MINISTRY OF NATURE PROTECTION OF THE REPUBLIC OF ARMENIA

National Greenhouse Gas Inventory Report of the Republic of Armenia 2010




under the United Nations Framework Convention on Climate Change

2014

REPUBLIC OF ARMENIA
MINISTRY OF NATURE PROTECTION

National Greenhouse Gas Inventory Report of the Republic of Armenia (2010)

under the United Nations Framework Convention on Climate Change

GHG National Inventory Report of the Republic of Armenia is prepared under coordination of the Ministry of Nature Protection of RA, with financial support of Global Environment Facility and under "Enabling Activities for the Preparation of Armenia's Third National Communication to the United Nations Framework Convention on Climate Change" project implemented with the assistance of the United Nations Development Programme.

Empowered lives.
Resilient nations.

Yerevan 2014

Working group members

Anastas Aghazaryan, PhD in Economy;
Anjela Turlikyan (advisor);
Ara Marjanyan, PhD in Technical Sciences;
Asya Muradyan (adviser);
Edward Karapoghosyan (adviser), PhD in Technical Sciences;
Edward Martirosyan;
Harutyun Karapetyan;
Hrachya Zakoyan, PhD in Economy;
Laert Harutyuntyan, PhD in Physics and Mathematics;
Martiros Tsarukyan (senior advisor);
Petros Tozalakyan (expert team leader), PhD in Biology;
Vahan Sargsyan, PhD in Technical Sciences;
Vahe Matsakyan, PhD in Biology;
Vram Tevosyan

Programme coordination body

Aram Gabrielyan, PhD in Physics and Mathematics	UNFCCC Focal Point
Diana Harutyunyan, PhD in Biology	UNDP-GEF Project Coordinator
Tatevik Vahradyan	UNDP-GEF Project Expert Team Assistant

Ministry of Nature Protection
Address: Government Building #3, Republic Square, Yerevan - Armenia, 0010
Tel.: (37410) 521099, 583932
Fax: (37410) 585469, 583933
E-mail: info@mnp.am, climate@nature.am
Web-site: www.mnp.am, www.nature-ic.am

TABLE OF CONTENTS

List of Tables

List of Figures

Abbreviations

AFOLU	Agriculture, forestry land other land use
BOD	Biochemical oxygen demand
BTU	British thermal unit
CHF	Chlorofluorocarbon
CJSC	Closed joint-stock company
COD	Chemical oxygen demand
CORINAIR	Core Inventory of Air Emissions
DOC	Degradable organic carbon
EMEP	European Monitoring and Evaluation Programme
FOD	First order decay
GHG NI	Greenhouse Gas National Inventory
GIS	Geographic Information System
GPG	Good Practice Guidance
HCA	High clay activity
HFC	Hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
IRI	Islamic Republic of Iran
KSM	Key source method
LCFL	Lands converted to forest lands
LULUCF	Land use, land-use change, forestry
MB	Mass balance
MCF	Methane correction factor
MENR	Ministry of Energy and Natural Resources
MSW	Municipal solid waste
NI	National Inventory
NIR	National Inventory Report
NMVOC	Non-methane volatile organic compounds
NSS	National Statistical Service
ODS	Ozone depleting substances
QA	Quality Assurance
QC	Quality control
RA	Republic of Armenia
RAC	Refrigeration and air conditioning
RF	Russian Federation
SNCO	State non-commercial organization
SPAN	Specially protected areas of nature
SRC	State Revenues Committee
SW	Solid waste
SWDS	Solid waste disposal sites
TA	Technical assistance
TPP	Thermal power plant
YCCTPP	Yerevan combined cycle thermal power plant

Shortenings

eq.	equivalent
mln.	million
bln	billion
toe	tonne of oil equivalent (1 toe = 1.43 t equivalent fuel)
t d.m.	tonne of dry material
t equivalent fuel	tonne of equivalent fuel (1 t equivalent fuel= 0.7 toe)

Measurment Units

BTU	British thermal unit
Gg	gigagram (10^9 g, or thousand t.)
Gcal	gigacalorie (10^9 calorie)
GWh	gigawatt hours (10^9 Wh)
t	tonne
TJ	terajoule (10^{12}J)
PJ	petajoule (10^{15}J)
MW	megawatt
^{0}C	degree Celsius

Chemichal Combinations

CO_2	Carbon Dioxide
CH_4	Methane
N_2O	Nitrous oxide
HFCs	Hydrofluorocarbons
PFCs	Perfluorocarbons
SF_6	Sulfur hexafluoride
CO	Carbon monoxide
NOx	Nitrous oxides
SO_2	Sulfur dioxide
NMVOC	Non-methane volatile organic compounds

Energy units conversion

1 BTU = 1.055 kJ
1 PJ = 277.8 GWh =23.88 * 10^3 toe
1 toe = 41.85 GJ

Background

Article 4 of the United Nations Framework Convention on Climate Change (UNFCCC) states that the primary responsibility of the Parties shall be “to develop, periodically update and make available to the Conference of Parties national inventories on anthropogenic emissions by sources and removals by sinks of all greenhouse gases”.

The Decree of the Government of RA No. 1594, dated November 10, 2011 “On approval of the list of activities for implementation of obligations of the Republic of Armenia under a number of International Environmental Conventions” stipulates the elaboration of the Third National Inventory of anthropogenic emissions of Greenhouse Gases for 2012-2014. According to the Decree the Ministry of Nature Protection, Ministry of Agriculture, Ministry of Economy, Ministry of Energy and Natural Resources, and Ministry of Transport and Communication of the Republic of Armenia are assigned responsible institutions for development of the Inventory.

According to the Program Document signed between UNDP and the Government of the Republic of Armenia on “Enabling Activities for the Preparation of Armenia’s Third National Communication to the UNFCCC”, 2010 will be the baseline year for the Third National Communication of Armenia.

Given the fact that since 2015 Armenia shall be obliged to regularly prepare National Greenhouse Gas (GHG) Inventory, and in order to gain experience of calculation under the new 2006 Guidelines requirements, this Inventory has been prepared according to the new requirements of IPCC, 2006. The Third National Inventory of Armenia includes the following sectors as described below:

- Energy
- Industrial processes and product use (IPPU),
- Agriculture, forestry and other land use (AFOLU),
- Waste

In contrast with the previous revised 1996 Guidelines for preparation of GHG Inventories, 2006 Guidelines recommends to use one “Industrial Processes and Product Use” (IPPU) Sector instead of “Industrial Processes” and “Use of Solvents”, and to use “Agriculture, Forestry and Other Land Use” (AFOLU) Sector instead of “Agriculture”, “Land Use, Land Use Change and Forestry” (LULUCF).

During preparation of the Inventory the group of experts have used Tier 1, 2 and 3 approaches for IPPU Sector, Tier 1 and 2 approaches for AFOLU, “Energy” and “Waste” Sectors.

The table below indicates the breakdown of GHG emissions and removals by gases and by sectors (in Gg)

Sectors	Net CO_2	CH_4	N_2O	HFCs In CO_2 eq.	Total $CO_{2\ eq.}$
Total national emissions and removals	**3911.92**	**107.67**	**1.56**	**255.19**	**6910.99**
Energy	4231.03	35.64	0.09	NA	5008.71
Industrial Processes and Product Use	225.96	NA	NA	255.19	481.16
Agriculture, forestry and other land use	-552.70	44.26	1.26	NA	767.80
Waste	7.64	27.77	0.20	NA	653.33

The Third National GHG Inventory of the Republic of Armenia includes also the following issues: Analysis of Basic Sources, Analysis of Trends in GHG Emissions, Uncertainty Assessment, Quality Control and Quality Assurance, References, and Annexes.

Taking into consideration the fact, that still there is no official decision by IPCC to use 2006 IPCC Guidelines while preparing the National Inventories [Gen-1], the general tables for 2000, 2006 and 2010 are presented in this Inventory per the requirements of 1996 IPCC Revised Guidelines [Gen-2].

Introduction

1.1 Basic Information on GHG Inventory

1.1.1 Legal Basis for Preparation of the Inventory

Article 4 of the United Nations Framework Convention on Climate Change (UNFCCC) states that the primary responsibility of the Parties shall be to "develop, periodically update and make available to the Conference of Parties national inventories on anthropogenic emissions by sources and removals by sinks of all greenhouse gases". This Article obligates the countries to develop national inventories by using comparable methodologies approved by the Conference of Parties.

The Decree of the Government of RA No. 1594, dated November 10, 2011 "On approval of the list of activities for implementation of obligations of the Republic of Armenia under a number of International Environmental Conventions" stipulates the elaboration of Third National Inventory of anthropogenic emissions of Greenhouse Gases" during 2012-2014. According to the Decree the Ministry of Nature Protection, Ministry of Agriculture, Ministry of Economy, Ministry of Energy and Natural Resources, and Ministry of Transport and Communication of the Republic of Armenia are assigned responsible institutions for development of the Inventory. For implementation of certain activities set by the Annexes of the Decree, as well as in regard to multi-sectoral character of activities intended to address issues under the United Nations Framework Convention on Climate Change, development of innovative approaches and mechanisms in combatting climate change, and the need of the Republic of Armenia in joining them through close cooperation with intergovernmental and international organizations, the perspective view of regional cooperation, the importance of participation of communities, civil society and scientific community, and training, and the necessity in effective cooperation and coordination between institutions to meet that purpose the Prime Minister of RA signed a Decree No 955-A, dated October 2, 2012 on approving the composition and the procedure of the Inter-institutional Coordination Board for implementation of requirements and provision of United Nations Framework Convention on Climate Change.

Minister of Nature Protection of RA was nominated the chairman of the Inter-agency Coordinating Council. The Council practically includes all ministries, and State Committee of Real Estate Cadaster, General Department of Civil Aviation, National Statistical Service, Public Services Regulatory Commission, National Academy of Sciences and National Focal Point of United Nations Framework Convention on Climate Change.

1.1.2 Overview of I, II and III GHG National Inventories of Armenia

The first National Inventory was developed by the Republic of Armenia over the period of 1996-1998 under the UNDP-GEF "Armenia-Country Study on Climate Change" Project, where 1990 was taken as a baseline year. In that Inventory emissions and removals were assessed for years 1990 and 1994-1996 by using IPCC, 1995 Methodology for making GHGs national inventories. Years 1994-1993 were not included in the Inventories as under the hardship and economic crisis of the transition period there were no sufficient information and data for making GHG Inventories.

Afterwards, in 2004 a UNDP-GEF regional project was launched on capacity building for quality enhancement of GHG Inventories. Within the framework of the project certain measures were taken to upgrade the First National Inventory of Armenia through preparation and sustainable technical and institutional capacity development. As an outcome of this regional programme the quality of the prepared GHG Inventory under the First National Communication of Armenia was improved, a group of trained experts was established, emission factors were adjusted, and the used methodology was revised. The programme made the analysis of sources and enabled to identify those priority sources where the Inventories need urgent improvements, including methane emissions from solid waste disposal sites and animal enteric fermentation for which new inventory has been developed.

As one of the outcomes of the project a Manual for National GHG Inventories was developed which was widely used for preparation of the Second GHG National Inventory.

Under the "Enabling Activities for the Preparation of Armenia's Second National Communication to the United Nations Framework Convention on Climate Change" UNDP-GEF/000351196 Project and according to Guidelines for Preparation of National Communications (Decision 17/CP.8) 2000 was taken as second inventory year and complete GHG inventory including all 6 sectors of UNFCCC was developed for that year. For the purpose of filling in 1990-2006 time series GHG inventories were also developed for those years for which relevant information was available.

According to the Program Document signed between UNDP and the Government of the Republic of Armenia on "Enabling Activities for the Preparation of Armenia's Third National Communication to the UNFCCC", 2010 will be the baseline year for the Third National Communication of Armenia.

The Third National Inventory of Armenia includes the following sectors as described below:

- Energy,
- Industrial processes and product use,
- Agriculture, forestry and other land use,
- Waste.

The Inventory was calculated for years indicated in Table 1.1.below:

Table 1.1 Inventory Years by Sectors

Sectors (subsectors)	Years	
	Inventories	Recalculation
Energy	2001- 2010	2000
Industrial processes and product use (IPPU)	1995-2010	2000
Agriculture	2001-2010	2000
Forestry	2000,2010	2000
Other land use	2000-2010	2000
Waste	1995-2010	1990-2000

The deference is that the "Industrial Processes and Solvents" as well as "Agriculture, Land Use, Land Use Change and Forestry" Sectors should be presented separately according to the 1996 IPCC Revised Guidelines. There are also some minor differences in calculations of waste open burning.

1.1.3 Overview of Mechanisms and Processes for Making Inventories

The Ministry of Nature Protection of the Republic of Armenia is assigned as Designated National Authority in the Republic of Armenia for coordination of issues relevant to UN Framework Convention on Climate Change. The Ministry, among other relevant issues, also coordinates the works for preparation of National Communication of Armenia under the United Nations Framework Convention on Climate Change. RA national GHG Inventories are developed within the framework of preparation of National Communications as Armenia, being non-Annex I Party, is not obliged to prepare annual inventories.

For preparation of GHG inventories under UNDP-GEF Project, Armenia has established a Working group on competitive basis sustainability of which in most cases depends on the continuality of activities. The Organizational Chart for preparation of the Third National Inventory of Armenia is presented in Figure 1.1.

Taking into account the peculiarities in regard to the required professional experience and collection of relevant data for the sectors of agriculture, forestry and land use AFOLU Sector was divided into Subsectors and calculations for the mentioned sector was done by three individual experts.

F-gases Subsector in "Industrial Processes and Product Use" Sector is included in National Inventory of GHG of Armenia for the first time.

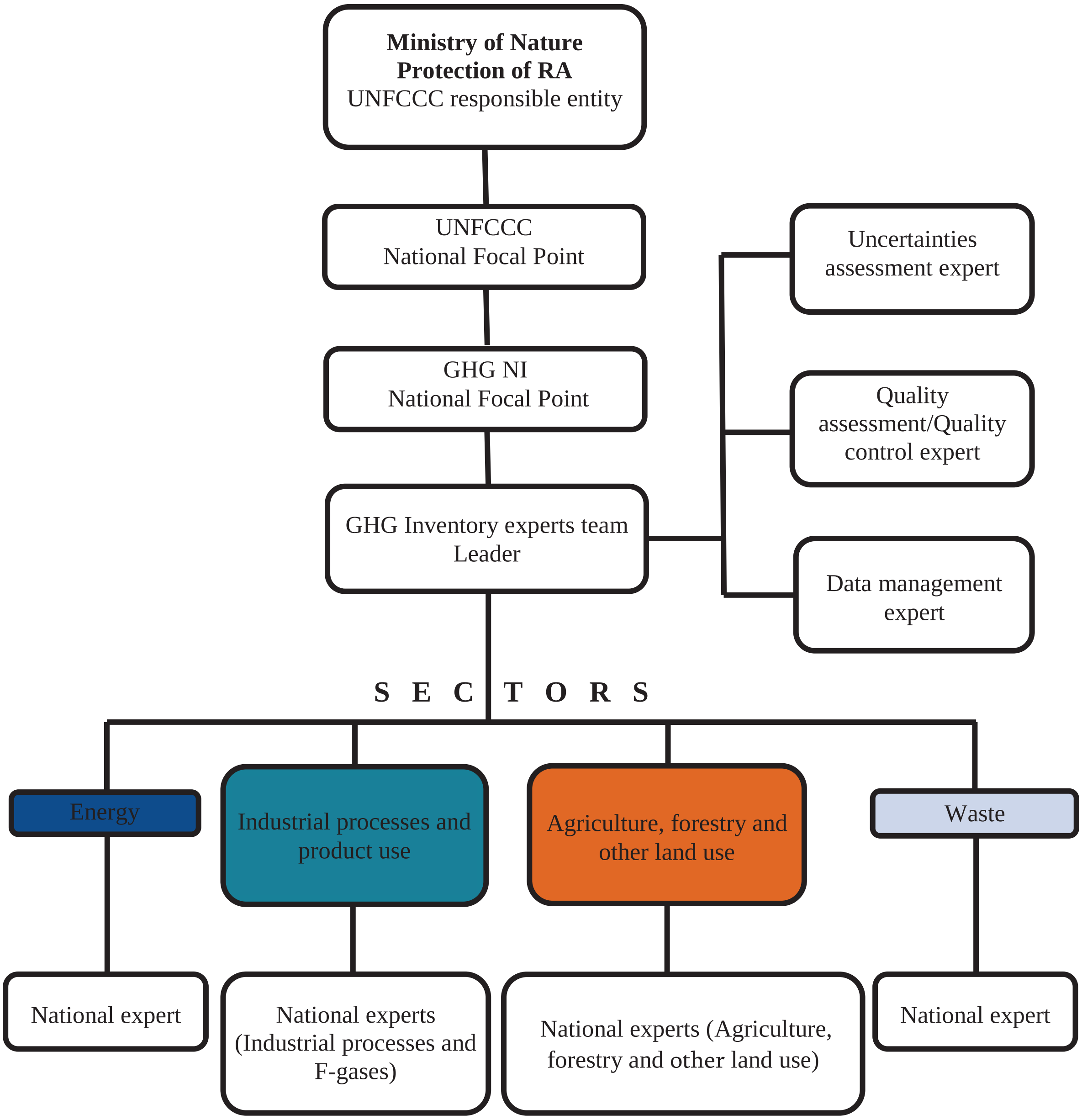

Figure 1.1 Organization Chart of National Inventory

The diagram presented in Figure 1.2 describes the cycle of actions for Inventories preparation performed by expert group for Greenhouse Gas National Inventory (GHG NI). Quality Assurance (QA) procedures include professional and public assessment of the Inventory.

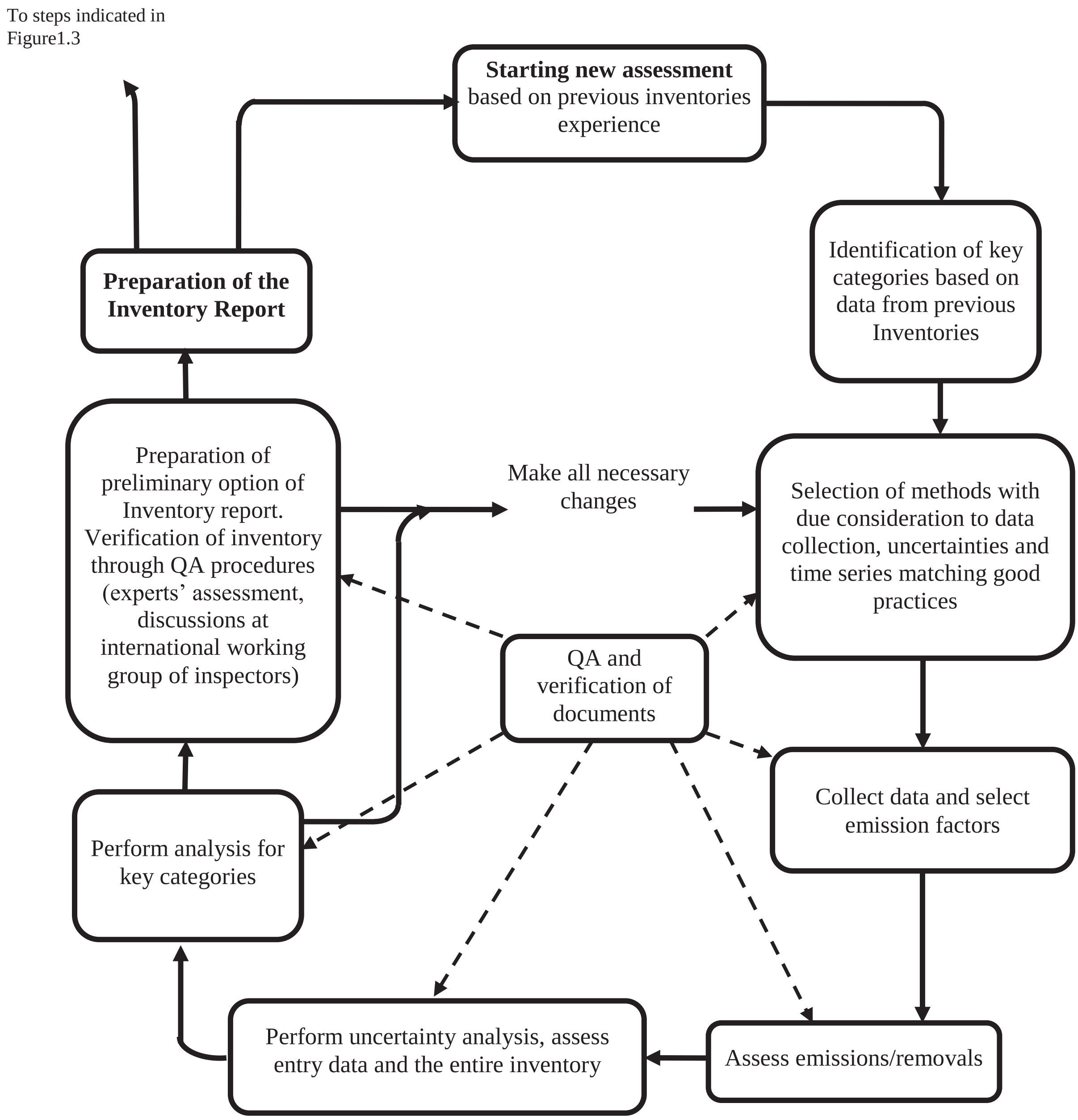

Figure 1.2 Inventory Preparation Activity Cycle Performed by GHG NI Group

Steps to be taken following the preparation of Inventory Report are described in Figure 1.3.

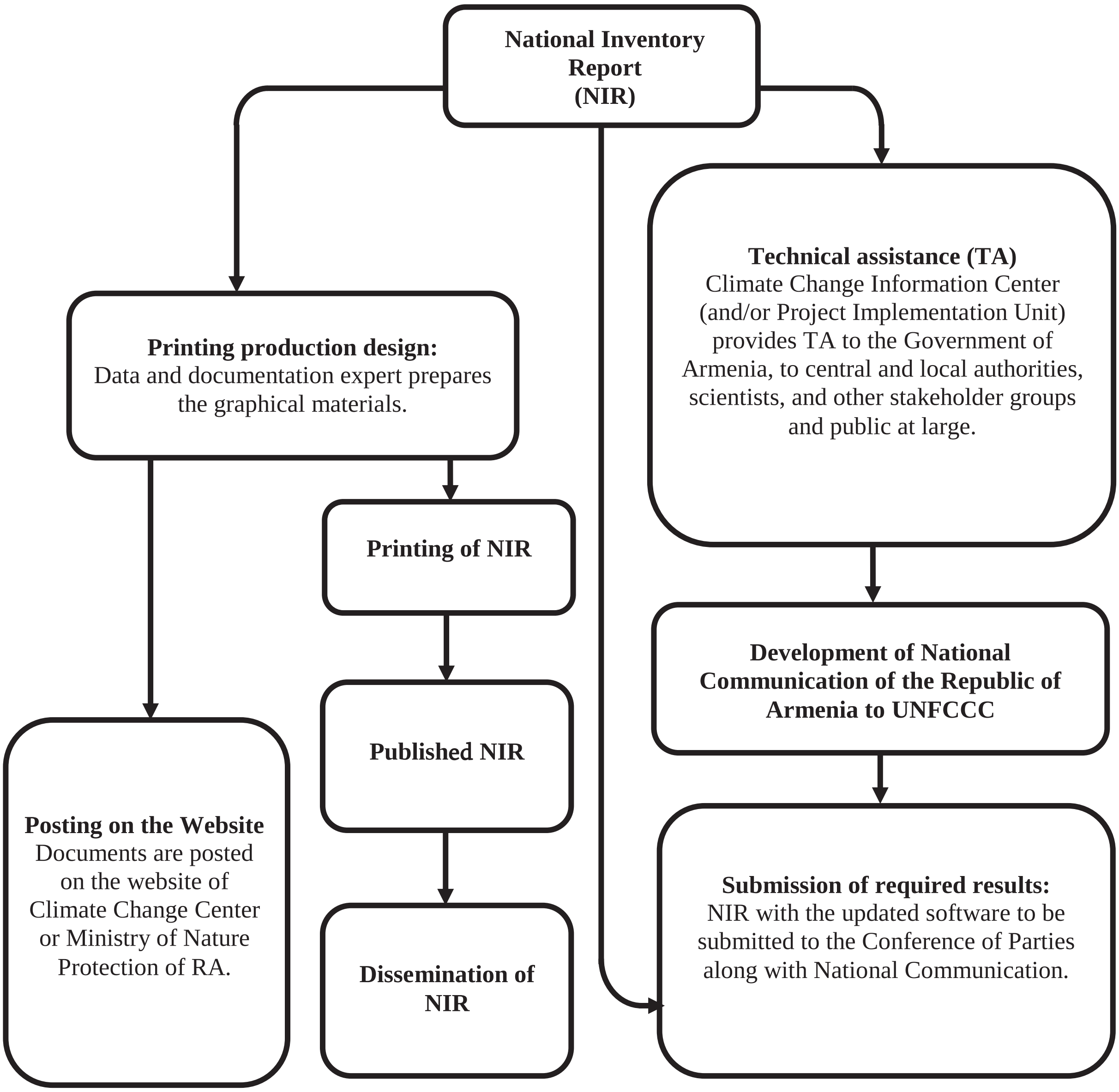

Figure 1.3 Follow –up Measures after Preparation of Inventory Report

1.2 Overview of Used Methodology and Data Sources

Given the fact that since 2015 Armenia shall be obliged to regularly prepare National Inventories of GHGs, and in order to gain experience of calculation under the new 2006 Guidelines requirements this Inventory has been prepared according to the new requirements of 2006 Guidelines. Pursing the objective of the best preparedness, a number of experts participated in the online training held by Convention Secretariat in Sri Lanka in January, 2012.

