewater	CH4	3.67582000	3.68	30%	30%	0.4243	0.0000		0.0004	0.0000	0.0002	2.77429E-08
5D2. Industrial wastewater	CH4	0.96790000	0.97	30%	30%	0.4243	0.0000		0.0001	0.0000	0.0000	1.92355E-09
1A1a. Public electricity and heat production	CO2	1675.77000000	1675.77	5%	5%	0.0707	0.0002		0.1790	0.0000	0.0127	0.000160166
1A1b. Petroleum refining	CO2	85.71820000	85.72	5%	5%	0.0707	0.0000		0.0092	0.0000	0.0006	4.1907E-07
1A2b. Non-ferrous metals	CO2	4.91000000	4.91	5%	5%	0.0707	0.0000		0.0005	0.0000	0.0000	1.375E-09
1A2c. Chemicals	CO2	2.19900000	2.20	5%	5%	0.0707	0.0000		0.0002	0.0000	0.0000	2.75798E-10
1A2d. Pulp, paper and print	CO2	4.82070000	4.82	5%	5%	0.0707	0.0000		0.0005	0.0000	0.0000	1.32544E-09
1A2e. Food processing, beverages and tobacco	CO2	72.57057000	72.57	5%	5%	0.0707	0.0000		0.0078	0.0000	0.0005	3.00374E-07
1A2f. Non-metallic minerals	CO2	379.82670000	379.83	5%	5%	0.0707	0.0000		0.0406	0.0000	0.0029	8.22833E-06
1A2g. Other	CO2	47.86990700	47.87	5%	5%	0.0707	0.0000		0.0051	0.0000	0.0004	1.30697E-07
1A3a. Domestic aviation	CO2	26.04500000	26.05	5%	5%	0.0707	0.0000		0.0028	0.0000	0.0002	3.86892E-08
1A3b. Road transportation	CO2	1183.50842423	1183.51	5%	5%	0.0707	0.0001		0.1264	0.0000	0.0089	7.98883E-05
1A3d. Domestic navigation	CO2	2.19800000	2.20	5%	5%	0.0707	0.0000		0.0002	0.0000	0.0000	2.75547E-10
1A4a. Commercial/institutional	CO2	75.21200000	75.21	5%	5%	0.0707	0.0000		0.0080	0.0000	0.0006	3.22637E-07
1A4b. Residential	CO2	299.70400000	299.70	5%	5%	0.0707	0.0000		0.0320	0.0000	0.0023	5.12302E-06

1A4c. Agriculture/forestry/fishing	CO2	55.48400000	55.48	5%	5%	0.0707	0.0000		0.0059	0.0000	0.0004	1.7558E-07
1A5a. Stationary	CO2	10.99500000	11.00	5%	5%	0.0707	0.0000		0.0012	0.0000	0.0001	6.89495E-09
2A1. Cement production	CO2	667.66400000	667.66	2%	2%	0.0283	0.0000		0.0713	0.0000	0.0020	4.06796E-06
2A2. Lime production	CO2	5.33260000	5.33	2%	5%	0.0539	0.0000		0.0006	0.0000	0.0000	2.59501E-10
2A4. Other process uses of carbonates	CO2	44.07600000	44.08	5%	5%	0.0707	0.0000		0.0047	0.0000	0.0003	1.10801E-07
2D1. Lubricant use	CO2	1.12000000	1.12	5%	5%	0.0707	0.0000		0.0001	0.0000	0.0000	7.15446E-11
2D2. Paraffin wax use	CO2	0.06349756	0.06	5%	5%	0.0707	0.0000		0.0000	0.0000	0.0000	2.29961E-13
2D3. Other	CO2	7.49150000	7.49	5%	5%	0.0707	0.0000		0.0008	0.0000	0.0001	3.20094E-09
2G4. Other	CO2	0.04121000	0.04	5%	500%	5.0002	0.0000		0.0000	0.0000	0.0000	9.68603E-14
3H. Urea application	CO2	1.81500000	1.82	20%	50%	0.5385	0.0000		0.0002	0.0000	0.0001	3.00617E-09
1A1a. Public electricity and heat production	N2O	0.01300000	0.01	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	9.6389E-15
1A1b. Petroleum refining	N2O	0.00036000	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	7.39172E-18
1A1c. Manufacture of solid fuels and other energy industries	N2O	0.00044800	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	1.14471E-17
1A2b. Non-ferrous metals	N2O	0.00002000	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	2.2814E-20
1A2c. Chemicals	N2O	0.00001800	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	1.84793E-20
1A2d. Pulp, paper and print	N2O	0.00003740	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	7.97781E-20
1A2e. Food processing, beverages and tobacco	N2O	0.00051000	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	1.48348E-17
1A2f. Non-metallic minerals	N2O	0.00481600	0.00	2%	300%	3.0001	0.0000		0.0000	0.0000	0.0000	2.11657E-16
1A2g. Other	N2O	0.00038100	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	8.27924E-18
1A3a. Domestic aviation	N2O	0.00072850	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	3.02691E-17
1A3b. Road transportation	N2O	0.07919871	0.08	5%	50%	0.5025	0.0000		0.0000	0.0000	0.0000	3.57748E-13
1A3d. Domestic navigation	N2O	0.00011600	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	7.67461E-19
1A4a. Commercial/institutional	N2O	0.00046820	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	1.25027E-17
1A4b. Residential	N2O	0.00234000	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	3.123E-16
1A4c. Agriculture/forestry/fishing	N2O	0.00043160	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	1.06244E-17
1A5a. Stationary	N2O	0.00008900	0.00	5%	300%	3.0004	0.0000		0.0000	0.0000	0.0000	4.51773E-19
2G3. N2O from product uses	N2O	0.13860000	0.14	5%	500%	5.0002	0.0000		0.0000	0.0000	0.0000	1.09564E-12
3B1a. Dairy cattle	N2O	0.01700000	0.02	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	1.64831E-14
3B1b. Non-dairy cattle	N2O	0.01070000	0.01	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	6.52992E-15
3B2. Sheep	N2O	0.02830000	0.03	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	4.56787E-14

3B3. Swine	N2O	0.02600000	0.03	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	3.85556E-14
3B4a. Goats	N2O	0.03010000	0.03	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	5.16742E-14
3B4b. Horses	N2O	0.00015000	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	1.28328E-18
3B4c. Mules and Asses	N2O	0.00101190	0.00	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	5.84004E-17
3B4d. Poultry	N2O	0.02640000	0.03	5%	100%	1.0012	0.0000		0.0000	0.0000	0.0000	3.9751E-14
3B5. Indirect N2O emissions	N2O	0.08180370	0.08	20%	50%	0.5385	0.0000		0.0000	0.0000	0.0000	6.1067E-12
3D. Agricultural soils	N2O	0.39629682	0.40	5%	3%	0.0583	0.0000		0.0000	0.0000	0.0000	9.12558E-12
3F. Field burning of agricultural residues	N2O	0.00160699	0.00	20%	20%	0.2828	0.0000		0.0000	0.0000	0.0000	2.35661E-15
5D1. Domestic wastewater	N2O	0.04020000	0.04	30%	30%	0.4243	0.0000		0.0000	0.0000	0.0000	3.31814E-12
5D2. Industrial wastewater	N2O	0.00104200	0.00	100%	30%	1.0440	0.0000		0.0000	0.0000	0.0000	2.47706E-14
2G1. Electrical equipment	SF6	0.00000113	0.00	5%	500%	5.0002	0.0000		0.0000	0.0000	0.0000	7.28431E-23
Total		4681.53083157	4681.52				0.0003					0.0003
Total Uncertainties						Uncertainty in total inventory %:	1.61%				Trend uncertainty %:	1.61%

Table A2.3.Analytical calculations of uncertainty, without LULUCF 2018

Member State:	Cyprus
Reporting year:	2018

IPCC category/Group	Gas	Base year emissions or removals	2018 emissions or removals	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty (2)	Uncertainty in trend in national emissions introduced by activity data uncertainty (3)	Uncertainty introduced into the trend in total national emissions
1A1a. Public electricity and heat production	CH4	0.06600	0.129357	3%	100%	1.0004	0.0000	0.0000	0.0000	0.0000	3.32149E-13
1A1b. Petroleum refining	CH4	0.00222	0.000000	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	0
1A1c. Manufacture of solid fuels and other energy industries	CH4	0.00336	0.003347	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	6.17827E-16
1A2b. Non-ferrous metals	CH4	0.00013	0.000045	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	1.10992E-19
1A2c. Chemicals	CH4	0.00009	0.000834	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	3.83226E-17
1A2d. Pulp, paper and print	CH4	0.00019	0.000081	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	3.58945E-19
1A2e. Food processing, beverages and tobacco	CH4	0.00264	0.004250	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	9.95839E-16
1A2f. Non-metallic minerals	CH4	0.03036	0.080937	3%	100%	1.0004	0.0000	0.0000	0.0000	0.0000	1.30031E-13
1A2g. Other	CH4	0.00191	0.002035	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	2.28261E-16
1A3a. Domestic aviation	CH4	0.00018	0.000006	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	2.12901E-21
1A3b. Road transportation	CH4	0.27500	0.146618	5%	40%	0.4031	0.0000	0.0000	0.0000	0.0000	1.18529E-12
1A3d. Domestic navigation	CH4	0.00012	0.000113	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	7.02341E-19
1A4a. Commercial/institutional	CH4	0.01499	0.052924	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	1.54439E-13
1A4b. Residential	CH4	0.07618	0.170314	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	1.59938E-12
1A4c. Agriculture/forestry/fishing	CH4	0.00734	0.012425	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	8.51226E-15
1A5a. Stationary	CH4	0.00148	0.002612	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	3.76254E-16
1A5b. Mobile	CH4	0.00000	0.000632	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	2.19895E-17
1B2a. Oil	CH4	0.01620	0.000000	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	0
3A1a. Dairy cattle	CH4	2.21400	3.944314	5%	50%	0.5025	0.0000	0.0004	0.0000	0.0000	8.57817E-10
3A1b. Non-dairy cattle	CH4	1.83940	2.216673	5%	50%	0.5025	0.0000	0.0002	0.0000	0.0000	2.70929E-10

3A2. Sheep	CH4	2.32000	2.487904	5%	50%	0.5025	0.0000	0.0003	0.0000	0.0000	3.41286E-10
3A3. Swine	CH4	0.41690	0.543078	5%	50%	0.5025	0.0000	0.0001	0.0000	0.0000	1.62621E-11
3A4a. Goats	CH4	1.03000	1.252060	5%	50%	0.5025	0.0000	0.0001	0.0000	0.0000	8.64374E-11
3A4b. Horses	CH4	0.00828	0.005094	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	1.43077E-15
3A4c. Mules and Asses	CH4	0.05026	0.012020	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	7.96637E-15
3B1a. Dairy cattle	CH4	0.23676	0.328378	5%	30%	0.3041	0.0000	0.0000	0.0000	0.0000	5.94566E-12
3B1b. Non-dairy cattle	CH4	0.14489	0.170244	5%	30%	0.3041	0.0000	0.0000	0.0000	0.0000	1.59807E-12
3B2. Sheep	CH4	0.08120	0.087077	5%	30%	0.3041	0.0000	0.0000	0.0000	0.0000	4.18076E-13
3B3. Swine	CH4	2.18210	1.269695	5%	30%	0.3041	0.0000	0.0001	0.0000	0.0000	8.88895E-11
3B4a. Goats	CH4	0.04100	0.050082	5%	30%	0.3041	0.0000	0.0000	0.0000	0.0000	1.383E-13
3B4b. Horses	CH4	0.00108	0.000662	5%	30%	0.3041	0.0000	0.0000	0.0000	0.0000	2.418E-17
3B4c. Mules and Asses	CH4	0.00553	0.001322	5%	30%	0.3041	0.0000	0.0000	0.0000	0.0000	9.63931E-17
3B4d. Poultry	CH4	0.08410	0.099244	5%	30%	0.3041	0.0000	0.0000	0.0000	0.0000	5.43074E-13
3F. Field burning of agricultural residues	CH4	0.06203	0.007080	20%	20%	0.2828	0.0000	0.0000	0.0000	0.0000	4.42175E-14
5A1. Managed waste disposal sites	CH4	0.00000	3.512141	30%	30%	0.4243	0.0000	0.0004	0.0000	0.0002	2.44849E-08
5A2. Unmanaged waste disposal sites	CH4	10.59840	16.687070	30%	30%	0.4243	0.0000	0.0018	0.0000	0.0007	5.52732E-07
5B1. Composting	CH4	0.00000	0.132500	30%	100%	1.0440	0.0000	0.0000	0.0000	0.0000	3.48486E-11
5D1. Domestic wastewater	CH4	3.67582	0.738996	30%	30%	0.4243	0.0000	0.0001	0.0000	0.0000	1.08402E-09
5D2. Industrial wastewater	CH4	0.96790	1.229633	30%	30%	0.4243	0.0000	0.0001	0.0000	0.0001	3.00127E-09
1A1a. Public electricity and heat production	CO2	1675.77000	3342.360000	3%	3%	0.0424	0.0001	0.3510	0.0000	0.0149	0.000221748
1A1b. Petroleum refining	CO2	85.71820	0.000000	5%	5%	0.0707	0.0000	0.0000	0.0000	0.0000	0
1A2b. Non-ferrous metals	CO2	4.91000	2.190000	5%	5%	0.0707	0.0000	0.0002	0.0000	0.0000	2.64448E-10
1A2c. Chemicals	CO2	2.19900	7.820000	5%	5%	0.0707	0.0000	0.0008	0.0000	0.0001	3.37183E-09
1A2d. Pulp, paper and print	CO2	4.82070	2.600000	5%	5%	0.0707	0.0000	0.0003	0.0000	0.0000	3.72733E-10
1A2e. Food processing, beverages and tobacco	CO2	72.57057	65.510000	5%	5%	0.0707	0.0000	0.0069	0.0000	0.0005	2.36628E-07
1A2f. Non-metallic minerals	CO2	379.82670	419.551723	3%	3%	0.0424	0.0000	0.0441	0.0000	0.0019	3.49402E-06
1A2g. Other	CO2	47.86991	51.930000	5%	5%	0.0707	0.0000	0.0055	0.0000	0.0004	1.48692E-07
1A3a. Domestic aviation	CO2	26.04500	0.890000	5%	5%	0.0707	0.0000	0.0001	0.0000	0.0000	4.36749E-11
1A3b. Road transportation	CO2	1183.50842	2048.205125	5%	5%	0.0707	0.0001	0.2151	0.0000	0.0152	0.000231312
1A3d. Domestic navigation	CO2	2.19800	2.140000	5%	5%	0.0707	0.0000	0.0002	0.0000	0.0000	2.5251E-10

1A4a. Commercial/institutional	CO2	75.21200	108.660000	5%	5%	0.0707	0.0000	0.0114	0.0000	0.0008	6.51015E-07
1A4b. Residential	CO2	299.70400	284.480000	5%	5%	0.0707	0.0000	0.0299	0.0000	0.0021	4.46226E-06
1A4c. Agriculture/forestry/fishing	CO2	55.48400	78.780000	5%	5%	0.0707	0.0000	0.0083	0.0000	0.0006	3.42203E-07
1A5a. Stationary	CO2	10.99500	19.360000	5%	5%	0.0707	0.0000	0.0020	0.0000	0.0001	2.06663E-08
1A5b. Mobile	CO2	0.00000	4.520000	5%	5%	0.0707	0.0000	0.0005	0.0000	0.0000	1.12649E-09
2A1. Cement production	CO2	667.66400	843.349000	2%	2%	0.0283	0.0000	0.0886	0.0000	0.0025	6.2746E-06
2A2. Lime production	CO2	5.33260	5.334758	2%	5%	0.0539	0.0000	0.0006	0.0000	0.0000	2.51074E-10
2A4. Other process uses of carbonates	CO2	44.07600	14.739064	5%	5%	0.0707	0.0000	0.0015	0.0000	0.0001	1.19782E-08
2D1. Lubricant use	CO2	1.12000	4.518105	5%	5%	0.0707	0.0000	0.0005	0.0000	0.0000	1.12555E-09
2D2. Paraffin wax use	CO2	0.06350	0.061681	5%	5%	0.0707	0.0000	0.0000	0.0000	0.0000	2.09775E-13
2D3. Other	CO2	7.44765	25.536658	5%	5%	0.0707	0.0000	0.0027	0.0000	0.0002	3.59567E-08
2G4. Other	CO2	0.04121	0.011830	5%	500%	5.0002	0.0000	0.0000	0.0000	0.0000	7.71651E-15
3H. Urea application	CO2	1.81500	0.223447	20%	50%	0.5385	0.0000	0.0000	0.0000	0.0000	4.40473E-11
2F1. Refrigeration and air conditioning	HFCs(1)	79.60035	288.0897503	5%	500%	5.0002	0.0088	0.0303	0.0000	0.0021	4.57622E-06
2F2. Foam blowing agents	HFCs(1)	0.00000	1.277352	5%	500%	5.0002	0.0000	0.0001	0.0000	0.0000	8.99648E-11
2F3. Fire protection	HFCs(1)	0.00000	4.274917	5%	500%	5.0002	0.0000	0.0004	0.0000	0.0000	1.00764E-09
2F4. Aerosols	HFCs(1)	0.00000	3.498209	5%	500%	5.0002	0.0000	0.0004	0.0000	0.0000	6.7475E-10
1A1a. Public electricity and heat production	N2O	0.01300	0.030000	3%	300%	3.0001	0.0000	0.0000	0.0000	0.0000	1.78647E-14
1A1b. Petroleum refining	N2O	0.00036	0.000000	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	0
1A1c. Manufacture of solid fuels and other energy industries	N2O	0.00045	0.000446	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	1.09836E-17
1A2b. Non-ferrous metals	N2O	0.00002	0.000006	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	2.09471E-21
1A2c. Chemicals	N2O	0.00002	0.000130	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	9.27553E-19
1A2d. Pulp, paper and print	N2O	0.00004	0.000015	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	1.19667E-20
1A2e. Food processing, beverages and tobacco	N2O	0.00051	0.000682	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	2.56257E-17
1A2f. Non-metallic minerals	N2O	0.00482	0.011502	3%	300%	3.0001	0.0000	0.0000	0.0000	0.0000	2.62619E-15
1A2g. Other	N2O	0.00038	0.000411	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	9.32154E-18
1A3a. Domestic aviation	N2O	0.00073	0.000025	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	3.40642E-20
1A3b. Road transportation	N2O	0.07920	0.041814	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	9.64017E-14
1A3d. Domestic navigation	N2O	0.00012	0.000113	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	7.02341E-19

1A4a. Commercial/institutional	N2O	0.00047	0.000859	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	4.07094E-17
1A4b. Residential	N2O	0.00234	0.003152	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	5.47681E-16
1A4c. Agriculture/forestry/fishing	N2O	0.00043	0.000633	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	2.20949E-17
1A5a. Stationary	N2O	0.00009	0.000157	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	1.35451E-18
1A5b. Mobile	N2O	0.00000	0.000045	5%	300%	3.0004	0.0000	0.0000	0.0000	0.0000	1.10664E-19
2G3. N2O from product uses	N2O	0.16067	0.217828	5%	500%	5.0002	0.0000	0.0000	0.0000	0.0000	2.61624E-12
3B1a. Dairy cattle	N2O	0.01700	0.022930	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	2.89907E-14
3B1b. Non-dairy cattle	N2O	0.01096	0.011293	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	7.03235E-15
3B2. Sheep	N2O	0.02830	0.030324	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	5.07004E-14
3B3. Swine	N2O	0.02600	0.012860	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	9.11802E-15
3B4a. Goats	N2O	0.03010	0.036769	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	7.45447E-14
3B4b. Horses	N2O	0.00015	0.000095	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	4.97177E-19
3B4c. Mules and Asses	N2O	0.00101	0.000242	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	3.22886E-18
3B4d. Poultry	N2O	0.02640	0.019852	5%	100%	1.0012	0.0000	0.0000	0.0000	0.0000	2.17304E-14
3B5. Indirect N2O emissions	N2O	0.08180	0.092261	20%	50%	0.5385	0.0000	0.0000	0.0000	0.0000	7.50946E-12
3D. Agricultural soils	N2O	0.39630	0.344738	5%	3%	0.0583	0.0000	0.0000	0.0000	0.0000	6.55285E-12
3F. Field burning of agricultural residues	N2O	0.00161	0.000184	20%	20%	0.2828	0.0000	0.0000	0.0000	0.0000	2.9721E-17
5B1. Composting	N2O	0.00000	0.007950	30%	100%	1.0440	0.0000	0.0000	0.0000	0.0000	1.25455E-13
5D1. Domestic wastewater	N2O	0.04020	0.055494	30%	30%	0.4243	0.0000	0.0000	0.0000	0.0000	6.11292E-12
5D2. Industrial wastewater	N2O	0.00104	0.000991	A100%	30%	1.0440	0.0000	0.0000	0.0000	0.0000	2.16765E-14
2G1. Electrical equipment	SF6	0.00000	0.000007	5%	500%	5.0002	0.0000	0.0000	0.0000	0.0000	2.89848E-21
Total		4761.374361	7666.237220				0.0090				0.0005
Total Uncertainties						Uncertainty in total inventory %:	9.49%			Trend uncertainty %:	2.18%

Annex 3: Detailed methodological descriptions for individual source or sink categories

A.3.1. Fuel combustion (1A)

The fuel consumption data published by the National Statistical Service in 2018 for the period 1990-2018 are presented in Table A3.1.3. In green are sectors/consumers that have been added for the first time in 2018 and in red are the revisions.