In order to enhance the capacity of the National Inventory Group two experts participated in the online training for Inventory review experts of Annex-1 countries held in September-October, 2013 and in the workshop held in Hanoi.

Approaches and default data of emissions were from “1996 Revised Guidelines for Preparation of National GHG Inventories”, “Good Practice Guidance and Uncertainties Management in National Inventories of Greenhouse Gases” (IPCC, 2000), “Good Practice Guidance for Land Use, Land Use Change and Forestry” (IPCC, 2003), and default CORINAIR-99 manuals of “Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe” (EMEP) also used during preparation of the Inventory report. The choice of “2006 IPCC Inventory Software” was

due to the use methodology from 2006 Guidelines for preparation of the Third National Inventory of for data entering, analyzing and summarizing.
In the early period, the Software 2.0.4510 version available at that time was used which, as it was found, needed some correction to be made. There had been programme errors and incorrectness identified during data entering and in routine quality control. In the event of any problem software producers were promptly notified about the issue and all remarks were addressed and commented on. As a result of Software upgrade IPCC has created a new v2.11 version which was eventually used for preparation of this Report. Details of this work can be seen in the correspondence with software designers shown in Annex 2.

The Third National Inventory was prepared according to the principles as described below:

- Clear observation of the logics and structure of IPCC methodology,
- Priority given to the use of national data and indicators,
- Utilization of all possible fact sheets,
- Maximum use of the capacities of national information sources.

During the preparation of the Third National Inventory of Armenia the highest priority was given to estimation of emission of gases with direct greenhouse effect, i.e. CO_2, CH_4 and N_2O from key sources of emissions. Estimation was also made for emissions of gases with indirect greenhouse effect, i.e. CO, NO_x, NMVOCs and SO_2, as well as for emission of Hydrofluorocarbons (HFCs) compounds. In contrast with the pervious inventories the Third Inventory has calculated emissions of sulphur dioxide from copper and ferromolybdenum production. A National Emission Factor was proposed for that purpose which was used for emission calculation for the above mentioned gas. Unlike the pervious inventories, the Third Inventory has accounted for so called F-gases, particularly chlorofluorocarbons (CHFs).

The Third National Inventory includes all sectors indicated in 2006 IPCC Guidelines:

1. Energy,
2. Industrial Processes and Product Use (including F-gases),
3. Agriculture, Forestry and Land Use,
4. Waste.

As we can see, unlike the previous GHG, 1996 revised manual 2006 Guidelines recommends to use one “Industrial Processes and Product Use” (IPPU) Sector instead of “Industrial Processes” and “Use of Solvents” Sectors, and to use “Agriculture, Forestry and Other Land Use” (AFOLU) Sector instead of previous “Agriculture”, “Land Use, Land Use Change and Forestry” Sectors.

Tier 1, 2 and 3 approaches are used for “Industrial Processes and Products Use” Sector, Tier 1 and 2 approaches are used for AFOLU, “Energy” and “Waste” Sectors.

National Statistical Service has served as main fact sheet source of input data for emissions calculation from various areas of activities. Information was also provided by the Ministry of Energy and Natural Resources of RA, State Revenues Committee of RA, Ministry of Economy of RA, Public Services Regulatory Commission of RA, State Committee of Real Estate Cadaster, National Academy of Sciences, municipalities of Yerevan, Gyumri, Vanadzor and other cities, “Scientific Research Institute of Energy” CJSC, “ArmRusGasProm” CJSC, “Armenergo” CJSC, “Armforest” SNCO, and others.

1.3 Analysis of Key Categories

The key category analysis allows assessment of the fractions of GHG emitted from various sectors in the total of national emissions. Therefore, by emphasizing the most essential areas in regard to emissions key category analysis also points out the most essential of them for emissions mitigation strategy development, and indicates the priority of the nee improving Inventory data and GHG emissions estimation methods. According to IPCC Guidelines, the key sources are accepted to be the sources (by the list of their emissions volume classification) that in total account for at least 95% of national emissions.

In the framework of this work, Tier assessment for 2000-2001 was conducted as those were the only years for which it was possible to apply "bottom-up" based sectoral method of assessment for "Energy" sector which is a necessary provision for performing key category analysis.

Table 1.2 below describes the results of key category analysis - level assessment for 2010:

As it can be seen from the table, there are 14 main sources for 2010 while there have been some shifts in and additions to sources in comparison with 2000. For example, there was emission reduction in the energy sector which could have been the result of economic decline on the one hand and limitation of liquid and solid fuel consumption and increase in use of natural gas on the other hand. F-gases (were not included in previous Inventories) and nitrous oxide is included in the list of key sources. In the previous Inventories methane emissions from manure management have reached to the border line of key and non-key sources.

Table 1.2 Key Category Analysis of GHG Emissions, 2010 (Level Assessment)

A	B	C	D	E	F
IPCC category code	IPCC category	GHG	2010 year Emissions (|Gg $CO_{2\,eq.}$|)	2010 year Emission level Assessment L_x	Cumulative total of column E
1.A.4	Other sectors - gaseous fuels	CO_2	1226.65	0.152	0.15
1.A.3.b	Road transportation	CO_2	1202.62	0.149	0.30
3.A.1	Enteric fermentation	CH_4	859.27	0.106	0.41
1.A.1	Energy Industries - gaseous fuels	CO_2	827.52	0.103	0.51
3.B.1.a	Forest land remaining forest land	CO_2	708.93	0.088	0.60
1.B.2.b	Natural gas	CH_4	677.43	0.084	0.68
1.A.2	Manufacturing industry and construction - gaseous fuels	CO_2	529.55	0.066	0.75
4.A	Solid waste disposal	CH_4	470.35	0.058	0.81
1.A.4	Other sectors - liquid fuel	CO_2	441.80	0.055	0.86
2.F.1	Refrigeration and air conditioning	HFCs, PFCs	245.54	0.030	0.88
2.A.1	Cement production	CO_2	225.96	0.027	0.90
3.C.4	Direct N_2O emissions from managed soils	N_2O	191.23	0.023	0.92
4.D	Wastewater treatment and discharge	CH_4	89.67	0.011	0.94
3.C.5	Indirect N_2O emissions from managed soils	N_2O	84.65	0.010	0.95
3.A.2	Manure management	CH_4	69.38	0.009	0.96
3.A.2	Manure management	N_2O	65.93	0.008	0.96
4.D	Wastewater treatment and discharge	N_2O	56.42	0.007	0.97
3.C.6	Indirect N_2O emissions from manure management	N_2O	49.15	0.006	0.98
1.A.4	Other sectors - biomass	CH_4	40.40	0.005	0.98
1.A.3.b	Road transportation	CH_4	26.52	0.003	0.99
4.C	Incineration and Open Burning of Waste	CH_4	23.11	0.003	0.99
1.A.3.b	Road transportation	N_2O	18.75	0.002	0.99
3.B.3.a	Grasslands remaining as grasslands	CO_2	13.46	0.002	0.99

Calculation of assessment of the trends of GHG emissions is considered as good practice. Analysis of key sources through assessment of trends is shown in Table1.3.

Table 1.3. Key Category Analysis of GHG Emissions, 2010 (Trend Assessment)

A	B	C	D	E	F	G	H
IPCC category code	IPCC category	GHG	2000 emission (Gg $CO_{2\,eq.}$)	2010 Emission (Gg $CO_{2\,eq.}$)	Assess-ment of trends	Contributi on in trends	Total of the column G
1.A.1	Energy Industries - gaseous fuels	CO_2	1667.06	827.52	0.23	0.32	0.32
1.A.4	Other sectors - gaseous fuels	CO_2	201.96	1226.65	0.15	0.21	0.53
3.B.1.a	Forest land remaining forest land	CO_2	-470.82	-552.93	0.06	0.08	0.61
1.A.3.b	Road transportation	CO_2	642.06	1202.62	0.05	0.07	0.68
1.A.4	Other sectors - liquid fuels	CO_2	115.51	441.80	0.05	0.06	0.74
2.F.1	Refrigeration and air Conditioning	HFCs, PFCs	0.69	245.54	0.04	0.05	0.80
3.C.4	Direct N_2O emissions from managed soils	N_2O	257.67	191.23	0.03	0.04	0.83
1.A.2	Manufacturing industries and construction - liquid fuels	CO_2	107.11	0.00	0.02	0.03	0.87
4.A	Solid waste disposal	CH_4	449.53	470.35	0.02	0.03	0.90
3.A.1	Enteric fermentation	CH_4	723.56	859.27	0.02	0.03	0.93
1.A.2	Manufacturing industries and construction - gaseous fuels	CO_2	339.54	529.55	0.01	0.01	0.94
2.A.1	Cement production	CO_2	119.68	225.96	0.01	0.01	0.95
1.B.2.b	Natural gas	CH_4	473.35	677.43	0.01	0.01	0.96
3.C.5	Indirect N_2O emissions from managed soils	CH_4	80.26	89.67	0.00	0.00	0.97
4.D	Wastewater treatment and discharge	N_2O	48.59	84.65	0.00	0.00	0.97
3.C.5.	Indirect N_2O Emissions from managed soils	CH_4	6.95	26.52	0.00	0.00	0.97
1.A.3.b	Road transportation	CH_4	63.32	69.38	0.00	0.00	0.98
3.A.2	Manure management	N_2O	59.20	65.93	0.00	0.00	0.98
3.A.2	Manure management	N_2O	49.94	56.42	0.00	0.00	0.98
4.D	Wastewater treatment and discharge	N_2O	42.62	49.15	0.00	0.00	0.99
1.A.1	Energy - liquid fuels	CO_2	6.57	0.00	0.00	0.00	0.99
1.A.4	Other fuel - biomass	CH_4	23.79	40.40	0.00	0.00	0.99

1.4 Information on Quality Assurance and Quality Control Processes

Quality assurance and quality control (QA/QC) processes were implemented as elements of the Good Practice to improve the quality of National Inventories. Quality assurance and quality control was implemented by IPCC Good Practice Guidance (GPG) Tier 1 procedures with participation of organizations from appropriate sectors.

1.4.1 Quality Control Processes

Following are the processes implemented for quality control for all sectors:

- checking typos made in received information,
- checking typos in entered information,

- checking calculations made for filling in data gaps,
- checking units of measurement, entries of emission factors,
- checking calculations made for GHGs,
- checking consistency/compatibility of time series in regard to changes in calculation methods, emission factors, or in any other parameters,
- checking correctness of formulas entered in nationally appropriate calculation sheets,
- checking calculation of national emission factors,
- checking required documentation and references.

1.4.2 Quality Assurance Processes

Quality assurance, as defined in IPCC GPG, is "a planned system for revision procedures conducted by personnel not directly involved in processes for development and making inventories". QA process usually includes both revision by experts and revision by public at large. Expert revision is implemented in two phases: revision of interim versions of emissions calculation files, and further revision of calculations and the text of Inventory Report.

During the Inventory preparation quality assurance and document checking was conducted by experts of GHG NI.

Furthermore, experts are selected and involved in the process of development of Inventory assessment, who provide additional revision and Inventory methodology and data consistency. The second phase assumes involvement of stakeholder institutions, as well as "Enabling Activities for the Preparation of Armenia's Third National Communication to the UNFCCC" project will request an international expert for revision of the developed Inventory. It is important that CC Inter-agency Working Group participates in the quality assurance process.

1.5 Uncertainty Assessment

For deriving the quantities of emissions or removals of gases by any sector of activities it is necessary to have quantitative data for activities used in the given sector as well as to have specific factors for emission and removals. This means that in order to derive GHG emission or removal uncertainties there will be a need to assess uncertainty of factors of data for used activities and GHG emissions (or removals). Data used for calculation of GHG emissions have a large range of uncertainties dependent on the area and institutions or organizations providing said data. Values of uncertainty of factors for data for all activities and GHG emissions (or removals) used in this Report are described in Tables 1.4 and 1.5.

Uncertainty assessment is based on 2006 IPCC; IPCC 2000 GPG; and IPCC 2003 GPG LULUCF Guidelines.

Uncertainty analysis by Tier 1 presented in Chapter herein uses classification similar to classification of key sources.

For Armenia, like other transition economies, difficulties with assessment of uncertainties for 1999-2010 data for activities were due to the conditions as follows:

- Rapid economic decline in 1990, then slow recovery after 1997, crisis in 2009,
- Information sources for activities (ministries or NSS) were changed and often data collection methodology was changed during that time-period,
- Difficulties in data accounting caused by shadow economy.

Generic Results of analysis made for generic uncertainties are described in Tables 1.4 and 1.5, the detailed calculation of uncertainties is shown in Annex 1, Table A1.7.

Table 1.4 Emission Uncertainties from Key Sources of GHG (without Forestry), 2010

Code	Category	Gas	Uncertainty, %
1.A.1	Energy industries, - gaseous fuels	CO_2	8.6
1.A.2	Manufacturing industries and construction - gaseous fuels	CO_2	7.07
1.A.3.b	Road transportation	CO_2	8.6
1.A.4	Other sectors - gaseous fuels	CO_2	8.6
1.A.4	Other sectors - liquid fuel	CO_2	7.07
2.A.1	Cement production	CO_2	12.2
CO_2 Generic uncertainty			**3.6**
1.B.2.b	Natural gas	CH_4	7.8
3.A.1	Enteric fermentation	CH_4	75.7
3.A.2	Manure management	CH_4	72.9
4.A	Solid waste disposal	CH_4	29.1
4.D	Wastewater treatment and discharge	CH_4	55.2
CH_4 Generic uncertainty			**24.4**
3.C.4	Direct N_2O emissions from managed soils	N_2O	25
3.C.5	Indirect N_2O emissions from managed soils	N_2O	36
N_2O Generic uncertainty			**21.9**
2.F.1	Refrigeration and air conditioning	HFCs PFCs	6.6
HFCs Generic uncertainty			**6.6**

Generic uncertainties are calculated according to 2006 IPCC Guidelines [Gen-1].

Table 1.5 Emission Uncertainties from Key Sources of GHG (with Forestry data), 2010

Code	Category	Gas	Uncertainty, %
1.A.1	Energy industries -gaseous fuels	CO_2	8.6
1.A.2	Manufacturing industries and construction - gaseous fuels	CO_2	7.07
1.A.3.b	Road transportation	CO_2	8.6
1.A.4	Other sectors - gaseous fuels	CO_2	8.6
1.A.4	Other sectors - liquid fuel	CO_2	7.07
2.A.1	Cement production	CO_2	12.2
3.B.1	Forest lands	CO_2	50.0
CO_2 Generic uncertainty			**7.8**
1.B.2.b	Natural gas	CH_4	7.8
3.A.1	Enteric fermentation	CH_4	75.7
3.A.2	Manure management	CH_4	72.9
4.A	Solid waste disposal	CH_4	29.1
4.D	Wastewater treatment and discharge	CH_4	55.2
CH4 Generic uncertainty			**24.4**
3.C.4	Direct N_2O emissions from managed soils	N_2O	25
3.C.5	Indirect N_2O emissions from managed soils	N_2O	36
N_2O Generic uncertainty			**21.9**
2.F.1	Refrigeration and air conditioning	HFCs PFCs	6.6
HFCSs Generic uncertainty			**6.6**

Emission or removal factors for GHG are defined by formulas taken from IPCC Guidelines. Dependent on areas of activities and GHG the formulas use a great number of data that should be provided by relevant institutions and organizations or should be collected through surveys. Their uncertainties should be provided together with these data. This is the only way to reduce emission uncertainties by using mathematical statistical methods. Otherwise, there will be a need to applying reserve uncertainties values taken from IPCC Guidelines.

In order to obtain necessary data there will be a need to make certain structural changes in NSS (National Statistical Service) reporting formats or in data collection formats of ministries.

Taking into account the peculiarities of sectors, there is a necessity of synergy between GHG Inventory expert group and data providing institutions or organizations for developing the list of necessary changes.

2. Main Outcomes of 2010 GHG Inventory

Total 2010 emissions and removals of GHGs in Armenia are described below in Table 2.1 and Table 2.2.

Table 2.1 Distribution of GHG Emissions and Removals by Gases and by Sectors (Gg)

Sector	Net CO_2	CH_4	N_2O	HFCs $CO_{2\ Ker}$	Total of $CO_{2\ eq.}$
Total national emissions and removals	**3911.92**	**107.67**	**1.56**	**255.19**	**6910.99**
Energy	4231.03	35.64	0.09	NA	5008.71
Industrial processes and product use	225.96	NA	NA	255.19	481.16
Agriculture, forestry and other land use	-552.70	44.26	1.26	NA	767.80
Waste	7.64	27.77	0.20	NA	653.33

Table 2.2 Distribution of GHG Emissions by Gases, without Removals (Gg)

Sector	Net CO_2	CH_4	N_2O	HFCs $CO_{2\ eq.}$	Total of $CO_{2\ eq.}$
Total national emissions and removals	**4464.63**	**107.67**	**1.56**	**255.19**	**7463.7**
Energy	4231.03	35.64	0.09	NA	5008.71
Industrial processes and product use	225.96	NA	NA	255.19	481.16
Agriculture, forestry and other land use		44.26	1.26	NA	1320.50
Waste	7.64	27.77	0.20	NA	653.33

Data from Table 2.2 are summarized in Figure 2.1.

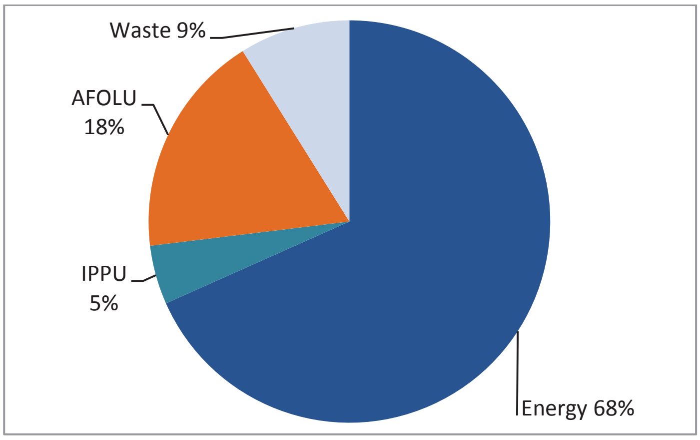

Figure 2.1 Distribution of GHG Emissions by Sectors (without Removals), ($CO_{2\ eq.}$).

As we can see 68% of emissions are emitted from "Energy" Sector.

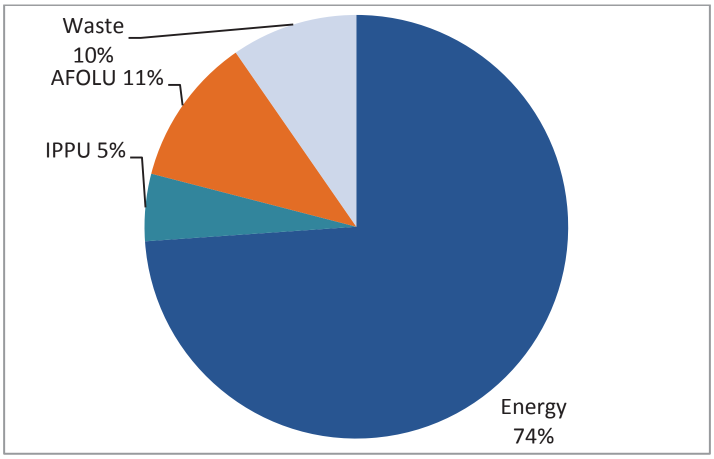

Figure 2.2 Distribution of Individually Emitted and Removed GHGs by Sectors.

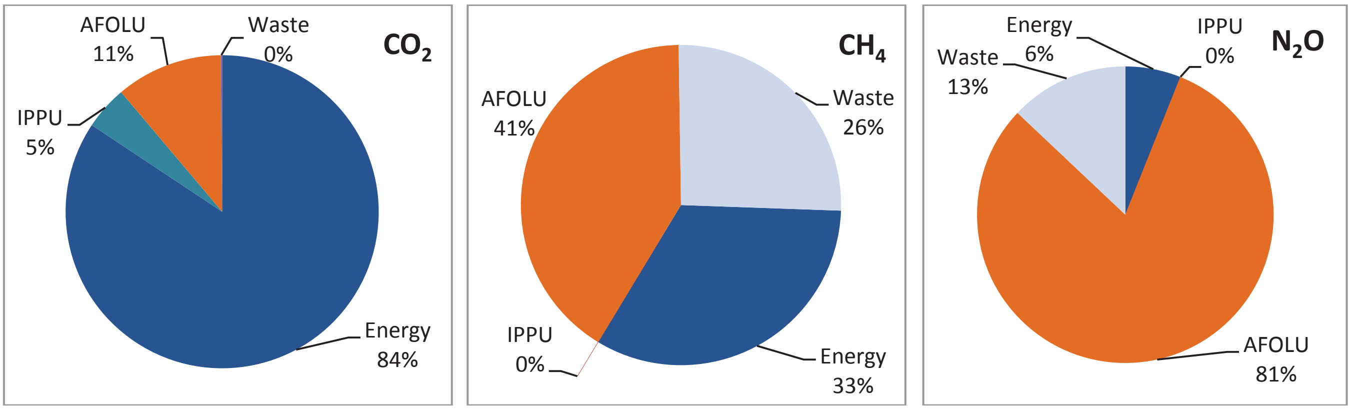

Figure 2.3 Distribution of GHGs by Sectors.

As it can be seen from Figure 2.3, emissions and removals of CO_2 are mainly linked with Energy and AFOLU Sectors. There are emissions of these gases from "Energy" Sector, while removals prevail in AFOLU Sector. Emissions from AFOLU Sector are significantly less and account for 5 % of the total.

Methane and nitrous oxide emissions are broken down between AFOLU, "Energy" and "Waste" Sectors.

Detailed information on emissions and removals with direct and indirect GHG effect is described in Table 2.3.

Table 2.3 Detailed Information on all GHG Emissions and Removals.

	Emissions (Gg)			Emissions $CO_{2\ eq.}$ (Gg)					Emissions (Gg)			
Categories	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with $CO_{2\ eq.}$ conversion factors	Other halogenated gases without $CO_{2\ eq.}$ conversion factors	NOx	CO	NMVOCs	SO_2
Total national emissions and removals	**3911.923**	**107.672**	**1.557**	**255.19**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**17.213**	**66.784**	**22.9**	**29.439**
1 - Energy	**4231.025**	**35.641**	**0.094**	**NA**	**NA**	**NA**	**NA**	**NA**	**17.213**	**66.784**	**11.514**	**0.189**
1.A - Fuel combustion activities	4230.937	3.382	0.094	**NA**	**NA**	**NA**	**NA**	**NA**	17.213	66.784	11.514	0.189
1.A.1 - Energy sectors	827.518	0.015	0.001	**NA**	**NA**	**NA**	**NA**	**NA**	2.213	0.295	0.074	NE
1.A.2 - Manufacturing industries and construction	531.522	0.010	0.001						1.416	0.283	0.047	0.012
1.A.3 - Transport	1202.622	1.263	0.060						11.831	62.476	10.952	0.057
1.A.4 - Other sectors	1669.275	2.095	0.031						1.753	3.73	0.441	0.12
1.A.5 - Not-specified	NO	NO	NO						NO	NO	NO	NO
1.B - Fugitive emissions from fuels	0.088	32.258	NA						NA	NA	NA	NA
1.B.1 - Solid fuels	NO	NO	NO						NO	NO	NO	NO
1.B.2 - Oil and natural gas	0.088	32.258	NA						NO	NO	NO	NO
1.B.3 - Other emissions from energy production	NO	NO	NO						NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO								NO	NO	NO	NO
1.C.1 - Transport of CO_2	NO								NO	NO	NO	NO
1.C.2 - Injection and storage	NO								NO	NO	NO	NO
1.C.3 - Other	NO								NO	NO	NO	NO
2 - Industrial processes and product use	**225.964**	**NA,NO**	**NO**	**255.19**	**NA,NO**	**NO**	**NO**	**NO**	**NA,NO**	**NA,NO**	**11.386**	**29.25**
2.A - Mineral Industry	225.964								NO	NO	NO	NE,NO
2.A.1 - Cement production	225.964								NO	NO	NO	NE
2.A.2 - Lime production	NO								NO	NO	NO	NO
2.A.3 - Glass production	NA								NO	NO	NO	NA
2.A.4 - Other Process Uses of Carbonates	NO								NO	NO	NO	NO
2.A.5 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
2.B - Chemical industries	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

2.B.1 - Ammonium production	NO								NO	NO	NO	NO
2.B.2 - Nitric acid production			NO						NO	NO	NO	NO
2.B.3 - Adipic acid production			NO						NO	NO	NO	NO
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production			NO						NO	NO	NO	NO
2.B.5 - Carbide production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.6 -Titanium dioxide production	NO								NO	NO	NO	NO
2.B.7 - Soda Ash Production	NO								NO	NO	NO	NO
2.B.8 - Petrochemical and Carbon Black Production	NO	NO							NO	NO	NO	NO
2.B.9 - Fluorinated chemicals production				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.10 - Other(please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal industries	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	29.25
2.C.1 - Iron and Steel Production	NA	NA							NA	NA	NA	NA
2.C.2 - Ferroalloys production	NA	NA							NA	NA	NA	5.9
2.C.3 - Aluminum production	NO				NO			NO	NO	NO	NO	NO
2.C.4 - Magnesium production	NO					NO		NO	NO	NO	NO	NO
2.C.5 - Lead production	NO								NO	NO	NO	NO
2.C.6 - Zinc production	NO								NO	NO	NO	NO
2.C.7 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	23.35
2.D - Non-Energy Products from Fuels and Solvent Use	NA	NO	NO						NO	NO	10.9	NA
2.D.1 - Lubricant Use	NA								NO	NO	NE	NA
2.D.2 - Paraffin Wax Use	NA								NO	NO	NE	NA
2.D.3 - Solvent Use		NO	NO						NO	NO	3.25	NA
2.D.4 - Other (please specify)	NA	NO	NO						NO	NO	7.65	NA
2.E - Electronics industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E.1 - Integrated Circuit or Semiconductor				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E.2 -TFT Flat Panel Display					NO	NO	NO	NO	NO	NO	NO	NO
2.E.3 - Photovoltaic					NO	NO			NO	NO	NO	NO
2.E.4 - Heat Transfer Fluid					NO	NO			NO	NO	NO	NO
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NO	NO	NO	255.19	NO	NO	NO	NO	NO	NO	NO	NO
2.F.1 - Refrigeration and Air				245.54					NO	NO	NO	NO

Conditioning												
2.F.2 - Foam Blowing Agents				0.397					NO	NO	NO	NO
2.F.3 - Fire Protection				0.168	NA				NO	NO	NO	NO
2.F.4 - Aerosols				9.092					NO	NO	NO	NO
2.F.5 - Solvents				NO	NO				NO	NO	NO	NO
2.F.6 - Other Applications (please specify)				NO	NO				NO	NO	NO	NO
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.G.1 - Electrical Equipment					NO	NO		NO	NO	NO	NO	NO
2.G.2 - SF6 and PFCs from Other Product Uses					NO	NO		NO	NO	NO	NO	NO
2.G.3 - N2O from Product Uses			NO						NO	NO	NO	NO
2.G.4 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NA,NO	NA,NO	NO						NA,NO	NA,NO	0.486	NA,NO
2.H.1 - Pulp and Paper Industry	NO	NO							NO	NO	NO	NO
2.H.2 - Food and Beverages Industry	NA	NA							NA	NA	0.486	NA
2.H.3 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
3 - Agriculture, forestry and other land use	**-552.704**	**44.264**	**1.261**						**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**
3.A - Livestock	NA	44.221	0.213						NE	NE	NE	NE
3.A.1 - Enteric fermentation		40.917							NE	NE	NE	NE
3.A.2 - Manure management		3.304	0.213						NE	NE	NE	NE
3.B - Land	-542.959		0						NE	NE	NE	NE
3.B.1 - Forest lands	-557.087								NE	NE	NE	NE
3.B.2 - Croplands	0.670								NE	NE	NE	NE
3.B.3 - Grasslands	13.459								NE	NE	NE	NE
3.B.4 - Wetlands	NA		0						NE	NE	NE	NE
3.B.5 - Settlements	NA								NE	NE	NE	NE
3.B.6 - Other land	NA								NE	NE	NE	NE
3.C - Aggregate sources and non-CO_2 emissions sources on land	0.969	0.042	1.049						NO	NO	NO	NO
3.C.1 - Emissions from biomass burning		0.042	0						NO	NO	NO	NO
3.C.2 - Liming	0								NO	NO	NO	NO
3.C.3 - Urea application	0.969								NO	NO	NO	NO

3.C.4 - Direct N2O emissions from managed soils			0.617						NO	NO	NO	NO
3.C.5 - Indirect N2O emissions from managed soils			0.273						NO	NO	NO	NO
3.C.6 - Indirect N2O emissions from manure management			0.159						NO	NO	NO	NO
3.C.7 - Rice cultivation		NO							NO	NO	NO	NO
3.C.8 - Other (please specify)		NO							NO	NO	NO	NO
3.D - Other	-10.715	NO	NO						NO	NO	NO	NO
3.D.1 -Harvested Wood Products	-10.715								NO	NO	NO	NO
3.D.2 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO
4 - Waste	**7.639**	**27.768**	**0.202**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
4.A - Solid Waste Disposal	NO	22.398	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.B - Biological Treatment of Solid Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.C - Incineration and Open Burning of Waste	7.639	1.100	0.020	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.D - Wastewater treatment and discharge	NO	4.270	0.182	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.E - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5 - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.B - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items (5)												
International bunkers	136.172	0.001	0.004						0.485	0.539	0.325	0.043
1.A.3.a.i - International Aviation (International Bunkers)	136.172	0.001	0.004						0.485	0.539	0.325	0.043
1.A.3.d.i - International Water-borne Navigation (International bunkers)	NO	NO	NO						NO	NO	NO	NO
1.A.5.c - Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

3. Trends of GHG Emissions

Table 3.1 describes 2000-2010 GHG emissions by sectors, and Table 3.2 describes 2000-2010 GHG emissions by gases.

Table 3.1 GHG Emissions by Sectors (Gg $CO_{2\,eq.}$)

	Sector	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Gg	Energy	3601.36	3798.04	3050.65	3417.81	3795.09	4367.59	4493.79	5480.02	5671.55	4932.61	5008.71
	Industrial processes and product use	123.4	132.8	176.6	209.2	296.5	362.7	397.0	477.2	542.8	413.5	481.2
	Agriculture, forestry and other land use	725.67	834.34	926.53	922.19	974.43	954.80	1039.74	860.17	792.05	785.05	767.80
	Waste	615.42	627.91	636.44	638.47	641.79	643.94	646.24	648.16	652.94	652.77	653.33
	Total	**5065.75**	**5392.10**	**4787.03**	**5180.83**	**5695.08**	**6306.80**	**6541.24**	**7411.39**	**7567.31**	**6696.96**	**6777.33**
%	Energy	71.09	70.42	63.68	65.88	66.49	69.01	68.33	73.54	74.07	72.73	72.47
	Industrial processes and product use	2.44	2.46	3.69	4.03	5.20	5.73	6.04	6.40	7.09	6.10	6.96
	Agriculture, forestry and other land use	14.32	15.47	19.34	17.78	17.07	15.09	15.81	11.36	10.34	11.58	11.11
	Waste	12.15	11.64	13.29	12.31	11.24	10.17	9.83	8.70	8.50	9.60	9.45
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 3.2 GHG Emissions by Gases (Gg $CO_{2\,eq.}$)

	Gas	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Gg	CO_2	2737.67	2957.14	2362.25	2731.43	3073.27	3554.40	3658.30	4413.72	4542.39	3802.13	3911.92
	CH_4	1844.64	1883.73	1800.72	1869.05	1966.34	2097.49	2163.87	2414.49	2458.02	2272.56	2261.12
	N_2O	479.81	544.16	615.97	569.36	640.46	632.14	681.38	513.23	483.94	502.65	482.76
	HFCs	3.75	8.08	11.32	17.79	27.77	45.05	73.21	110.46	172.99	204.54	255.19
	Total	**5065.87**	**5393.11**	**4790.26**	**5187.64**	**5707.84**	**6329.08**	**6576.76**	**7451.90**	**7657.34**	**6781.88**	**6910.99**
%	CO_2	54.04	54.83	49.31	52.65	53.84	56.16	55.62	59.23	59.32	56.06	56.60
	CH_4	36.41	34.93	37.59	36.03	34.45	33.14	32.90	32.40	32.10	33.51	32.72
	N_2O	9.47	10.09	12.86	10.98	11.22	9.99	10.36	6.89	6.32	7.41	6.99
	HFCs	0.07	0.15	0.24	0.34	0.49	0.71	1.11	1.48	2.26	3.02	3.69
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Time series graphs are described in Figure 3.1.

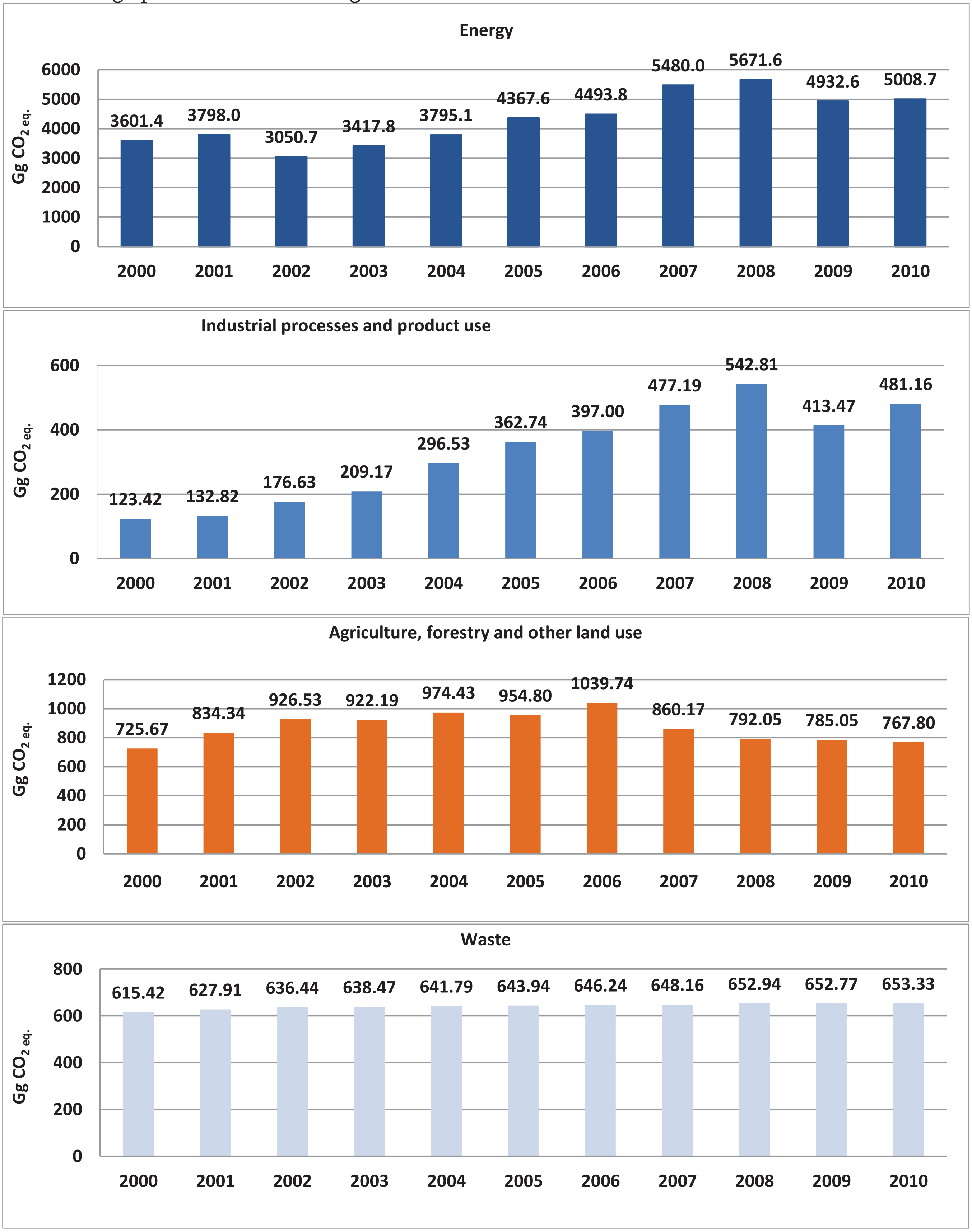

Figure 3.1 Emission Time Series by Sectors, 2000- 2010 (Gg $CO_{2\ eq.}$)

This Figure shows that economic crisis started after 2008 had made its impact especially on emissions from "Energy" and IPPU Sectors. There was no decline in "Waste" Sector as methane emissions from waste disposal sites have long latent time-period.

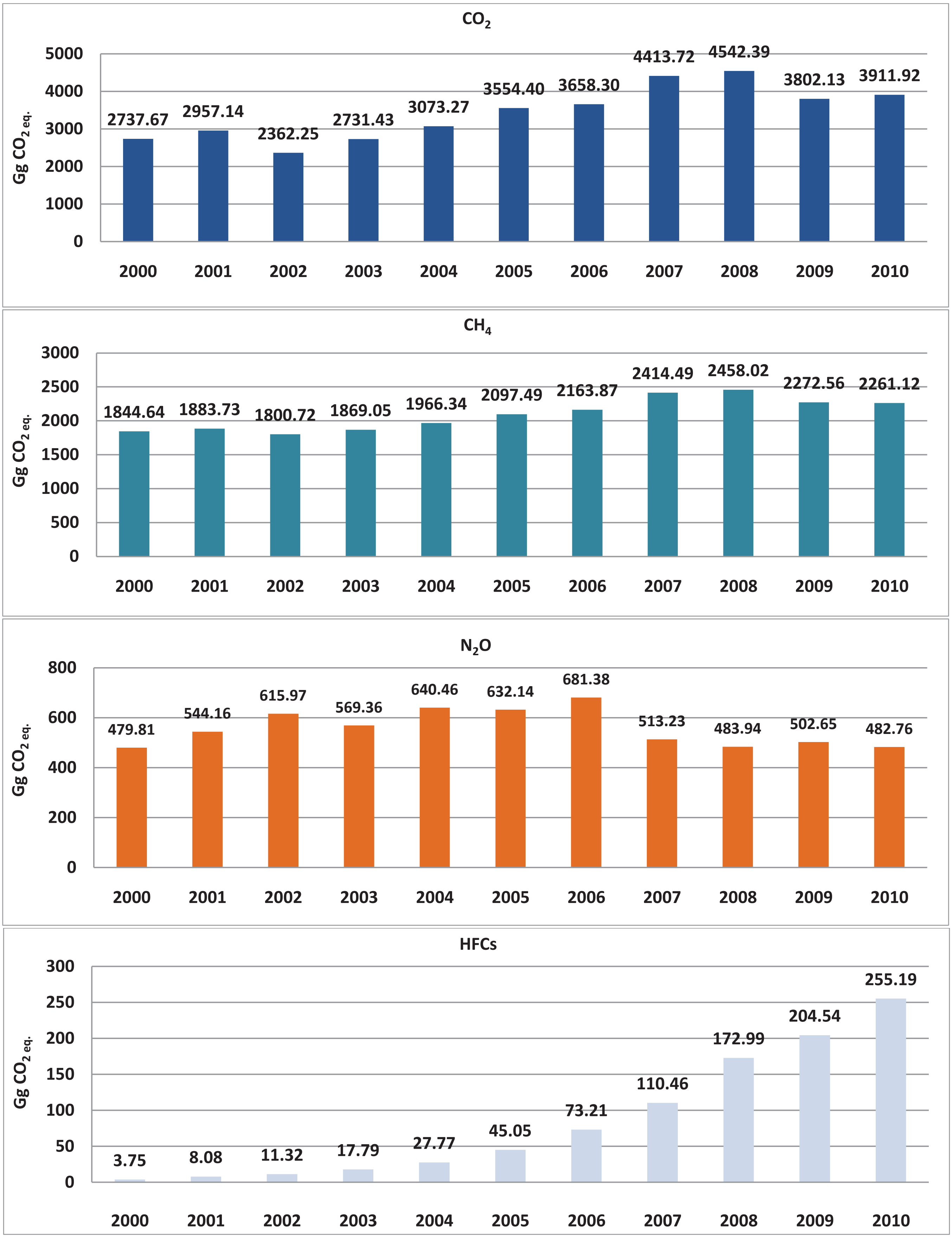

Figure 3.2 Emission Time Series by Gases, for 2000 - 2010 (Gg $CO_{2\ eq.}$)

Reduction in CO_2 emissions after 2008 was caused by economic decline.

Reduction in nitrous oxide is resulted by reduction in use of fertilizers. However, there is uncertainty here which is due the fact that during calculation as a result of unavailability of data on annual use of fertilizers it was assumed that fertilizers imported by Armenia was consumed in that particular year.

Economic crisis has caused reduction of CO_2, methane and nitrous oxide emissions for 2009-2010.

Increase in emissions of F-gases for 2000-2009 period is due to HFCs substitutes of ozone layer depleting substances, as well as the use of foams in construction and rapid growth of this sector in Armenia after 2008. Under the pressure of crisis construction growth went slow resulting in stabilization of the growth of F-gases emission.

4. Sectoral inventories

4.1 Energy

4.1.1 Description of the Sector

According to data from the Second GHG Inventory of Armenian for 2000 [Ref2] “Energy” Sector is classified as one of the key sources of emissions. Emissions from this sector accounted for 53% (in 2000) and 68% (in 2010) of the country’s total GHG emissions.

“Energy” Sector in general includes more than 70 categories, over 50 types of fuel (solid, liquid and gas), three tiers of detailed methods emission estimation, 7 types of GHGs (CO_2, CH_4, N_2O, NOx, CO, NMVOCs, SO_2), conversion factors (of calorific value, emission, incomplete combustion).

According to “2006 IPCC Guidelines for Preparation of National GHG Inventories” [Gen-1] the structure of “Energy” Sector on top Tier can be described as follows:

- **1A. Fuel combustion**
- 1A1. Energy industries
- 1A2. Manufacturing industries and construction
- 1A3. Road transportation
- 1A4. Other
- 1A5. Not-specified
- **1B. Fugitive emissions**
- 1B1. Solid fuel
- 1B2. Petroleum products and natural gas
- 1B3. Non-energy production emissions
- **1C. Carbon dioxide transport and storage**
- 1C1. Carbon dioxide transportation
- 1C2. Injection and storage
- 1C3. Other

Each lower Tier subsector is presented by types of activities.

4.1.2 Methodologies for Estimation of “Energy” Sector Emissions

2006 IPCC Manual [Gen1] recommends various Tier methods for GHG NI “Energy” Sector:

- Direct GHG emissions - Tier 1 and 2 methods:
- Tier 1 method for estimation of CO_2 direct emissions,
  - Estimation of CO_2 direct emissions by main emission categories,
  - Estimation of individual non-CO_2 gases (CH_4, N_2O, NO_X, CO, NMVOC) emission by emission categories,
  - Tier 2 method for “Aviation” Subsector in “Transport” category (CO_2, CH_4, N_2O, NO_X, CO, NMVOC, SO_2).
- GHG fugitive emissions- Tier 1, 2 and 3 methods:
  - Estimation of CH_4 fugitive emissions from coal mining,
  - Estimation of CH_4 fugitive emissions from oil and gas mining,
  - Estimation of ozone depleting substances and SO_2 emissions from oil refining.

4.1.2.1 2006 IPCC Tier 1 Reference Approach for Estimation of CO_2 Emissions

The essence of Reference Approach of 2006 IPCC [Gen-1] is briefly characterized as follows: Estimation of CO_2 emissions in GHG NI “Energy” Sector for a specific year is based on the quantity of primary and secondary fossil energy carriers produces, imported, processes and used in the country in such year. Based on the statistical data for total fuel and energy balances in specific year a “Top-down” method is made towards combustion of fuel type and/or subtype and estimation of emissions of CO_2 generation from such fuel. Hence, Reference Approach is called “Top-down” method.

Following are the steps for calculating emissions by Reference Approach. First, combustion volumes of given fossil fuel in subsectors are converted into thermal energy equivalents, then volume of CO_2 gas emitted from combustion is assessed giving an account to the level of fuel incomplete combustion.

Calculations are based on the use of standard factor values offered by IPCC. These are averaged factor values derived for various countries for fossil fuel of various types and subtypes, as follows:

- Minimum calorific value,
- Carbon content,
- Level of incomplete combustion.

At the same time, IPCC encourages the use of corrected values of such quantity in all cases when such corrected values or their calculation methods are available in the country. In such cases complete description of corrections or substantiated reference to original sources shall be a mandatory condition.

It should be noted that CO_2 emissions from combustion of fuel used in the international cargo and passenger transport (International bunker) is deducted from total emissions of CO_2 released from fuel combustion in the specific country. However, according to 2006 IPCC [Gen-1] approach the quantity of CO_2 emissions from bunkers shall be described in a separate list in GHG NI appropriate sector.

4.1.2.2 2006 IPCC Tier 1 Approach for Sectoral approach

2006 IPCC Manual [Gen-1] recommends Sectoral approach for Estimation of direct emissions of non-CO_2 gases. It is a simplified version of “Bottom-up” method. The use of this method assumes that in a specific year not only the fuel and energy balance of the country is known but also volumes of fossil fuels used in different sectors of economy. In other words, for using KSM it is necessary to have relevant information on the use (combustion) of any type of fossil fuel for that specific year in regard to anthropogenic activities in GHG NI “Energy” Sector:

1. Energy production (generation of electric and thermal energy),
2. Manufacturing industries and construction,
3. Transport (including local aviation, Road transportation , railway, local Water-borne Navigation , pipeline transport),
4. Other areas, including: services, residential, agriculture, forestry, fishing industry,
5. Other, not-specified.

From detailed view-point on areas of activities under consideration this method is in middle position between Tier 1 Reference Approach and higher Tier detailed technology methods. In terms of mere calculations, Sectoral method like Tier 1 Reference Approach is based on consecutive use of calorific value factors and GHG emission factors of a specific type of fossil fuel. Contrary to the Reference method, the Tier 1 Sectoral method (bottom-up approach) is based on real fuel consumption data (by types of fuels) reported for the subsectors (subcategories) and provide CO2 emissions both from these subcategories and totalIn addition, use of KSM and more complicated methods is reasonable only in cases where there is access to detailed and reliable statistical data on sectors in the country, e.g. in the form of inter-sectoral and general fuel and energy balances.

4.1.2.3 Selected Methodology for “Energy” Sector

Selection of the methodology for “Energy” sector in GHG NI depends on the issue of access to information on activities and national emission factors. Below is the description of possible key sources of emissions in the Republic of Armenia - numbered as specified by 2006 IPCC Manual [Gen-1]:

1 A Activities related to fuel combustion/burning

1 A 1 Energy production

1 A 1 a Production of electric and thermal energy

i *Condensing thermal power plants:* **Hrazdan Thermal Power Plant (TPP)** unit part has 3 units with 200MW, and 1 with 210MW power generators, **Yerevan TPP** unit part with 2 unit with 150MW power generators [EnRef2].

ii *Thermal power plants:* **Hrazdan TPP** non-unit part that has 2 units with 100MW and 2 units with 50MW power generators, **Unit 5 of Hrazdan TPP** - with 445MW installed capacity, **Yerevan TPP** non-unit part has 5 units with 50MW power generators, **Yerevan TPP** cogeneration unit with 242MW installed capacity unit (YCCTPP). In the country there is **Vanadzor Thermal Power Center**, but it is privatized and out of operation and as part of Vanadzor Chemical Plant it has self-sufficient status. In the country there are also several low capacity cogeneration plants of which we can speak about "Lusakert Biogas Plant" of Lusakert Poultry Farm which runs on biomass; cogeneration plant of "Lous Astgh Sugar" sugar plant, "Armruscogenaration" CJSC, etc. During the Soviet period in Armenia there were 516 boiler houses of various capacity of which 236 were in Yerevan (currently there is no information on small boiler houses under operation).

1 A 1 b No oil is refined in Armenia.

1 A 1 c There is no solid fuel mining in Armenia.

For Armenia fuel oil is the only possible petroleum product used in energy production that is considered as strategic reserve fuel. The entire energy and heat generation is bases on natural gas. Currently, there is a plan of reconstructing one of the existing units at Yerevan TPP to run on coal. Therefore, in estimation of emissions from burning/combustion processes we should take natural gas only.