Due to the unavailability of consumption data for several years, using the data as is would create issues of inconsistence and incomparability. Therefore it was decided to complete the period using the following assumptions. The resulting data used for the estimation of the emissions will be presented at the methodological issues Section of the appropriate sector in Chapter 3. The following pages present the assumptions made to allocate consumption to activities where data was not available.

LPG

(a) 2006-2009 consumption from Not elsewhere specified (Industry) has been moved to Non-metallic minerals.

(b) There is available data for all the consumers of LPG during the period 2006-2015. Since there is no particular trend during this period, it was decided to use the same ratio as 2006 to distribute the consumption that was allocated to residential to all sectors for the period 1990-2005 (Table A3.1.1).

Table A3.1.1. Contribution of different activities to LPG consumption (2006) used to allocate consumption to different sectors for 1990-2005

Activity	Consumption
Non-ferrous metals	1.9%
Non-metallic minerals	1.9%
Food, beverages and tobacco	5.6%
Commercial and public services	24.1%
Residential	64.8%
Agriculture/forestry	1.9%

Jet kerosene

Information on fuel consumption for domestic flights is not available from national statistics. To estimate the emissions from aviation, the available information on fuel consumption from EUROCONTROL was used (Table A3.1.2) for 2005-2016.

Table A3.1.2. International and domestic flights' fuel consumptions, EUROCONTROL data (2005-2016)

Fuel consumption (kt)	2005	2006	2007	2008	2009	2010	2011	2012
Domestic	3.958	3.344	2.967	2.823	2.282	2.429	0.739	0.471
International	264.2	266.4	262.4	272.3	257.4	262.6	272.5	263.4
	2013	**2014**	**2015**	**2016**	**2017**			
Domestic	0.305	0.191	0.286	0.179	0.3			
International	245.7	246.0	238.1	278.2	217			

Table A3.1.3. Fuel consumption according to the National Energy balance 2017 in kt (1990-2017)

(a) 1990-2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Crude oil															
Refinery intake (Observed)	636	763	727	781	906	828	760	1043	1082	1180	1173	1156	1086	971	279
Refinery losses	10	16	3	3	4	2	2	5	6	4	1	5	4	3	
Refinery gas															
Refinery fuel	18	17	17	13	24	13	12	16	16	20	19	19	21	21	9
LPG															
Non-ferrous metals															
Non-metallic minerals															
Food, beverages and tobacco															
Not elsewhere specified (Industry)															
Commercial and public services															
Residential	49	49	55	51	50	51	51	52	50	49	53	53	54	58	56
Agriculture/forestry															
Not elsewhere specified (Other)															
Non-biogasoline = GASOLINE															
Road	163	170	172	169	180	183	186	191	195	203	206	219	228	252	282
International aviation	236	280	272	231	237	260	249	245	258	264	268	314	302	323	295
Not elsewhere specified (Other)															
Other kerosene															
Residential	12	12	17	16	17	17	18	20	21	20	24	24	31	31	24
Oil and gas extraction															
Not elsewhere specified (Industry)															
Residential	12	12	17	16	17	17	18	20	21	20	24	24	31	31	24
Not elsewhere specified (Industry)															
Road															
Non-bio gas/diesel oil = DIESEL															
International marine bunkers	24	20	21	14	12	15	25	27	35	46	50	47	33	36	27
Main activity producer electricity plants			11	3	2	8	6	6	12	21	19	4	2	5	8
Autoproducer electricity plants															

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Road	210	202	246	255	261	285	298	314	334	340	350	355	341	351	354
Chemical and petrochemical															
Non-ferrous metals															
Non-metallic minerals															
Mining and Quarrying															
Food, beverages and tobacco															
Construction															
Not elsewhere specified (Industry)	98	109	132	137	141	153	161	169	180	185	191	193	185	190	171
Commercial and public services															
Residential															
Agriculture/forestry															
Fishing															
Not elsewhere specified (Other)															
Total fuel oil															
International marine bunkers	34	36	38	36	50	54	65	71	63	108	143	145	105	88	27
Refinery fuel	11	12	13	13	14	17	16	14	15	16	16				
Main activity producer electricity plants	540	561	645	697	727	662	703	743	811	856	902	897	932	1095	1046
Autoproducer electricity plants															
Autoproducer CHP Plants														2	5
Chemical and petrochemical															
Non-metallic minerals	37	124	118	100	110	97	111	70	68	68	70	54	55	62	68
Food, beverages and tobacco															
Paper, pulp and printing															
Construction															
Not elsewhere specified (Industry)															
Commercial and public services															
White spirit and SPB															
Not elsewhere specified (Industry)				1		1	1	1		1		1			
Lubricants															
International marine bunkers							1	1	1	1	1	1	1	1	1
Non-energy use: Road				6	8	8	9	8	5	5	5	5	6	6	7
Non-energy use: Not elsewhere specified (Industry)				2	3	3	3	3	2	2	2	2	2	2	3
Bitumen															

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Construction															
Non-energy use: Not elsewhere specified (Industry)	33	23	50	59	57	54	57	62	75	86	83	81	84	70	65
Pet-coke															
Non-metallic minerals		93	85	114	112	125	147	152	150	154	141	133	139	137	146
Other products (liquid)															
Refinery fuel													16	16	
Not elsewhere specified (Industry)	40	5						1							6
Bituminous Coal															
Non-metallic minerals	97	97	26	31	27	20	18	19	26	30	49	53	53	53	57
Lignite															
Not elsewhere specified (Other)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Waste (non-biomass fraction)															
Industrial waste (non-renewable) (TJ)															
Non-metallic minerals	0	0	0	0	0	0	0	0	0	0	0	18	0	15	71
Municipal waste (non-renewable) TJ															
Non-metallic minerals															
RENEWABLES															
Solid biofuels (TJ)															
Charcoal production plants (Transformation)	112	112	112	112	405	388	328	288	314	281	248	253	235	209	184
Chemical and petrochemical															
Non-metallic minerals											41	70	90	211	127
Food, beverages and tobacco															
Commercial and public services															
Residential															
Agriculture/Forestry															
Not elsewhere specified (Other)	145	120	118	117	85	91	136	70	64	88	78	80	74	67	61
Charcoal (kt)															
Commercial and public services															
Residential															
Not elsewhere specified (Other)	1	1	1	1	2	7	7	7	8	7	5	5	7	7	8
Biogases (TJ)															
Main activity producer CHP plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer CHP plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Commercial and public services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Forestry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Municipal waste (renewable)															
Non-metallic minerals															

(b) 2005-2016

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Crude oil													
Refinery intake (Observed)													
Refinery losses													
Refinery gas													
Refinery fuel													
LPG													
Non-ferrous metals		1	1		1	1	1	1			1	1	0.569
Chemical and Petrochemical													0.21
Non-metallic minerals						1	1	1	1	1	1	1	0.376
Food, beverages and tobacco		3	3	3	3	3	4	5	4	4	5	4	5.515
Paper, pulp and printing													0.285
Wood and wood products													0.003
Not elsewhere specified (Industry)		1	1	1	1				0	1	0	0	0.227
Commercial and public services		13	13	14	13	13	14	14	12	10	11	11	13.171
Residential	53	35	36	34	36	34	38	37	33	31	34	35	32.467
Agriculture/forestry		1	1	1	1	1	1	1	1		1	2	2.424
Not elsewhere specified (Other)									1	1	1	1	1.315
Non-biogasoline = GASOLINE													
Road	303	323	352	373	383	390	385	372	349	341	345	354	351
International aviation	291	300	287	286	265	270	294	264	235	231	233	263	298
Domestic aviation													2
Not elsewhere specified (Other)					1	1	2	1	2	2	1	1	1
Other kerosene													
Residential	13	16	16	14	19	14	16	17	12	9	14	14	14
Oil and gas extraction										2			
Not elsewhere specified (Industry)	3												

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Non-metallic minerals													0.06
Food, beverages and tobacco													0.03
Residential	16	16	16	14	19	14	16	17	12	9	14	14	14
Not elsewhere specified (Industry)										2			
Commercial and Public Services													0.003
Road			1	16	17	17	18	18	17	11	11	10	10
Non-bio gas/diesel oil = DIESEL													
International marine bunkers	67	106	104	88	73	53	58	69	83	80	75	95	101
Main activity producer electricity plants	16	7	16	23	92	158	112	214	236	124	89	150	255
Autoproducer electricity plants			1				2	2	2	1	2	2	2
Road	346	323	337	330	321	329	313	272	231	224	241	274	285
Chemical and petrochemical								1	0	1	1	1	1
Non-ferrous metals								1				1	1
Non-metallic minerals								3	1	1	2	2	2
Transport Equipment													0.005
Machinery													0.257
Mining and Quarrying								5	2	1	3	2	4
Food, beverages and tobacco								3	2	2	4	3	5
Textiles and Leather													0.027
Construction								5	5	6	6	7	9
Not elsewhere specified (Industry)	47	24	20	18	18	14	16	3	1	1			
Commercial and public services		19	18	20	19	23	20	16	17	13	13	15	18
Residential	83	98	89	78	83	70	80	76	62	57	65	65	65
Agriculture/forestry	27	28	28	23	20	19	22	21	21	19	22	21	22
Fishing				3	4	4	3	3	2	2	2	2	1
Not elsewhere specified (Other)		4	6	13	5	5	6	5	5	9	6	6	6
Total fuel oil													
International marine bunkers	225	190	171	165	146	134	141	128	157	153	169	193	154
Refinery fuel													
Main activity producer electricity plants	1104	1137	1174	1219	1163	1053	1058	896	649	793	858	883	778
Autoproducer electricity plants			4	3	2	2	2		2	4			
Autoproducer CHP Plants	6	7	14	12	11	8	2	2	2	0			1
Chemical and petrochemical											1	1	1

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Non-metallic minerals	37	35	38	38	30	25	15	13	8	7	8	10	13
Mining													0.2
Food, beverages and tobacco								9	8	8	9	9	12
Paper, pulp and printing										1	1	1	1
Construction								1	1	3	2	3	2
Not elsewhere specified (Industry)	28	19	27	25	17	20	34	2	2	3	1	2	0.4
Commercial and public services	1	2	2	2	2	2	2	4	4	2	3	4	4
White spirit and SPB													
Not elsewhere specified (Industry)	1	1	1										
Lubricants													
International marine bunkers	1	1	1	1									
Non-energy use: Road	2	2	2	2	2	2	2	1	1	1	1	1	1
Non-energy use: Not elsewhere specified (Industry)	4	4	4	4	4	4	4	4	3	3	3	3	2
Bitumen													
Construction	69	69	57	66	74	83	64	36	24	21	21	37	36
Non-energy use: Not elsewhere specified (Industry)													
Pet-coke													
Non-metallic minerals	154	146	143	152	144	116	100	94	135	162	128	123	
Other products (liquid)													
Refinery fuel													
Not elsewhere specified (Industry)													
Bituminous Coal													
Non-metallic minerals	52	54	49	40	21	26	12	0	0	4	6	0	5
Lignite													
Not elsewhere specified (Other)	1	1	1	1	1	1	1	1	1	0	0	0	0
Waste (non-biomass fraction)													
Industrial waste (non-renewable) (TJ)													
Non-metallic minerals	138	73	288	239	276	299	4	0	0	279	221	94	122
Municipal waste (non-renewable) TJ													
Non-metallic minerals								24	45	37	295	569	812
RENEWABLES													
Solid biofuels (TJ)													
Charcoal production plants (Transformation)	174	135	274	211	47	48	45	82	71	58	94	163	172

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chemical and petrochemical										42	52	21	22
Non-metallic minerals	38	61	133	281	304	347	306	29	28	116	95	55	86
Food, beverages and tobacco										44	7	36	51
Commercial and public services			14	15	15	15	13	16	16	16	15	15	17
Residential		74	95	123	500	260	339	419	353	249	551	531	691
Agriculture/Forestry		5											
Not elsewhere specified (Other)	58												
Charcoal (kt)													
Commercial and public services		5	7	7	6	6	6	6	6	6	7	7	7
Residential		5	6	6	5	5	6	6	6	6	6	8	8
Not elsewhere specified (Other)	10												
Biogases (TJ)													
Main activity producer CHP plants	0	0	0	0	13	21	92	91	118	116	130	130	145
Autoproducer CHP plants	0	0	9	78	131	148	180	192	171	176	179	182	178
Commercial and public services	0	0	0	0	11	12	11	11	11	12	12	16	16
Agriculture/Forestry	0	0	6	0	54	93	165	182	166	172	151	163	96
Municipal waste (renewable)													
Non-metallic minerals								88	150	161	325	427	752

The share of domestic flights to the total fuel consumption is presented in Table A3.1.4. It can be noticed that there is a decreasing trend in the share of domestic flights to the total fuel consumption. The trend for these years can be represented by the equation y=-0.0014x+0.0154. This equation was used to estimate the share of domestic flights to the total for the years 1990-2004 (Table A3.1.5), years for which data is not available for domestic flights. By multiplying the share by the total fuel consumption reported all under international flights by the Statistical Service for 1990-2004, the fuel consumption of domestic flights was estimated. The international flights consumption for 1990-2004 was revised by subtracting the estimated fuel consumption for domestic flights. The resulting fuel consumption for domestic and international flights for the years 1990-2004 is presented in Table A3.1.5. Fuel consumption obtained from the Statistical Service is in kt, and converted to TJ using the default NCV proposed by the 2006 IPCC Guidelines, i.e. 44.1 TJ/Gg (Table 1.2, pg.1.18, vol.2).

Table A3.1.4. Share of domestic flights to the total fuel consumption, EUROCONTROL data (2005-2016)

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Share of domestic to total	1.48%	1.24%	1.12%	1.03%	0.88%	0.92%	0.27%	0.18%
	2013	**2014**	**2015**	**2016**				
Share of domestic to total	0.12%	0.08%	0.12%	0.06%				

Table A3.1.5. Share of domestic flights to the total fuel consumption, consumption for domestic and international flights (1990-2004)

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

<u>Other kerosene</u>

(a) Other kerosene consumption was recorded for non-elsewhere specified (industry) only for 2005. For the same year the consumption of residential sector was much lower than other years. The consumption from non-elsewhere specified (industry) of 2005 was moved to residential.

(b) Oil and gas extraction consumption reported only for 2014 was moved to Not elsewhere specified (Industry).

<u>Diesel</u>

According to the energy balance, the consumers of gas-diesel oil are Main activity producer electricity plants, Road, Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco, Construction, Not elsewhere specified (Industry), Commercial and public services, Residential, Agriculture/ Forestry and Not elsewhere specified (Other). Consumption data for Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco, Construction is only available for 2012 to 2017.

(a) For the years 2006-2011 all consumption from industrial activities (incl. autoproducers) was included in Not elsewhere specified (Industry). The consumption was allocated to the industrial sectors according to the ratio of 2012 (Table A3.1.6).

Table A3.1.6. Contribution of different activities to gas-diesel oil consumption (2012) used to allocate consumption to Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco,

Construction, Not elsewhere specified (Industry) for 2006-2011

Activity	Consumption
Chemical and petrochemical	5%
Non-ferrous metals	5%
Non-metallic minerals	14%
Mining and Quarrying	24%
Food, beverages and tobacco	14%
Construction	24%
Not elsewhere specified (Industry)	14%

(b) The contribution of fishing consumption to the total for the years 2005-2007 is assumed the same as 2008.

(c) For 2005, consumption is available for Main activity producer electricity plants, road, Residential and Agriculture/forestry. Due to the large increase of the Not elsewhere specified (Industry) compare to 2006-2011, it is assumed that consumption by Commercial and public services, and Not elsewhere specified (Other) is included in the Not elsewhere specified (Industry). The assumed contribution of each sector to the consumption allocated to Not elsewhere specified (Industry) is based on the 2012 consumption ratio for these sectors (Table A3.1.7).

Table A3.1.7. Contribution of different activities to gas-diesel oil consumption (2012) used to allocate consumption to Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Mining and Quarrying, Food, beverages and tobacco, Construction, Not elsewhere specified (Industry), Commercial and public services, Not elsewhere specified (Other) from Not elsewhere specified (Industry) for 2005

Activity	Consumption
Chemical and petrochemical	2%
Non-ferrous metals	2%
Non-metallic minerals	7%
Mining and Quarrying	12%
Food, beverages and tobacco	7%
Construction	12%
Not elsewhere specified (Industry)	7%
Commercial and public services	38%
Not elsewhere specified (Other)	12%

(d) To estimate the consumption for the years 1990-2004, the consumption ratio compared to Not elsewhere specified (Industry) is assumed to be the same as 2012 (Table A3.1.8).

Table A3.1.8. Contribution of different activities to gas-diesel oil consumption (2012) used to allocate consumption to from Not elsewhere specified (Industry) for 1990-2004

Activity	Consumption
Chemical and petrochemical	0.7%
Non-ferrous metals	0.7%
Non-metallic minerals	2.11%
Mining and Quarrying	3.52%
Food, beverages and tobacco	2.11%
Construction	3.52%
Not elsewhere specified (Industry)	2.11%
Commercial and public services	11.27%
Residential	53.52%
Agriculture/ forestry	14.79%
Fishing	2.11%
Not elsewhere specified (Other)	3.52%

(e) Consumption for Water-borne navigation activities is available for the years 1998-2015[96] (Table

[96] Mr. George Ioannou, Statistical Service, Estimation based on fuel expenses assuming that all fuel is road diesel

A3.1.9). The consumption for the period 1990-1997 was estimated assuming that the contribution of the activity to road transport consumption is the same as 1998; the consumption for 2016 was estimated assuming that the contribution of the activity to road transport consumption is the same as 2015.

(f) The consumption for Water-borne navigation activities was subtracted from Road transport. Therefore road transport consumption was revised for the whole reporting period.

Table A3.1.9. Consumption diesel for Water-borne navigation activities

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
t	1097.05	1236.84	531.915	430.208	561.862	430.478	596.723	730.847	558.887
kt	1.10	1.24	0.53	0.43	0.56	0.43	0.60	0.73	0.56
% of road	0.33%	0.36%	0.15%	0.12%	0.16%	0.12%	0.17%	0.21%	0.17%

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
t	626.709	757.997	1491.21	946.597	886.776	625.631	472.399	558.96	558.96
kt	0.63	0.76	1.49	0.95	0.89	0.63	0.47	0.56	0.56
% of road	0.19%	0.23%	0.46%	0.29%	0.28%	0.23%	0.20%	0.25%	0.23%

RFO

(a) All consumption allocated to Autoproducer electricity and Autoproducer CHP Plants was moved to Not elsewhere specified (Industry).

(b) The consumption for food, beverages and tobacco, is only available for 2012-2017. For 2005-2012 consumption is also reported for non – metallic minerals and commercial and public services.

(c) All consumption during 1990-2004 except Refinery fuel and Main activity producer electricity plants was allocated to non-metallic minerals, food, beverages and tobacco, not elsewhere specified (industry) and commercial and public services.

Bitumen

All bitumen consumption allocated to Non-energy use: Not elsewhere specified (Industry) during 1990-2004 has been moved to construction.