1 A 1 Manufacturing industries and construction

1 A 1 a Iron and steel production
1 A 1 b Non-metal production
1 A 1 c Chemical industry
1 A 1 d Woodworking and papermaking industry
1 A 1 e Food, beverages, tobacco production
1 A 1 f Non-metal mining
1 A 1 g Transport equipment
1 A 1 h Automobile production
1 A 1 i Mining (except fuel)
1 A 1 j Wood and woodwork
1 A 1 k Construction
1 A 1 l Textile industry and leather production
1 A 1 m Other industries

It should be noted that petroleum products consumed by manufacturing industries and construction are mainly used as fuel for transport and according to the methodology they are classified as consumption in transport sector. In industries natural gas is burnt in furnaces only for generation of thermal energy and some part of it - for heating, with the exception of "Nairit Factory" CJSC where natural gas is used as raw material for some technological processes.

1 A 2 Transport

1 A 2 a Civil aviation

i International air transport (international bunker) is represented by two airports - "Zvartnots" and "Shirak" [EnRef-3].

ii There is no regular domestic passenger and cargo transport in Armenia.

1 A 2 b Road transportation

i Light passenger cars are characterizes as mixed use of foreign and Soviet (CIS) made vehicles [EnRef-4, EnRef-5].

ii Light trucks are characterizes as mixed use of foreign and Soviet (CIS) made vehicles.

iii Heavy trucks and buses are characterizes as mixed use of foreign and Soviet (CIS) made vehicles.
iv Motorcycles are not widely used.
v Emission of exhaust fumes from automobile engines is a very serious problem and needs to be considered. However, in the Republic of Armenia there are no relevant statistical data such emissions.

1 A 2 c Railway transport in Armenia fully runs on electricity and does not generate direct emissions.

1 A 2 d Water-borne Navigation.
i International Water-borne Navigation (bunker) does not exist in Armenia.
ii Domestic Water-borne Navigation is included in 1 A 4 c iii. There is no regular domestic Water-borne Navigation in Armenia. Emissions from fuel combusted by rescue and touristic vessels available on Lake Sevan are indirectly included in emission calculations for imported fuel (Reference Approach).

1 A 2 e Other.
i Pipeline transport includes pipelines.

It should be noted that transport sector is the main user of petroleum products. The mostly consumed petroleum products in Armenia are: gasoline, diesel oil, LPG, aviation gasoline, jet kerosene, as well as liquified natural gas.

1 A 3 Other areas

1 A 3 a Commercial/institutional
1 A 3 b Residential
1 A 3 c Agriculture/forestry/fishing industry
i Permanent/fixed facilities are pumping stations and they all run on electricity, they do not generate direct emissions and are not considered herein [EnRef-6].
ii Non-road vehicles and other machinery (e.g. combined harvesters) are private property and there are no accurate data available on their quantities.
iii There is no regular domestic navigation in the Republic of Armenia.

1 A 4 Other (Not-specified)

1 A 4 a There are no permanent/fixed facilities in this sector.
1 A 4 b Mobile facilities are machinery for transporting construction materials (e.g. tractors, bulldozers, excavators, etc.). Obtaining information of this type is related to difficulties of making enquiries to private companies and receiving answers from them.
1 A 4 c There are no multilateral operations in this sector.

1 B Fugitive emissions of fuel

For conditions of Armenia fugitive emissions in “Energy” is possible to accurately evaluate only for natural gas transmission and distribution systems which is included in indicator 1 B 2 b ii - “Transmission and distribution” of “Natural gas” in “Oil and natural gas”. This also includes emissions from gas delivery systems caused by accidents and planned maintenance activities [EnRef-7]. In future, as a result of commissioning of coal power unit at Yerevan Thermal Power Plant it might be necessary to consider other fugitive emissions from coal transportation, storage and other handling activities. However, at present study of such cases is not a valid issue.

1 C Transport and Storage of carbon dioxide

There is no Transport and Storage of carbon dioxide in Armenia and GHG emissions of this sector is not considered.

Except mandatory Reference Approach the Key Sources Method was also practiced for preparation of “Energy” sector of GHG Inventory given the current condition of data base in Armenia.

4.1.3 Entry data sources for "Energy" Sector

For GHG emissions estimation and Inventories development it is necessary to have quantities of each type of fuel burnt/combusted (fugitive emissions) by each of the categories as described in the previous sector.

Key sources for entry data are as follows:

- National Statistical Service of RA [EnRef-8]
- Public Services Regulatory Commission [EnRef-9]
- State Revenues Committee under the Government of RA[EnRef-10]
- Ministry of Energy and Natural Resources of RA [EnRef-2]
- Ministry of Transport and Communication of RA [EnRef-4]
- Ministry of Agriculture od RA [EnRef-6]
- Police of RA [EnRef-5]
- General Department of Civil Aviation under the Government of RA [EnRef-3]
- "ArmRusGasProm" CJSC [EnRef-7]
- Energy Companies of RA
- Strategy documents adopted by the Government of RA
    - Guideline program for Renewable Energy development in Armenia [EnRef-11]
    - Strategy for Energy Sector Development in General Economy Development of Armenia [EnRef-12]
    - RA National program for Energy Conservation and Renewable Energy [EnRef-13]
    - Action Plan of the Ministry of Energy and Natural Resources of RA defined by the Provisions of National Security Strategy of RA [EnRef-14]
    - Sustainable Development Program [EnRef-15]
    - The Report on The Potential of Enhancing Energy Efficiency and Reduction of Greenhouse Gas Emissions for Transport Sector in Armenia [EnRef-16]
- Publications by International Statistical and Energy Agencies [Gen-5, Gen-6].

4.1.4 Factors uses in calculations

In calculations, in order to present Fuel and Energy Resources (F&ER) in energy units IPCC energy standard conversion factors as described in Table 4.1.1 were used. Calculation of GHG quantities was made for types of FERs as described in Table 4.1.2 by using calorific value and CO_2 emission factors as indicated in said Table.

Table 4.1.1 IPCC Energy Standard Conversion Factors

	TJ	Gcal	mln toe	mln t equivalent fuel	mln BTU	GW/h
TJ	1	238.8	2.388×10^{-5}	3.412×10^{-5}	947.8	0.2778
Gcal	4.1868×10^{-3}	1	10^{-7}	1.4286×10^{-7}	3.968	1.163×10^{-3}
mln toe	4.1868×10^{4}	10^{7}	1	1.4286	3.968×10^{7}	11 630
mln t equivalent fuel	2.9308×10^{4}	7×10^{-6}	0.7	1	2.778×10^{7}	8 141.5
mln BTU	1.0551×10^{-3}	0.252	2.52×10^{-8}	3.6×10^{-9}	1	2.931×10^{-4}
GW/h	3.6	860	8.6×10^{-5}	1.228×10^{-4}	3412	1

Table 4.1.2 Factors for Conversion of Real Units of Fuel to Energy and Emission Units

Fuel Type	Heat transfer factor, TJ/thousand t.	Carbon emission factor, ton C/TJ
Gasoline (including aviation gasoline)	44.8	18.9
Jet kerosene	44.59	19.5
Diesel oil	43.33	20.2
Natural gas	33.704 *)	15.3
Liquid gas	47.31	17.2
Lignite	11.9	27.6
Wood	8.689 (TJ/thou. cubic meter) *)	30.5
Manure	11.6	27.3

*) *National (local) values of heat transfer factors are indicated for natural gas and wood using the sources as described in "Collected Entry Data" Section.*

Table 4.1.3 describes non-CO_2 emission (CH_4, N_2O, NO_x, CO, NMVOCs) factors, and Table 4.1.4 shows sulphur content in various types of fuel, sulphur retention in ash for all types of fuel is 10%. Calculation of SO_2 emission factors was based on these facts.In tha purpose of estimation of above mentioned GHG emissions Tier 1 Sectoral Approach was used.

Table 4.1.3 Non CO_2 Emission Factors (kg/TJ)

Area (activity)		CH_4				N_2O				N_2O			
		Coal	Natural gas	Natural gas		Coal	Natural gas	Oil		Coal	Natural gas	Oil	
Energy generation		1	1		3	1.4	0.1		0.6	300	150		200
Construction		10	5		2	1.4	0.1		0.6	300	150		200
	Domestic aviation			Gasoline	Diesel oil			Gasoline	Diesel oil			Gasoline	Diesel oil
Transport	Road		92	33	3.9		3	3.2	3.9		600	600	800
	Railway	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other sectors	Services	10	5	1	10	1.4	0.1		0.6	100	50		100
	Households	300	5		5	1.5	0.1		0.1	100	50		100
	Agriculture	300	5		10	1.4	0.1		0.6	100	50		100
International aviation bunkers					0.5								

		CO				NMVOCs			
		Coal	Natural gas	Oil		Coal	Natural gas	Oil	
Energy generation		20	20		15	5	5		5
Construction		150	30		10	20	5		5
	Domestic aviation			Gasoline	Diesel oil			Gasoline	Diesel oil
Transport	Road		400	8000	1000		5	1500	200
	Railway	NA	NA	NA	NA	NA	NA	NA	NA
Other sectors	Services	2000	50		20	200	5		5
	Households	2000	50		20	200	5		5
	Agriculture	2000	50		20	200	5		5
International aviation bunkers					100				50

Table 4.1.4 Sulphur Content in Various Types of Fuel

Fuel	Sulphur content in fuel*, %
Other bituminous coal	0.5
Crude oil	1.3
Fuel oil	4
Liquid gas	0.3
Jet kerosene	0.05
Gasoline	0.001
Diesel oil	0.001

4.1.5 Collected Entry Data

Data for "Energy" Sector of National GHG Inventory were collected through official inquiries to public institutions and private companies made by the Ministry of Nature Protection, as well as from officially published sources. These data are presented below:

4.1.5.1 Fuel and Energy Resources: General Description

Figure 4.1.1 shows the consumption structure of fuel and energy resources by sectors in 2010 in Armenia, and Figure 4.1.2 shows the same by types of fuel. As we can see, most of the energy was consumed by residential and transportation sectors (30% and 25% respectively). Natural gas accounts for 78.9%, gasoline for 10.8%, and diesel oil for 7.3% (aggregate 97.0%) of the total of consumed energy carriers [EnRef-7, EnRef-10, EnRef-17].

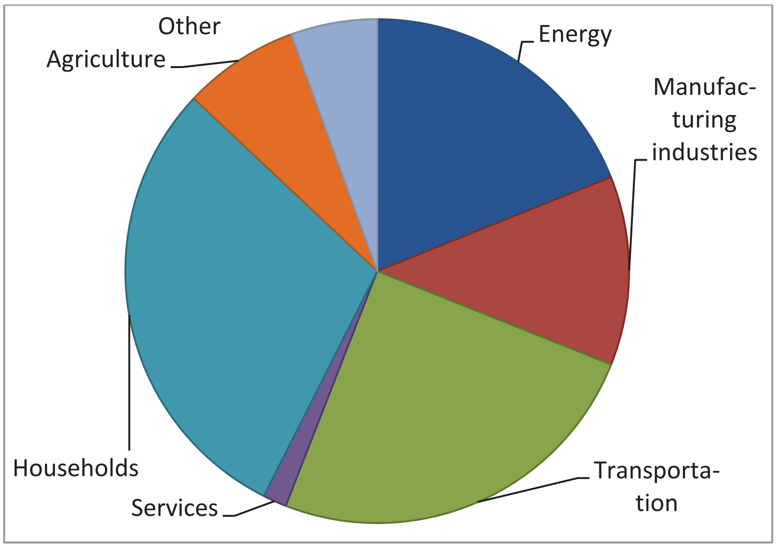

Figure 4.1.1 Consumption Structure for F&ER by Sectors, 2010, (%)

Because of unavailability of data, a similarity approach was applied for making fuel consumption structure by sectors for Inventory series for other years (2007, 2008 and 2009). The previous [Ref-2] 2006 Inventories structure was taken as a basis for 2007 and 2008 see Table 4.1.5. According to the expert assessment, economy development in 2007 and 2008 was in normal pace and was similar to the 2006 structure, and it was used for calculation of required values for 2007 and 2008, see Table 4.1.6. The same approach was practiced for making 2009 fuel consumption structure by using data from 2010, see Table 4.1.7.

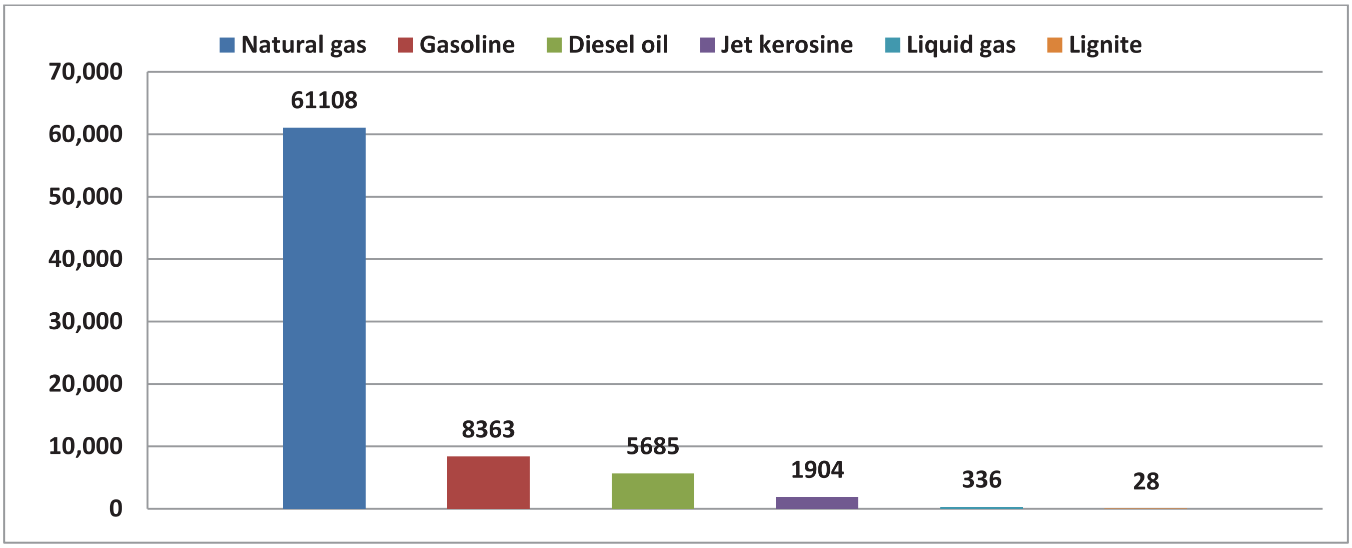

Figure 4.1.2 Consumption Structure for Fossil Fuel by Type, 2010, (TJ)

Table 4.1.5 Structure of Fuel Consumption by Sectors, 2006

Sector/Fuel	Liquid gas	Gasoline	Diesel oil	Coal	Wood
Road transportation	15%	85%	20%	-	-
Households	85%	-	-	100%	100%
Agriculture	-	15%	80%	-	-

Source: GHG Second Inventory, 2010.

Table 4.1.6 Structure of Fuel Consumption by Sectors, 2007 and 2008

Sector/Fuel	Liquid gas, thousand ton	Gasoline, thou. ton	Diesel oil, thou. ton	Coal, thou. ton	Wood, thou. cubic meter
2007					
Total	**11.398**	**169.133**	**121.118**	**2.73**	**47.96**
Road transportation	1.71	143.85	24.25	NO	NO
Households	9.69	NO	NO	2.73	47.96
Agriculture	NO	25.28	96.87	NO	NO
2008					
Total	**8.611**	**198.22**	**129.372**	**2.508**	**51.37**
Road transportation	1.29	168.59	25.90		
Households	7.32			2.51	51.37
Agriculture		29.63	103.47		

Source: GHG Second Inventory.

Table 4.1.7 Structure of Fuel Consumption by Sectors, 2009

Sector/Fuel	Liquid gas	Gasoline	Diesel oil	Coal	Wood
Unit of measurement	thousand ton	th. ton	th. ton	th. ton	th. cubic meter
Total	**7.55**	**183.99**	**118.12**	**0.358**	**60.12**
Road transportation	1.17	156.48	23.58	NO	NO
Households	6.38	NO	NO	0.106	54.65
Agriculture	NO	27.51	94.55	NO	NO
Services	NO	NO	NO	NO	5.47
Manufacturing industries	NO	NO	NO	0.252	NO

**According to 2010 Energy Balances.*

4.1.5.2 Natural Gas

Table 4.1.8 describes data received from the Ministry of Energy and Natural Resources (MENR) on natural gas consumption by sectors [EnRef-20].

Table 4.1.8 Gas Consumption by Sectors (million cubic meters)

Year	2007	2008	2009	2010
Energy	506.9	607.4	366.2	145.3
Compressed Gas filling stations	285.6	343.9	305.6	318.3
Manufacturing Industries	403.6	368.4	259.7	270.8
Public Funded Organizations	44.5	48.3	36.4	32.5
Households	532.2	589.5	553.2	470.9
Other Consumers	96.5	121.4	139.6	124.0
Total	**1869.3**	**2079.0**	**1660.8**	**1361.8**

** MENR*

Table 4.1.9 describes official data on natural gas heat transfer factors [EnRef-21] received from "ArmRusGasProm" CJSC (Figure 4.1.3).

Table 4.1.9 Calorific Values for Natural Gas

Heat transfer factor, kcal/cubic meter	2007	2008	2009	2010
Imported from Russian Federation	8023	8004	8298	8333
Imported from the Islamic Republic of Iran	-	-	8010	7974

** "ArmRusGasProm" CJSC*

Data from "ArmRusGasProm" CJSC is used for calculation of emissions [EnRef-21].

Reference 1 in Annex 2 describes the volume of natural gas imported both from the Russian Federation and, since 2009, from the Islamic Republic of Iran. According to Reference Armenia did not export natural gas to neighbor countries during 2007-2010. Volume of natural gas consumption was used for calculation of GHG emissions. The difference of changes between volumes of gas imported, consumed and stored in underground storages is accounted as the volume of fugitive emissions. However, losses calculated in this manner are 3 times more (2007-113Gg, 2008-111Gg, 2009.-95Gg, 2010-93Gg) than that recognized by the methodology. For that reason volumes of emission are calculated according to fugitive emission factors as recommended by the Methodology [Gen-1], which equals to 0.0005279 Gg CH_4/TJ.

Also, weighted average heat transfer for net natural gas was defined for calculation of 2009-2010 emissions. See summary in Table 4.1.10.

Table 4.1.10 Calculation of Weighted Average Heat Transfer for Natural Gas

Activity/Heat transfer	2009	2010
Imports from RF, million cubic meter	1628.726	1440.144
Imports from IRI, million cubic meter	183.271	325.355
Gas consumed in YCCTPP, million cubic meter	113.837	290.158
Remainder of gas from Iran, million cubic meter	69.434	35.197
Heat transfer factor of Russian gas, TJ/ million cubic meter	34.742	34.889
Heat transfer factor of Iranian gas, TJ/ million cubic meter	33.536	33.386
Heat transfer factor of mixed gas, TJ/ million cubic meter	34.693	34.853
Heat transfer of mixed gas for "Reference Approach", TJ/ million cubic meter	34.620	34.612

4.1.5.3 Solid, Liquid and Gaseous Fuel Energy Resources

Table 4.1.11 summarizes official information on yearly export from and import to Armenian of solid, liquid and gaseous fuels provided by State Revenues Committee of RA (SRC) [EnRef-22]. As Armenia is lack of its own mineral organic fuel and energy resources, processing facilities, as well as large storage capacities for liquid and solid fuel, then it is accepted that all annual remainder of said fuels in the country is fully consumed (with the exception of natural gas).

Table 4.1.11 Import and Export of Energy Carriers by Years, 2007-2010

Fuel type	unit	Imports				Exports			
		2007	2008	2009	2010	2007	2008	2009	2010
Gasoline	ton	169133	198220	183992	188791	-	-	-	-
Diesel oil	ton	121164	129372	118024	132280	46	-	49	69
Jet kerosene	ton	56499	55808	29354	43186	-	-	522	-
Kerosene	ton	-	-	-	-	-	-	-	-
Crude oil	ton	-	-	-	-	-	-	-	-
Coal	ton	2730	2508	358	2324	-	-	-	-
Liquid gas	ton	11398	8611	7547	7757	-	-	-	640
Natural gas (by pipelines)	mln. m^3	2010.8	2276.6	1742.7	1856.9	24.9	31.9	34.6	68.7

** State Revenues Committee*

4.1.5.4 Fuelwood

Although, access to natural gas in Armenia is rather high - 588 of 920 settlements including the city of Yerevan can connect to gas distribution system (http://www.armrusgasprom.am, December, 2013, [EnRef-7]), however the rural population continue to use wood and manure as fuel.

Table 4.1.12 summarizes data received from “Armforest” SNCO on the quantity of harvested fuelwood and brushwood from legal logging and illegal (registered) logging by years [EnRef-18].

Table 4.1.12 Volume of Harvested Wood Products by “Forestry” Branches of “Armforest” SNCO, Brushwood and Illegal Harvesting, 2007-2010 (thousand cubic meters)

Year	Harvested	Brushwood	Illegal harvesting	Total
2007	35.08	9.52	3.36	**47.96**
2008	29.94	13.86	3.70	**47.51**
2009	30.92	23.35	4.04	**58.31**
2010	32.43	19.54	4.39	**56.35**

** “Armforest” SNCO*

Other than woodlands under the control of Armforest SNCO, there are also other forests in Armenia that are classified as Specially Protected Areas of Nature (SPAN) [EnRef-19]. Table 4.1.13 summarizes quantity of harvested by SPAN fuelwood, brushwood from both legal and illegal logging by years.

Average density of fuelwood for Armenia is 0.557 t/ cubic meter. According to IPCC Guidelines the average heat transfer factor of fuelwood is 15.6 TJ/Gg.

Table 4.1.13 Actual Volume of Harvested Wood Products, Brushwood and Illegal Harvesting from SPANs, 2007-2010 (thousand cubic meters)

Year	Actual harvested	Brushwood	Found illegal harvesting	Total
2008	-	-	-	**3.8551**
2009	-	-	-	**1.8117**
2010	1.3897	1.0024	4.5224	**6.9147**

Total volume of forest wood used as fuelwood is derived from the sum of total quantity of wood registered by “Armforest” SNCO and SPANs (Tables 4.1.12 and 4.1.13):

4.1.5.5 Manure

Manure is largely used as fuel in rural areas of Armenia. The quantity of manure exposed to burning was calculated for the respective years based on information received from the Ministry of Agriculture of RA [EnRef6]. According to [EnRef-6] each animal produces 5-6 tons of moist manure (5.5 ton average is taken for calculations), of which 0.98 fraction is dry [EnRef-6], and 0.7 fraction of the latter is used as fuel [EnRef-6]. According to expert assessment about 20% of the total quantity can be exposed to burning as the rest 80% is moisture. Table 14 summarizes annual volumes of manure produces and burned as fuel.

Table 4.1.14 Volume of Manure Produced and Burned, 2007-2010

Year	2007	2008	2009	2010
Cattle livestock population	728898	708957	676051	669717
Annual manure production, ton	4008939	3899264	3718281	3683444
Dry lot, ton	3928760	3821278	3643915	3609775
Used as fuel - moist, ton	2750132	2674895	2550740	2526842
Used as fuel - dry, ton	550026	534979	510148	505368
Total manure exposed to burning, Gg	**550.0**	**535.0**	**510.1**	**505.4**
Total manure exposed to burning, TJ	**6380.3**	**6205.8**	**5917.7**	**5862.3**

Heat transfer factor of manure is 11.6 TJ/Gg which complies with the value for "Other primary solid biomass" as defined in IPCC manual [Gen-1, table 1.2]. It is accepted that manure was fully consumed as fuel by households sector.

4.1.6 Completeness of Collected Entry Data

Data collected for estimation of GHG emissions ensures in general the level of reliable completeness of data which ensures applicability of the reference approach recommended by IPCC Methodology.

At the same time, currently there is no data collection in the country in such a format that would fully ensure completeness and applicability and fully comply with recommendations of the Methodology. There is semi-official information on certain types of fuel that, however, does not cover all requires directions of activities.

Hence, data on biomass and fuelwood consumption are derived from indirect calculations and expert judgment results.

Data on petroleum products is available only in values accounted by customs service on the border check-points of the country. There are no data on further consumption of said products.

The status of information collection on natural gas is fairly good. It includes the complete chain of gas supply system starting from the moment of import to finial consumption by (consolidated) sectors and, among other things, it also includes all types of fugitive emissions and country-specific calorific values of gas. However, this kind of complete information has been made publicly available only since 2011 which does not include the time period under consideration [EnRef-9]. At the same time there is slight deviation between data received from various sources.

Therefore, data publicly available in Armenia for using in calculation of GHG need further correction with relevant public and private sources. However, this kind of approximation of data in some cases requires expert judgment and does not reflect the real situation in the highest accuracy.

4.1.7 Uncertainty of Data

As it was described in Methodology guideline [Gen-1] the accuracy of emission values almost fully depends on the availability of statistical data on fuel supply or combustion. Main uncertainties relate to:

- Degree of statistical consistency in inclusion of all sources,
- Degree of consistency in inclusion of all fuels (both commercial and non-commercial).