Pet-coke

Pet-coke in Cyprus is consumed only for cement production. According to the information received from the cement installations, pet-coke was consumed in 1990. The energy balance shows that pet-coke was not imported in 1990. To reduce the inconsistency and the impact on the times series, it was decided to move the "other liquid fuels" consumption of 1990 to cement as pet-coke.

Solid biofuels

(a) All consumption of solid biofuels for the period 1990-1999 is reported as non-elsewhere specified (other).

(b) For 2001-2005 consumption is reported as non-elsewhere specified (other) and non-metallic minerals.

(c) Consumption in agriculture is reported only for 2006.

The consumption of agriculture of 2006 was moved to commercial and public services for which consumption is reported for 2007-2015. All the consumption reported as non-elsewhere specified (other) for 1990-2005 was distributed to commercial and public services, and residential sector according to the consumption ratio the two sectors had in 2007 (Table A3.1.10).

Table A3.1.10. Contribution of different activities to solid biofuels consumption (2007) used to allocate consumption to commercial and public services, and residential for 1990-2005

Activity	Consumption
Commercial and public services	12.8%
Residential	87.2%

Charcoal

All charcoal consumption for the period 1990-2005 was reported as non-elsewhere specified (other). For the period 2006-2016, the charcoal consumption is allocated to commercial and public services, and residential sectors using the ratio of 50:50. This ratio was used to allocate charcoal consumption to the two sectors for the period 1990-2005.

Biogases

Biogas consumption is available in Cyprus after 2006, when the first anaerobic digester of the country started it operation. The biogas in Cyprus is consumed onsite to produce electricity and heat through a combined heat power (CHP) generator. Therefore, the biogas consumed by “Main activity producer CHP plants” (2009-2012) and “Autoproducer CHP plants” (2007-2016) was moved to agriculture.

A.3.2. Solid waste management (5A)

Historical solid waste production

The IPCC Waste Model requires MSW and non-MSW activity data to be reported annually going back to the year 1950.

MSW activity data in Cyprus were only recorded between the years of 1996-2016, while the previously reported period of 1990-1995 was linearly extrapolated from the trend observable in years 1996-2009.

In an attempt to determine the historical waste per capita data going back to the year 1950, as recommended during the TERT review, a linear extrapolation from the small sample size of recorded data would not have sufficed, or otherwise been applicable. Therefore, a more pertinent indicator of waste activity was required, and, as such, the national GDP was used to correlate the annual waste activity against the corresponding years.

The methodology used to determine the historical waste per capita data was applied as follows:
(a) The 1960-2014 GDP data[97] was extrapolated backwards, to expand the range to the year 1950.
(b) Waste activity data from 1996-2009 was fitted exponentially to the respective GDP value of each year to provide for a correlation between waste per capita and GDP.
(c) Hence, a hind cast of the annual waste activity was calculated going back to 1950 using the derived relation of waste per capita to GDP.

Regarding non-MSW, the first reference year which data are available is 2014 in accordance with the provisions of the Waste Statistics Regulation (EC) No 2150/2002. No data are available for Cyprus before 2004. The methodology applied is may differ between years, due to the amendment of the Regulation (data 2010 and onwards) and moreover due to improved methods of reporting waste following Eurostat's recommendations. Data revisions were applied from 2012 onwards.

An estimation of the activity data for the years 2013 and 2015 was made by obtaining the average of the years before and after; i.e. 2012 and 2014, 2014 and 2016 respectively.

An extrapolation of the trend available from the years 2012-2016 was used to estimate activity data for 2017 and 2018.

To estimate the activity data for the years prior to 2012, the annual change of the Gross Domestic Product at Constant market prices of 2005 was used, as published by the Statistical Service in the Statistical Abstract.

GDP data alongside the calculated waste activity derived from the methodology of the model is summarized annually in Table A3.2.1. The aforementioned methodology is described analytically below in conjunction with the relevant data.

Table A3.2.1. Data used for fitting and extrapolating GDP and waste activity is tabulated by year.

	GDP (€m)	Waste (kg/capita)	Food (Gg)	Wood (Gg)	Textile (Gg)	Sludge (Gg)
1950	1052.3	457.96	0.770489	0.454752	0.000601	0.007601
1951	1103	458.65	0.809490	0.477771	0.000632	0.007986
1952	1156.2	459.37	0.850512	0.501983	0.000664	0.008391
1953	1211.9	460.13	0.893559	0.527390	0.000697	0.008816
1954	1270.2	460.92	0.938717	0.554043	0.000733	0.009261
1955	1331.4	461.76	0.986236	0.582088	0.000770	0.009730
1956	1395.6	462.64	1.036201	0.611579	0.000809	0.010223
1957	1462.8	463.56	1.088620	0.642517	0.000849	0.010740

[97] Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance. Tel. no.: +357 22 60 1231. Email: mmatsi@mof.gov.cy

1958	1533.3	464.52	1.143743	0.675051	0.000893	0.011284
1959	1607.1	465.54	1.201576	0.709185	0.000938	0.011854
1960	1468.8528	463.64	1.106401	0.653011	0.000863	0.010915
1961	1631.9978	465.88	1.244643	0.734603	0.000971	0.012279
1962	1778.7189	467.91	1.367593	0.807170	0.001067	0.013492
1963	1888.7596	469.44	1.457779	0.860399	0.001138	0.014382
1964	1709.1906	466.95	1.331217	0.785701	0.001039	0.013133
1965	2090.2273	472.24	1.713132	1.011112	0.001337	0.016901
1966	2217.787	474.03	1.824474	1.076827	0.001424	0.018000
1967	2519.4411	478.28	2.111698	1.246350	0.001648	0.020833
1968	2635.504	479.92	2.213675	1.306538	0.001727	0.021839
1969	2880.769	483.42	2.440823	1.440604	0.001905	0.024080
1970	2970.0061	484.69	2.518849	1.486656	0.001966	0.024850
1971	3349.9479	490.17	2.888344	1.704736	0.002254	0.028495
1972	3571.1244	493.39	3.092524	1.825246	0.002413	0.030510
1973	3606.7097	493.91	3.123651	1.843617	0.002437	0.030817
1974	2997.3794	485.09	2.672200	1.577165	0.002085	0.026363
1975	2428.0142	476.98	2.245632	1.325400	0.001752	0.022155
1976	2870.3672	483.27	2.745900	1.620664	0.002143	0.027090
1977	3323.122	489.78	3.260134	1.924172	0.002544	0.032163
1978	3577.1465	493.48	3.529971	2.083432	0.002755	0.034826
1979	3930.2624	498.66	3.916595	2.311623	0.003056	0.038640
1980	4162.9357	502.11	4.163049	2.457083	0.003249	0.041071
1981	4289.948	504	4.294062	2.534409	0.003351	0.042364
1982	4546.16		4.566812	2.695389	0.003564	0.045055
1983	4802.3767	511.7	4.839562	2.856369	0.003776	0.047746
1984	5227.7582	518.18	5.309898	3.133968	0.004144	0.052386
1985	5478.4979	522.03	5.577408	3.291855	0.004352	0.055025
1986	5675.5858	525.09	5.785542	3.414699	0.004515	0.057078
1987	6078.5212	531.38	6.227673	3.675649	0.004860	0.061440
1988	6583.8328	539.39	6.792323	4.008913	0.005300	0.067011
1989	7117.0653	547.96	7.390923	4.362214	0.005767	0.072916
1990	7650.2977	556.68	7.989522	4.715515	0.006235	0.078822
1991	7703.9494	557.56	8.045949	4.748818	0.006279	0.079379
1992	8428.2477	569.64	8.880900	5.241617	0.006930	0.087616
1993	8487.3741	570.64	8.943642	5.278648	0.006979	0.088235
1994	8987.7585	579.15	9.503960	5.609355	0.007416	0.093763
1995	10190.74	600.13	10.972607	6.476169	0.008562	0.108252
1996	10355.25	605	11.152646	6.582429	0.008703	0.110028
1997	10602.94	612	11.425946	6.743734	0.008916	0.112725
1998	11138.88	616	12.034232	7.102753	0.009391	0.118726
1999	11662.88	620	12.628298	7.453378	0.009854	0.124587
2000	12330.36	629	13.394904	7.905838	0.010453	0.132150
2001	12772.74	650	13.893360	8.200033	0.010841	0.137067
2002	13185.748	655	14.357615	8.474042	0.011204	0.141648
2003	13556.11	671	14.772547	8.718940	0.011528	0.145741
2004	14179.977	685	15.485193	9.139552	0.012084	0.152772
2005	14730.58	688	16.110768	9.508774	0.012572	0.158944
2006	15396.7	694.38	16.873805	9.959128	0.013167	0.166471
2007	16156.38	704.31	17.749577	10.476020	0.013851	0.175111
2008	16746.54	728.88	18.422514	10.873196	0.014376	0.181750
2009	16406.76	729.86	18.056163	10.656970	0.014090	0.178136
2010	16630.61	698	18.305924	10.804383	0.014285	0.180600
2011	16697.85	684	18.380238	10.848244	0.014343	0.181333
2012	16289.047	670	17.941000	10.589000	0.014000	0.177000
2013	15321.63	629	14.927000	9.679000	0.013500	0.358000
2014	14939.02	626	11.913000	8.769000	0.013000	0.539000
2015			11.173500	7.092000	0.013000	0.605500

2016			10.434000	5.415000	0.013000	0.672000
2017			9.694500	4.249333	0.012667	0.814833
2018			8.955000	3.083667	0.012333	0.957667

(a) Reliable national GDP data is available, courtesy of the Statistical Service of Cyprus (CYSTAT), starting from 1960 – marked by the establishment of the Republic of Cyprus, and using constant market prices of 2005.

GDP data between the years of 1950-59 was extrapolated exponentially to allow for the waste activity to be fitted to that period as well, as shown in Figure; not much growth was to be expected during those years due to the British rule and Cyprus Emergency, and the fitted model is shown to be in accord. The GDP data appear to effectively gauge the socio-political economics of the time period, as they factor in any fluctuations in the market that may economically influence waste activity, as well as by modelling the situation in the aftermath of a war, such as the Turkish invasion of 1974.

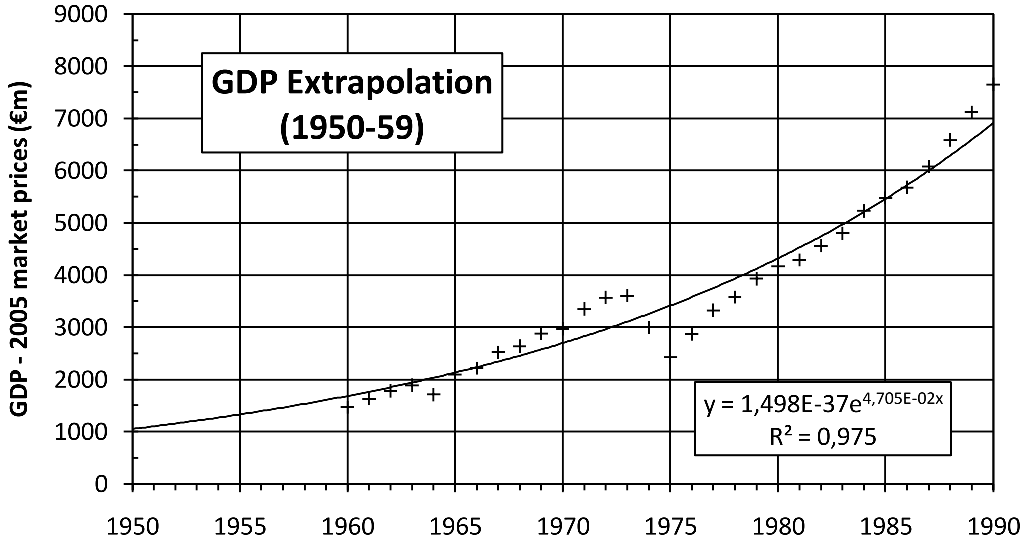

Figure A.3.2.1. GDP data 1960-2014 (CYSTAT) extrapolated for the years of 1950-59.

(b) As illustrated in Figure, the waste activity data showing a linear trend between the years 1996-2009 was used to fit waste per capita to GDP exponentially, and, by association, correlate waste activity with each corresponding year.

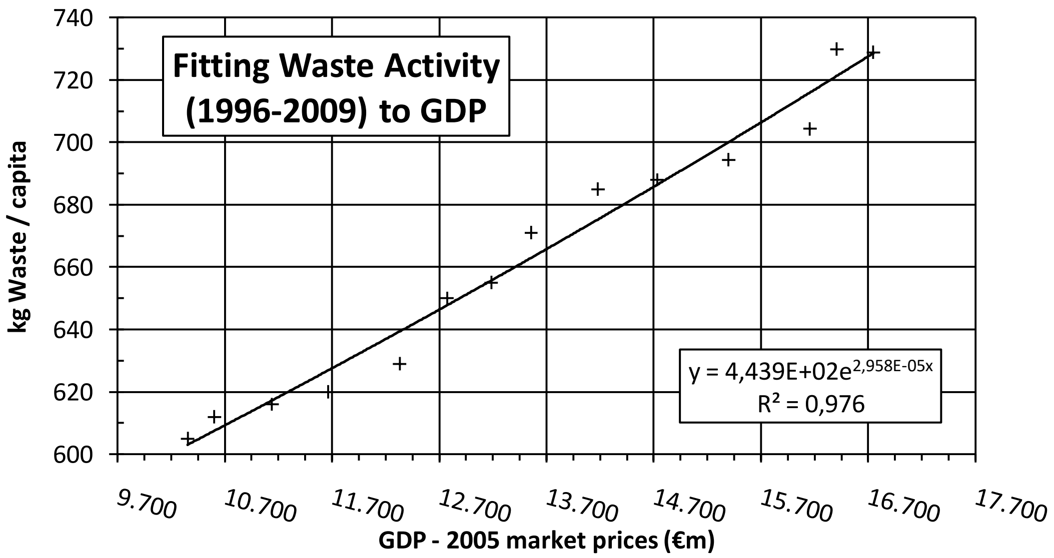

Figure A.3.2.2. Plotting the linear period of waste activity data from 1996-2009 against their corresponding annual GDP, and fitting to an exponential model.

(c) The GDP data from 1950-2014 could now be normalized to waste activity data by relation to the exponential fit determined from plotting waste activity to GDP for 1996-2009 in Figure. Hence, the waste activity data can be hind cast for each year going back to 1950 through a correlation to the annual GDP, as in Figure A.3.2.3.

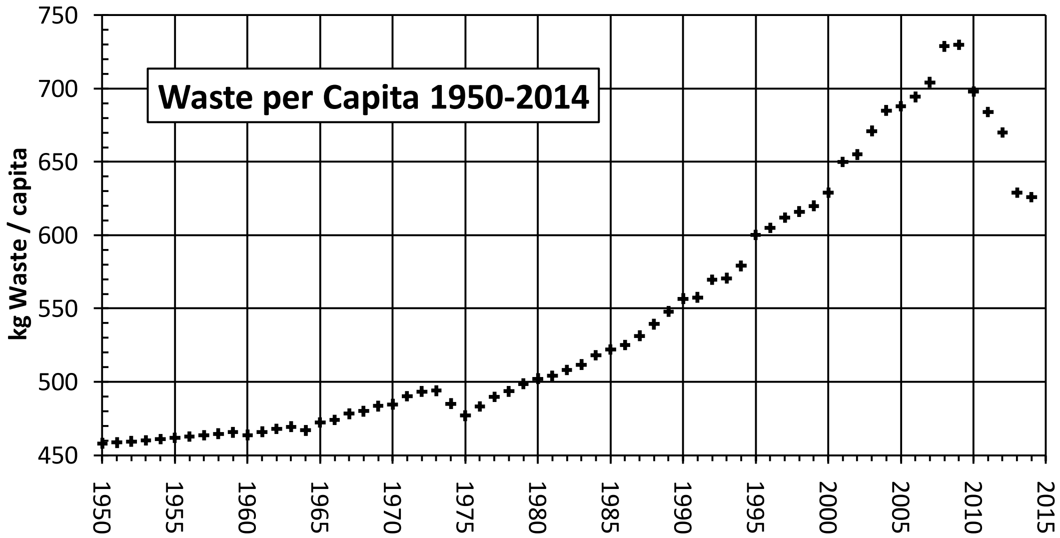

Figure A.3.2.3. Waste per capita derived from annual GDP data and hind casts.

Annex 4: The national energy balance for the most recent inventory year (2018)

The national energy balance prepared by the Statistical Service of Cyprus according to the requirements of Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics (OJ L 304, 14.11.2008, p. 1–62) is presented in the tables that follow.

Table A.4.1. Energy balance 2018 - Liquid Fuels (LPG, Non-bio gasoline, Non-bio jet kerosene, Other kerosene, Road diesel, Heating and other gas oil, Total gas/diesel oil, Biodiesel), in kt

Flow	LPG	Non-bio gasoline	Non-bio jet kerosene	Other kerosene	Road Diesel	Heating and other gas oil	Total gas/diesel oil	Biodiesel
Indigenous production								
Receipts from other sources								
Solid fuels								
Natural gas								
Renewables								
Backflows	-	-	-	-	-	-	0.000	-
Of which: backflows for direct export or sale	-	-	-	-	-	-	0.000	-
Primary product receipts	-	-	-	-	3.496	-	3.496	3.496
Refinery gross output	-	-	-	-	-	-	0.000	-
Recycled products	-	-	-	-	-	-	0.000	-
Refinery fuel	-	-	-	-	-	-	0.000	-
Imports (Balance)	53.527	339.272	306.450	11.596	379.680	395.624	775.304	6.632
Exports (Balance)	-	-	-	-	-	-	0.000	-
International marine bunkers	-	-	-	-	-	117.778	117.778	-
Interproduct transfers	-	-	-	-	-10.622	10.622	0.000	-
Products transferred	-	-	-	-	-	-	0.000	-
Direct use								
Stock changes	0.349	5.250	-1.792	0.049	3.567	10.098	13.665	-
Refinery intake (Calculated)								
Gross inland deliveries (Calculated)	**53.876**	**344.522**	**304.658**	**11.645**	**376.121**	**298.566**	**674.687**	**10.128**
Statistical difference	*0.212*	*2.918*	*-6.774*	*0.630*	*28.804*	*-26.956*	*1.848*	*0.000*
Gross inland deliveries (Observed)	**53.664**	**341.604**	**311.432**	**11.015**	**347.317**	**325.522**	**672.839**	**10.128**
Refinery intake (Observed)								
Opening stock level (National territory)	2.964	59.561	37.073	2.607	59.123	129.933	189.056	-

Closing stock level (National territory)	2.615	54.311	38.865	2.558	55.556	119.835	175.391	-
Average net calorific value of Production								
Average net calorific value of Imports								
Average net calorific value of Exports								
Average net calorific value of Average	47,300.000	44,300.000	44,100.000	43,800.000	42,800.000	42,740.000	42,785.000	37,000.000
Refinery fuel used for Electricity generation	-	-	-	-	-	-	*0.000*	-
Refinery fuel used CHP production	-	-	-	-	-	-	*0.000*	-
Refinery fuel used Heat production	-	-	-	-	-	-	*0.000*	-
Stock changes at Main activity plants	-	-	-	-	-	-	0.000	-
Refinery losses								
Gross deliveries to Petrochemical industry	-	-	-	-	-	-	0.000	-
Energy use in Petrochemical industry	-	-	-	-	-	-	0.000	-
Non-energy use in Petrochemical industry	-	-	-	-	-	-	0.000	-
Net deliveries of Total products								
Net deliveries to the Petrochemical industry								
Gross inland deliveries for energy use	**53.664**	**341.604**	**311.432**	**11.015**	**347.317**	**325.522**	**672.839**	**10.128**
Transformation sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**248.089**	**248.089**	**0.000**
Main activity producer electricity	-	-	-	-	-	246.110	246.110	-
Autoproducer electricity	-	-	-	-	-	1.746	1.746	-
Main activity producer CHP	-	-	-	-	-		0.000	-
Autoproducer CHP Plants	-	-	-	-	-	0.233	0.233	-
Main activity producer heat	-	-	-	-	-	-	0.000	-
Autoproducer heat	-	-	-	-	-	-	0.000	-
Gas works (and other conversion to gases)	-	-	-	-	-	-	0.000	-
Natural gas blending plants	-	-	-	-	-	-	0.000	-
Coke ovens (Transformation)	-	-	-	-	-	-	0.000	-

Blast furnaces (Transformation)	-	-	-	-	-	-	0.000	-
Petrochemical industry	-	-	-	-	-	-	0.000	-
Patent fuel plants (Transformation)	-	-	-	-	-	-	0.000	-
Not elsewhere specified (Transformation)	-	-	-	-	-	-	0.000	-
Energy sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Coal mines	-	-	-	-	-	-	0.000	-
Oil and gas extraction	-	-	-	-	-	-	0.000	-
Coke ovens (Energy)	-	-	-	-	-	-	0.000	-
Blast furnaces (Energy)	-	-	-	-	-	-	0.000	-
Gas works (Energy)	-	-	-	-	-	-	0.000	-
Electricity, CHP and Heat	-	-	-	-	-	-	0.000	-
Non elsewhere specified (Energy)	-	-	-	-	-	-	0.000	-
Distribution losses	-	-	-	-	-	-	0.000	-
Total final energy consumption	**53.664**	**341.604**	**311.432**	**11.015**	**347.317**	**77.433**	**424.750**	**10.128**
Transport sector	**0.441**	**341.604**	**310.000**	**0.000**	**308.669**	**0.000**	**308.669**	**10.128**
International aviation	-	-	308.233	-	-	-	0.000	-
Domestic aviation	-	-	-	-	-	-	0.000	-
Road	0.441	341.604	-	-	307.996	-	307.996	10.128
Rail	-	-	-	-	-	-	0.000	-
Domestic navigation	-	-	1.767	-	0.673	-	0.673	-
Pipeline transport	-	-	-	-	-	-	0.000	-
Non elsewhere specified (Transport)	-	-	-	-	-	-	0.000	-
Industry sector	**7.585**	**0.000**	**0.000**	**0.075**	**3.986**	**13.893**	**17.879**	**0.000**
Iron and steel	-	-	-		-	-	0.000	-
Chemical and petrochemical	0.219	-	-		0.490	0.546	1.036	-
Non-ferrous metals	0.594	-	-		0.035	0.095	0.130	-
Non-metallic minerals	0.392	-	-	0.047	0.209	1.153	1.362	-

Transport equipment	-	-	-		0.006	-	0.006	-
Machinery	0.086	-	-		0.069	0.155	0.224	-
Mining and Quarrying	-	-	-		2.802	0.861	3.663	-
Food, beverages and tobacco	5.757	-	-	0.023	0.310	3.702	4.012	-
Paper, pulp and printing	0.297	-	-		0.020	0.008	0.028	-
Wood and wood products	0.003	-	-		0.010	0.013	0.023	-
Construction	-	-	-		-	7.171	7.171	-
Textiles and leather	-	-	-		0.010	0.013	0.023	-
Not elsewhere specified (Industry)	0.237	-	-	0.005	0.025	0.176	0.201	-
Other sectors	**45.638**	**0.000**	**1.432**	**10.940**	**34.662**	**63.540**	**98.202**	**0.000**
Commercial and public services	13.748	-	-	1.641	7.133	9.194	16.327	-
Residential	28.448	-	-	9.299		53.444	53.444	-
Agriculture/forestry	2.530	-	-	-	20.568		20.568	-
Fishing	-	-	-	-	1.788		1.788	-
Not elsewhere specified (Other)	0.912	-	1.432	-	5.173	0.902	6.075	-
Gross inland deliveries for non energy use	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Transformation Sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Main activity producer electricity	-	-	-	-	-	-	0.000	-
Autoproducer electricity	-	-	-	-	-	-	0.000	-
Main activity producer CHP	-	-	-	-	-	-	0.000	-
Autoproducer CHP Plants	-	-	-	-	-	-	0.000	-
Main activity producer heat	-	-	-	-	-	-	0.000	-
Autoproducer heat	-	-	-	-	-	-	0.000	-
Gas works (and other conversion to gases)	-	-	-	-	-	-	0.000	-
Natural gas blending plants	-	-	-	-	-	-	0.000	-
Coke ovens (Transformation)	-	-	-	-	-	-	0.000	-
Blast furnaces (Transformation)	-	-	-	-	-	-	0.000	-

Petrochemical industry	-	-	-	-	-	-	0.000	-
Patent fuel plants (Transformation)	-	-	-	-	-	-	0.000	-
Not elsewhere specified (Transformation)	-	-	-	-	-	-	0.000	-
Energy sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Coal mines	-	-	-	-	-	-	0.000	-
Oil and gas extraction	-	-	-	-	-	-	0.000	-
Coke ovens (Energy)	-	-	-	-	-	-	0.000	-
Blast furnaces (Energy)	-	-	-	-	-	-	0.000	-
Gas works (Energy)	-	-	-	-	-	-	0.000	-
Electricity, CHP and Heat	-	-	-	-	-	-	0.000	-
Non elsewhere specified (Energy)	-	-	-	-	-	-	0.000	-
Distribution losses	-	-	-	-	-	-	0.000	-
Total final non energy use consumption	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Transport sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
International aviation	-	-	-	-	-	-	0.000	-
Domestic aviation	-	-	-	-	-	-	0.000	-
Road	-	-	-	-	-	-	0.000	-
Rail	-	-	-	-	-	-	0.000	-
Domestic navigation	-	-	-	-	-	-	0.000	-
Pipeline transport	-	-	-	-	-	-	0.000	-
Non elsewhere specified (Transport)	-	-	-	-	-	-	0.000	-
Industry sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Iron and steel	-	-	-	-	-	-	0.000	-
Chemical and petrochemical	-	-	-	-	-	-	0.000	-
Non-ferrous metals	-	-	-	-	-	-	0.000	-
Non-metallic minerals	-	-	-	-	-	-	0.000	-
Transport equipment	-	-	-	-	-	-	0.000	-

Machinery	-	-	-	-	-	-	0.000	-
Mining and Quarrying	-	-	-	-	-	-	0.000	-
Food, beverages and tobacco	-	-	-	-	-	-	0.000	-
Paper, pulp and printing	-	-	-	-	-	-	0.000	-
Wood and wood products	-	-	-	-	-	-	0.000	-
Construction	-	-	-	-	-	-	0.000	-
Textiles and leather	-	-	-	-	-	-	0.000	-
Not elsewhere specified (Industry)	-	-	-	-	-	-	0.000	-
Other sectors	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Commercial and public services	-	-	-	-	-	-	0.000	-
Residential	-	-	-	-	-	-	0.000	-
Agriculture/forestry	-	-	-	-	-	-	0.000	-
Fishing	-	-	-	-	-	-	0.000	-
Not elsewhere specified (Other)	-	-	-	-	-	-	0.000	-

Table A.4.2. Energy balance 2018 - Liquid Fuels (Non-bio gas/diesel oil, Total fuel oil, Lubricants, Bitumen, Pet-coke), in kt

Flow	Non bio-gas Diesel Oil	Total fuel oil	Lubricants	Bitumen	Pet-Coke
Indigenous production					
Receipts from other sources					
Solid fuels					
Natural gas					
Renewables					
Backflows	-		-	-	-
Of which: backflows for direct export or sale	-		-	-	-
Primary product receipts	-		-	-	-
Refinery gross output	-		-	-	-
Recycled products	-	4.649	-	-	-
Refinery fuel	-		-	-	-
Imports (Balance)	768.672	1,015.751	7.768	46.804	44.000
Exports (Balance)	-		-	-	-
International marine bunkers	117.778	154.115	-	-	-
Interproduct transfers	-		-	-	-
Products transferred	-		-	-	-
Direct use					
Stock changes	13.665	-19.435	-0.105	-6.648	30.569
Refinery intake (Calculated)					
Gross inland deliveries (Calculated)	**664.559**	846.850	**7.663**	**40.156**	**74.569**
Statistical difference	*664.559*	8.998	*4.055*	*3.454*	*0.103*
Gross inland deliveries (Observed)	**0.000**	837.852	**3.608**	**36.702**	**74.466**
Refinery intake (Observed)					
Opening stock level (National territory)	189.056	109.972	0.809	2.895	44.174

Closing stock level (National territory)	175.391	129.407	0.914	9.543	13.605
Average net calorific value of Production					
Average net calorific value of Imports					
Average net calorific value of Exports					
Average net calorific value of Average	42,872.000	80,955.000	40,200.000	40,200.000	31,336.000
Refinery fuel used for Electricity generation	-		-	-	-
Refinery fuel used CHP production	-		-	-	-
Refinery fuel used Heat production	-		-	-	-
Stock changes at Main activity plants	-		-	-	-
Refinery losses					
Gross deliveries to Petrochemical industry	-		-	-	-
Energy use in Petrochemical industry	-		-	-	-
Non-energy use in Petrochemical industry	-		-	-	-
Net deliveries of Total products					
Net deliveries to the Petrochemical industry					
Gross inland deliveries for energy use	**662.711**	837.852	**0.000**	**0.000**	**74.466**
Transformation sector	**248.089**	804.268	**0.000**	**0.000**	**0.000**
Main activity producer electricity	246.110	804.268	-	-	-
Autoproducer electricity	1.746		-	-	-
Main activity producer CHP	-		-	-	-
Autoproducer CHP Plants	0.233		-	-	-
Main activity producer heat	-		-	-	-
Autoproducer heat	-		-	-	-
Gas works (and other conversion to gases)	-		-	-	-
Natural gas blending plants	-		-	-	-
Coke ovens (Transformation)	-		-	-	-
Blast furnaces (Transformation)	-		-	-	-

Petrochemical industry	-		-	-	-
Patent fuel plants (Transformation)	-		-	-	-
Not elsewhere specified (Transformation)	-		-	-	-
Energy sector	**0.000**	0.000	**0.000**	**0.000**	**0.000**
Coal mines	-		-	-	-
Oil and gas extraction	-		-	-	-
Coke ovens (Energy)	-		-	-	-
Blast furnaces (Energy)	-		-	-	-
Gas works (Energy)	-		-	-	-
Electricity, CHP and Heat	-		-	-	-
Non elsewhere specified (Energy)	-		-	-	-
Distribution losses	-		-	-	-
Total final energy consumption	**414.622**	33.584	**0.000**	**0.000**	**74.466**
Transport sector	**298.541**	0.000	**0.000**	**0.000**	**0.000**
International aviation	-		-	-	-
Domestic aviation	-		-	-	-
Road	297.868		-	-	-
Rail	-		-	-	-
Domestic navigation	0.673		-	-	-
Pipeline transport	-		-	-	-
Non elsewhere specified (Transport)	-		-	-	-
Industry sector	**17.879**	30.380	**0.000**	**0.000**	**74.466**
Iron and steel	-		-	-	-
Chemical and petrochemical	1.036	1.235	-	-	-
Non-ferrous metals	0.130		-	-	-
Non-metallic minerals	1.362	14.532	-	-	74.466
Transport equipment	0.006		-	-	-

Machinery	0.224	0.107	-	-	-
Mining and Quarrying	3.663		-	-	-
Food, beverages and tobacco	4.012	11.345	-	-	-
Paper, pulp and printing	0.028	0.520	-	-	-
Wood and wood products	0.023		-	-	-
Construction	7.171	2.201	-	-	-
Textiles and leather	0.023		-	-	-
Not elsewhere specified (Industry)	0.201	0.440	-	-	-
Other sectors	**98.202**	3.204	**0.000**	**0.000**	**0.000**
Commercial and public services	16.327	3.204	-	-	-
Residential	53.444		-	-	-
Agriculture/forestry	20.568		-	-	-
Fishing	1.788		-	-	-
Not elsewhere specified (Other)	6.075		-	-	-
Gross inland deliveries for non energy use	**0.000**	0.000	**3.608**	**36.702**	**0.000**
Transformation Sector	**0.000**	0.000	**0.000**	**0.000**	**0.000**
Main activity producer electricity	-		-	-	-
Autoproducer electricity	-		-	-	-
Main activity producer CHP	-		-	-	-
Autoproducer CHP Plants	-		-	-	-
Main activity producer heat	-		-	-	-
Autoproducer heat	-		-	-	-
Gas works (and other conversion to gases)	-		-	-	-
Natural gas blending plants	-		-	-	-
Coke ovens (Transformation)	-		-	-	-
Blast furnaces (Transformation)	-		-	-	-
Petrochemical industry	-		-	-	-

Patent fuel plants (Transformation)	-		-	-	-
Not elsewhere specified (Transformation)	-		-	-	-
Energy sector	**0.000**	0.000	**0.000**	**0.000**	**0.000**
Coal mines	-		-	-	-
Oil and gas extraction	-		-	-	-
Coke ovens (Energy)	-		-	-	-
Blast furnaces (Energy)	-		-	-	-
Gas works (Energy)	-		-	-	-
Electricity, CHP and Heat	-		-	-	-
Non elsewhere specified (Energy)	-		-	-	-
Distribution losses	-		-	-	-
Total final non energy use consumption	**0.000**	0.000	**3.608**	**36.702**	**0.000**
Transport sector	**0.000**	0.000	**1.200**	**0.000**	**0.000**
International aviation	-		-	-	-
Domestic aviation	-		-	-	-
Road	-		1.200	-	-
Rail	-		-	-	-
Domestic navigation	-		-	-	-
Pipeline transport	-		-	-	-
Non elsewhere specified (Transport)	-		-	-	-
Industry sector	**0.000**	0.000	**2.408**	**36.702**	**0.000**
Iron and steel	-		-	-	-
Chemical and petrochemical	-		-	-	-
Non-ferrous metals	-		-	-	-
Non-metallic minerals	-		-	-	-
Transport equipment	-		-	-	-
Machinery	-		-	-	-

Mining and Quarrying	-		-	-	-
Food, beverages and tobacco	-		-	-	-
Paper, pulp and printing	-		-	-	-
Wood and wood products	-		-	-	-
Construction	-		-	36.702	-
Textiles and leather	-		-	-	-
Not elsewhere specified (Industry)	-		2.408	-	-
Other sectors	**0.000**	0.000	**0.000**	**0.000**	**0.000**
Commercial and public services	-		-	-	-
Residential	-		-	-	-
Agriculture/forestry	-		-	-	-
Fishing	-		-	-	-
Not elsewhere specified (Other)	-		-	-	-

Table A.4.3. Energy balance 2018 - Solid Fuels (Bituminous coal), in kt

Supply, transformation and end-use sectors	
Indigenous production	**-**
Underground production	-
Surface production	-
From other sources	-
From other sources - Oil	
From other sources - Natural gas	
From other sources - Renewables	
Total imports (Balance)	22.000
Total exports (Balance)	-
International marine bunkers	-
Stock changes (National territory)	0.554
Inland consumption (Calculated)	**22.554**
Statistical difference	**-**
Transformation sector	**-**
Main activity producer electricity	-
Main activity producer CHP	-
Main activity producer heat	-
Autoproducer electricity	-
Autoproducer CHP	-
Autoproducer heat	-
Patent fuel plants (Transformation)	-
Coke ovens (Transformation)	
BKB/PB plants (Transformation)	-
Gas works (Transformation)	-
Blast furnaces (Transformation)	-
Coal liquefaction plants (Transformation)	-
For blended natural gas	
Not elsewhere specified (Transformation)	-
Energy sector	**-**
Own use in electricity, CHP and heat	-
Coal mines	-
Patent fuel plants (Energy)	-
Coke ovens (Energy)	-
BKB/PB plants (Energy)	-
Gas works (Energy)	-
Blast furnaces (Energy)	-
Oil refineries	-
Coal liquefaction plants (Energy)	-
Not elsewhere specified (Energy industry own use)	-
Distribution losses	-
Total final consumption	**22.554**
Total non-energy use	**-**
Non-energy use industry/transformation/energy	-
Of which: Non-energy use-Chemical/petrochem	-

Non-energy use in transport	-
Non-energy use in other sectors	-
Final energy consumption	**22.554**
Industry sector	**22.554**
Iron and steel	-
Chemical and petrochemical	-
Non-ferrous metals	-
Non-metallic minerals	22.554
Transport equipment	-
Machinery	-
Mining and quarrying	-
Food, beverages and tobacco	-
Paper, pulp and printing	-
Wood and wood products	-
Construction	-
Textiles and leather	-
Not elsewhere specified (Industry)	-
Transport sector	**-**
Rail	-
Domestic navigation	-
Not elsewhere specified (Transport)	-
Other sectors	**-**
Commercial and public services	-
Residential	-
Agriculture/forestry	-
Fishing	-
Not elsewhere specified (Other)	-

Table A.4.4. Energy balance 2018 – Industrial waste (non-renewable), Municipal waste (renewable), Municipal waste (non-renewable), Solid biofuels, Charcoal, Biogases, in TJ

	Industrial Waste (non-renewable)	Municipal Waste (renewable)	Municipal Waste (non-renewable)	Solid Biofuels	Charcoal	Biogases
Indigenous production	157.831	31.300	20.341	948.791	1.617	553.550
Total imports (balance)	0.000	1,115.293	786.510	51.635	12.464	0.000
Total exports (balance)	0.000	0.000	0.000	0.000	0.000	0.000
Stock changes (national territory)	-1.044	10.143	-1.992	0.902	0.000	0.000
Inland consumption (calculated)	**156.787**	**1,156.736**	**804.859**	**1,001.328**	**14.081**	**553.550**
Statistical differences	**0.000**	**0.000**	**0.000**	**0.000**	**-0.408**	**0.041**
Transformation sector	**0.000**	**0.000**	**0.000**	**111.580**	**0.000**	**347.120**
Main activity producer electricity	0.000	0.000	0.000	0.000		0.000
Main activity producer CHP	0.000	0.000	0.000	0.000		143.246
Main activity producer heat	0.000	0.000	0.000	0.000		0.000

Autoproducer electricity	0.000	0.000	0.000	0.000		0.000
Autoproducer CHP	0.000	0.000	0.000	0.000		203.874
Autoproducer heat	0.000	0.000	0.000	0.000		0.000
Patent fuel plants (Transformation)	0.000					
BKB plants (Transformation)	0.000	0.000	0.000	0.000	0.000	
Gas works (Transformation)						0.000
Blast furnaces (Transformation)					0.000	0.000
Natural gas blending plants						0.000
For blending with Motor gasoline/Diesel/Kerosene						
Charcoal production plants (Transformation)				111.580		
Not elsewhere specified (Transformation)	0.000	0.000	0.000	0.000	0.000	0.000
Energy sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Gasification plants for Biogas	0.000	0.000	0.000	0.000	0.000	0.000
Own use in electricity, CHP and heat	0.000	0.000	0.000	0.000	0.000	0.000
Coal mines	0.000	0.000	0.000	0.000	0.000	0.000
Patent fuel plants (Energy)	0.000	0.000	0.000	0.000	0.000	0.000
Coke ovens (Energy)	0.000	0.000	0.000	0.000	0.000	0.000
Oil refineries	0.000	0.000	0.000	0.000	0.000	0.000
BKB plants (Energy)	0.000	0.000	0.000	0.000	0.000	0.000
Gas works (Energy)	0.000	0.000	0.000	0.000	0.000	0.000
Blast furnaces (Energy)	0.000	0.000	0.000	0.000	0.000	0.000
Charcoal production plants (energy)	0.000	0.000	0.000	0.000	0.000	0.000
Not elsewhere specified (Energy)	0.000	0.000	0.000	0.000	0.000	0.000
Distribution losses	0.000	0.000	0.000	0.000	0.000	0.000
Total final consumption	**156.787**	**1,156.736**	**804.859**	**889.748**	**14.489**	**206.389**
Final energy consumption	**156.787**	**1,156.736**	**804.859**	**889.748**	**14.489**	**206.389**
Industry sector	**156.787**	**1,156.736**	**804.859**	**163.549**	**0.000**	**66.182**
Iron and steel	0.000	0.000	0.000	0.000	0.000	0.000
Chemical and petrochemical	0.000	0.000	0.000	18.000	0.000	0.000
Non-ferrous metals	0.000	0.000	0.000	0.000	0.000	0.000
Non-metallic minerals	156.787	1,156.736	804.859	78.358	0.000	0.000
Transport equipment	0.000	0.000	0.000	0.000	0.000	0.000
Machinery	0.000	0.000	0.000	0.000	0.000	0.000
Mining and quarrying	0.000	0.000	0.000	0.000	0.000	0.000
Food, beverages and tobacco	0.000	0.000	0.000	67.191	0.000	66.182
Paper, pulp and printing	0.000	0.000	0.000	0.000	0.000	0.000
Wood and wood products	0.000	0.000	0.000	0.000	0.000	0.000
Construction	0.000	0.000	0.000	0.000	0.000	0.000
Textiles and leather	0.000	0.000	0.000	0.000	0.000	0.000
Not elsewhere specified (Industry)	0.000	0.000	0.000	0.000	0.000	0.000
Transport sector	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Rail	0.000	0.000	0.000	0.000	0.000	0.000
Road	0.000	0.000	0.000	0.000	0.000	0.000
Domestic navigation	0.000	0.000	0.000	0.000	0.000	0.000

Not elsewhere specified (Transport)	0.000	0.000	0.000	0.000	0.000	0.000
Other sectors	**0.000**	**0.000**	**0.000**	**726.199**	**14.489**	**140.207**
Commercial and public services	0.000	0.000	0.000	17.000	5.976	44.610
Residential	0.000	0.000	0.000	709.199	8.513	0.000
Agriculture/Forestry	0.000	0.000	0.000	0.000	0.000	95.597
Fishing	0.000	0.000	0.000	0.000	0.000	0.000
Not elsewhere specified (Other)	0.000	0.000	0.000	0.000	0.000	0.000

Annex 5: Indirect greenhouse gases and SO2

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

These gases are generated through a variety of anthropogenic activities. Emissions for indirect greenhouse gases and SO2 are presented in the tables that follow. The emissions have been estimated by the Department of Labour Inspection that is the competent authority for the preparation of air pollutants inventories under Directive 2001/81/EC.