At the same time, uncertainty related to emissions factor may occur in two main elements that are: degree of accuracy that measures respective values, and change in source of fuel supply.

Uncertainty of data is not only related to insufficiency of provided data but is also due to the necessity of using averaged data. National information was maximally used in calculations, however, under the conditions of unavailability of sufficient information there was a need to use averaged indicators (for emissions, calorific value, conversion and other factors and indicators) recommended by the Methodology and accepted internationally. As it was indicated in previous sector, data available for estimation of GHG emissions is not sufficient to fully meet requirements of the Methodology format. Certain deviations occur in the process of collection of such data causing serious difficulties in estimating their values.

Therefore, fugitive losses of gas in years 2007-2010 estimated by changes in imported, consumed quantities of gas and quantity of gas stored in underground gas storages accounts for 8.4% in 2007, 7.5% in 2008, 8.0% in 2009 and 8.0% in 2010 respectively.

These values are 3.0-3.4 times greater than those calculated by the Methodology. The method and factor for fugitive emissions (0.0005279 Gg CH_4/TJ) recommended by the Methodology [Gen-1] was used in order to keep time series uninterrupted and smooth.

Hence, uncertainty for fugitive emissions reaches up to 240%.

Data on consumption of manure is based on [EnRef6] recommendation on the population of cattle, averaged factor of moist manure generated by them, dry factor and indicator for the fraction of said manure used as fuel. These indicators are the products derived by assessments made by sector experts and are generalized for the entire territory of Armenia. It is known that regardless the relatively small area Armenia has various climatic zones[1] which result in various indicators for livestock production for different Marzes (regions). Analysis of data published by National Statistical Service of Armenia shows that standard deviation rates for production of livestock products per cattle unit for various years by Marzes vary in the rage of 17-30%. Assuming that this deviation is due to quality and quantity of animal feed[2] we can say that uncertainty level of the quantity[3] of moist manure generated by animals by Marzes will also be up to 30%, and the same will be true for maximum rate of standard deviation for products manufacture.

Uncertainties in consumption of petroleum products are related to capacities of liquid fuel storages owned by large fuel companies. As it was indicated before, in calculations it is assume that all imported petroleum products are consumed during the same year of import. In Armenia there are, however, large importers (“C P S”, “Flash”, “Ran Oil”, “Mika”, “Titan Petrol”, “Max Oil”) who own liquid fuel storages where the quantity of fuel available in year beginning and year ending generate uncertainties in data on consumption of petroleum products. Information on official website of “CPS” company says that the capacity of the company’s storage facilities total to 10,000 cubic meters. Assessment and analysis show that this volume equals to 7.5% of the company’s total imports of fuel. There is no similar information about other companies as such information is considered to be their commercial secret. We can then assume, that uncertainty level for petroleum products consumption data do not exceed 10%.

The information collected on natural gas is rather accurately presented in annual reports [EnRef-7] of “ArmRusGasProm” CJSC. Similar data are also available at PSRC of RA [EnRef-9], Customs Service of the State Revenues Committee of RA [EnRef-10]. Comparative analysis of these data show that deviations rage between 1.0 to 6.5%.

Hence, total weighted average uncertainty rate for “Energy” Sector (without fugitive emissions) is estimated to range between 2.9 to 7.3%.

[1] Armenia lies between latitude of 38° and 42° N and meridians 42° and 43° E. The global border of subtropical and moderate climatic zones usually spread at these latitudes. These two zones, however, do not cover the entire territory of the country as it could be assumed. Because of mountainous relief Armenia has a strongly expressed up-going climatic zonality. There are 8 types of climate: arid subtropical, moderate warm, arid acutely continental, arid continental, moderate continental, moderate, cold and subarctic. (http://hy.wikipedia.org/wiki/Հայաստանի_աշխարհագրություն).

[2] For production of 1 centner of milk a dairy cow needs to eat a certain quantity of feed units. (http://gendocs.ru/v13684/курсовая_работа_-_технология_производства_и_переработки_молока?page=4).

[3] For planning the manure output it is accepted that about half of the dry matter of feed is digested by the animal and the other half turns into manure (http://www.ngpedia.ru/id633851p1.html)

4.1.8 Data Quality Assurance

Quality of collected data are assured by such documents from information providing organizations which are used to make reports on financial and economic performance, tax returns, accounting for country's economic development indicators, etc. This is basically true in regard to natural gas and organic fuel. As it was indicated before, among such organizations are Customs Service of the State Revenues Committee of RA [EnRef-10], National Statistical Service of RA [EnRef-8], Public Services Regulatory Commission of RA [EnRef-9], Ministry of Energy and Natural Resources of RA and other Ministries [EnRef-2, EnRef-4, EnRef-6, EnRef-19], "ArmRusGasProm" CJSC [EnRef-7] and others.

Currently it is a big problem in Armenia to obtain information on solid fuel. The quantity of used fuelwood and manure is still based in part on certain assessments made by sector specialists. For enhancement of credibility and quality of said information there will be a need to collect clear indicators on forestry and livestock production by accounting and monitoring activities conducted through relevant state and rural community governments.

In 2007 there was a significant increase in gas consumption by about 10 PJ against previous year which resulted in sharp increase in time series of emissions.[4]

Furthermore, in 2007 the consumption of biomass increases by about 5 PJ against 2006. This happened as a result of accounting for data on manure exposed to burning which was not available for development of the previous Inventories. At present there are data available on manure generated by cattle during the 1997-2006 period which made it possible to reevaluate the volume of GHG emissions from manure burned over the period of 1997 - 2006. These results are summarized in "Calculation Results for GHG Emissions from Manure for 1997-2006" Subsector.

4.1.9 Data Archiving

All information used for developing "Energy" Sector of GHG National Inventory is collected, numbered and uploaded along with appropriate references in 2006 IPCC software [Gen-7].

Electronic correspondence as well as information obtained from official websites was also collected, sorted and stored in electronic carriers.

4.1.10 Calculation Results

4.1.10.1 Estimation of GHG Emissions: Reference Approach

In Armenia GHG emissions are assessed for 2007-2010. There was no re-estimation of GHG emissions for 2006 and for earlier (until 2000) years as information on said years received from appropriate sources that are in fact official data (see Third National Report [Ref-3]) was not revised by said sources. Consequently, it is accepted that said information was accurate. There were also no changes in emission factors and methodology, and calculation results also need no revision. Corrections have been made only in 1997-2006 volumes of emissions from manure exposed to burning. At the same time, 2000-2006 data were recalculated in order to get time series consistency by using new IPCC software.

Calculations for 2010 GHG emissions based on reference approach are summarized in Table 4.1.15 and Annex 1 summarizes consolidated and calculation tables of "2006 IPCC National Greenhouse Gas Inventories" software report.

[4] http://armrusgasprom.am/images/ARG-2007_ru.pdf

Table 4.1.15 Consumption of Fossil F&ER and CO_2 Emissions (Reference approach), 2010

Fuel type			Obvious consumption (TJ)	Carbon emission factor (t C/TJ)	Actual CO_2 emission (Gg CO_2)
Liquid fossil	Secondary fuel	Gasoline	8363	18.9	579.6
		Jet kerosene	1904	19.5	136.1
		Diesel oil	5685	20.2	421.1
		Liquid gas	336	17.2	21.2
Total liquid fossil			16289	-	1158.1
Solid fossil	Primary fuel	Lignite	28	27.6	2.8
Total solid fossil			28	-	2.8
Gas fossil		Natural gas	61108	15.3	3428.1
Total			**77882**	**-**	**4589.0**

Table 4.1.15 shows that natural gas is the key component in fuels and accounts for 78.9% of F&ER and 74.6% of all GHG emissions. This phenomenon is caused by the increase of natural gas connections in the country during recent years - reaching to more than 90%. It should be noted that large quantities of natural gas is also used by road transportation as a significant part of gasoline driven vehicles are equipped with additional natural gas-fuel devices. Relative structure of CO_2 emissions by types of fuel is described in Figure 4.1.3

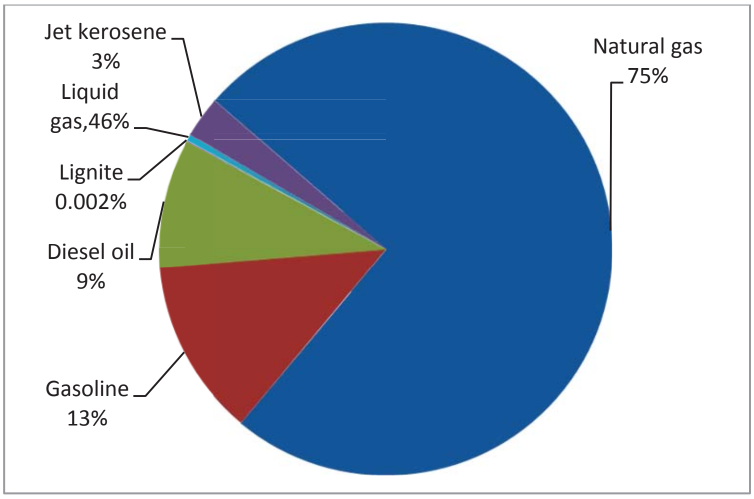

Figure 4.1.3 Relative Structure for CO_2 Emissions by Type of Fuel, 2010

Table 4.1.16 describes volume of CO_2 emissions for 2007-2010 by types of fuel calculated by Reference Approach, which is also summarized in Figure 4.1.4.

Table 4.1.16 Volume of CO_2 Emissions (Reference approach), 2007-2010

Fuel type			Years			
			2007	2008	2009	2010
Liquid fossil	Secondary fuel	Gasoline	519.2	608.5	564.8	579.6
		Jet kerosene	178.1	173.1	90.9	136.1
		Diesel oil	385.7	412.0	375.7	421.1
		Liquid gas	34.0	25.7	22.5	21.2
Total liquid fossil					**1054.0**	**1158.1**
Solid fossil	Primary fuel	Lignite	3.3	3.0	0.4	2.8
Total solid fossil					**0.4**	**2.8**
Gaseous fossil		Natural gas		4238.1	3519.2	3428.1
Total					**4573.7**	**4589.0**

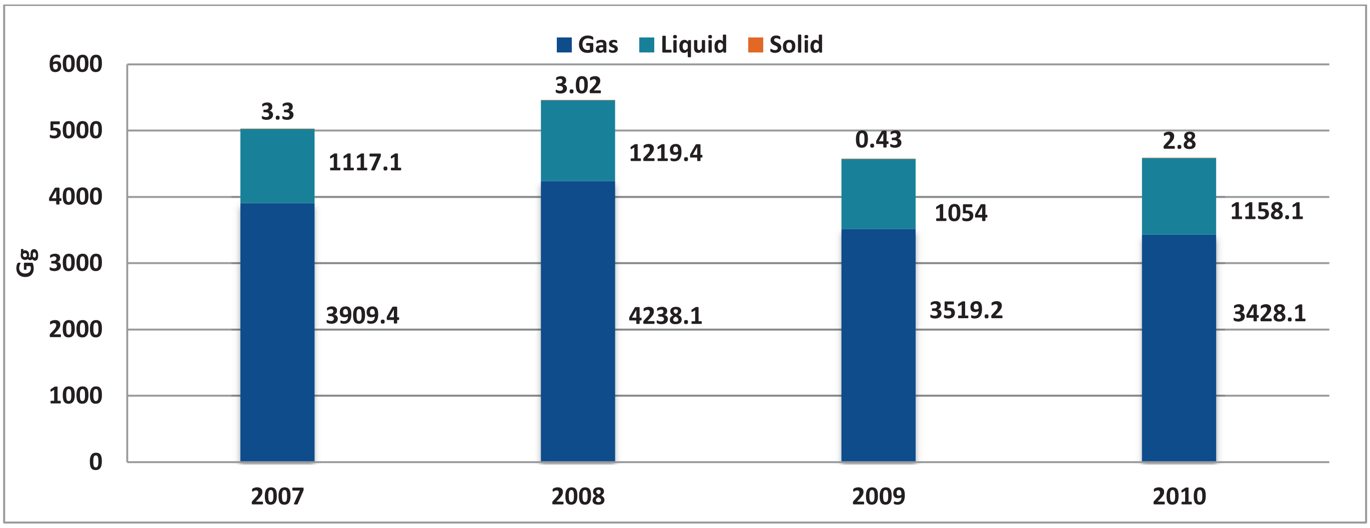

Figure 4.1.4 Emission of CO_2 by F&ER Types, 2007-2010 (Gg)

4.1.10.2 Estimation of GHG Emissions by Sectors

Table 4.1.17 describes annual emissions from key sectors of economy of Armenia of carbon dioxide in real units and calculated by percent of the total of a specific year for the time period of 2007-2010. Calculation results are also summarized in Figure 4.1.5.

Table 4.1.17 Carbon Dioxide Emission Indicators, 2007-2010

Code	Sector	U.M.	2007	2008	2009	2010
1.A.1	Energy production	Gg	955.3	1141.8	926.9	827.5
		%	21.4%	23.0%	21.0%	19.6%
1.A.2	Manufacturing industries/construction	Gg	760.6	692.7	505.8	531.5
		%	17.0%	14.0%	11.5%	12.6%
1.A.3	Transport	Gg	1062.2	1250.5	1153.7	1202.6
		%	23.8%	25.2%	26.2%	28.4%
1.A.4.a	Services	Gg	83.9	90.8	70.9	63.5
		%	1.9%	1.8%	1.6%	1.5%
1.A.4.b	Households	Gg	1035.0	1133.0	1095.9	939.5
		%	23.2%	22.9%	24.8%	22.2%
1.A.4.c	Agriculture	Gg	386.3	420.7	385.7	423.8
		%	8.7%	8.5%	8.7%	10.0%
1.A.5	Not-specified	Gg	181.8	228.3	271.7	242.5
		%	4.1%	4.6%	6.2%	5.7%
Total		**Gg**	**4465.1**	**4957.8**	**4410.6**	**4231.0**

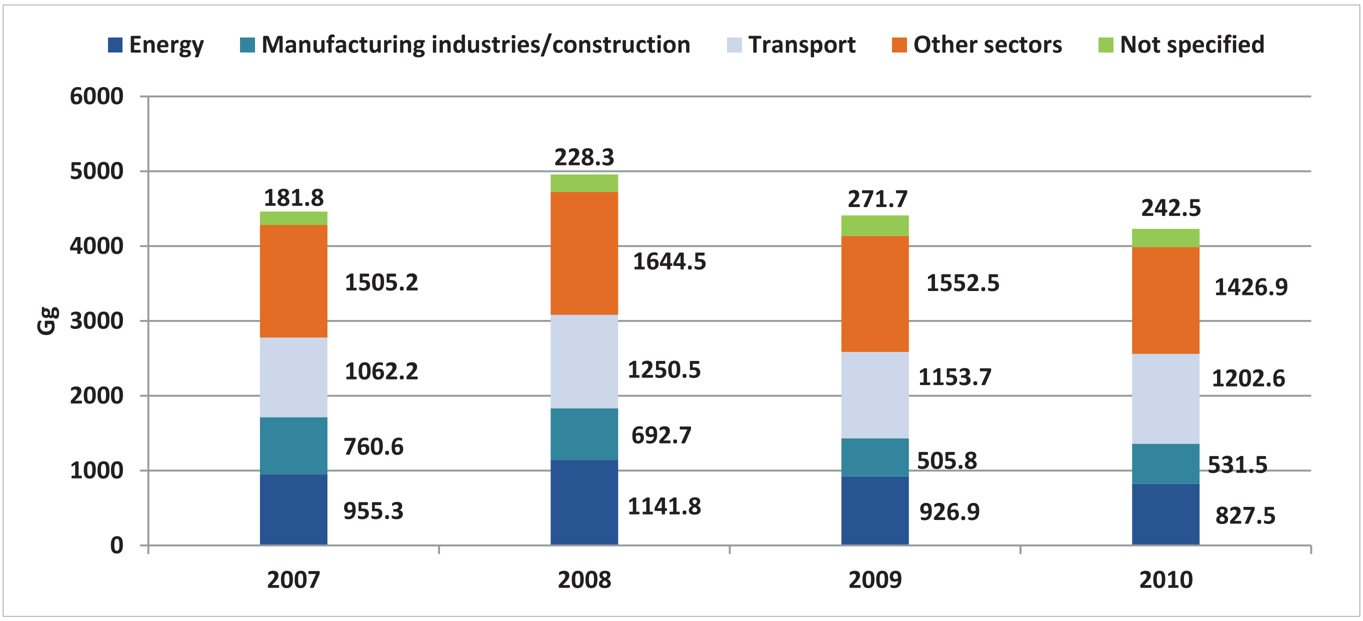

Figure 4.1.5 Structure of CO_2 Emissions by Sectors of Economy of RA, 2007-2010 (Gg)

It should be noted, that the results as indicated above are rather closer to data described in Figure 4.1.1 (2010). There are some differences which, however, come to prove the accuracy of calculations. So, the fraction of fuel consumed by transport totals to 25%, and the fraction of emissions relevant to it is 28.4%. The reason is that along with natural gas the automotive transport also consumes gasoline and diesel oil emission factors of which are greater than that of natural gas - that accounts for 78.9% of the total of all F&ER consumed in the country (Figure 4.1.2). These fractions are similar with the sectors that mainly consume natural gas.

Table 4.1.18 shows main GHG and indirect GHG emissions by sectors.

Table 4.1.18 Volume of GHG Emissions by Sectors, 2007-2010 (Gg)

GHG/sector	2007	2008	2009	2010
CO_2	**4283.3**	**4729.5**	**4139**	**3989**
Energy production	955.3	1141.8	926.9	827.5
Manufacturing industries/construction	760.6	692.7	505.8	531.5
Transport	1062.2	1250.5	1153.7	1202.6
Other sectors	1505.2	1644.5	1552.5	1426.9
CH_4	**3.334**	**3.518**	**3.326**	**3.383**
Energy production	0.017	0.020	0.017	0.015
Manufacturing industries/construction	0.014	0.012	0.009	0.010
Transport	1.102	1.315	1.211	1.263
Other sectors	2.201	2.171	2.089	2.095
N_2O	**0.088**	**0.098**	**0.092**	**0.095**
Energy production	0.002	0.002	0.002	0.002
Manufacturing industries/construction	0.001	0.001	0.001	0.001
Transport	0.053	0.063	0.058	0.061
Other sectors	0.032	0.032	0.031	0.031
NO_X	**17.421**	**18.875**	**16.401**	**17.213**
Energy production	2.554	3.053	2.478	2.213
Manufacturing industries/construction	2.906	1.852	1.449	1.416
Transport	10.414	12.288	11.331	11.831
Other sectors	1.547	1.682	1.143	1.753
CO	**57.932**	**67.499**	**62.365**	**66.784**
Energy production	0.341	0.407	0.33	0.295
Manufacturing industries/construction	0.581	0.370	0.275	0.283

GHG/sector	2007	2008	2009	2010
Transport	55.861	65.472	60.711	62.476
Other sectors	1.149	1.250	1.049	3.730
NMVOCs	**10.128**	**11.790**	**10.892**	**11.514**
Energy production	0.085	0.102	0.083	0.074
Manufacturing industries/construction	0.097	0.062	0.047	0.047
Transport	9.815	11.483	10.654	10.952
Other sectors	0.131	0.143	0.108	0.441
SO_2	**0.206**	**0.199**	**0.166**	**0.189**
Energy production	0.000	0.000	0.000	0.000
Manufacturing industries/construction	0.000	0.000	0.002	0.012
Transport	0.056	0.059	0.054	0.057
Other sectors	0.150	0.140	0.11	0.120

Table 4.1.19 describes the total main GHG (CO_2, CH_4 և N_2O) emissions for 2007-2010 that are also summarized in $CO_{2\ equivalent}$.

Table 4.1.19 Emission of Main GHGs, 2007-2010 (Gg)

GHG	2007	2008	2009	2010
CO_2	4465.1	4957.8	4410.6	4231.0
CH_4	3.350	3.529	3.350	3.382
N_2O	0.089	0.099	0.092	0.094
Total $CO_{2\ eq.}$	**4563.04**	**5062.52**	**4509.45**	**4331.29**

4.1.10.3 Emissions from International Bunkers

International bunkers (international marine and air transport) according to IPCC Methodology are not accounted for in national balances of GHG emissions, nevertheless such information is included in national reports. For Armenia fuel used for international flights from “Zvartnots” and “Shirak” airports are considered as international bunkers [EnRef-3]. Calculations include quantitative data of jet kerosene provided by Customs Service of Armenia [EnRef-22].

Table 4.1.20 describes GHG emissions by types from international bunkers for the time period of 2007-2010, and Figure 4.1.6 graphically describes said emissions expressed in $CO_{2\ eq.}$

Table 4.1.20 GHG Emissions from International Bunkers, 2007-2010

Years	2007	2008	2009	2010
Consumption, TJ	***2491.6***	***2461.1***	***1294.5***	***1904.5***
Emissions, Gg				
CO_2	178.1	176.0	92.6	136.2
CH_4	0.0012	0.0012	0.0006	0.0010
N_2O	0.0050	0.0049	0.0026	0.0038
NOx	0.491	0.738	0.485	0.485
CO	0.164	0.246	0.539	0.539
NMVOC	0.082	0.123	0.325	0.325
SO_2	0.056	0.055	0.029	0.043
$CO_{2\ eq.}$	**179.72**	**177.52**	**93.37**	**137.37**

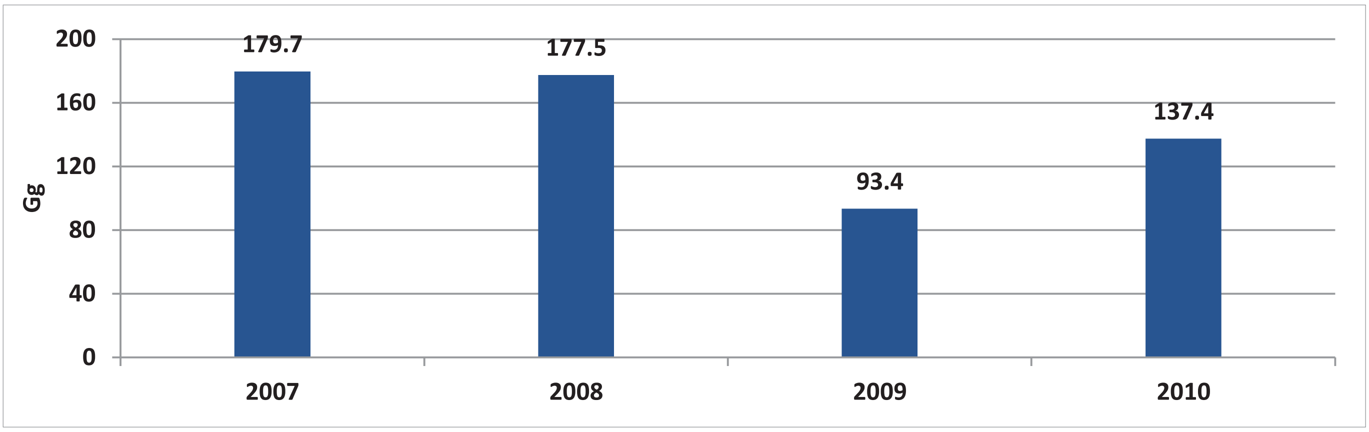

Figure 4.1.6 Emissions from international bunkers, 2007-2010 (Gg $CO_{2\ eq.}$)

4.1.10.4 Emissions from Biomass

Fuelwood and manure were considered as GHG emission source from burning biomass over the period of 2007-2010. According to IPCC Methodology biomass as well as international bunkers are not accounted for in national balances of GHG emissions, nevertheless such information is included in national reports.

Calculations of the volume of emissions released from burning of fuelwood are made on the basis of data from Tables 4.1.12, 4.1.13 and 4.1.14.

Table 4.1.21 describes quantities of fuelwood and manure consumed and emissions of CO_2 released from burning, and same is graphically shown in Figure 4.1.7.

Table 4.1.21 GHG Emissions from Biomass Exposed to Burning, 2007-2010

Years	2007	2008	2009	2010
		Biomass consumption (TJ)		
Fuelwood	416.2	446.3	522.4	499.7
Manure	6380.0	6206.0	5917.1	5862.6
Total	**6796.2**	**6652.3**	**6439.5**	**6362.3**
		CO_2 emissions from biomass (Gg)		
Fuelwood	46.7	49.9	58.5	55.9
Manure	638.0	620.6	591.7	586.3
Total	**684.7**	**670.5**	**650.2**	**642.2**

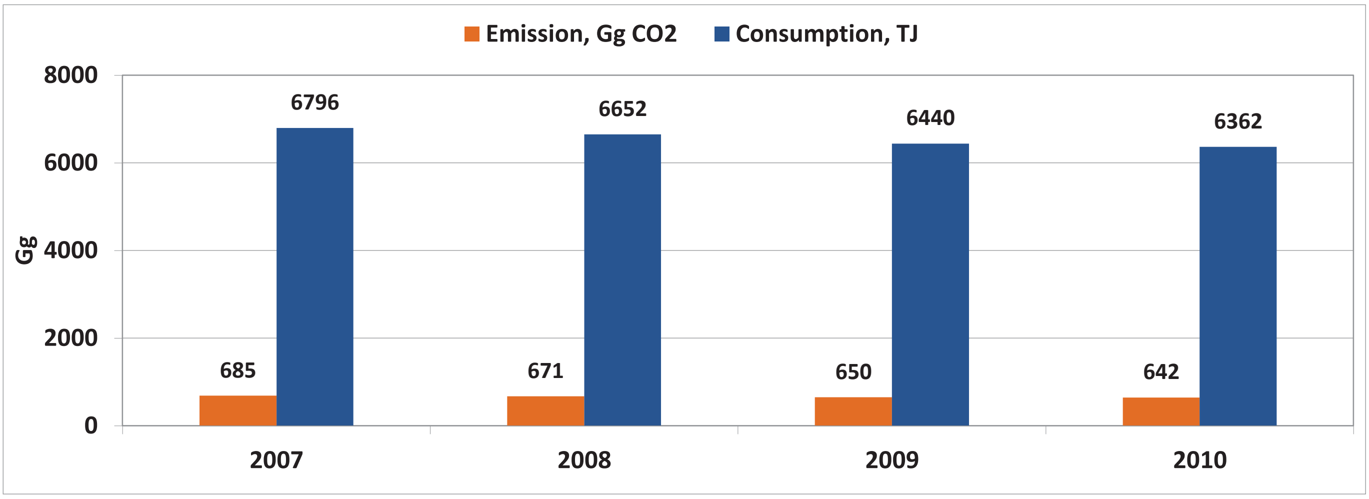

Figure 4.1.7 Quantities (TJ) of Use of Biomass and CO_2 Emissions as a Result of Burning, 2007-2010 (Gg)

4.1.10.5 Fugitive Emissions

In Armenia fugitive emission occur during operation of natural gas delivery system (accidental leakage, emissions as a result of maintenance activities, losses, from gas underground storages). As it was indicated before, emissions are calculated according to calculation method recommended by [Gen-1] Methodology. In this case fugitive emissions are calculated by using the total quantity of transmitted gas by applying 0.0005279 Gg CH_4/TJ emission factor.

For the time period under consideration generic values of fugitive emissions of natural gas are described in Table 4.1.22, and Figure 4.1.8 shows the same in graphical form.

Table 4.1.22 Indicators for Fugitive Emissions, 2007-2010

Years	2007	2008	2009	2010
Natural gas transmission, million cubic meter	2054.3	2254.3	1811.9	1765.0
Fugitive emissions, Gg	36.8	39.8	33.1	32.3

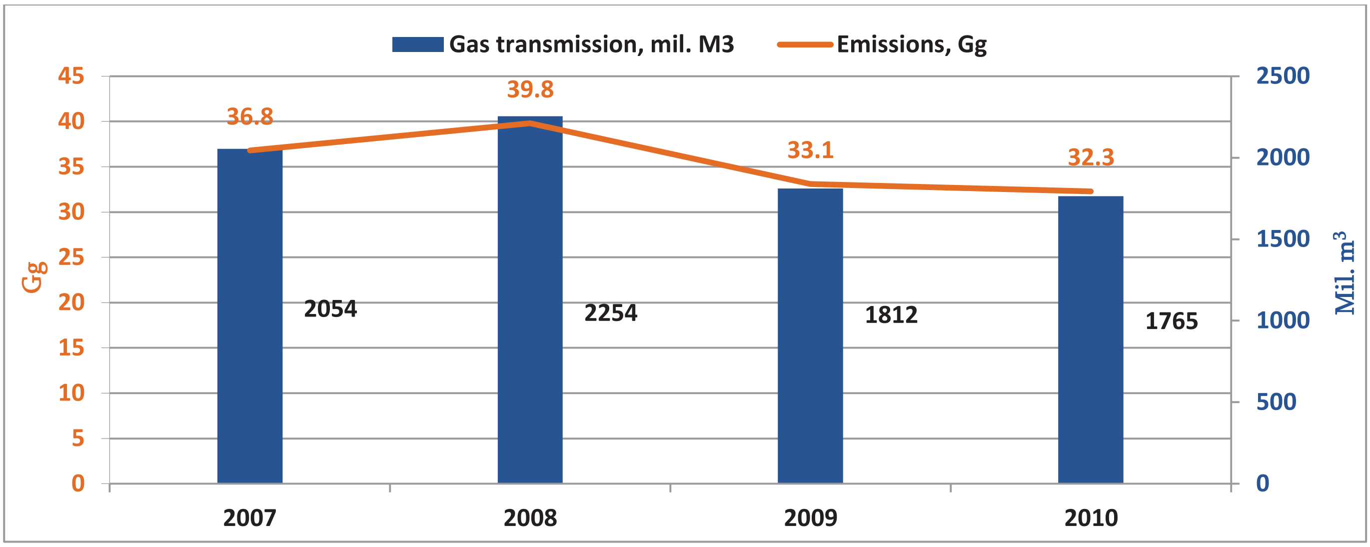

Figure 4.1.8 Generic Values of Fugitive Emissions of Natural Gas, for 2007-2010

4.1.11 2000-2010 Series of GHG Emissions for "Energy" Sector

Figure 4.1.9 graphically shows 2000-2010 series of aggregate GHG emission values and their breakdown by sectors, and Table 4.1.23 shows the same in numerical values.

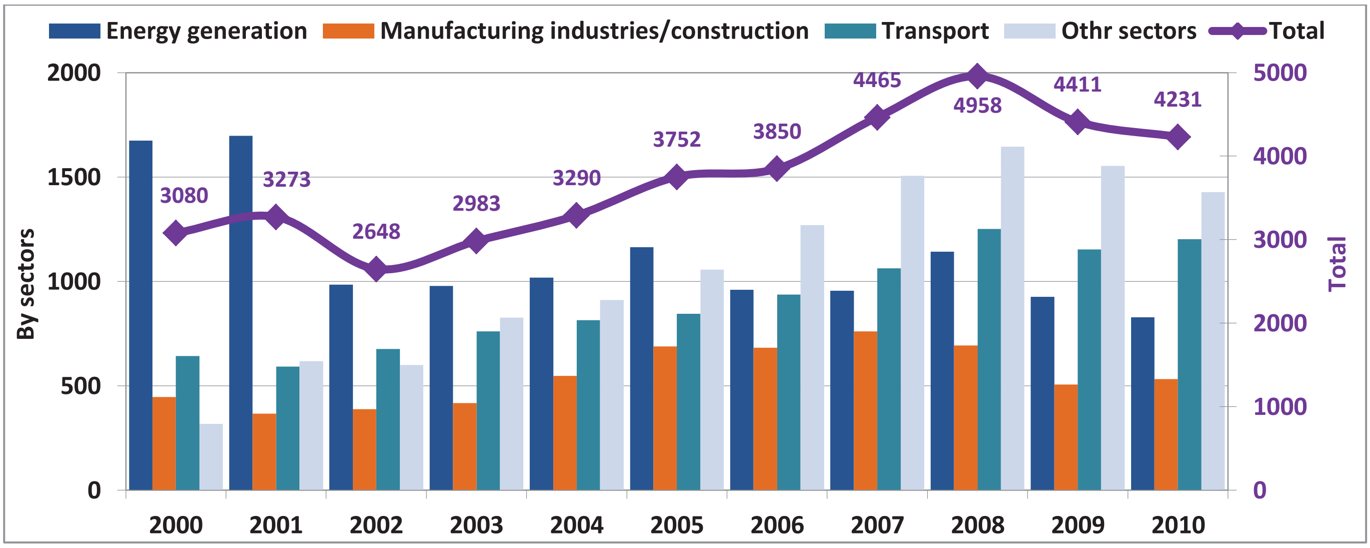

Figure 4.1.9 CO_2 Emission Series, 2000 - 2010 (Gg)

As we can see from calculation results there was a significant increase in emissions in 2007 against 2008, and in 2006 - against 2007. Main reasons for this phenomenon are elaborated below.

In 2007 and 2008 according to "ArmRusGasProm" annual report (www.armrusgasprom.am) there was unprecedented increase in new gas connections in the territory of Armenia which resulted in sharp increase of natural gas consumption particularly by households: in 2007 it increased by 32.3% against 2006, and there was additional 11.2% increase in 2008.

There was also fairly high increase in transport sector. According to official data from Customs Service of RA (www.customs.am) the import of vehicles into Armenia in 2007 was increased by 32.6% compared with the previous year and there was additional 20.9% increase against 2007 which boosted the consumption of natural gas and other petroleum products.

Table 4.1.23 CO_2 Emissions by Areas of "Energy" Sector, 2000-2010 (Gg)

Sector/ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total	**3079.8**	**3272.7**	**2648.3**	**2982.9**	**3290.4**	**3752.3**	**3850.1**	**4465.1**	**4957.8**	**4410.6**	**4231.0**
Energy production	1673.6	1696.8	985.1	978.3	1018.6	1163.1	960.0	955.3	1141.8	926.9	827.5
Manufacturing industries/construction	446.6	366.4	388.2	417.2	547.0	688.9	682.7	760.6	692.7	505.8	531.5
Transport	642.1	591.4	676.0	760.9	813.6	844.2	937.5	1062.2	1250.5	1153.7	1202.6
Other sectors	317.5	618.1	599.0	826.6	911.3	1056.1	1269.9	1505.2	1644.5	1552.5	1426.9
Services	*39.7*	*90.4*	*84.7*	*141.1*	*73.8*	*35.9*	*109.4*	*83.9*	*90.8*	*70.9*	*63.5*
Households	*195.9*	*208.6*	*198.8*	*335.8*	*470.2*	*637.5*	*795.4*	*1035.0*	*1133.0*	*1095.9*	*939.5*
Agriculture	*81.9*	*319.0*	*315.5*	*349.7*	*367.3*	*382.7*	*365.2*	*386.3*	*420.7*	*385.7*	*423.8*
Not-specified	-	-	-	-	-	-	-	181.8*	228.3*	271.7*	242.5*
International bunkers	**90.5**	**121.0**	**117.9**	**94.8**	**110.0**	**111.7**	**115.8**	**178.1**	**176.0**	**92.6**	**136.2**
International air transport	*90.5*	*121.0*	*117.9*	*94.8*	*110.0*	*111.7*	*115.8*	*178.1*	*176.0*	*92.6*	*136.2*

) Clarification:** *In 2007there was a need to us "Not-specified" row in Table 4.1.23 which include only data on natural gas. This is due to the changes in the format of "ArmRusGasProm" CJSC annual reports on consumption data. For example, until 2006 included the company reported on natural gas consumption by following sectors: **Energy, Manufacturing industries, Households, Compressed gas filling stations**, and **Small and medium businesses**. Since 2007 the company reports on the data by **Energy, Manufacturing industries, Households, Compressed gas filling stations**, **Budget supported organizations and Other sectors.

4.1.12 Calculation Results for CO_2 Emissions from Manure, for 1997-2006

Figure 4.1.10 describes manure burning emission series for 1997- 2006, in Gg $CO_{2\ eq.}$

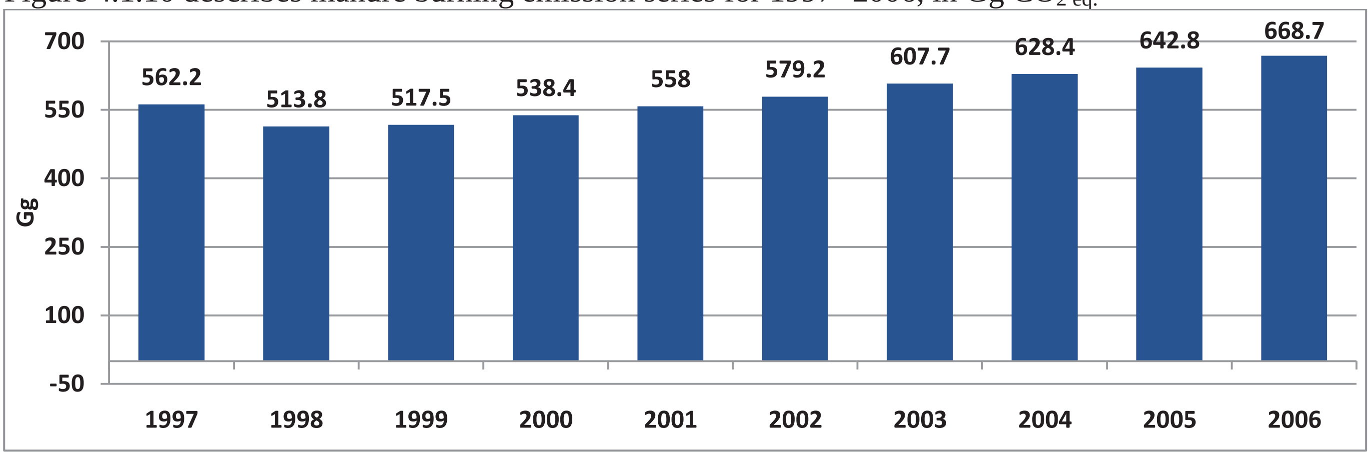

Figure 4.1.10 Manure Burning Emission Series, 1997- 2006 (Gg $CO_{2\ eq.}$)

As it was indicated, calculations of such emissions were not included in previous GHG Inventories and consequently it was impossible to make comparative analysis of derived values. For that purposes estimation of emissions for said years was made by using 2007-2010 calculation principles and by same factors (see “Manure” Subsector).

4.1.13 Classification of Key Sources of GHG Emissions for “Energy” Sector

Table 4.1.24 Key Sources of Emissions of “Energy” Sector, 2010

IPCC code	IPCC category	GHG	2010 Ex,t (Gg $CO_{2\ eq.}$)
1.A.3.b	Road transportation	Carbon dioxide (CO_2)	1202.622
1.A.4	Other sectors - gaseous fuels	Carbon dioxide (CO_2)	984.302
1.A.1	Energy industries - gaseous fuels	Carbon dioxide (CO_2)	827.518
1.B.2.b	Natural gas	Methane (CH_4)	677.426
1.A.2	Manufacturing industries and construction - gaseous fuels	Carbon dioxide (CO_2)	529.553
1.A.4	Other sectors - liquid fuel	Carbon dioxide (CO_2)	441.799
1.A.5	Not-specified - gaseous fuels	Carbon dioxide (CO_2)	242.451
1.A.4	Other sectors - biomass	Methane (CH_4)	40.398
1.A.3.b	Road transportation	Methane (CH_4)	26.522
1.A.3.b	Road transportation	Nitrous oxide (N_2O)	18.748
1.B.1	Solid fuels	Methane (CH_4)	14.700
1.A.4	Other sectors - biomass	Nitrous oxide (N_2O)	7.951
1.A.2	Manufacturing industries and construction - solid fuels	Carbon dioxide (CO_2)	1.969
1.A.4	Other sectors - gaseous fuels	Methane (CH_4)	1.842
1.A.4	Other sectors - liquid fuels	Methane (CH_4)	1.248
1.A.4	Other sectors - liquid fuels	Nitrous oxide (N_2O)	1.088
1.A.4	Other sectors - solid fuels	Carbon dioxide (CO_2)	0.825
1.A.4	Other sectors - gaseous fuels	Nitrous oxide (N_2O)	0.544
1.A.1	Energy industries - gaseous fuels	Nitrous oxide (N_2O)	0.457
1.A.5	Not-specified - gaseous fuels	Methane (CH_4)	0.454
1.A.1	Energy areas - gaseous fuels	Methane (CH_4)	0.310
1.A.2	Manufacturing industries and construction - gaseous fuels	Nitrous oxide (N_2O)	0.293
1.A.2	Manufacturing industries and construction - gaseous fuels	Methane (CH_4)	0.198
1.A.5	Not-specified - gaseous fuels	Nitrous oxide (N_2O)	0.134
1.B.2.b	Natural gas	Carbon dioxide (CO_2)	0.088
1.A.4	Other sectors - solid fuels	Methane (CH_4)	0.051
1.A.2	Manufacturing industries and construction - solid fuels	Nitrous oxide (N_2O)	0.009
1.A.2	Manufacturing industries and construction - solid fuels	Methane (CH_4)	0.004
1.A.4	Other sectors - solid fuel	Nitrous oxide (N_2O)	0.004

4.2 Industrial Processes and Product Use

4.2.1 Description of the Sector

"Industrial Processes and Product Use" (IPPU) Sector of the National GHG Inventory of Armenia includes the following emission source subcategories:

- Mineral industry (2A), which considers:
  - Cement production (2A1),
- Metal production (2C), which considers:
  - Ferro-alloy production (2C2),
  - Copper production (2C7),
- Non-energy products from fuel and use of Solvents (2D), which considers:
  - Use of solvents (2D3),
  - Bitumen asphalt production and use (2D4),
- Use of ozone layer depleting substances (2F),
- Production and use of other substances (2H), which considers:
  - Food and alcoholic beverage production (2H2).

All other sources indicated in 2006 IPCC Guidelines [Gen-1] for IPPU Sector do not exist in Armenia and are not considered in this Inventory.

GHGs released from combustion of fuel are not included here either. They are covered in "Energy" Sector.

There are no manufacturing industries in Armenia where it is difficult to separate emissions released from fuel use and technological processes (e.g. iron and steel production).

4.2.2 Key Categories

For this sector, cement production (2A1), and refrigeration and air-conditioning (2F1) are key sources of GHG (carbon dioxide and HFCs respectively) emissions in Armenia. Emissions of carbon dioxide from cement production account for country's 2.8% of GHG emissions in $CO_{2\ equivalent}$, and refrigeration and air-conditioning generate 1.4% of HFCs emissions.

4.2.3 Quantitative Review

Emissions from this sector come from:

Mineral industry (cement production) - 225.94 Gg CO_2,

Product use (substances substituting ozone layer depleting substances) - 255.19 Gg $CO_{2\ eq.}$ hydrofluorinated carbons.

In this sector there are also gases with indirect impact, i.e. non-methane volatile organic compounds and sulfurous gas. Their volumes are described in respective Subsectors.

4.2.4. Production of Minerals

Production of minerals in Armenia is represented by cement production.

4.2.4.1 Cement Production

In Armenia cement is produced by two plants: "Mika-Cement" CJSC and "Araratcement" CJSC.

4.2.4.1.1 Selection of Calculation Methodology

Cement production is classified as one of the key sources of GHG. Given this fact, for calculation of carbon dioxide by the software Tier 2 calculation method of 2006 IPCC Guidelines [Gen-1] was applied, and Tier 3 method was applied for correction of results. Tier 3 method requires a number of production specifications and information on raw materials. Calculation results are more precise in this case.

Calculation is based on real data from individual plants (productions) and methodology factors [Gen-1]. Tier 3 calculation allows to include both the key results, as well as factors of cement dust retained and recovered to furnace.

a. Calculation method for emissions of carbon dioxide

Calculations of emissions from carbonate charged into furnace are made by using 2.3. formula (see [Gen-1], vol.3)

$$C0_2 = \Sigma(EF_1 \bullet M_1 \bullet F_1) - M_d \bullet C_d \bullet (1 - F_d) \bullet EF_d + \Sigma(M_k \bullet X_k \bullet EF_k)$$

$C0_2$ = carbon dioxide emissions from cement production, t
EFi = **i** carbonate emission factor, $tC0_2$/t of carbonate (see Methodology, Table 2.1[Gen-1])
Mi = quantity of **i** carbonate consumed in furnace, t
Fi = calcification level of **i** carbonate, fraction[5]
M_d = quantity of cement dust (CD) not recovered into furnace (lost CD), t
C_d = weighted portion of initial carbonate in CD not recovered into furnace, fraction[6]
F_d = calcification level of CD not recovered into furnace[1]
EF_d = the factor of emissions of non-calcified carbonate in CD not recovered into furnace, $tC0_2$/t carbonate[2]
M_κ = quantity of non-fuel κ raw material containing carbon, t[7]
X_κ = the content of total carbon in non-fuel raw materials, fraction[3]
EF_k = emission factor of non-fuel κ carbon containing raw material, t $C0_2$/t carbonate[3].

b. Entry data

A questionnaire for initial date has developed and sent to managers of "Araratcement" CJSC and "Mika-Cement" CJSC. Copies of letters and received data are presented in Annex 2 herein.
Data on productivity, quantity and composition of raw materials used by, as well as on emissions from "Araratcement" CJSC and "Mika-Cement" CJSC plants are described below:

c. "Araratcement" CJSC [IndRef-4]

Table 4.2.1 Number of Product and Main Row Materials, 2006-2011 (in thousand ton)

Year	Annual productivity		Quantity of main raw materials	
	Cement	Clinker	Clay	Lime
2006	425.92	373.34	164.61	630.68
2007	500.08	452.15	212.99	767.49
2008	554.89	509.71	224.60	840.01
2009	347.078	296.44	117.63	463.71
2010	367.33	342.78	129.76	577.76
2011	328.63	270.36	172.16	548.39

Quantity of captured dust in 2011 - 109368 t/year
Dust recovery system efficiency - 99.7 %:
Quantity of dust emission (loss) - 329.1 ton

[5] As actual data are not available we can assume that given the actual temperature in furnace and time-duration of roasting the calcification level of all carbonates in clinker equals to 100%, thus Fi = 1.

[6] As the raw material for cement production is mainly calcium carbonate, we can assume that CD also contains calcium carbonate only. Therefore, we can state that C_d is equivalent to carbonate in the raw material. With same assumption we can state that EF_d is equal to calcium carbonate emission factor.

[7] If heat contribution of non-fuel carbon in total thermal balance of fuel does not exceed 5%, then emissions of non-carbonate carbon can be ignored ($M_\kappa \bullet X_\kappa \bullet EF_k = 0$).

Table 4.2.2 Chemical Composition of Main Row Materials (%)

Chemical component	Raw material	
	Clay	Lime
SiO_2	40.6 - 47.7	1.0 - 4.8
Al_2O_3	12.5 - 14.5	0.8 - 2.6
Fe_2O_3	5.0 - 7.0	0.1 - 0.6
CaO	12.9 - 16.0	50.5 - 53.8
MgO	1.3 - 2.6.	0.2 - 1.5
SO_3	0.07 - 0.55	0.06 - 0.31
Ignition losses	14.0 - 18.4	40.6 - 43.1

d. "Mika-Cement" CJSC [IndRef-5]

Table 4.2.3 Main Row Materials for Cement Production and their Specific Consumption

Raw material	Specific consumption
Marly limestone	0.8
Clay	0.1
Slag, containing iron	0.045
Gypsum	0.08
Lithoid pumice stones (additives)	Up to 0.15

Table 4.2.4 Chemical Composition of Row Materials (%)

Chemical component	Lime	Slag, containing iron	Clay	Gypsum	Pumice stone
CaO	47.68	4.02	5.64	-	2.61
SiO_2	8.83	32.41	57.32	-	70.82
Al_2O_3	2.20	8.29	18.60	-	14.84
Fe_2O_3	0.94	50.41	7.50	-	20.8
MgO	0.71	1.06	2.81	-	0.49
$Na_2O + K_2O$	0.27	1.5	1.94	-	-
SO_3	0.08	0.34	0.16	33.1	0.08
Ignition losses	38.62	-	6.03	-	-

Table 4.2.5 Production of Cement and Clinker by years (thousand ton)

Year	Cement	Clinker
2006	198.7	265.1
2007	221.8	271.1
2008	215.0	219.6
2009	120.2	115.6
2010	120.3	102.8
2011	93.6	69.6

Yearly average of captured dust - 30000 t/year
Dust recovery system efficiency - 97.0 - 98.0 %:

These data can be directly inserted into the formula, however many of them need recalculation or to be used with some provisions.

As we can see from the formula the quantity of used carbonate will be necessary for calculations. Data presented by plants show CaO (Lime) content in main raw materials.

Given that 80-90% of lime in raw materials is carbonated the calculations are made on carbonate basis.

As date from “Araratcement” CJSC and “Mika-Cement” CJSC plants are presented in generic form, data on calcium oxide content are presented in certain range and the calculations have used averaged indicator.

Conversion is made by the following comparison:

CaO (56) ⟶ $CaCO_3$ (100)

Below is an example of calculation of carbonate for “Araratcement” by using 2010 data:

Clay - 129755.0 ton,

- Content of calcium oxide - 12.9 - 16.0 % (14.45 % in average),
- Carbonate = 129755.0 x 0.1445 = 18749.6 ton,

Lime - 577757.0 ton,

- Content of calcium oxide - from 50.5 to 53.8 % (52.15 % in average),
- Carbonate - 577757.0 x 0.5215 = 301300.3 ton

Total calcium oxide -18749.6 + 301300.3 = 320049.9 t/year

Calculated carbonate - 320049.9 x 100/56 = 571517.7 t/year.