Sectors which are not presented in the tables are reported NO or IE or NA.

Table A5.1.NOx emissions 1990-2018 (as Gg NO_2)

	1990	1991	1992	1993	1994	1995	1996	1997
1A1a	3.2129	3.3323	3.8327	4.1307	4.3188	3.9313	4.1767	4.4168
1A1b	0.1300	0.1400	0.1400	0.1400	0.1700	0.1600	0.1500	0.1600
1A2a	0.0024	0.0024	0.0021	0.0021	0.0021	0.0021	0.0021	0.0019
1A2b	0.0816	0.0838	0.0881	0.0891	0.0902	0.0902	0.0902	0.0945
1A2c	0.0279	0.0290	0.0300	0.0301	0.0310	0.0344	0.0365	0.0387
1A2d	0.0140	0.0161	0.0183	0.0193	0.0226	0.0236	0.0247	0.0258
1A2e	0.2320	0.2470	0.2578	0.2685	0.2792	0.2900	0.3007	0.3114
1A2f	1.6213	1.5288	1.6518	1.8062	1.8862	1.8070	1.9436	1.8704
1A2gvii	0.4039	0.4046	0.4046	0.4053	0.4066	0.4072	0.4079	0.4085
1A2gviii	0.4940	0.4979	0.4963	0.4988	0.5037	0.5065	0.5069	0.5091
1A3ai(i)	0.3100	0.3138	0.3177	0.3215	0.3253	0.3291	0.3330	0.3368
1A3aii(i)	0.0069	0.0069	0.0084	0.0087	0.0092	0.0097	0.0095	0.0100
1A3bi	2.8688	2.6483	2.6692	2.6149	2.6319	2.5359	2.5013	2.4704
1A3bii	2.2291	2.4469	2.9831	3.0748	3.5217	3.3261	3.3781	3.4363
1A3biii	3.0281	3.1255	3.6244	3.5635	3.8618	3.5345	3.6634	3.7547
1A3biv	0.0290	0.0272	0.0276	0.0268	0.0263	0.0263	0.0260	0.0272
1A3dii	0.0374	0.0374	0.0374	0.0374	0.0374	0.0374	0.0374	0.0374
1A4bi	0.1591	0.1690	0.2021	0.2069	0.2323	0.2214	0.2315	0.2424
1A4ci	0.1563	0.1681	0.2028	0.2061	0.2343	0.2227	0.2338	0.2453
1A4cii	0.2121	0.2281	0.2751	0.2796	0.3178	0.3022	0.3171	0.3328
1A4ciii	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
1A5b	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081
1B2aiv	0.1525	0.1621	0.1694	0.1838	0.1897	0.1987	0.1825	0.2502
1B2c	0.0404	0.0429	0.0448	0.0486	0.0502	0.0526	0.0483	0.0662
2G	0.0069	0.0069	0.0075	0.0021	0.0021	0.0061	0.0064	0.0072
3B1a	0.0056	0.0058	0.0060	0.0064	0.0069	0.0074	0.0068	0.0064
3B1b	0.0012	0.0012	0.0012	0.0014	0.0014	0.0015	0.0016	0.0014
3B2	0.0007	0.0007	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006
3B3	0.0113	0.0121	0.0139	0.0149	0.0147	0.0154	0.0162	0.0170
3B4d	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0007
3B4e	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3B4f	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
3B4gi	0.0014	0.0013	0.0013	0.0017	0.0016	0.0016	0.0017	0.0016
3B4gii	0.0037	0.0034	0.0039	0.0046	0.0043	0.0045	0.0048	0.0050
3B4giii	0.0003	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003
3B4giv	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001
3Da1	0.8703	0.8789	1.1000	0.9288	0.9061	0.8570	0.9042	0.7231
3Da2b	0.0012	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013	0.0014
3F	0.0794	0.0771	0.0809	0.0811	0.0701	0.0630	0.0569	0.0520
5C1biii	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011
5C2	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017	0.0017	0.0017
TOTAL	16.4450	16.6603	18.7140	19.0189	20.1712	19.0211	19.6157	19.8765

	1998	1999	2000	2001	2002	2003	2004	2005
1A1a	4.8215	5.0901	5.3539	5.3139	5.5342	5.9476	6.1958	6.5557
1A1b	0.1700	0.1900	0.2100	0.2000	0.1700	0.0800	0.0400	NO
1A2a	0.0017	0.0017	0.0017	0.0009	0.0009	0.0006	0.0004	0.0002

1A2b	0.0945	0.0945	0.0945	0.0967	0.0967	0.0967	0.0967	0.0966
1A2c	0.0408	0.0430	0.0451	0.0473	0.0473	0.0432	0.0430	0.0408
1A2d	0.0279	0.0279	0.0290	0.0290	0.0279	0.0258	0.0258	0.0236
1A2e	0.3179	0.3265	0.3351	0.3394	0.3437	0.3523	0.3566	0.3624
1A2f	1.7690	1.7775	1.8309	1.7914	1.8520	1.8292	1.9781	1.9405
1A2gvii	0.4163	0.4177	0.4242	0.4274	0.4291	0.4307	0.4323	0.4340
1A2gviii	0.5099	0.5101	0.5103	0.5106	0.5107	0.5108	0.5110	0.5131
1A3ai(i)	0.3406	0.3444	0.3483	0.3521	0.3559	0.3597	0.3636	0.3675
1A3aii(i)	0.0103	0.0108	0.0116	0.0127	0.0126	0.0127	0.0132	0.0335
1A3bi	2.3701	2.3109	2.2846	2.2430	2.2256	2.2608	2.1249	1.9820
1A3bii	3.5592	3.6254	4.0292	3.7557	3.6566	3.5607	3.2630	3.1066
1A3biii	3.8218	3.8566	4.3939	4.0627	4.0474	4.2804	4.1428	4.1428
1A3biv	0.0282	0.0307	0.0316	0.0345	0.0363	0.0408	0.0427	0.0432
1A3dii	0.0374	0.0374	0.0374	0.0317	0.0341	0.0390	0.0339	0.0484
1A4bi	0.2549	0.2638	0.2693	0.2726	0.2821	0.2697	0.3054	0.4355
1A4ci	0.2589	0.2683	0.2747	0.2774	0.2881	0.2759	0.2406	0.2499
1A4cii	0.3513	0.3640	0.3727	0.3763	0.3908	0.3743	0.3091	0.3072
1A4ciii	0.0019	0.0019	0.0019	0.0026	0.0025	0.0034	0.0037	0.0028
1A5b	0.0081	0.0081	0.0081	0.0063	0.0060	0.0053	0.0042	0.0053
1B2aiv	0.2599	0.2831	0.2816	0.2774	0.2607	0.2328	0.0669	NO
1B2c	0.0688	0.0749	0.0745	0.0734	0.0690	0.0616	0.0177	NO
2G	0.0073	0.0102	0.0193	0.0059	0.0055	0.0040	0.0059	0.0052
3B1a	0.0059	0.0060	0.0059	0.0061	0.0065	0.0066	0.0065	0.0061
3B1b	0.0012	0.0012	0.0012	0.0011	0.0012	0.0012	0.0013	0.0013
3B2	0.0006	0.0006	0.0006	0.0007	0.0007	0.0006	0.0007	0.0007
3B3	0.0173	0.0165	0.0167	0.0184	0.0197	0.0196	0.0187	0.0173
3B4d	0.0008	0.0008	0.0009	0.0010	0.0011	0.0010	0.0009	0.0008
3B4e	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001
3B4f	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
3B4gi	0.0018	0.0015	0.0012	0.0013	0.0013	0.0013	0.0017	0.0014
3B4gii	0.0049	0.0050	0.0052	0.0052	0.0054	0.0054	0.0045	0.0046
3B4giii	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002
3B4giv	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
3Da1	0.6105	0.6514	0.6567	0.7159	0.5732	0.4575	0.5178	0.5498
3Da2b	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0015	0.0015
3F	0.0489	0.0447	0.0355	0.0348	0.0327	0.0351	0.0275	0.0214
5C1biii	0.0012	0.0012	0.0012	0.0012	0.0012	0.0003	NO	NO
5C2	0.0018	0.0018	0.0018	0.0018	0.0018	0.0019	0.0019	0.0019
TOTAL	20.2450	20.7022	22.0022	21.3300	21.3325	21.6306	21.2007	21.3039

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1A1a	6.7618	7.0797	6.3209	7.4322	6.3266	9.7045	10.9561	6.3250
1A1b	NO	NO	NO	NO	NO	NO	NO	NO
1A2a	NO	NO	0.0086	0.0081	0.0107	0.0098	NO	NO
1A2b	0.0965	0.0967	0.0943	0.0593	0.0602	0.0721	0.0414	0.0676
1A2c	0.0406	0.0309	0.0188	0.0304	0.0407	0.0598	0.0504	0.0337
1A2d	0.0229	0.0196	0.0229	0.0210	0.0205	0.0189	0.0190	0.0206
1A2e	0.3668	0.3728	0.3615	0.3542	0.3463	0.3589	0.3770	0.3427
1A2f	2.0215	1.9912	2.1254	1.8067	1.5821	1.4641	1.3250	1.8911
1A2gvii	0.4356	0.4370	0.3443	0.2941	0.3173	0.2876	0.1714	0.1084
1A2gviii	0.5164	0.5049	0.1336	0.0877	0.0708	0.1141	0.0658	0.0939
1A3ai(i)	0.3649	0.3735	0.3870	0.3772	0.3798	0.3755	0.3661	0.3439
1A3aii(i)	0.0286	0.0256	0.0252	0.0220	0.0191	0.0050	0.0031	0.0010
1A3bi	1.8918	1.9003	1.8283	1.7036	1.6644	1.5418	1.4249	1.2649
1A3bii	2.8476	2.6338	2.4212	2.1890	2.1810	1.9657	1.5375	1.2774
1A3biii	3.9989	4.1222	4.2701	3.9560	3.8989	3.8118	3.5751	2.9292
1A3biv	0.0410	0.0401	0.0414	0.0398	0.0387	0.0375	0.0371	0.0340
1A3dii	0.0470	0.0680	0.0806	0.0950	0.1045	0.1066	0.1273	0.1835
1A4bi	0.4333	0.3966	0.3887	0.3730	0.3204	0.3531	0.3476	0.3001
1A4ci	0.2549	0.2336	0.2258	0.2027	0.1999	0.2066	0.1983	0.1952
1A4cii	0.3049	0.3161	0.3070	0.2750	0.2712	0.2803	0.2690	0.2649
1A4ciii	0.0037	0.0037	0.0032	0.0023	0.0021	0.0034	0.0036	0.0020
1A5b	0.1086	0.1675	0.1009	0.0745	0.0506	0.0580	0.0571	0.0701
1B2aiv	NO	NO	NO	NO	NO	NO	NO	NO
1B2c	NO	NO	NO	NO	NO	NO	NO	0.0066
2G	0.0032	0.0034	0.0033	0.0036	0.0039	0.0032	0.0035	0.0027
3B1a	0.0060	0.0059	0.0059	0.0058	0.0058	0.0060	0.0060	0.0062
3B1b	0.0012	0.0012	0.0012	0.0012	0.0012	0.0013	0.0013	0.0012
3B2	0.0007	0.0007	0.0007	0.0007	0.0008	0.0009	0.0008	0.0008
3B3	0.0182	0.0188	0.0183	0.0182	0.0182	0.0170	0.0153	0.0140
3B4d	0.0008	0.0009	0.0008	0.0007	0.0008	0.0007	0.0007	0.0006

3B4e	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3B4f	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3B4gi	0.0014	0.0012	0.0013	0.0013	0.0012	0.0013	0.0014	0.0014
3B4gii	0.0038	0.0042	0.0040	0.0039	0.0040	0.0038	0.0035	0.0030
3B4giii	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
3B4giv	0.0000	0.0000	0.0000	NO	NO	NO	NO	NO
3Da1	0.4984	0.4695	0.3668	0.3018	0.3764	0.2762	0.2983	0.2888
3Da2b	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017	0.0017	0.0017
3F	0.0163	0.0090	0.0053	0.0043	0.0045	0.0050	0.0052	0.0043
5C1biii	NO	NO	NO	NO	NO	NO	NO	NO
5C2	0.0019	0.0020	0.0020	0.0021	0.0022	0.0022	0.0022	0.0022
TOTAL	21.1412	21.3324	19.9211	19.7490	18.3265	21.1546	21.2927	16.0829

	2014	**2015**	**2016**	**2017**	**2018**			
1A1a	6.9664	4.8595	4.0555	3.6551	3.6261			
1A1b	NO	NO	NO	NO	NO			
1A2a	0.0001	NO	NO	NO	NO			
1A2b	0.0969	0.0401	0.0237	0.0416	0.0433			
1A2c	0.0435	0.0383	0.0412	0.0391	0.0407			
1A2d	0.0213	0.0176	0.0181	0.0153	0.0159			
1A2e	0.4602	0.3776	0.4087	0.4174	0.4345			
1A2f	2.3626	2.1737	2.1336	2.2387	2.0911			
1A2gvii	0.1073	0.0910	0.1021	0.1218	0.1268			
1A2gviii	0.1086	0.0454	0.0503	0.0693	0.0722			
1A3ai(i)	0.3498	0.3528	0.4068	0.4706	0.4832			
1A3aii(i)	0.0006	0.0014	0.0011	0.0010	0.0007			
1A3bi	1.2696	1.3388	1.4389	1.6109	1.6543			
1A3bii	1.2637	1.2618	1.3606	1.3651	1.2902			
1A3biii	2.9242	2.9963	3.2037	3.1558	2.9678			
1A3biv	0.0331	0.0324	0.0340	0.0325	0.0316			
1A3dii	0.1391	0.1285	0.1055	0.1396	0.1411			
1A4bi	0.2615	0.3059	0.3179	0.3177	0.2662			
1A4ci	0.1796	0.1981	0.1931	0.2029	0.1886			
1A4cii	0.2437	0.2687	0.2619	0.2753	0.2559			
1A4ciii	0.0016	0.0012	0.0012	0.0005	0.0020			
1A5b	0.0861	0.0478	0.0554	0.0522	0.0601			
1B2aiv	NO	NO	NO	NO	NO			
1B2c	NO	NO	NO	NO	NO			
2G	0.0011	0.0025	0.0020	0.0022	0.0020			
3B1a	0.0063	0.0065	0.0071	0.0075	0.0080			
3B1b	0.0013	0.0012	0.0013	0.0014	0.0015			
3B2	0.0007	0.0007	0.0007	0.0008	0.0008			
3B3	0.0134	0.0138	0.0136	0.0136	0.0140			
3B4d	0.0006	0.0006	0.0006	0.0006	0.0006			
3B4e	0.0000	0.0000	0.0000	0.0000	0.0000			
3B4f	0.0000	0.0000	0.0000	0.0000	0.0000			
3B4gi	0.0013	0.0012	0.0012	0.0012	0.0012			
3B4gii	0.0038	0.0032	0.0033	0.0034	0.0036			
3B4giii	0.0000	0.0000	0.0000	0.0001	0.0001			
3B4giv	NO	NO	NO	NO	NO			
3Da1	0.2359	0.2549	0.2989	0.2355	0.2257			
3Da2b	0.0017	0.0017	0.0017	0.0017	0.0018			
3F	0.0035	0.0046	0.0033	0.0028	0.0033			
5C1biii	NO	NO	NO	NO	NO			
5C2	0.0022	0.0022	0.0022	0.0022	0.0022			
TOTAL	17.1914	14.8702	14.5495	14.4957	14.0569			

Table A5.2.CO emissions 1990-2018 (Gg)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
1A1a	0.3416	0.3543	0.4076	0.4392	0.4593	0.4180	0.4441	0.4697
1A1b	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1A2a	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
1A2b	0.0105	0.0108	0.0113	0.0115	0.0116	0.0116	0.0116	0.0122
1A2c	0.0036	0.0037	0.0039	0.0039	0.0040	0.0044	0.0047	0.0050
1A2d	0.0018	0.0021	0.0023	0.0025	0.0029	0.0030	0.0032	0.0033
1A2e	0.0298	0.0318	0.0332	0.0345	0.0359	0.0373	0.0387	0.0401
1A2f	1.8930	1.7847	1.9300	2.1101	2.2055	2.1117	2.2723	2.1874
1A2gvii	0.1334	0.1336	0.1336	0.1338	0.1342	0.1345	0.1347	0.1349
1A2gviii	0.0636	0.0641	0.0639	0.0642	0.0648	0.0652	0.0652	0.0655
1A3ai(i)	0.1224	0.1039	0.1258	0.1298	0.1377	0.1448	0.1423	0.1494
1A3aii(i)	0.0027	0.0023	0.0028	0.0028	0.0030	0.0032	0.0031	0.0033

1A3bi	26.6038	24.1749	23.8709	22.9640	22.4492	21.3605	20.4288	19.3612
1A3bii	5.7366	5.8760	6.2729	6.1142	6.2793	5.8536	5.6293	5.4112
1A3biii	1.0145	1.0424	1.2084	1.1912	1.2681	1.1404	1.1620	1.1639
1A3biv	3.7367	3.5538	3.6548	3.5882	3.5764	3.5848	3.5618	3.4425
1A4bi	0.3969	0.5040	0.5219	0.6042	0.5422	0.5431	0.5253	0.5282
1A4ci	0.0208	0.0223	0.0269	0.0274	0.0311	0.0296	0.0311	0.0326
1A4cii	0.0706	0.0759	0.0916	0.0931	0.1058	0.1006	0.1056	0.1108
1B2aiv	0.0572	0.0608	0.0635	0.0689	0.0711	0.0745	0.0684	0.0938
1B2c	0.0090	0.0095	0.0100	0.0108	0.0112	0.0117	0.0107	0.0147
2D3c	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
2G	0.2114	0.2114	0.2299	0.0637	0.0637	0.1860	0.1974	0.2203
3F	2.3012	2.2351	2.3451	2.3506	2.0330	1.8270	1.6511	1.5093
5C1biii	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
5C2	0.0264	0.0272	0.0279	0.0285	0.0291	0.0295	0.0300	0.0304
TOTAL	42.7903	40.2874	41.0409	40.0397	39.5218	37.6776	36.5242	34.9922