Table 4.2.6 Calculated Volume of Carbonate by Years (ton)

Year	Clay	CaO %	CaO	Lime	CaO %	CaO	Total CaO	Total carbonate
2006	164608	14.45	23785.8	630676	52.15	328897.5	352683.3	629791.6
2007	212992	14.45	30777.3	767492	52.15	400247.0	431024.3	769686.3
2008	224599	14.45	32454.5	840013	52.15	438066.8	470521.3	840216.6
2009	117633	14.45	16998.0	463713	52.15	241826.3	258824.3	462186.3
2010	129755	14.45	18749.6	577757	52.15	301300.3	320049.9	571517.7
2011	172156	14.45	24876.5	548385	52.15	285982.8	310859.3	555105.9

For the case of “Mika-Cement” CJSC 4 materials are presented as lime containing raw material. Annual quantity of calcium oxide by years was calculated based on the quantity of said materials and the content of calcium oxide and the results are described in Table 4.2.7.

Table 4.2.7 Annual Volume of Calcium Oxide (ton)

Year	Lime	CaO	Slag	CaO	Clay	CaO	Pumice	CaO	Total CaO
2006	158960	75792.1	8941.5	359.4	19870	1120.7	29805.0	778.0	78050.2
2007	177440	84603.4	9981.0	401.2	22180	1251.0	33270.0	868.3	87123.9
2008	172000	82009.6	9675.0	389.0	21500	1212.6	32250.0	841.7	84452.9
2009	96160	45849.1	5409.0	217.4	12020	678.0	18030.0	470.6	47215.1
2010	96240	45887.2	5413.5	217.6	12030	678.5	18045.0	471.0	47254.3
2011	74880	35702.8	4212.0	169.3	9360	528.0	14040.0	366.4	36766.5

Calculation of carbonate of “Mika-Cement” Plant was conducted in the same manner and results are described in Table 4.2.8.

Table 4.2.8 Calculated Volume of Carbonate (ton)

Year	Volume of lime in all raw materials, ton	Total carbonate, t
2006	78050.2	139375.4
2007	87123.9	155578.4
2008	84452.9	97237.3
2009	47215.1	84312.7
2010	47254.3	84382.7
2011	36766.5	65654.5

Calculation of carbon dioxide emissions

Carbon dioxide emission factors for 2010 are calculated based on initial data, calculation results and above clarifications in regard to formula and the results are described in Table 4.2.9.

Table 4.2.9 Emission Factors for Carbon Dioxide, 2010

Indicators	"Araratcement" CJSC	"Mika-Cement" CJSC
EFi ($tC0_2$/t carbonate)	0.44	0.44
Mi (t)	571517.7	84382.7
Fi (degree)	1	1
M_d (t)	329.1	750.0
C_d (fraction)	1	1
F_d (fraction)	1	1
EF_d (t $C0_2$/t carbonate[2])	1	1
$M_к$ (t)	0	0
$X_к$ (fraction)	0	0
EF_k (t $C0_2$/t carbonate)	0	0
$C0_2$ (t)	251302.0	37103.9

4.2.4.1.2 Time Series and Uncertainty Assessment

Emission of carbon dioxide by years from cement production for both plants was calculated by inserting all data and calculated factors into formula 2.6 ([Gen-1] Vol.3) which sums up the country's total volume. Calculation results are described in Table 4.2.10.

Table 4.2.10 Emissions of Carbon Dioxide from "Araratcement" CJSC and "Mika-Cement" CJSC (thousand ton/year)

Year	"Araratcement" CJSC	"Mika-Cement" CJSC	Total
2006	276.93	61.28	338.21
2007	338.44	68.41	406.85
2008	369.45	42.76	412.21
2009	203.23	37.10	240.33
2010	251.30	37.10	288.40

In the previous GHG Inventories calculation of carbon dioxide emissions from cement production was conducted by using Tier 2 method - based on the quantity of clinker.

For ensuring the consistency of calculations the results of presented calculations are compared with Tier 2 calculation results, and for that reason 2007-2010 calculations are made based on the clinker quantity (Tier 2), which is conducted on the basis of annual clinker quantity and specific factor.

Calculation results are included in Table 4.2.11 below.

Table 4.2.11 Emissions from Clinker Production, by 2010

Year	Volume of clinker produced, thousand ton	Carbon dioxide emissions from cement production, Gg
1990	630.3	319.62
1991	656.7	333.01
1992	164.9	83.62
1993	92	46.65
1994	53	26.88
1995	114	57.81

Year	Volume of clinker produced, thousand ton	Carbon dioxide emissions from cement production, Gg
1996	130	65.923
1997	278	141.00
1998	347	176.00
1999	284	144.00
2000	236	119.70
2001	246	124.70
2002	326	165.30
2003	377.4	191.40
2004	530	268.80
2005	626.5	317.70
2006	638.5	323.80
2007	723.2	366.70
2008	729.3	369.80
2009	412.0	208.90
2010	445.6	225.90

Calculation results for 2007-2010 derived by two methods are described in Table below.

Table 4.2.12 Emissions of Carbon Dioxide from Cement Production, 2007-2010, Calculated by Tier 2 and Tier 3

Year	Carbon dioxide emissions, thousand ton		Ratio
	Tier 2	Tier 3	
2007	366.70	406.85	366.7/406.85 (90.0%)
2008	369.80	412.21	369.8/412.21 (89.7%)
2009	208.90	240.33	208.9/240.33 (86.9%)
2010	225.90	288.40	225.9/288.4 (78.3%)

The comparison of 2007-2010 result show from 10 to 22.6 % of difference, while in 2007-2009 the difference was 10.0-13.1%, and in 2010-21.7%. This difference is due to uneven annual data for clinker and cement, thus quantities of clinker and cement production in 2007-2009 are equal but in 2010 clinker went up by 8.2%, while cement was reduced by 35.8%.

4.2.5 Identification of Sulphur Dioxide National Factors for Nonferrous Metallurgy Production

Main outputs from metal mining in Armenia are metal concentrates (except gold mining).

Fraction of concentrate is exported as a ready product. Fraction of copper concentrate is processed at Alaverdi copper smeltery, and molybdenum concentrate is practically fully used in the Republic of Armenian for ferromolybdenum production.

Calculations of specific factors and emissions of sulphur dioxide (as a gas with indirect greenhouse effect) from copper and ferromolybdenum production were made in this sector.

Given the fact that there is no access to information on industrial processes and technological indicators the calculations are made on the basis of production quantities and sulphur content in the raw material.

There are no appropriate national factors in 2006 IPCC Guidelines and EMEP/CORINAIR methodology for calculation of emissions from copper and ferromolybdenum production. These calculations applied sulphur dioxide calculation methods presented by copper and ferromolybdenum producers.

4.2.5.1 Copper Production

The production of primary copper is practiced only at “Armenia Copper Program” CJSC Alaverdi copper smeltery. The plant uses copper concentrate as a raw material. As a result of thermal treating sulphur content bound in the concentrate is fully transformed into sulphur dioxide. During the process about 4 % of sulphur remains in gas cleaning system along with slag.

$E_{SO2} = \Sigma$ [(B_{conc1} x $P_{S1)}$ + ($B_{conc\ 2}$ x $P_{S\ 2}$) + … + (B_{concn} x P_{sn})] x 0.96 x 2, where:

E_{SO2} - annual emissions of sulphur dioxide, t/year

B_{concn} - sulphur content derived from next batch of concentrate (analysis), ton

P_{sn} - sulphur content in next consignment of concentrate, part (fraction).

Given that the laboratory of “Armenia Copper Program” CJSC Alaverdi copper smeltery conducts analysis in a manner of control tests the average factor of said laboratory analysis is taken as the average sulphur content factor - 33.5% (generic values recorded in “Armenia Copper Program” CJSC Alaverdi copper smeltery laboratory register), or 0.335 part.

Given that the slag retains 4% of sulphur, sulphur dioxide released from the rest of sulphur is emitted and respectively the emission factor is accepted as 0.96, 2 - the factor of transformation of concentrate sulphur into sulphur dioxide.

Generated sulphur dioxide dimensionless factor will be:

$K_{SO2} = P_{s\ ave}$ x 0.96 x 2, where

$P_{s\ ave}$` 0.335

K_{SO2} = 0.335 x 0.96 x 2 = 0.6432

The annual amount of sulphur dioxide will be:

$E_{SO2} = B_{conc.year}$ x K_{SO2}

As information provided by National Statistical Service of RA shows the quantity of produced copper the annual quantity of concentrate used for copper production is estimated by specific factor of copper output. According to data from “Armenia Copper Program” CJSC the output factor equals to 1 ton of copper from 4.5 - 5 tons of concentrate (“Armenia Copper Program” CJSC acceptable marginal emission norms project). We take 1/4.75 as average.

Table 4.2.13 below describes annual quantities of produced copper, copper concentrate used for production and generated sulphur dioxide for 2007-2010.

Table 4.2.13 Annual Quantities of Produced Copper, Used Copper Concentrate, and Generated Sulphur Dioxide, 2007- 2010

Year	Quantity of copper converter, ton	Quantity of copper concentrate, ton	Annual quantity of sulphur dioxide emissions, ton
2006	8791	41757.3	26858.3
2007	6954	33031.5	21245.9
2008	6480	30780.0	19797.7
2009	6858	32575.5	20952.6
2010	7644	36309.0	23353.9

The gas mixture containing sulphur dioxide generated by “Armenia Copper Program” CJSC Alaverdi copper smeltery is emitted into the atmosphere without cleaning.

I should also be noted that the factor calculated by the method above does not depend on the use of cleaning processes.

4.2.5.2 Ferromolybdenum Production

In Armenia ferromolybdenum is produced by 3 plants:

- “Maqur Yerkat Plant” OJSC

- “Armenian Molybdenum Production” LLC
- “Hoktemberyan Ferroalloy Plant” LLC

The latter, however, does not operate regularly and during recent years the plan has not produced any ferromolybdenum.

Sulphur dioxide is released from roasting process of molybdenum concentrate. Uncertainties are due to the following factors:

- The composition of molybdenum concentrate varies in different consignments,
- Technological equipment and technological indicators vary from plant to plant respectively,
- There is significant difference in gas-cleaning levels and effectiveness in these plants.

By analyzing the available data (“Hoktemberyan Ferroalloy Plant” LLC Environmental Assessment Report) we can determine the average sulphur content to be 35%, or 0.35 part.

Oxidization process of molybdenum concentrate is as follows:

$$MoS_2 + 3.5\ O_2 = MoO_3 + 2SO_2 + 228.5\ \text{kkal.}$$

According to same Environmental Assessment Report the residual content of sulphur in ferromolybdenum is 0.1% - which can be ignored, and sulphur in slag is 2-3%, or 2.5% in average. Thus 97.5% or 0.975 part of total sulphur participate in generation of sulphur dioxide.

Based on the chemical formula the mass of sulphur dioxide is the double of sulphur mass, hence emission dimensionless factor will be:

$$K_{so2} = 0.35 \times 0.975 \times 2 = 0.6825$$

As all molybdenum concentrate produced in Armenia is practically used for production of ferromolybdenum, for calculations we can refer to data from NSS of RA [Ref-4] on quantity of molybdenum concentrate production as the quantity of raw material.

Calculation results on annual emissions are described in Table 4.2.14.

Table 4.2.14 Annual Quantities of Concentrate for Ferromolybdenum Production and Emission of Generated Sulphur Dioxide

Year	Quantity of molybdenum concentrate, ton	Quantity of sulphur dioxide emission, ton
2006	8016	5470.9
2007	8422	5748.0
2008	8769	5984.8
2009	8559	5841.5
2010	8583	5857.9

As it is in the case of copper, the quantity of sulphur dioxide emissions from ferromolybdenum production depends on the efficiency of gas-cleaning system. The level of cleaning at mentioned plants vary in the rage from 72 to 88%. The level of cleaning has no effect on emission factor but it has significant effect on the quantity of final emissions.

4.2.6 Non-methane Volatile Organic Compounds (NMVOCs) Calculations

4.2.6.1 Asphalt Pavement

4.2.6.1.1 Description of Source Category

Bitumen is melted for preparation of asphalt mixture which is then shipped to road construction or repair sites and spread on the road surface in hot state. NMVOC emissions occur during these processes.

4.2.6.1.2 Methodology issues

Emission factors for NMVOCs are taken from “Programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe” (EMEP) emission calculation manual (CORINAIR, SNAP 2.A.6) [Gen-8]. The product quantities are taken from RA NSS Yearbook [Ref-4].

The calculation was made by using Tier 1 method given the classification of sources (non-key) and insufficient data.

$E_{pollutant} = AP_{production} \times EF_{pollutant}$, where
$E_{pollutant}$ - annual quantity of emitted substance (NMVOC), ton
$AP_{production}$ - the quantity of used bitumen-asphalt mixture, ton
$EF_{pollutant}$ - specific factor of emission of said substance (NMVOC), 16 g/ton (EPA, 2004).

4.2.6.1.3 Uncertainties

- In most cases asphalt plants in Armenia operate from case to cases. The majority of them do not submit statistical or environmental administrative reports. For that reason all asphalt plants are included in general source of “Asphalt pavement” and are calculated as per quantity of used asphalt (calculation is based on the area of asphalt cover).
- As there is no accurate information on either composition of asphalt mixture or on bitumen content we have used the design data from “Dorozhnik” LLC and “Sisian Asphalt” plants.
- There are no true data on imported bitumen. It can be used in asphalt production or for waterproofing. Given the fact that the quantity of bitumen used in asphalt production significantly exceeds the quantity used for other purposes then calculation herein used the imported bitumen in all.

4.2.6.1.4 Calculation of NMVOCs Emission during Asphalting Works

Table 4.2.15 describes import of bitumen, estimated quantity of asphalt mixture made from it and NMVOCs emissions calculated by using the formula from Subsectors 4.2.6.1.2. Calculation factor is - 64 g/t bitumen, or 16 g/t asphalt mixture (according to Environmental Assessment report from “Dorozhnik” LLC Plant bitumen content may reach up to 25%):

Table 4.2.15 NMVOCs Emissions from the Use of Bitumen

Year	Quantity of bitumen imports, ton	Estimated quantity of asphalt mixture, ton	NMVOCs emission, ton
2006	32519.4	130077.6	2.08
2007	53550.2	214200.8	3.43
2008	40220.3	160881.2	2.57
2009	43307.0	173228.0	2.77
2010	32174.6	128698.4	2.1

4.2.7 Food and Beverages (2H2)

4.2.7.1 Description of Source Category

Non-methane volatile organic compounds are emitted from fermentation during cereal and fruit processing, as well as during meat, margarine, pastry production.

NMVOCs emission factors are taken from EMEP/CORINAIR Manual [Gen-8] and product quantities are taken from RA National Statistical Service Yearbook [Ref-4].

4.2.7.2 Calculation of NMVOCs Emission

NMVOCs emissions from meat, margarine, bread, beer, pastry, wine and cognac production are described in Table 4.2.16. The emission factors are taken from “Programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe" Guidebook (EMEP/ CORINAIR, 1999) [Gen-8]. The quantity of emissions is taken from RA NSS Yearbook [Ref -4].

Table 4.2.16 Production of Bakery Goods and Other Food Products: NMVOC Emission Factors (kg/y)

Product	Emission factors
Meat	0.3
Margarine and hard fats	10
Pastry	1
Bread	8

Table 4.2.17 Production of Alcoholic Drinks: NMVOCs Emission Factors (kg/100 L)

Beverage type	Emission factors
Bear	0.035
Wine	0.08
Cognac/brandy/	3.5

Annual emissions of NMVOCs are presented in Table 4.2.18.

Table 4.2.18 Emission of NMVOCs from Food Production, 1995-2011 (ton)

Year	Meat	Margarine	Pastry	Bread	Bear	Wine	Cognac
1995	0.03	1	3.9	2.4	1.9	7.5	114
1996	9.5	0.6	1.9	3	1	3.8	81
1997	9.6	4	1.5	3	1.8	2.6	137
1998	9.9	2.7	1	3	4.7	1.1	89
1999	10.7	0.5	0.8	2.7	3	3.9	42
2000	12.3	-	3.5	2.4	3	2.9	100
2001	11.5	-	3	2.4	3.5	5.1	176
2002	11.5	-	3.5	2.4	2.5	3.2	212
2003	12.3	-	3.9	2.3	2.6	1.6	248
2004	13	-	4	2.4	3	5	257
2005	13.7	-	4.5	2.4	3.8	5.4	320
2006	16.1	-	7.4	2.4	4.4	3.1	328
2007	16.7	-	9.4	2.4	4	2.9	493
2008	17.9	-	8.6	2.4	3.7	2.7	561
2009	17.3	-	10.0	2.4	3.8	3.4	345
2010	16.3	-	11.5	2.4	5.4	4.1	446

NMVOCs emissions also occur during the use of Solvents. At present IPCC Methodology does not offer recommendations on Inventory methods for emissions of gases with indirect greenhouse effect from the use of Solvents. For that reason we have used "Programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe" (EMEP) emission estimation Guidebook (CORINAIR, 1999 and EMEP/CORINAIR 2009 edition) for emission estimation.

Calculations for NMVOCs emitted from the use of paints are made by using factors (370kg/ton of paint used, 30kg/ton of water-dispersion paints used) from CORINAIR, 1999 Method.

Calculations are based on information on quantity of import and export of paints, provided by RA NSS.

Table 4.2.19 Emission of NMVOCs from Use of Paints, 2000-2011 (ton)

Year	Emissions
2000	920
2001	1170
2002	1445
2003	1720
2004	2479
2005	3578
2006	4258
2007	4178
2008	7579
2009	7343
2010	7647

Emission of NMVOCs from use of Solvents by households is calculated by using the factor (1kg per capita) from CORINAIR 2009 methodology, Table 3-1.

Table 4.2.20 Emission of NMVOCS from Domestic Use of Solvents, 2000-2011 (ton)

Year	Emissions
2000	3803
2001	3802
2002	3213
2003	3210
2004	3212
2005	3216
2006	3219
2007	3222
2008	3230
2009	3238
2010	3249

4.2.8 Emissions of Fluorinated Substitutes for Ozone Layer Depleting Substances (F-gases)

4.2.8.1 Introduction

In Armenia the first Inventory of emissions of fluorinated substitutes for ozone layer depleting substances (F-gases) was made in 2013.

The Inventory was made in compliance with Chapter 7, 2006 IPCC Guidelines ([Gen-1], vol.3). Among F-gases the largely used ones in Armenia are HFCs (use of PFCs is not registered).

HFCs are never manufactured in Armenia. They usually come to Armenia in ready-made substances or products containing the above mentioned gases.

4.2.8.2 Sector Description

The following sources of HFCs use along with their components are considered in Armenia:

- Refrigeration and air-conditioning (2F1). HFCs are used here as cooling agents. Their emissions during 2010 accounted for 96.216% of total $CO_{2\ equivalent}$ emissions from the sector during the given period.

Source components are:

- Home refrigerators,
- Individual commercial refrigerators,
- Small and medium commercial and industrial refrigerating equipment,
- Air-conditioners,

- Refrigerator trucks/cars,
- Air-conditioners in vehicles

Main HFCs considered in this sector are CHF-134a and CHF mixtures - CHF-404A (CHF-125 - 44%, CHF-143a - 52%, CHF-134a - 4%), CHF-407C (CHF-32 - 23%, CHF-125-25%, CHF-134a - 52%), CHF-410A (CHF-32 - 50%, CHF-125 - 50%). HFCs mainly come to substitute previously used CFC-12 and HCFC-22 which is currently phasing-out.

- Aerosols (2F4), where HFCs are used as propellants and solvents.

3.563% of HFCs are emitted from this source.

Source components are:

- MDIs used in medicine for patients with asthma,
- Items for personal care (e.g. hair care items, deodorants),
- Home care items (e.g. air-fresheners, stove and fabric cleaners),
- Aerosol paints.

There are many other cases of the use of aerosols but this report includes only those referred above as there are no reliable data on other cases of use.

The study mainly covers the exclusive use of HFCs as propellant in aerosols. Propellants used in aerosols imported by Armenia are: CHF-134a, CHFea, and CHF-152a. The latters in general come to substitute not only CFC-12 previously used in subsector, but also CFC-11, and sometimes CFC-114 [Gen-9, Gen-10].

- Foam production (2F2) that accounts for 0.156% of total HFCs $CO_{2\ equivalent}$ emissions in 2010.

As a result of activities conducted under GHG NI we could obtain information only on CHF-134a used in production of hard foams. CHF-134a here comes to substitute previously used CFC-11, and currently used HCFC -141b that comes in ready polyol and is used in foam production.

- Fire Protection (2F3) that accounts for 0.066% of total HFCs $CO_{2\ equivalent}$ emissions in 2010. HFCs are used in fire extinguishers and other fire protection systems both as propellants and active agents.

Research conducted by experts has found that of HFCs only CHF-227ea is used in Armenia. It is used only in automatic fire-extinguishing systems. In this subsector HFCs come to substitute halons previously used in fire-extinguishing systems: Halon-1211 - in mobile fire extinguishers, and Halon -1301- in fixed systems.

- *Solvents (non-aerosol).* No use of HFCs in Solvents is found in Armenia.

Probably there is minor use of HFCs in many other sectors but they are not included in this report.
Subsectors in Armenia that use HFCs along with materials containing HFCs are described in the table below.

Table 4.2.21 HFCs Used in Armenia: by Subsectors

HFCs	Refrigeration and air-conditioning	Aerosols (propellants)	Foam production	Fire-fighting
CHF-134a	x	x	x	
CHF -32	x			
CHF -125	x			
CHF -143a	x			
CHF -227ea		x[8]		x
CHF -152a		x		

[8] It is used in DI. It is not included in Gg $CO_{2\ equivalent}$ calculations of CHFs because of minor quantities.

4.2.8.3 Collection of Activity Data

Following are the sources (see Annex 2) of initial data on quantities of CHF emissions: Customs Service of the State Revenues Committee under the Government of RA [IndRef-1], Rescue Service under the Ministry of Emergency Situations of RA [IndRef-3], National Statistical Service of RA[Ref-5], the representative of Armenian Drugs and Medical Technology Agency [Ref-6], a number of sector's other companies and specialists/experts. A partial study of the local market was also conducted. In order to have a good understanding on HFCs use and their quantities in Armenia we have also studied the 2011-2014 National Programs Document [Ref-7] on HCFC substitution".

The next step was to study the "Commodity List of Foreign Economic Activities of the Commonwealth of Independent States", fifth edition [IndRef-2] and "Customs and Enforcement Officers Information Note" 2012 joint publication by UNEP and WCO [Gen-11]. For data collection and calculations we have used Inventory Reports of other countries [Gen-12], a number of IPCC communications and reports relevant to the sector [Gen-9, Gen-10], as well as several sources and materials from the internet [Gen-13].

4.2.8.4 Methodological Issues

The Inventory of F-gases was conducted in compliance with 2006 IPCC Guidelines ([Gen-1], vol.3).

Inventory for all HFCs emission sources, except 2F1, was conducted by using Method 1A. As there are data available for each component level Method 2A was applied for Inventory of emissions from 2F1 sources.

4.2.8.5 Emission Calculation Formulae and Emission Factors Selection

HFCs emissions for Refrigeration and Air Conditioning (RAC) are calculated by using formulae 7.10, 7.11, 7.12, 7.13, 7.14 in Chapter 7 of the above mentioned Guidelines and emission default factors described in Table 7.9 presented in same source [Gen-1]. Calculations for aerosol subsector was made according to formula 7.6 in the same Chapter, for foam production - formula 7.7, and for default factors - Table 7.5 in same source, for fire protection - formula 7.17. In the event of unavailability (in Chapter 7 of the Guidelines) of emission default factors for certain sources the latter was taken from IPCC emission factors database (EFDB) [Gen-14].

Data on calculated emissions were uploaded in the software in order to derive $CO_{2\ equivalent}$ final data.

Given that the software allows to make RAC calculations for only 2 separate components instead 6 components studied by experts, therefore a decision was made to calculate generic factors for annual average emissions of individual substances for 2 components indicated in the program based on expert's calculations (Annex 1).

4.2.8.5.1 Emission Estimation; Time Series

CHG emissions in Gg $CO_{2\ eq.}$ by sources for the reference period are presented in Table 2.

There is sustainable growth in annual emissions for all sources, however growth rate for each source is different. While 2010 indicator of HFCs emission in RAC Subsector is about 358 times more than that in 2000 indictor, then for the case of aerosols it is only about 3 times more. 2010 indicator for HFCs emissions from foam production is almost 11 times more than 2006 indicator of the imported substances, and for the case of fire protection it is about 5 times more than 2004 indicator of imports.

The reason of such growth for RAC is that regardless active discussions and advocacy to use natural cooling agents (mainly ammonium, carbon dioxide and hydrocarbon) as alternative OCSs, HFCs still continue to be considered especially in the developing counties as main substitutes for CFCs and HFCs and regulated by Montreal Protocol.