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A1a	0.5127	0.5413	0.5693	0.5651	0.5885	0.6325	0.6589	0.6971
1A1b	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	NO
1A2a	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000
1A2b	0.0122	0.0122	0.0122	0.0124	0.0124	0.0124	0.0124	0.0124
1A2c	0.0053	0.0055	0.0058	0.0061	0.0061	0.0056	0.0055	0.0053
1A2d	0.0036	0.0036	0.0037	0.0037	0.0036	0.0033	0.0033	0.0030
1A2e	0.0409	0.0420	0.0431	0.0437	0.0442	0.0453	0.0459	0.0561
1A2f	2.0685	2.0780	2.1413	2.0954	2.1668	2.1390	2.3103	2.2666
1A2gvii	0.1375	0.1379	0.1401	0.1411	0.1417	0.1422	0.1428	0.1433
1A2gviii	0.0656	0.0656	0.0657	0.0657	0.0657	0.0657	0.0657	0.0803
1A3ai(i)	0.1543	0.1626	0.1736	0.1910	0.1885	0.1909	0.1972	0.1962
1A3aii(i)	0.0034	0.0036	0.0038	0.0042	0.0041	0.0042	0.0043	0.0101
1A3bi	17.8593	16.8451	15.6793	15.4540	15.5451	15.9614	15.3605	14.5753
1A3bii	5.1223	4.8811	4.8126	4.4144	4.0307	3.9534	3.4766	3.2543
1A3biii	1.1589	1.1451	1.2657	1.1376	1.1072	1.1536	1.1105	1.1075
1A3biv	3.2459	3.0403	2.8067	2.6716	2.4066	2.4463	2.2827	2.2298
1A4bi	0.5078	0.5111	0.4823	0.5205	0.4904	0.4479	0.4581	0.5434
1A4ci	0.0344	0.0356	0.0365	0.0369	0.0383	0.0367	0.0320	0.0332
1A4cii	0.1169	0.1211	0.1240	0.1252	0.1301	0.1246	0.1029	0.1023
1B2aiv	0.0975	0.1062	0.1056	0.1040	0.0978	0.0873	0.0251	NO
1B2c	0.0153	0.0166	0.0166	0.0163	0.0153	0.0137	0.0039	NO
2D3c	0.0024	0.0024	0.0027	0.0022	0.0024	0.0022	0.0027	0.0021
2G	0.2242	0.3139	0.5896	0.1817	0.1701	0.1226	0.1822	0.1588
3F	1.4189	1.2973	1.0301	1.0080	0.9477	1.0183	0.7972	0.6213
5C1biii	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	NO	NO
5C2	0.0307	0.0311	0.0314	0.0318	0.0321	0.0325	0.0330	0.0335
TOTAL	32.8387	31.3995	30.1419	28.8327	28.2356	28.6416	27.3138	26.1318

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1A1a	0.7191	0.7431	0.2524	0.4688	0.4596	0.5713	0.5614	0.4279
1A1b	NO	NO	NO	NO	NO	NO	NO	NO
1A2a	NO	NO	0.0011	0.0010	0.0014	0.0013	NO	NO
1A2b	0.0124	0.0124	0.0121	0.0076	0.0077	0.0093	0.0053	0.0087
1A2c	0.0052	0.0040	0.0024	0.0039	0.0052	0.0354	0.0398	0.0479
1A2d	0.0029	0.0025	0.0029	0.0027	0.0026	0.0024	0.0024	0.0027
1A2e	0.0575	0.0589	0.0674	0.0664	0.0678	0.0535	0.0499	0.0486
1A2f	2.3613	2.3250	2.3739	1.9567	1.6389	1.5843	1.4405	2.1005
1A2gvii	0.1438	0.1443	0.1137	0.0971	0.1048	0.0950	0.0566	0.0358
1A2gviii	0.0981	0.1129	0.0176	0.0113	0.0210	0.0147	0.0085	0.0121
1A3ai(i)	0.1910	0.1794	0.1783	0.1560	0.1986	0.2196	0.2189	0.1949
1A3aii(i)	0.0085	0.0076	0.0072	0.0058	0.0064	0.0042	0.0028	0.0013
1A3bi	13.8836	12.9993	12.0473	10.7105	9.9503	8.8212	8.0198	7.1042
1A3bii	2.8044	2.7130	2.4177	2.1502	2.1554	1.8540	1.4142	1.2041
1A3biii	1.0679	1.0590	1.0809	0.9944	0.9805	0.9530	0.9085	0.7404
1A3biv	1.7001	1.8646	1.7919	1.6870	1.5924	1.5229	1.3991	1.2962
1A4bi	0.5184	0.6176	0.5876	0.4882	0.4169	0.4364	0.6135	0.5165
1A4ci	0.0339	0.0310	0.0300	0.0269	0.0266	0.0275	0.0263	0.0259
1A4cii	0.1015	0.1052	0.1022	0.0915	0.0903	0.0933	0.0895	0.0882
1B2aiv	NO	NO	NO	NO	NO	NO	NO	NO
1B2c	NO	NO	NO	NO	NO	NO	NO	0.0295
2D3c	0.0019	0.0018	0.0017	0.0029	0.0039	0.0038	0.0029	0.0016
2G	0.0993	0.1034	0.1006	0.1119	0.1195	0.0974	0.1060	0.0831
3F	0.4738	0.2617	0.1549	0.1249	0.1317	0.1437	0.1513	0.1233
5C1biii	NO	NO	NO	NO	NO	NO	NO	NO

5C2	0.0341	0.0350	0.0359	0.0369	0.0378	0.0388	0.0390	0.0386
TOTAL	24.3189	23.3819	21.3796	19.2025	18.0193	16.5829	15.1563	14.1320

	2014	2015	2016	2017	2018			
1A1a	0.5847	0.4440	0.4478	0.3656	0.3172			
1A1b	NO	NO	NO	NO	NO			
1A2a	0.0000	NO	NO	NO	NO			
1A2b	0.0125	0.0052	0.0031	0.0054	0.0056			
1A2c	0.0238	0.0279	0.0148	0.0130	0.0135			
1A2d	0.0027	0.0023	0.0023	0.0020	0.0020			
1A2e	0.0725	0.0511	0.0712	0.0812	0.0845			
1A2f	2.6855	2.4253	2.4338	2.5443	2.3686			
1A2gvii	0.0354	0.0300	0.0337	0.0402	0.0419			
1A2gviii	0.0140	0.0058	0.0065	0.0121	0.0126			
1A3ai(i)	0.2017	0.1865	0.2330	0.2663	0.2860			
1A3aii(i)	0.0010	0.0013	0.0011	0.0012	0.0012			
1A3bi	6.6560	6.3019	6.3636	6.0130	5.6874			
1A3bii	1.1543	1.1259	1.1613	1.0899	0.8006			
1A3biii	0.7376	0.7506	0.8025	0.7804	0.7058			
1A3biv	1.2613	1.2468	1.2886	1.1955	0.8674			
1A4bi	0.4393	0.6090	0.7636	0.7125	0.5092			
1A4ci	0.0239	0.0263	0.0257	0.0270	0.0251			
1A4cii	0.0811	0.0894	0.0872	0.0916	0.0852			
1B2aiv	NO	NO	NO	NO	NO			
1B2c	NO	NO	NO	NO	NO			
2D3c	0.0007	0.0006	0.0006	0.0008	0.0008			
2G	0.0331	0.0760	0.0624	0.0668	0.0613			
3F	0.1013	0.1336	0.0952	0.0809	0.0961			
5C1biii	NO	NO	NO	NO	NO			
5C2	0.0381	0.0382	0.0385	0.0389	0.0394			
TOTAL	14.1605	13.5778	13.9365	13.4285	12.0113			

Table A5.3.NMVOCs emissions 1990-2018 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997
1A1a	0.0520	0.0540	0.0621	0.0669	0.0700	0.0637	0.0677	0.0715
1A1b	0.4100	0.4900	0.4600	0.5000	0.5700	0.5300	0.4900	0.6700
1A2a	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
1A2b	0.0040	0.0041	0.0043	0.0043	0.0044	0.0044	0.0044	0.0046
1A2c	0.0014	0.0014	0.0015	0.0015	0.0015	0.0017	0.0018	0.0019
1A2d	0.0007	0.0008	0.0009	0.0009	0.0011	0.0012	0.0012	0.0013
1A2e	0.0113	0.0120	0.0126	0.0131	0.0136	0.0141	0.0147	0.0152
1A2f	0.0398	0.0378	0.0377	0.0425	0.0419	0.0406	0.0419	0.0402
1A2gvii	0.0418	0.0419	0.0419	0.0419	0.0421	0.0421	0.0422	0.0423
1A2gviii	0.0241	0.0243	0.0242	0.0243	0.0245	0.0247	0.0247	0.0248
1A3ai(i)	0.0126	0.0107	0.0130	0.0134	0.0142	0.0149	0.0147	0.0154
1A3aii(i)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003
1A3bi	2.8941	2.6598	2.6658	2.5782	2.5396	2.4372	2.3531	2.2318
1A3bii	0.5278	0.5422	0.5824	0.5693	0.5882	0.5640	0.5574	0.5524
1A3biii	0.4429	0.4537	0.5265	0.5172	0.5424	0.4807	0.4832	0.4740
1A3biv	1.4149	1.3620	1.4174	1.4077	1.4188	1.4280	1.4242	1.3679
1A3bv	1.5411	1.4700	1.4537	1.4379	1.4322	1.3987	1.3532	1.3187
1A3dii	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
1A4bi	0.0613	0.0506	0.0481	0.0599	0.0464	0.0483	0.0440	0.0427
1A4ci	0.0066	0.0071	0.0086	0.0088	0.0100	0.0095	0.0099	0.0104
1A4cii	0.0218	0.0234	0.0283	0.0287	0.0327	0.0311	0.0326	0.0342
1A4ciii	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
1A5b	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
1B2aiv	0.1271	0.1351	0.1412	0.1532	0.1581	0.1656	0.1521	0.2085
1B2av	0.7159	0.7083	0.7588	0.7662	0.7843	0.8057	0.8188	0.8397
1B2c	0.0015	0.0016	0.0017	0.0018	0.0019	0.0019	0.0018	0.0025
2C1	0.0003	0.0002	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002
2D3a	0.7045	0.7237	0.7430	0.7595	0.7745	0.7876	0.7996	0.8102
2D3b	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075
2D3c	0.0325	0.0325	0.0325	0.0325	0.0325	0.0325	0.0325	0.0325
2D3d	1.7387	1.4241	1.5170	1.5202	1.7083	1.4102	1.4097	1.5604
2D3f	0.2002	0.2003	0.2003	0.2004	0.2005	0.2006	0.2007	0.2008
2D3g	0.0388	0.0388	0.0388	0.0413	0.0442	0.0471	0.0498	0.0474
2D3h	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
2D3i	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2G	0.0185	0.0185	0.0202	0.0056	0.0056	0.0163	0.0173	0.0193
2H2	0.2599	0.2902	0.3244	0.3288	0.3350	0.3498	0.3534	0.3439
3B1a	0.3828	0.3949	0.4082	0.4381	0.4710	0.5036	0.4666	0.4354

3B1b	0.1267	0.1253	0.1253	0.1392	0.1444	0.1517	0.1679	0.1450
3B2	0.0261	0.0266	0.0257	0.0248	0.0230	0.0225	0.0227	0.0221
3B3	0.2205	0.2396	0.2738	0.2896	0.2962	0.3053	0.3180	0.3375
3B4d	0.0139	0.0139	0.0135	0.0134	0.0142	0.0149	0.0162	0.0204
3B4e	0.0015	0.0014	0.0013	0.0012	0.0011	0.0014	0.0017	0.0020
3B4f	0.0072	0.0064	0.0055	0.0047	0.0038	0.0036	0.0034	0.0032
3B4gi	0.0529	0.0513	0.0492	0.0639	0.0624	0.0631	0.0658	0.0612
3B4gii	0.2483	0.2268	0.2641	0.3093	0.2906	0.3006	0.3223	0.3329
3B4giii	0.0151	0.0114	0.0137	0.0105	0.0125	0.0165	0.0158	0.0140
3B4giv	0.0007	0.0008	0.0010	0.0011	0.0011	0.0014	0.0011	0.0013
3De	0.0495	0.0506	0.0560	0.0594	0.0546	0.0523	0.0507	0.0499
3F	0.0173	0.0168	0.0176	0.0176	0.0152	0.0137	0.0124	0.0113
5A	0.1635	0.1667	0.1702	0.1740	0.1780	0.1822	0.1869	0.1917
5C1biii	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
5C2	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007
5D1	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
TOTAL	12.8844	12.3640	12.8047	12.8857	13.2193	12.7981	12.6610	12.8254

	1998	1999	2000	2001	2002	2003	2004	2005
1A1a	0.0781	0.0824	0.0867	0.0861	0.0896	0.0963	0.1004	0.1062
1A1b	0.6900	0.7500	0.6900	0.7300	0.6800	0.7300	0.2500	NO
1A2a	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1A2b	0.0046	0.0046	0.0046	0.0047	0.0047	0.0047	0.0047	0.0047
1A2c	0.0020	0.0021	0.0022	0.0023	0.0023	0.0021	0.0021	0.0020
1A2d	0.0014	0.0014	0.0014	0.0014	0.0014	0.0013	0.0013	0.0012
1A2e	0.0155	0.0159	0.0163	0.0165	0.0167	0.0172	0.0174	0.0227
1A2f	0.0376	0.0396	0.0405	0.0386	0.0423	0.0448	0.0516	0.0489
1A2gvii	0.0431	0.0432	0.0439	0.0442	0.0444	0.0446	0.0447	0.0449
1A2gviii	0.0248	0.0249	0.0249	0.0249	0.0249	0.0249	0.0249	0.0326
1A3ai(i)	0.0159	0.0168	0.0179	0.0197	0.0195	0.0197	0.0204	0.0299
1A3aii(i)	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0009
1A3bi	2.0742	1.9701	1.8514	1.8208	1.8182	1.8591	1.7379	1.5994
1A3bii	0.5462	0.5415	0.5655	0.5228	0.4908	0.4792	0.4265	0.4001
1A3biii	0.4640	0.4511	0.4869	0.4252	0.3997	0.3991	0.3716	0.3600
1A3biv	1.2779	1.1782	1.0837	1.0047	0.8263	0.8332	0.7687	0.7621
1A3bv	1.2784	1.2403	1.1965	1.1940	1.1961	1.2388	1.2355	1.2429
1A3dii	0.0027	0.0027	0.0027	0.0023	0.0025	0.0029	0.0025	0.0035
1A4bi	0.0376	0.0367	0.0314	0.0367	0.0306	0.0261	0.0220	0.0293
1A4ci	0.0110	0.0114	0.0117	0.0118	0.0123	0.0117	0.0102	0.0106
1A4cii	0.0361	0.0374	0.0383	0.0387	0.0545	0.0385	0.0318	0.0316
1A4ciii	0.0001	0.0001	0.0001	0.0002	0.0002	0.0003	0.0003	0.0002
1A5b	0.0005	0.0005	0.0005	0.0004	0.0004	0.0003	0.0003	0.0003
1B2aiv	0.2166	0.2359	0.2347	0.2312	0.2173	0.1940	0.0558	NO
1B2av	0.8621	0.8918	0.9084	0.9627	1.0075	1.1418	1.2437	1.3311
1B2c	0.0025	0.0028	0.0028	0.0027	0.0026	0.0023	0.0007	NO
2C1	0.0003	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
2D3a	0.8195	0.8286	0.8370	0.8466	0.8564	0.8675	0.8796	0.8928
2D3b	0.0075	0.0075	0.0084	0.0069	0.0075	0.0071	0.0085	0.0068
2D3c	0.0325	0.0325	0.0366	0.0298	0.0324	0.0308	0.0368	0.0293
2D3d	1.4476	1.4578	1.6020	1.4785	2.2579	2.8364	3.5522	3.8150
2D3f	0.2009	0.2012	0.2021	0.2005	0.2004	0.2001	0.1998	0.1930
2D3g	0.0490	0.0512	0.0500	0.0597	0.0636	0.0625	0.0674	0.0574
2D3h	0.2000	0.3273	0.3355	0.3801	0.3075	0.2884	0.3399	0.3446
2D3i	0.0000	0.0000	6.8564	7.0691	6.5514	7.7469	9.9307	11.0847
2G	0.0197	0.0275	0.0518	0.0159	0.0149	0.0107	0.0160	0.0139
2H2	0.3154	0.3168	0.2911	0.2805	0.2746	0.2747	0.2529	0.2569
3B1a	0.4069	0.4108	0.4016	0.4162	0.4481	0.4546	0.4454	0.4199
3B1b	0.1257	0.1186	0.1204	0.1141	0.1253	0.1252	0.1344	0.1295
3B2	0.0216	0.0210	0.0222	0.0267	0.0265	0.0239	0.0251	0.0242
3B3	0.3349	0.3132	0.3312	0.3607	0.3804	0.3767	0.3579	0.3365
3B4d	0.0218	0.0234	0.0256	0.0289	0.0311	0.0276	0.0256	0.0223
3B4e	0.0023	0.0026	0.0029	0.0032	0.0035	0.0038	0.0036	0.0034
3B4f	0.0030	0.0028	0.0026	0.0024	0.0022	0.0020	0.0018	0.0017
3B4gi	0.0695	0.0596	0.0454	0.0495	0.0495	0.0495	0.0669	0.0535
3B4gii	0.3306	0.3347	0.3484	0.3484	0.3617	0.3600	0.3054	0.3092
3B4giii	0.0153	0.0144	0.0183	0.0163	0.0171	0.0169	0.0124	0.0092
3B4giv	0.0014	0.0015	0.0016	0.0016	0.0017	0.0016	0.0012	0.0011
3De	0.0508	0.0507	0.0443	0.0481	0.0509	0.0625	0.0571	0.0534
3F	0.0106	0.0097	0.0077	0.0076	0.0071	0.0076	0.0060	0.0047
5A	0.1967	0.2016	0.2066	0.2117	0.2173	0.2229	0.2286	0.2345
5C1biii	0.0004	0.0004	0.0004	0.0004	0.0004	0.0001	NO	NO

5C2	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
5D1	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
TOTAL	12.4084	12.3987	19.1945	19.2274	19.2759	21.2744	23.3815	24.3635

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1A1a	0.1095	0.1131	0.1173	0.1101	0.0999	0.1787	0.2842	0.0627
1A1b	NO	NO	NO	NO	NO	NO	NO	NO
1A2a	NO	NO	0.0004	0.0004	0.0005	0.0005	NO	NO
1A2b	0.0047	0.0047	0.0046	0.0029	0.0029	0.0035	0.0020	0.0033
1A2c	0.0020	0.0015	0.0009	0.0015	0.0020	0.0176	0.0201	0.0247
1A2d	0.0011	0.0010	0.0011	0.0010	0.0010	0.0009	0.0009	0.0010
1A2e	0.0233	0.0240	0.0287	0.0283	0.0292	0.0214	0.0191	0.0191
1A2f	0.0488	0.0489	0.0620	0.0533	0.0517	0.0355	0.0301	0.0351
1A2gvii	0.0451	0.0452	0.0356	0.0304	0.0328	0.0298	0.0177	0.0112
1A2gviii	0.0420	0.0500	0.0067	0.0043	0.0097	0.0056	0.0032	0.0046
1A3ai(i)	0.0251	0.0190	0.0185	0.0152	0.0213	0.0241	0.0251	0.0222
1A3aii(i)	0.0007	0.0005	0.0006	0.0005	0.0004	0.0004	0.0002	0.0001
1A3bi	1.4989	1.4571	1.3432	1.1782	1.0860	0.9450	0.8413	0.7337
1A3bii	0.3473	0.3227	0.2850	0.2512	0.2478	0.2123	0.1526	0.1274
1A3biii	0.3381	0.3137	0.3058	0.2668	0.2451	0.2259	0.2047	0.1620
1A3biv	0.5483	0.6205	0.5675	0.5108	0.4666	0.4352	0.4385	0.3981
1A3bv	1.2329	1.2939	1.2720	1.2326	1.2113	1.2097	1.1516	1.1445
1A3dii	0.0034	0.0049	0.0058	0.0069	0.0076	0.0077	0.0092	0.0133
1A4bi	0.0257	0.0468	0.0427	0.0297	0.0259	0.0251	0.0528	0.0444
1A4ci	0.0108	0.0099	0.0096	0.0086	0.0085	0.0088	0.0084	0.0083
1A4cii	0.0313	0.0325	0.0316	0.0283	0.0279	0.0288	0.0276	0.0272
1A4ciii	0.0003	0.0003	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002
1A5b	0.0071	0.0109	0.0066	0.0048	0.0033	0.0038	0.0037	0.0046
1B2aiv	NO	NO	NO	NO	NO	NO	NO	NO
1B2av	0.8722	0.9500	1.0874	1.1192	1.1003	1.0844	0.9899	0.8577
1B2c	NO	NO	NO	NO	NO	NO	NO	0.0084
2C1	NO	NO	NO	NO	NO	NO	NO	NO
2D3a	0.9095	0.9317	0.9563	0.9829	1.0078	1.0344	1.0391	1.0296
2D3b	0.0061	0.0057	0.0054	0.0091	0.0122	0.0119	0.0093	0.0049
2D3c	0.0265	0.0246	0.0233	0.0396	0.0529	0.0516	0.0403	0.0213
2D3d	4.0272	4.3205	3.3507	3.1421	3.4997	1.5792	1.6311	1.4271
2D3f	0.1100	0.1110	0.0789	0.0602	0.0605	0.0600	0.0539	0.0265
2D3g	0.0600	0.0580	0.0254	0.0278	0.0302	0.0137	0.0145	0.0120
2D3h	0.3628	0.3195	0.4469	0.3260	0.2464	0.3347	0.2658	0.2072
2D3i	11.0722	10.8674	11.9954	9.9609	9.8579	5.9958	6.2987	5.5351
2G	0.0087	0.0091	0.0088	0.0098	0.0105	0.0086	0.0093	0.0073
2H2	0.2380	0.2385	0.2351	0.2116	0.2099	0.2082	0.1862	0.1607
3B1a	0.4088	0.4048	0.4037	0.3962	0.4001	0.4111	0.4117	0.4219
3B1b	0.1263	0.1225	0.1258	0.1213	0.1229	0.1290	0.1289	0.1277
3B2	0.0245	0.0263	0.0241	0.0271	0.0296	0.0321	0.0313	0.0283
3B3	0.3535	0.3630	0.3458	0.3414	0.3395	0.3121	0.2803	0.2601
3B4d	0.0233	0.0249	0.0215	0.0190	0.0208	0.0196	0.0183	0.0164
3B4e	0.0032	0.0030	0.0028	0.0026	0.0024	0.0024	0.0024	0.0024
3B4f	0.0015	0.0013	0.0011	0.0009	0.0007	0.0007	0.0007	0.0007
3B4gi	0.0528	0.0479	0.0502	0.0500	0.0458	0.0490	0.0536	0.0529
3B4gii	0.2570	0.2796	0.2706	0.2633	0.2674	0.2550	0.2348	0.2025
3B4giii	0.0090	0.0061	0.0056	0.0042	0.0040	0.0030	0.0024	0.0026
3B4giv	0.0007	0.0006	0.0003	NO	NO	NO	NO	NO
3De	0.0509	0.0375	0.0333	0.0268	0.0283	0.0309	0.0325	0.0265
3F	0.0036	0.0020	0.0012	0.0009	0.0010	0.0011	0.0011	0.0009
5A	0.2403	0.2466	0.2527	0.2593	0.2660	0.2741	0.2816	0.2897
5C1biii	NO	NO	NO	NO	NO	NO	NO	NO
5C2	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009
5D1	0.0003	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004
TOTAL	23.5962	23.8241	23.8997	21.1690	21.1996	15.3242	15.3123	13.5794

	2014	**2015**	**2016**	**2017**	**2018**
1A1a	0.0753	0.0814	0.0852	0.0762	0.0784
1A1b	NO	NO	NO	NO	NO
1A2a	0.0000	NO	NO	NO	NO
1A2b	0.0047	0.0020	0.0012	0.0020	0.0021
1A2c	0.0118	0.0140	0.0070	0.0061	0.0064
1A2d	0.0010	0.0009	0.0009	0.0007	0.0008
1A2e	0.0295	0.0197	0.0298	0.0349	0.0363
1A2f	0.0410	0.0394	0.0380	0.0412	0.0392
1A2gvii	0.0111	0.0094	0.0106	0.0126	0.0131

1A2gviii	0.0053	0.0022	0.0025	0.0051	0.0053
1A3ai(i)	0.0236	0.0209	0.0273	0.0309	0.0319
1A3aii(i)	0.0001	0.0001	0.0001	0.0001	0.0001
1A3bi	0.6813	0.6386	0.6439	0.5993	0.5547
1A3bii	0.1221	0.1188	0.1228	0.1156	0.0994
1A3biii	0.1610	0.1591	0.1699	0.1557	0.1186
1A3biv	0.3792	0.3644	0.3695	0.3407	0.2530
1A3bv	1.1519	1.1441	1.1572	1.1749	1.1519
1A3dii	0.0100	0.0093	0.0076	0.0101	0.0102
1A4bi	0.0380	0.0583	0.0794	0.0720	0.0483
1A4ci	0.0076	0.0084	0.0082	0.0086	0.0080
1A4cii	0.0251	0.0276	0.0269	0.0283	0.0263
1A4ciii	0.0001	0.0001	0.0001	0.0000	0.0002
1A5b	0.0056	0.0031	0.0036	0.0034	0.0039
1B2aiv	NO	NO	NO	NO	NO
1B2av	0.7972	0.7822	0.6591	0.5892	0.5892
1B2c	NO	NO	NO	NO	NO
2C1	NO	NO	NO	NO	NO
2D3a	1.0164	1.0180	1.0258	1.0370	1.0511
2D3b	0.0023	0.0020	0.0020	0.0026	0.0026
2D3c	0.0098	0.0086	0.0089	0.0111	0.0111
2D3d	1.2511	1.6473	1.7402	2.0232	2.1742
2D3f	0.0262	0.0527	0.0261	0.0526	0.0262
2D3g	0.0099	0.0111	0.0110	0.0107	0.0107
2D3h	0.2618	0.2526	0.2651	0.2655	0.2273
2D3i	4.3655	4.4814	5.6652	7.2541	7.4339
2G	0.0029	0.0067	0.0055	0.0059	0.0053
2H2	0.1561	0.1535	0.1572	0.1668	0.1668
3B1a	0.4326	0.4473	0.4861	0.5148	0.5445
3B1b	0.1344	0.1283	0.1350	0.1437	0.1527
3B2	0.0264	0.0268	0.0274	0.0290	0.0280
3B3	0.2500	0.2509	0.2508	0.2506	0.2584
3B4d	0.0157	0.0158	0.0167	0.0174	0.0169
3B4e	0.0024	0.0024	0.0024	0.0024	0.0024
3B4f	0.0007	0.0007	0.0007	0.0007	0.0007
3B4gi	0.0490	0.0458	0.0476	0.0471	0.0464
3B4gii	0.2550	0.2161	0.2220	0.2304	0.2409
3B4giii	0.0027	0.0027	0.0027	0.0033	0.0028
3B4giv	NO	NO	NO	NO	NO
3De	0.0218	0.0287	0.0205	0.0174	0.0206
3F	0.0008	0.0010	0.0007	0.0006	0.0007
5A	0.2958	0.3011	0.3069	0.3126	0.3180
5C1biii	NO	NO	NO	NO	NO
5C2	0.0008	0.0008	0.0008	0.0009	0.0009
5D1	0.0004	0.0005	0.0005	0.0005	0.0005
TOTAL	12.1728	12.6067	13.8784	15.7087	15.8210

Table A5.4.SOx emissions 1990-2018 (as Gg SO_2)

	1990	1991	1992	1993	1994	1995	1996	1997
1A1a	21.6153	22.4186	25.8482	27.8109	29.0674	26.4977	28.1351	29.7495
1A1b	0.5900	0.6000	0.6200	0.6200	0.7500	0.7000	0.6600	0.7200
1A2a	0.0055	0.0055	0.0050	0.0050	0.0050	0.0050	0.0050	0.0045
1A2b	0.1900	0.1950	0.2050	0.2075	0.2100	0.2100	0.2100	0.2200
1A2c	0.0650	0.0675	0.0699	0.0700	0.0723	0.0800	0.0850	0.0900
1A2d	0.0325	0.0375	0.0425	0.0450	0.0525	0.0550	0.0575	0.0600
1A2e	0.5400	0.5750	0.6000	0.6250	0.6500	0.6750	0.7000	0.7250
1A2f	0.4825	0.4549	0.4927	0.5382	0.5628	0.5392	0.5805	0.5586
1A2gvii	0.2476	0.2480	0.2480	0.2484	0.2492	0.2496	0.2500	0.2504
1A2gviii	1.1500	1.1590	1.1554	1.1611	1.1726	1.1791	1.1800	1.1850
1A3ai(i)	0.0263	0.0260	0.0257	0.0254	0.0250	0.0247	0.0244	0.0241
1A3aii(i)	0.0004	0.0003	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005
1A3bi	1.0594	1.0865	1.2050	1.2128	1.3125	1.2652	1.3232	1.4024
1A3bii	1.8371	2.0578	2.5950	2.7088	3.1731	3.0889	3.2311	3.3785
1A3biii	1.5680	1.6176	1.8768	1.8418	2.0077	1.8475	1.9246	1.9885
1A3biv	0.0196	0.0186	0.0189	0.0184	0.0182	0.0179	0.0173	0.0164
1A3dii	0.0380	0.0380	0.0380	0.0380	0.0380	0.0380	0.0380	0.0380
1A4bi	1.4168	1.5232	1.8372	1.8673	2.1223	2.0177	2.1177	2.2222
1A4ci	0.2462	0.2648	0.3194	0.3246	0.3690	0.3508	0.3682	0.3863
1A4cii	0.1231	0.1324	0.1597	0.1623	0.1845	0.1754	0.1841	0.1932
1A4ciii	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
1A5b	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1B2aiv	0.3940	0.4188	0.4376	0.4748	0.4901	0.5134	0.4714	0.6464

1B2c	0.0575	0.0612	0.0639	0.0693	0.0716	0.0750	0.0688	0.0944
2G	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
3F	0.0173	0.0168	0.0176	0.0176	0.0152	0.0137	0.0124	0.0113
5C1biii	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003
5C2	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	31.7348	33.0353	37.8942	40.1049	42.6318	39.6316	41.6571	43.9778

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A1a	32.5070	34.3284	32.7969	29.8277	30.3351	32.8993	31.3996	34.0730
1A1b	0.7500	0.8500	0.6600	0.9800	1.0600	0.7200	0.3200	NO
1A2a	0.0040	0.0040	0.0040	0.0020	0.0020	0.0015	0.0010	0.0005
1A2b	0.2200	0.2200	0.2200	0.2250	0.2250	0.2250	0.2250	0.2249
1A2c	0.0950	0.1000	0.1050	0.1100	0.1100	0.1005	0.1000	0.0950
1A2d	0.0650	0.0650	0.0675	0.0675	0.0650	0.0600	0.0600	0.0550
1A2e	0.7400	0.7600	0.7800	0.7900	0.8000	0.8200	0.8300	0.8402
1A2f	0.5286	0.5304	0.5468	0.5347	0.5519	0.5442	0.5873	0.5754
1A2gvii	0.2552	0.2560	0.2600	0.2620	0.2630	0.2640	0.0093	0.0013
1A2gviii	1.1870	1.1875	1.1880	1.1885	1.1888	1.1890	1.1895	1.1893
1A3ai(i)	0.0238	0.0235	0.0231	0.0228	0.0225	0.0222	0.0219	0.0204
1A3aii(i)	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0007	0.0017
1A3bi	1.4555	1.4958	1.4990	1.5150	1.4728	1.3248	0.5053	0.0341
1A3bii	3.6202	3.7857	3.8821	3.7549	3.6231	3.3501	1.1413	0.0185
1A3biii	2.0336	2.0576	2.1002	2.0090	1.9440	1.9722	0.7075	0.0117
1A3biv	0.0152	0.0142	0.0128	0.0120	0.0107	0.0081	0.0037	0.0006
1A3dii	0.0380	0.0380	0.0380	0.0322	0.0347	0.0397	0.0341	0.0486
1A4bi	2.3453	2.4301	2.4880	2.5122	2.6091	2.4988	2.4307	0.5629
1A4ci	0.4078	0.4225	0.5320	0.5200	0.5320	0.4345	0.3789	0.0787
1A4cii	0.2039	0.2113	0.3080	0.3000	0.3080	0.2172	0.1794	0.0357
1A4ciii	0.0019	0.0019	0.0019	0.0026	0.0025	0.0034	0.0037	0.0028
1A5b	0.0100	0.0100	0.0100	0.0077	0.0075	0.0066	0.0052	0.0066
1B2aiv	0.6714	0.7314	0.7274	0.7167	0.6735	0.6015	0.1729	NO
1B2c	0.0980	0.1068	0.1062	0.1046	0.0983	0.0878	0.0252	NO
2G	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
3F	0.0106	0.0097	0.0077	0.0076	0.0071	0.0076	0.0060	0.0047
5C1biii	0.0003	0.0003	0.0003	0.0003	0.0003	0.0001	NO	NO
5C2	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	47.2880	49.6408	48.3658	45.5060	45.9478	47.3990	40.3383	37.8817

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1A1a	27.5192	25.5145	20.5216	16.0816	20.3445	19.3755	14.7525	12.0961
1A1b	NO	NO	NO	NO	NO	NO	NO	NO
1A2a	NO	NO	0.0080	0.0075	0.0099	0.0091	NO	NO
1A2b	0.2247	0.2250	0.0878	0.0552	0.0560	0.0671	0.0386	0.0630
1A2c	0.0945	0.0720	0.0175	0.0283	0.0379	0.0520	0.0425	0.0257
1A2d	0.0533	0.0457	0.0213	0.0196	0.0191	0.0176	0.0177	0.0192
1A2e	0.8502	0.8639	0.3339	0.3271	0.3194	0.3332	0.3508	0.3185
1A2f	0.6002	0.5908	0.7006	0.6364	0.6065	0.5148	0.4625	0.6377
1A2gvii	0.0013	0.0013	0.0011	0.0002	0.0002	0.0002	0.0001	0.0001
1A2gviii	1.1906	1.1581	0.1244	0.0817	0.0643	0.0634	0.0613	0.0612
1A3ai(i)	0.0202	0.0205	0.0208	0.0199	0.0215	0.0218	0.0213	0.0196
1A3aii(i)	0.0014	0.0013	0.0013	0.0011	0.0010	0.0003	0.0002	0.0001
1A3bi	0.0362	0.0392	0.0415	0.0086	0.0088	0.0087	0.0083	0.0077
1A3bii	0.0173	0.0165	0.0157	0.0029	0.0030	0.0027	0.0023	0.0019
1A3biii	0.0114	0.0123	0.0132	0.0025	0.0025	0.0025	0.0024	0.0019
1A3biv	0.0006	0.0006	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001
1A3dii	0.0477	0.0677	0.0804	0.0950	0.1049	0.1057	0.1260	0.1815
1A4bi	0.5621	0.4869	0.1557	0.1600	0.1306	0.1463	0.1449	0.1149
1A4ci	0.0803	0.0736	0.0356	0.0319	0.0315	0.0325	0.0312	0.0307
1A4cii	0.0354	0.0367	0.0178	0.0160	0.0157	0.0163	0.0156	0.0154
1A4ciii	0.0037	0.0037	0.0032	0.0023	0.0022	0.0034	0.0036	0.0020
1A5b	0.1342	0.2070	0.1247	0.0920	0.0625	0.0717	0.0705	0.0866
1B2aiv	NO	NO	NO	NO	NO	NO	NO	NO
1B2c	NO	NO	NO	NO	NO	NO	NO	0.0001
2G	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000
3F	0.0036	0.0020	0.0012	0.0009	0.0010	0.0011	0.0011	0.0009
5C1biii	NO	NO	NO	NO	NO	NO	NO	NO
5C2	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	31.4883	29.4394	22.3280	17.6708	21.8434	20.8463	16.1537	13.6851

	2014	**2015**	**2016**	**2017**	**2018**
1A1a	15.0454	11.3598	14.5972	14.7243	15.3730

1A1b	NO	NO	NO	NO	NO
1A2a	0.0001	NO	NO	NO	NO
1A2b	0.0902	0.0374	0.0221	0.0388	0.0807
1A2c	0.0381	0.0326	0.0371	0.0354	0.0735
1A2d	0.0198	0.0164	0.0168	0.0142	0.0296
1A2e	0.4268	0.3512	0.3781	0.3850	0.8010
1A2f	0.7607	0.7270	0.6807	0.7188	0.7484
1A2gvii	0.0001	0.0001	0.0001	0.0001	0.0001
1A2gviii	0.0476	0.0423	0.0468	0.0642	0.0668
1A3ai(i)	0.0199	0.0199	0.0231	0.0266	0.0281
1A3aii(i)	0.0000	0.0001	0.0001	0.0001	0.0001
1A3bi	0.0076	0.0079	0.0083	0.0086	0.0086
1A3bii	0.0019	0.0019	0.0020	0.0020	0.0020
1A3biii	0.0020	0.0021	0.0022	0.0022	0.0022
1A3biv	0.0001	0.0001	0.0001	0.0001	0.0001
1A3dii	0.1370	0.1266	0.1041	0.1382	0.1397
1A4bi	0.0925	0.1162	0.1269	0.1264	0.0985
1A4ci	0.0283	0.0312	0.0304	0.0320	0.0297
1A4cii	0.0141	0.0156	0.0152	0.0160	0.0149
1A4ciii	0.0016	0.0012	0.0012	0.0005	0.0020
1A5b	0.1064	0.0591	0.0685	0.0645	0.0743
1B2aiv	NO	NO	NO	NO	NO
1B2c	NO	NO	NO	NO	NO
2G	0.0001	0.0001	0.0001	0.0000	0.0003
3F	0.0008	0.0010	0.0007	0.0006	0.0007
5C1biii	NO	NO	NO	NO	NO
5C2	0.0001	0.0001	0.0001	0.0001	0.0001
TOTAL	16.8413	12.9498	16.1618	16.3986	17.5742

Annex 6: Implementation of recommendations and adjustments

A6.1. EU review Process

Table A6.1.Summary of Recommendations from the TERT and status of implementation

Category, gas, year	Summary of Recommendation	Status of implementation
1.A.3.d Domestic Navigation - liquid fuels - CO2, CH4 and N2O	Use notation keys for the category other fossil fuels, other liquid fuels.	Resolved.
1.AB Lubricant use - CO2	Change reporting for lubricant use reported in Table 1A(d), Columns I and G.	Will be resolved in the next submission (March 2020).
2.D.3 Other (non-energy products from fuels and solvent use) – CO2	Use the carbon content factors which are specific for asphalt roofing and road paving with asphalt.	Resolved.
2.F.1 Refrigeration and air conditioning – HFCs / Completeness	Correct the information in the NIR on refrigerant shares used and estimate HFCs emissions from all refrigerant blends containing HFCs in industrial refrigeration, commercial refrigeration, chillers.	Resolved.
3.B Manure management	Provide a revised typical mass for non-dairy cattle.	Resolved.
3.D.2 Indirect N2O emissions from managed soils.	Completeness. No emissions for category 3.D.2.2 Indirect emissions from leaching and runoff. Investigate if it occurs and correct data.	Resolved.
4.A Forest land	For the year 2016, under forest land remaining forest land the carbon pools living biomass and mineral soils are reported as a source of emissions also in the CRF table 4.A and at the same time emissions are reported for CO2 in the CRF table 4(V). beside this potential double counting, mineral soils are not affected in such a way that result in a source of emissions in the year of the incidence as it is reported in the CRF table 4.A for 2016. Revise carbon stock change resulting in emissions in the CRF table 4.A under forest land remaining forest land, both in living biomass and mineral soils.	On-going.
4.A Forest land - CO2 / Adherence to the UNFCCC Annex I inventory reporting guidelines	Revise the reporting of the area of settlements converted to forest land and ensure consistency between the areas reported in the NIR, CRF table 4.1 and CRF table 4.A.	On-going.

5.D.1 Domestic wastewater – CH_4 and N_2O / Accuracy	Account for the component of organic material and N removed as sludge, because it is reported that there are good data sources for sludge in Cyprus, and explain any recalculations for categories 5.D.1 and 3.D.1.a.2.b as a result of this change.	Further improvements in future submissions

A6.2. UNFCCC/KP review Process

Table A6.2.Summary of Recommendations from the ERT and status of implementation

CRF, gas, year	Summary of Recommendation	Status of implementation
Archiving	Adherence to the UNFCCC Annex I inventory reporting guidelines - Enhance the security and performance of the data archiving and storage system.	In progress. Data is version controlled for incremental changes and archived separately for each completed submission. Archival versions are backed up securely onsite and offsite across the inventory team and external technical consultants.
CRF Tables / Comparability	Provide relevant explanations in CRF table 9(a), specifically for all cases of the notation key “NE” being reported and for sources reported as “IE” (e.g. for indirect emissions from agricultural soils). In addition, correct the allocation of emissions used that is erroneously reported in the column “allocation per IPCC Guidelines”.	In progress. Comments are currently provided for the majority of "NE" and "IE" cases, and will be correctly reported in the two "allocation" columns, as well as the "explanation" column.
Key category analysis	Adherence to the UNFCCC Annex I inventory reporting guidelines - Correct the cut-off criterion to use a 95 per cent threshold and disaggregate emissions in the energy sector and in the agricultural soils categories in the key category analysis.	Resolved in the current submission.
Methods / Accuracy	Ensure that appropriate methods are used to estimate emissions from key categories.	In progress.
Kyoto Protocol units	Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol - Report in the NIR information in accordance with decision 15/CMP.1, annex, paragraphs 12–18, in conjunction with decision 3/CMP.11, including on: information reported in the SEF tables; discrepancies and notification; publicly accessible registry information; and the calculation of the CPR and the method used to calculate it.	Resolved.

National registry	Include in the NIR information on the national registry in accordance with decision 5/CMP.1 and the annex to decision 13/CMP.1 in conjunction with decision 3/CMP.11 and other relevant provisions and standards (the submission did not include contact information for a designated organization and registry administrator, or a description of the standardized electronic database applied for registry performance and publicly accessible information).	Resolved.
National registry	Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol - Report any change to its national registry (compared with the information in the previous submission) in its NIR, in accordance with decision 15/CMP.1, annex, paragraph 22.	Resolved.
National system	Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol - Report on the progress of implementation of the workplan that includes the description of legal, institutional and procedural arrangements for performing the functions of the national system of Cyprus, and explain the ongoing activities put in place for continuous and sustainable reporting, including inter alia the enhancement of reporting capacity on supplementary information under the Kyoto Protocol, in particular on the LULUCF sector.	Resolved.
National system	Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol - Implement the workplan in accordance with the listed tasks and deadlines and update the text in the NIR accordingly to describe any changes to the national system.	In progress.
Uncertainty analysis / Transparency	Include an uncertainty analysis for LULUCF after the LULUCF reporting has been completed.	Planned for 2022 submission.
Notation keys / Completeness	Insufficient information on significance of categories for reporting emissions as "NE"	Planned for 2022 submission.
Uncertainty analysis / Transparency	Provide the sources of expert judgment used to quantitatively assess uncertainty of source or sink categories for AD or EFs in annex 2 of the NIR.	In progress.
1. General (energy sector) - all fuels- CO_2, CH_4 and N_2O.	Transparency. Provide information on how emissions are estimated by including infromation on efforts to reconcile the energy balance and EU ETS data	In progress.
1. General - liquid fuels - CO_2, CH_4 and N_2O.	Adherence to the UNFCCC Annex 1 Inventory reporting guidelines.Provide further explanation on the use of notation keys.	Resolved.
1.A.1.c Manufacture of solid fuels and other energy industries - biomass - CO_2, CH_4 and N_2O	Adherence to the UNFCCC Annex 1 inventory reporting guidelines. Correct NIR table 3.3 (NO) by reporting emissions from manufacture of solid fuels in order to ensure consistency between the NIR and the CRF table 1.A(a).	Resolved.

1.A.2.b Non-ferrous metals - liquid fuels - CO2, CH4 and N2O.	Transparency. Describe in the NIR the rationale for reporting "NO" for liquid consumption for 2013 and 2014 and provide supporting information	Planned for 2021 submission
1.A.2.c Chemicals - liquid fuels - CO2,CH4 and N2O.	Transparency. Explain the interannual variation in the AD and CO2, CH4 and N2O emissions for 2013 in the NIR	Planned for 2021 submission
1.A.2.c Chemicals - liquid fuels - CO2,CH4 and N2O.	Completenss. Estimate CO2, CH4 and N2O emissions from LPG consumption under chemicals and report the emissions in the NIR and the CRF table 1.A(a)s2.	Resolved.
1.A.2.d Pulp, paper and print - liquid fuels - CO2, CH4 and N2O.	Comparability. Allocate emissions from LPG consumption reported under paer, pulp and printing in the national energy balance to category 1.A.2.d both in the NIR (table 3.10) and CRF table 1.A(a)s2.	Resolved.
1.A.2.f Non-metallic minerals - liquid fuels - CO2, CH4 and N2O	Accuracy. Correct reporting for 2017 of the CO2 emissions for liquid fuels for non-metallic minerals in CRF table 1.A(a)s2.	Resolved.
1.A.2.g Other (manufacturing industries and construction) - liquid fuels - CO2, CH4 and N2O	Comparability. Correct reporting by allocating the LPG consumption reported in the energy balance under other sector and the corresponding emissions to the category other stationary (1.A.5a.) in both the NIR (tables 3.24 and 3.25) and CRF table 1.A(a)	Resolved.
1.A.3.b Road transportation - liquid fuels -CO2	Accuracy. Correct the CO2 EF used to estimate emissions from gasoline consumption inroad transportation for 1993 and 1994 and ensure the time series consistency of the applied EFs.	Resolved.
1.A.3.b Road transportation - liquid fuels -CO2, CH4 and N2O	Transparency. Provide in the NIR a description of the composition of the biofuels used for ad transportation and explain whether all diesel and gasoline are mixed with biofuels and at what percentage	In progress.
1.A.3.b Road transportation - liquid fuels -CO2, CH4 and N2O	Transparency. Document in the NIR how COPERT V model and the Efs applied are appropriate to the national circumstances	In progress.
1.A.3.b Road transportation - liquid fuels -N2O	Accuracy. Correct the N2O EF used to estimate emissions from diesel consumption in road transportation and ensure the time series consitency of the applied EF.	Resolved.
1.A.3.b Road transportation - liquid fuels -N2O	Completeness. Correct he stimates of N2O emissions from consumption of diesel light-duty trucks for 1990-1999.	Resolved.
1.A.3.d Domestic navigation - liquid fuels - CO2, CH4 and N2O	Transparency. Provide information or references in relation with splitting fuel usage and making backward projections offuel use in domestic navigation for 1990-1997.	In progress.
1.A.4.a Commercial/institutional - biomass- CO2, CH4 and N2O	Accuracy. Correct the CO2, CH4 and N2O emission estimates based on corrected biogas consumption data under commercial/institutional for 2014-2017 and report the correct estimates in its NIR and CRF tables.	Resolved.
1.A.4.c.i Stationary - biomass - CO2, CH4, N2O	Transparency. Explain in the NIR that the consumption of biogas by autoproducers is accounted under category 1.A.4.c.i because all the production and consumption of biogas occurs at farms with anerobic digesters.	Resolved.

1.B.2.a Oil -CH4	Accuracy. Revise the reported CH4 EF for 1990-2004, report revised emission estimates and explain the recalculation in the NIR.	Resolved.
2.D.3 Other (non-energy products from fuels and solvent use) – CO2 / Comparability	Report the AD for urea-based catalysts in kt, instead of TJ, in CRF table 2(I).A-Hs2, according to IPCC 2006 Guidelines (volume 2, chapter 3, equation 3.2.2)	Resolved.
2.F Product uses as substitutes for ozone-depleting substances – PFCs and NF3 / Adherence to the UNFCCC Annex I inventory reporting guideline	Further examine whether PFC and NF3 emissions from category 2.F (product uses as substitutes for ODS) occur in the country and, as appropriate, report estimates or use an appropriate notation key (i.e. “NO”) in the corresponding CRF tables (blank cells were still reported for those emissions for some subcategories (2.F.1, 2.F.2, 2.F.3, 2.F.5 and 2.F.6) in CRF tables 2 and 2(I)).	Resolved.
2.F. Product uses as substitutes for ozone depleting substances – HFCs / Accuracy	Continue efforts to collect AD and report emissions fully in accordance with the 2006 IPCC Guidelines - subcategory transport refrigeration of 2.F.1 emissions was not estimated and reported as NE in CRF table 2(II).B-Hs2.	Resolved.
2.F. Product uses as substitutes for ozone depleting substances – HFCs / Accuracy	Continue efforts to collect AD and report emissions fully in accordance with the 2006 IPCC Guidelines - Emissions from blowing agents (2.F.2), fire protection (2.F.3) and aerosols (2.F.4), Cyprus used country-specific estimation methodologies that are not fully in accordance with 2006 IPCC Guidelines. If the lack of AD due to national circumstances prohibit use of methods from the 2006 IPCC Guidelines to estimate emissions from categories 2.F.2, 2.F.3 and 2.F.4, Cyprus may use surrogate data as detailed in the 2006 IPCC Guidelines (vol. 1,chap. 2, section 2.2.1)	Further improvements in future submissions
2.F.1 Refrigeration and air conditioning – HFCs / Accuracy	Correct the AD and revise its estimates of HFC-134a remaining in products at decommissioning and HFC-134a emissions from disposal under stationary air conditioning (2.F.1.f) and report the correct values in CRF table 2(II)B-Hs2 for 1994 and 1995.	Resolved.
2.F.1 Refrigeration and air conditioning – HFCs / Completeness	Further examine whether emissions from manufacturing of refrigeration and air-conditioning equipment occur in the country and, as appropriate, report values or revise the use of the notation keys reported.	Further improvements in future submissions
2.F.1 Refrigeration and air conditioning – HFCs / Completeness	Cyprus reported HFC-134a emissions from mobile air conditioning (2.F.1.e) as "NE" for 1990-2004 due to lack of data for the estimation. Cyprus should estimate emissions using the methods provided in the 2006 IPCC Guidelines (vol. 3, chap.7) for 1990-2004. If national circumstances prohibit use of those methods, Cyprus should use surrogate data to estimate the emissions in accordance with the 2006 IPCC Guidelines (vol. 1, chap. 2, section 2.2.1).	Resolved.

2.G Other product manufacture and use – N2O and SF6 / Accuracy	Recalculate SF6 emissions from 2.G.1 (electrical equipment), N2O emissions from 2.G.3.a (medical applications) and N2O emissions from 2.G.3.b (other – propellant for pressure and aerosol products) and include the most updated values for population and average per capita emissions and update the values in CRF tables 2(I).A-Hs2 and 2(II)B-Hs2.	New methodology was applied for 2.G.3.a (medical applications). Further improvements in future admissions for 2.G.1 and 2.G.3.b
2.G.3 N2O from product uses - N2O / Accuracy	Cyprus used a country-specific method to estimate N2O emissions from product uses that is not in accordance with the 2006 IPCC Guidelines. The country-specific method is a proxy method thatr uses N2O emissions per capita from product use in Greece as the EF and the population of Cyprus as AD. Cyprus should estimate N2O emissions from product uses by using the method provided in the 2006 IPCC Guidelines (vol. 3, chap. 8). If national circumstances prohibit use of those methods, Cyprus should use surrogate data to estimate the emissions in accordance with the 2006 IPCC Guidelines (vol. 1, chap. 2, section 2.2.1), including, the use, for example, of the parameter power grid installed capacity as a driver of SF6 emissions.	New methodology was applied for 2.G.3.a (medical applications). Further improvements in future admissions for 2.G.3.b
3.A Enteric fermentation - CH4	Accuracy. Estimate emissions for all significant livestock categories using and enhanced livestock characterization and a tier 2 methodology in accordance with the IPCC good practice guidance.	Further improvements in future submissions.
3.D.a Direct N2O emissions from managed soils - N2O	Accuracy. Implement a tier 2 methodology to estimate emissions for categories 3.D.a.1 and 3.D.A.2 considerung desk tudies or expert judgment as alternatives given in the national circumstances.	Will be resolved in the 2021 submission.
3.F Field burning of agricultural residues - CO2, CH4 and N2O.	Accuracy. Include reference to the legislation on the bannig of crop residue burning in the NIR along with applied expert judgment on the occurrence of fires and undertake a desk study to identify the appropriateness of the current FracBURN.	Further improvements in future submissions.
4(V) Biomass burning / Transparency	Provide the missing estimates of emissions from forest fires for land converted to forest land for 2011.	In progress.
4. General (LULUCF) – CO2 / Accuracy	Explore the use of, where relevant, the carbon stock change factors and assumptions used for the estimation of the carbon stock changes in biomass, dead wood and litter, and ensure comparability between the land-use changes both to and from a category.	In progress.
4. General (LULUCF) – CO2, CH4 and N2O / Comparability	Report “NO” for any category, pool and/or gas for which there is information confirming that it does not occur, and provide such information in the NIR, and report “NE” for categories, pools and/or gases for which there is no information on emissions/removals or for which net emissions/removals are negligible.	In progress.

4. General (LULUCF) / Accuracy	Report the areas converted to a different land use under the relevant land-use conversion category for 20 consecutive years before reporting them under the corresponding land remaining category.	In progress.
4.A Forest land - CO_2 / Adherence to the UNFCCC Annex I inventory reporting guidelines	Revise the reporting of the area of settlements converted to forest land and ensure consistency between the areas reported in the NIR, CRF table 4.1 and CRF table 4.A.	In progress.
4.A Forest land / Transparency	Provide a description of the methodology and assumptions used to identify the forest area.	In progress.
4.D Wetlands - CO_2 / Adherence to the UNFCCC Annex I inventory reporting guidelines	Revise the reporting of land areas converted to wetlands and ensure consistency between the information reported in CRF tables 4.1 and 4.D.	In progress.
4.E Settlements - CO_2 / Adherence to the UNFCCC Annex I inventory reporting guidelines	Revise the area of settlements reported in NIR table 6.14 and ensure consistency with the total area of settlements reported in CRF table 4.E.	In progress.
5. General (waste) – CO_2, CH_4 and N_2O / Accuracy	Ensure that there is proper accounting and alignment of waste streams used as alternative fuel sources in the energy sector and in the waste sector (categories 5.A, 5.B and 5.D), taking into account whether the newly available data from the Statistical Service of Cyprus are applicable, and whether these are deducted from the waste sector, because they may be resulting in an overestimation of waste sector emissions.	To be resolved by the 2021 submission
5. General (waste) – CO_2, CH_4 and N_2O / Transparency	Include in the NIR under the waste sector a discussion to transparently explain the waste streams (i.e. the AD) that are reported in the energy sector and in the waste sector based on the revised data from the Statistical Service of Cyprus.	To be resolved by the 2021 submission
5.A Solid waste disposal on land - CH_4 / Accuracy	Estimate AD from industrial waste prior to 1990 and revise the associated CH_4 emissions from industrial waste for the whole time series, and provide in the NIR the methodology used to estimate such emissions.	Further improvements in future submissions
5.B.2 Anaerobic digestion at biogas facilities – CH_4 / Completeness	Report CH_4 emissions from sludge transported for anaerobic treatment for biogas production under the category anaerobic digestion at biogas facilities (5.B.2) and include an explanation in the energy section of the NIR concerning the consumption of biogas at farms with anaerobic digesters of solid waste	Further improvements in future submissions
5.C.1 Waste incineration – CO_2, CH_4, N_2O / Completeness	Cyprus reports the emissions from category waste incineration as "NO", excluding waste incineration in the cement kiln as energy recovery which is reported on energy sector. On the other hand, the Eurostat reports the amount of waste incinerated without energy recovery in Cyprus. Estimate and report emissions from waste incineration without energy recovery	To be resolved by the 2021 submission

5.D Wastewater treatment and discharge – CH4 / Transparency	Provide information in the NIR under category-specific planned improvements to reflect whether any plans are in place to move to higher-tier methods, as this category has been identified as key according to CRF table 7.	Further improvements in future submissions
5.D.1 Domestic wastewater – CH4 and N2O / Accuracy	Account for the component of organic material and N removed as sludge, because it is reported that there are good data sources for sludge in Cyprus, and explain any recalculations for categories 5.D.1 and 3.D.1.a.2.b as a result of this change.	Further improvements in future submissions
General (KP-LULUCF activities) / Adherence to reporting guidelines under Article 7, paragraph 1, of the KP	Implement the workplan to report any emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, including: application of method 2 from the Kyoto Protocol Supplement to address information on geographical location; completion by 2018 of a map of woody forest vegetation in state and private forests, with a minimum mapping unit of 0.3 ha; acquire or utilize satellite information to obtain the areas of AD for forest management and the geographic location; and acquire capacity-building assistance to estimate non-CO2 emissions.	In progress.
General (KP-LULUCF activities) / Transparency	Report on the progress of the implementation of the workplan designed to report any emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.	In progress.
General (KP-LULUCF activities) / Transparency	Clarify in the NIR how the losses of carbon stock calculated using the IPCC default biomass gain-loss method have been calculated and what types of losses have been considered.	In progress.
General (KP-LULUCF activities) / Transparency	Include estimates of the background level and margin.	In progress.
General (KP-LULUCF activities) / Adherence to the UNFCCC Annex I inventory reporting guidelines	Enter the FM cap in the accounting table.	In progress.
FM – CO2 / Adherence to the UNFCCC Annex I inventory reporting guidelines	Revise the area of forests included in the land transition matrix in order to be consistent with those reported in CRF table NIR-2 and 4(KP-I)B.1.	In progress.

Annex 7: Key actions of the National Inventory Improvement Plan

Table A7.1 presents the key actions identified for the improvement of the national inventory, after the preparation of the 2020 submission.

Table A7.1.Key actions of the National Inventory Improvement Plan

	Description	**Planned Implementation**
General		
1	Improve QA/QC plan	Continuous
2	Improve implementation of QA/QC procedures	Continuous
3	Improve descriptive information in NIR (e.g. inter-annual variations) to improve transparency	Continuous
4	Implement Tier 2 methodologies for key categories	Continuous
5	Undertake category specific quantitative uncertainty assessment and report the results in the NIR	To be assessed for 2020 submission
Sector 1. Energy		
1	1.A.3.b Road transportation: Development of country-specific EFs	To be assessed for 2021 submission
Sector 2. IPPU		
1	2.F Product uses as substitutes for ozone depleting substances: Continue efforts to collect AD and report emissions fully in accordance with the 2006 IPCC Guidelines - Emissions from blowing agents (2.F.2), fire protection (2.F.3) and aerosols (2.F.4)	Collection of the necessary data is ongoing. Further improvements in future submissions
2	2.G Other product manufacture and use: Recalculate SF6 emissions from 2.G.1 (electrical equipment), N2O emissions from 2.G.3.a (medical applications) and N2O emissions from 2.G.3.b (other – propellant for pressure and aerosol products)	New methodology was applied for 2.G.3.a (medical applications). Further improvements in future admissions for 2.G.3.b
Sector 3. Agriculture		
1	3A. Improvement of DE time series for the improvement of estimation of CH4 emissions from enteric fermentation dairy cattle.	In view of the difficulty to find reasonably good data on time series for feeding plans and in the absence of historical data, we plan by the 2021 submission to explore some modelling approach which could be used to derive DE from other related variables.
2	3D. Improvement of N2O leaching estimates	Explained and reference provided
3.	3D. Implement a tier 2 methodology to estimate emissions for categories 3.D.a.1 and 3.D.A.2 considering desk studies or expert judgment as alternatives given in the national circumstances.	In progress. Will be resolved for the 2021 submission.
Sector 4. LULUCF		
1	Report fully uncertainty assessment and recalculations	To be included in the 2022 submission
Sector 5. Waste		
1	5.A. Solid waste disposal on land: Estimate AD from industrial waste prior to 1990 and revise the associated CH4 emissions from industrial waste for the whole time series, and provide the methodology used to estimate such emissions.	Further improvements in future submissions
2	5.B.2. Anaerobic digestion at biogas facilities: Report CH4 emissions from sludge transported for anaerobic treatment for biogas production under the category anaerobic digestion at biogas facilities (5.B.2) and include an explanation in	Further improvements in future submissions

	the energy section of the NIR concerning the consumption of biogas at farms with anaerobic digesters of solid waste	
3	5.C.1 Waste incineration: Estimate and report emissions from waste incineration without energy recovery	To be resolved by the 2021 submission
4	5.D Wastewater treatment and discharge: Move to higher-tier methods	Further improvements in future submissions
5	5.D.1 Domestic wastewater: Account for the component of organic material and N removed as sludge and explain any recalculations for categories 5.D.1 and 3.D.1.a.2.b as a result of this change.	Further improvements in future submissions
KP LULUCF		
1	Natural Disturbances	To be included in the 2022 submission

References

All references used in the national inventory report are presented as footnotes to the text.