Table 4.2.22 HFCs Emissions: by Sources, 2000 -2010 (Gg $CO_{2\ eq.}$)

Year	Refrigeration and air-conditioning	Aerosols	Foam production	Fire Protection	Total
2000	0.686	3.060	NA	NA	**3.746**
2001	1.958	6.120	NA	NA	**8.078**
2002	5.053	6.263	NA	NA	**11.316**
2003	10.754	7.038	NA	NA	**17.792**
2004	20.077	7.657	NA	0.035	**27.769**
2005	37.093	7.909	NA	0.045	**45.046**
2006	64.836	8.282	0.036	0.058	**73.213**
2007	101.881	8.432	0.071	0.076	**110.459**
2008	163.473	9.282	0.132	0.099	**172.986**
2009	194.939	9.242	0.231	0.129	**204.540**
2010	245.536	9.092	0.397	0.168	**255.193**

The picture is quite different with regard to aerosols. HFCs substitute only 2% of previously used CFC-12, CFC-11 and sometimes CFC-114. The remaining 98% of demand is met by hydrocarbons, dimethyl ether, carbon dioxide, nitric propellants and alternative non-synthetic substances. Global trends show that here natural cooling agents will gradually come to replace HFCs substitutes.

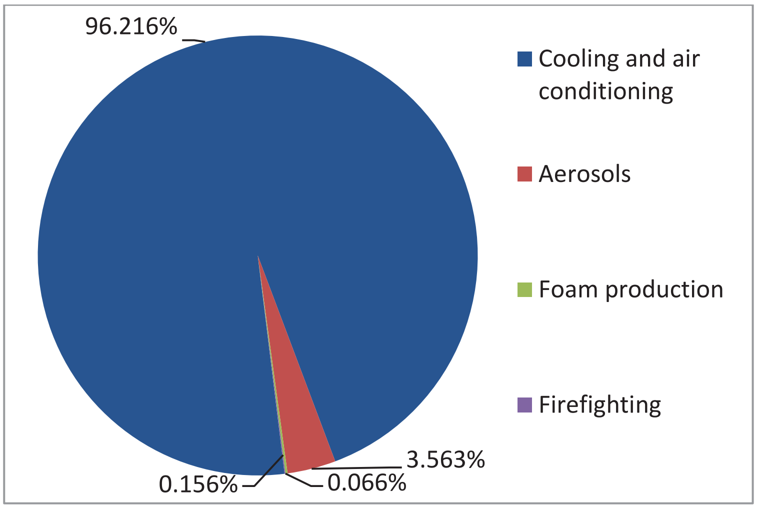

Figure 4.2.1 Breakdown of Total HFCs Emissions by Subsectors, 2010 (Gg $CO_{2\ eq.}$)

The situation with fire protection and foam production is similar. Not only did imports of HFCs in these subsectors start relatively late - in 2004 and 2006 respectively, but they are also not the only OCS substitutes. Natural substances such as hydrocarbons and carbon dioxide are also used as substitutes in foam production; and nitrous oxide, carbon dioxide and pressurized air - in fire protection.

Relatively high emission indicators in all subsectors have been recorded since 2005. This phenomenon is due to measures taken in the country during said time-period aiming at OCS substitute.

HFCs emissions for 2000-2010 and breakdown of 2010 emission by types of gas are described in Figure 4.2.2 and Figure 4.2.3 respectively.

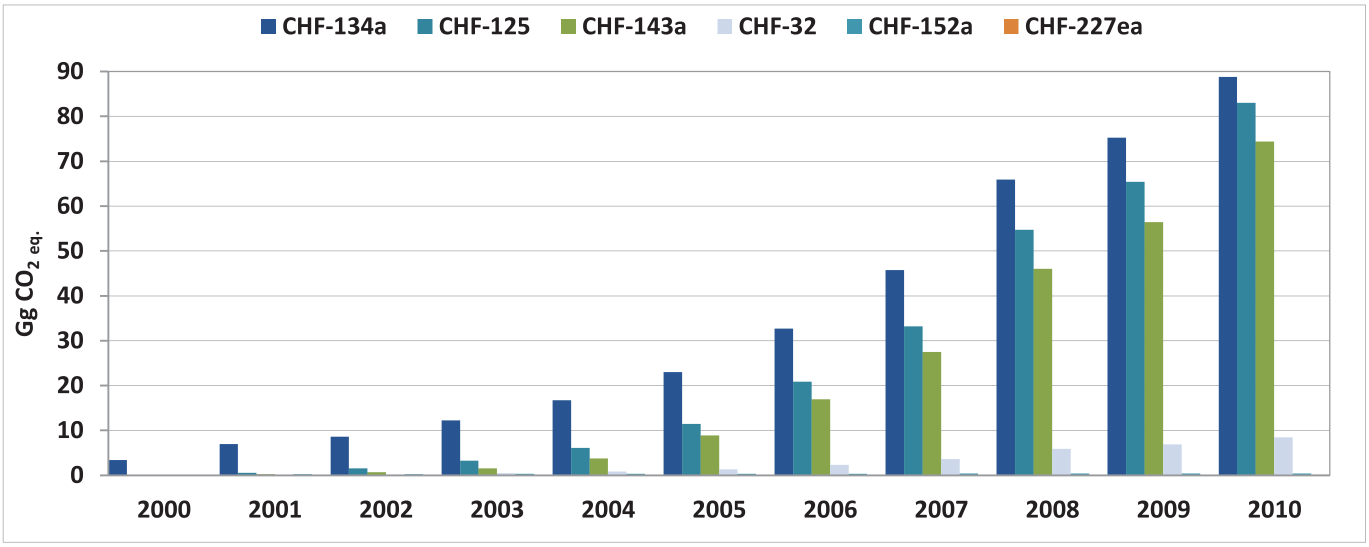

Figure 4.2.2 HFCs Emissions by Types of Gas, 2000-2010 (Gg $CO_{2\ eq.}$)

34.79% fraction of CHF-134a is due to multifunctional use of this substance: it is widely used in all components of CAC (which is the country's CHF key source) both as pure substance and as mixture (R-404A, R-410A, R-407C) component. It also goes in aerosols - as propellant; it is used in foam production - as Foam Blowing Agents. The fractions of CHF-125, CHF-143a և CHF-32 is also due to wide usage of these substances in mixtures for refrigeration and air-conditioning. Insignificant fraction of CHF-152a and CHF-227ea is due to the use of the former in aerosols only, and the latter - only in fire protection.

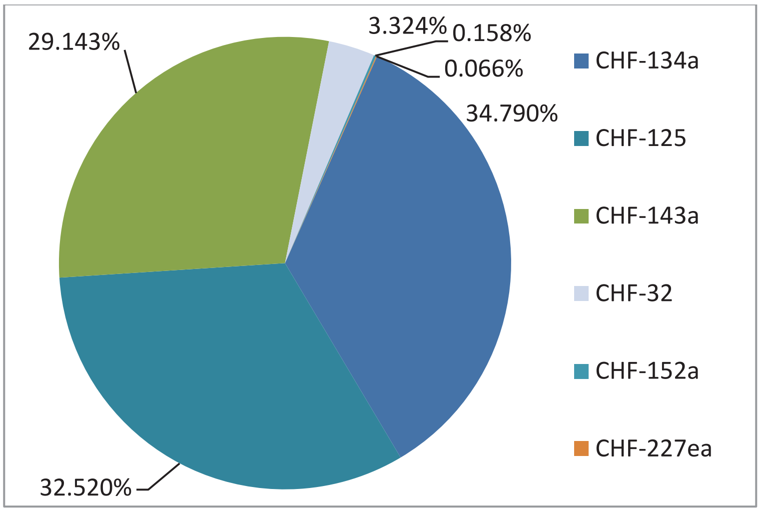

Figure 4.2.3 Breakdown of Total HFCs Emissions by Types of Gas, 2010 (Gg $CO_{2\ eq.}$)

4.2.8.5.2 Completeness of Data

During the data collection for RAC by using Method 2A we succeeded in including almost 70% of data. It was due to availability of relevant database and experience obtained during years. According to expert appraisal 60% of aerosols (including DIs, aerosol items for personal care and domestic detergents, aerosol paints) were included in data collection process. Data collection for foam production is fairly poor. These data have been obtained mostly form country's large foam producers which according to expert appraisal account for only 40% of hard foam market of the country. Thus, completeness of data for this case amounts to 40%. Calculation for Fire Protection subsector was made by using statistical data and according to expert assessment. Completeness of data here amounts to 40%.

4.2.8.6 Uncertainty Assessment

In general, uncertainty assessment for RAC and aerosols subsectors is 30%: 50-60% for foam production subsector; 40% for fire protection subsector.

4.2.8.7 Quality Control and Quality Assurance (QC/QA)

Quality control activities are conducted in compliance with 2006 IPCC Guidelines ([Gen-1], vol.1) are as follows:

Following are the processes implemented for quality control for all sectors:

- checking typos and mechanical errors made in received information,
- checking typos and mechanical errors in entered information,
- checking calculations made for filling in data gaps,
- checking units of measurement, entries of emission factors,
- checking calculations made for F- gases,
- checking continuousness/comparability of time series in regard to changes in calculation methods, emission factors, or in any other parameters,
- checking correctness of entered formulas,
- checking required documentation and references.

Quality assurance was conducted in due diligence. Emission inventories report was reviewed by the expert. The review process was conducted in two phases: firstly - revision of interim versions of emissions calculation package, and then revision of calculations and the text of the Inventory report.

4.2.8.8 Expected Improvements

During further Inventories we are planning to improve data collection process especially for foam production and fire protection subsectors. It will be possible to achieve improvements provided availability of sufficient human and time resources as well as by upgrading calculation methods or development of new methodology.

We are also planning to develop nationally appropriate methodology for data collection in the subsector of “Solvents” which in future will also enable to take Inventories in that subsector as well as to eliminate the existing shortcomings in data collection for all other sectors by correcting data completeness and uncertainties.

4.3 Agriculture, Forestry and Other Land use

4.3.1 Description of the Sector

"Agriculture, Forestry and Other Land Use" (AFOLU) Sector of GHG Inventory of Armenia includes the following subcategories of GHG emission sources.

- Enteric fermentation (3A1),
- Manure/bird excrements collection, storage and handling (3A2),
- Forestlands (3B1),
- Agricultural soils (3B2-6),
- Crop residue burning in fields (3C1),
- Aggregated sources of emissions from soils and non- CO_2 emissions (3C3-3C6):

Other IPCC subcategories ("Rice cultivation" 3C7, "Burning in savannahs", and "Other" 3D) do not exist in Armenia and therefore this report does not consider emissions from said sources.

Livestock production is the most important source of methane emissions. The key sources of methane emission are animal enteric fermentation (the most part of emissions from enteric fermentation in Armenia come from cattle), as well as manure management.

Nitrous oxide emissions are caused by nitrification and de-nitrification processes in soil. Manure storage and handling and fertilization of soils with mineral fertilizers are the key sources of nitrous oxide emissions.

4.3.2 Key Sources

The total quantity of emissions in AFOLU Sector for the year 2010 amounts to 1389.8 Gg $CO_{2\ equivalent}$, which accounts for 19.7% of total emissions (total emissions - 6777.3 Gg $CO_{2\ equivalent}$). Key emission sources in "Agriculture" Sector are:

- Emission from animal "enteric fermentation" is 859.26 Gg $CO_{2\ eq.}$, which is 64.1% of emissions in this sector and accounts for 12.7% of total emissions. Emissions from "Enteric fermentation" are the third in specific weight among key sources in GHG Inventory.
- Indirect N_2O emissions from managed soils amount to 191.2 Gg $CO_{2\ equivalent}$, which accounts for 14.3% of emissions from this sector and 2.3% of total emissions. It is the 11th in specific weight among key sources in 2010 GHG Inventory.

The Table below describes 2010 GHG emissions by key categories in CO_2 equivalents.

Table 4.3.1 GHG Emissions from "Agriculture" Subsector, 2010 (Gg $CO_{2\ eq.}$)

IPCC category code	IPCC category	GHG	2010 Emissions (Gg $CO_{2\ eq.}$)
3.A.1	**Enteric fermentation**	**Methane (CH_4)**	**859.27**
3.B.1.a	**Woodland remaining as woodland**	**Carbon dioxide (CO_2)**	**-552.93**
3.C.4	**Direct N_2O emissions from managed soils**	**Nitrous oxide (N_2O)**	**191.23**
3.C.5	**Indirect N_2O emissions from managed soils**	**Nitrous oxide (N_2O)**	**84.65**
3.A.2	Manure management	Methane (CH_4)	69.38
3.A.2	Manure management	Nitrous oxide (N_2O)	65.93
3.C.6	Indirect N_2O emission from Manure management	Nitrous oxide (N_2O)	49.15
3.B.3.a	Grassland remaining grassland	Carbon dioxide (CO_2)	13.46
3.B.1.b	Land converted to forestland	Carbon dioxide (CO_2)	-4.16
3.C.3	Urea application	Carbon dioxide (CO_2)	0.97
3.C.1	Emissions from biomass burning	Methane (CH_4)	0.89

Emission of methane from livestock production accounts for the greatest part of GHG emissions from agriculture in Armenia.

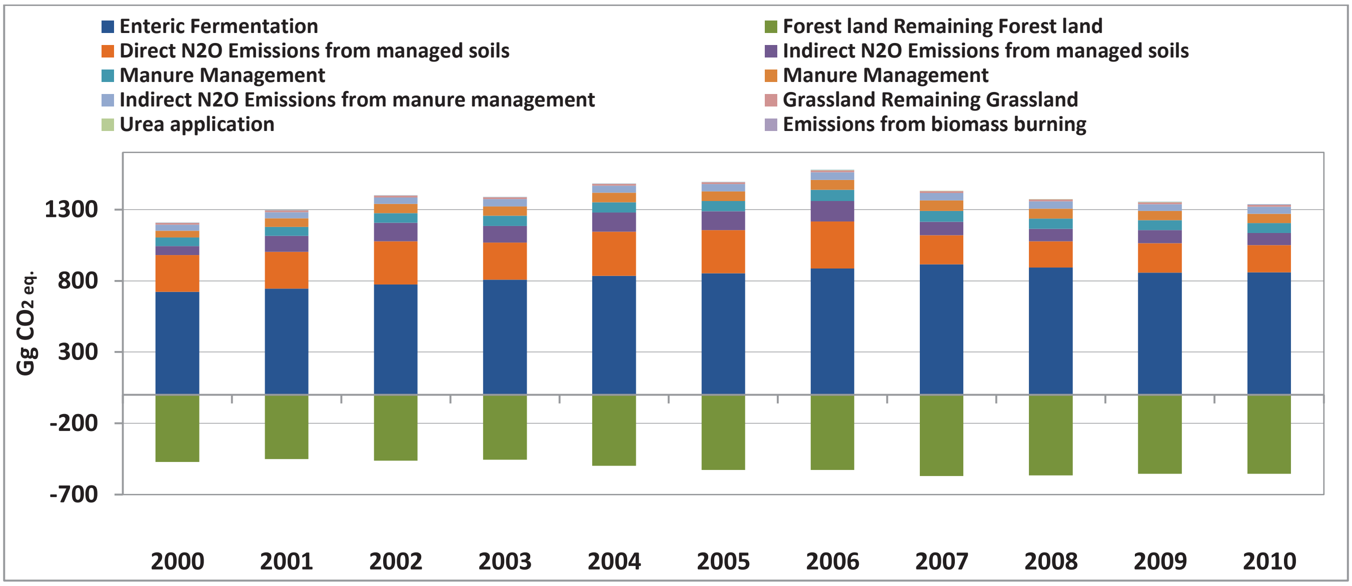

Figure 4.3.1 Emission of GHG from Agriculture of Armenia, 2000- 2010 (Gg $CO_{2\ eq.}$)

4.3.3 Quantitative Review

In 2010 gross agricultural product in Armenia at current prices totaled to AMD 636.7 billion (18.2% of gross domestic product), of which: gross crop production - AMD 392.7 billion; gross animal production - AMD 244.0 billion. The peculiarity of post-Soviet period agriculture of Armenia is that individual farms maintain their dominating position in production of agricultural product. Over the period of 2007-2010 there were 100 commercial organizations operating in the agricultural sector - producing about 3% of total agricultural product. The rest of agricultural product is produced by family farms (about 340 thousand farms in all).

Table 4.3.2 The Structure of Gross Agricultural Products by Economies, 2006-2010 (%)

	Fraction in gross product structure				
	2006	2007	2008	2009	2010
Commercial organizations	2.4	2.9	2.8	3.2	3.0
Family farms	97.6	97.1	97.2	96.8	97.0

Source: NSS of RA, Armenia Statistical Yearbook, 2011, NSS RA, Ye., 2011, page 298-299.

The changes in general economy - peculiar to the entire transition period - have caused certain cyclical shifts in livestock population.

Table 4.3.3 Livestock Population in all Economies[9], as of January 1 (heads)

	2007	2008	2009	2010	2011
Cattle, including:	620197	629146	584779	570633	571357
cows	307080	310610	283048	273854	272572
bulls	16686	17678	18094	16834	18518
Buffalos	527	497	440	455	460
Pigs	151791	86710	84801	112608	114777
Sheep and goats, of which	632894	637101	559218	511029	532515
Sheep	589972	598116	526638	481342	503624
Goats	42922	38985	32580	29687	28891
Horses	12628	11776	11290	10777	10042
Donkeys and mules	6780	6354	5725	4890	3999
Poultry, in thousands	4098.1	4018.2	4188.2	4134.6	3462.5

[9]Agricultire in Armenia, 2006-2010, Satatistical digest, NSS of RA, Ye. 2011, page 126-127. RA Statistical Yearbook, 2011, page 310-313.

Over the period of 1990 -2011 there were significant changes in cattle population. In particular, during last five years the situation obviously tends to return to that of early 1990s when population of caws in total cattle population again stared to go down (see Figure 4.3.1 and 4.3.2). In the event when trends of reduction in cattle population and reduction of cow population in the general structure of cattle persist there will also be essential reduction in emissions from enteric fermentation. Data from 2010 show that cows account for 58.3% of methane emissions from enteric fermentation.

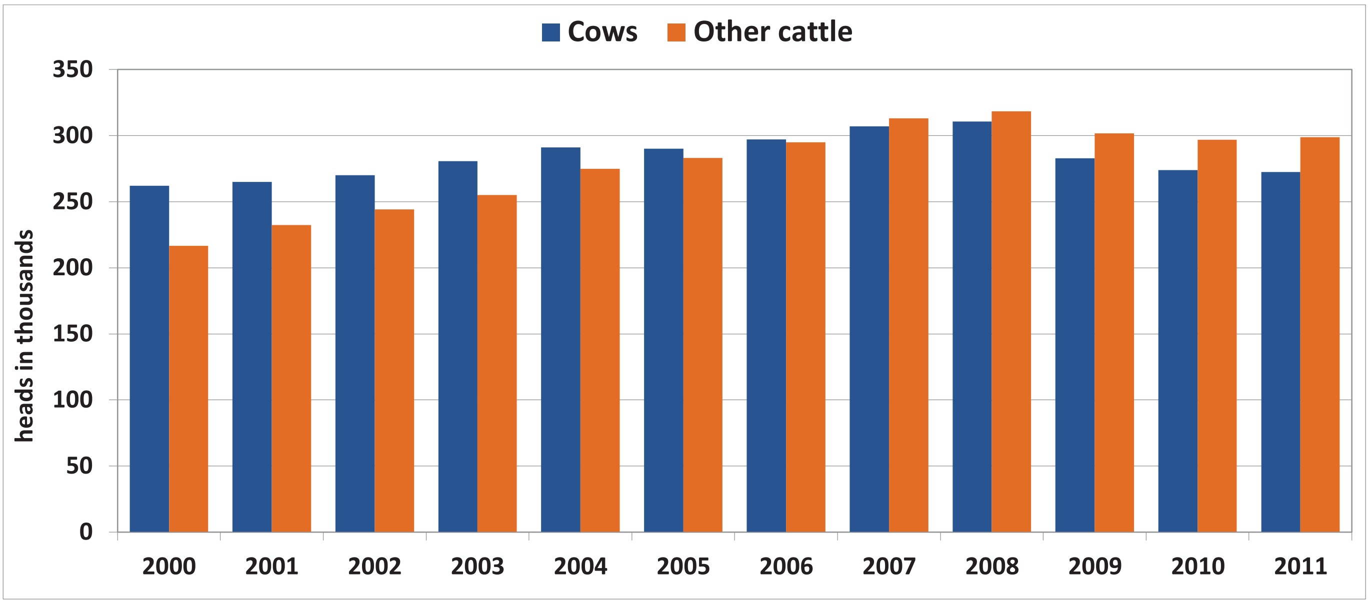

Figure 4.3.2 Cattle Population as of January 1, 2000-2011 (thousand heads)

In 2010 the population of sheep and goats was almost reduced by half compared with year 1990 population. During the transition period, in the general background of reduction of medium horned animal population there was some cyclically fluctuating growth in 2009-2010 which, afterwards, was followed by sustainable decline in population.

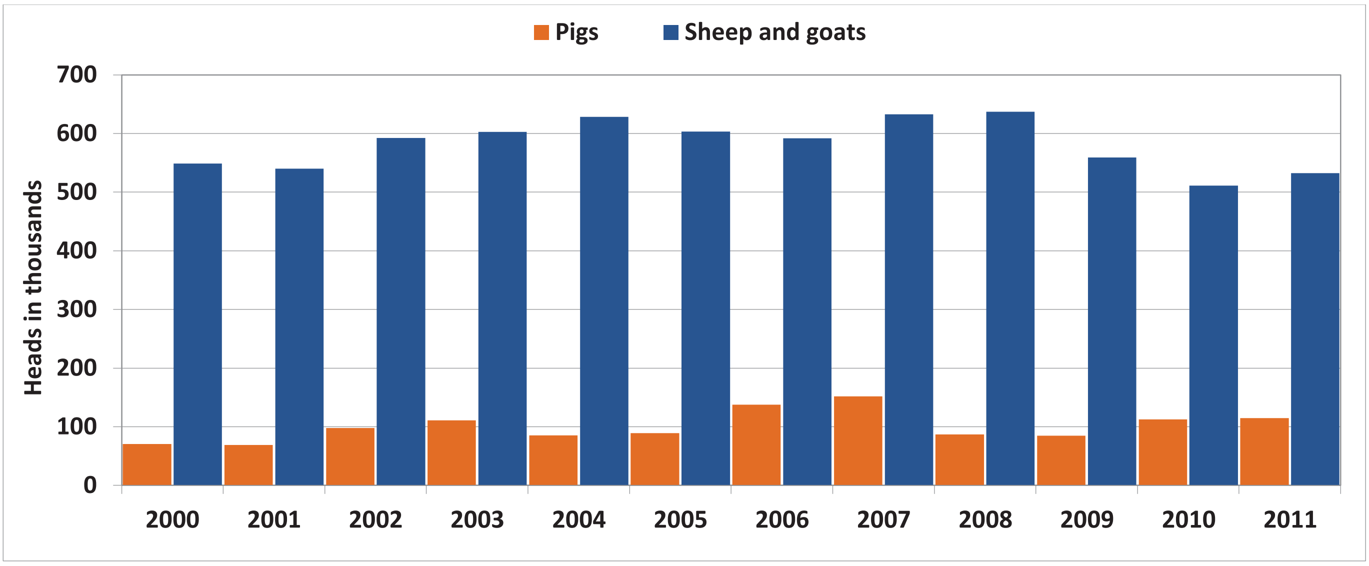

Figure 4.3.3 Population of Sheep, Goats and Pigs as of January 1, for 2000-2011, thousand heads

4.3.4 Emissions From Livestock Production

4.3.4.1 Description of the Sector

“Domestic Animals” in “Agriculture” Subsector of GHG Inventory of Armenia includes the following subcategories of GHG (methane and nitrous oxide) emission sources.

- Enteric fermentation **(3A1)**,

- Manure/bird excrements collection, storage and handling **(3A2),**

This classification and definitions are graphically presented below.

Table 4.3.4 Classification and Definition for Emission Categories

Code	Category	Definition	Gas
3A	Cattle and other domestic animals	Methane and nitrous oxide emissions from enteric fermentation and manure handling	CH_4
3A1	Enteric fermentation		CH_4
3A2	Manure collection, storage and handling		CH_4 N_2O

4.3.4.2 Key Categories

In this sector enteric fermentation is the key source of methane emissions, and in the category of domestic animals most of emissions are released from enteric fermentation of cattle. Due to this fact, it is recommended to calculate methane emission factors for enteric fermentation from this category of animals by using Tier 2 Method, while for other categories of domestic animals it is recommended to apply Tier 1 Method, or Reference Approach.

Manure management is also a source of methane and nitrous oxide emissions and calculation of their factors - as from non-key source - is also conducted by using Reference Approach.

4.3.5 Enteric Fermentation (3A1)

4.3.5.1 Description of Source Category

This category includes emissions from enteric fermentation of cattle, sheep and goats, pigs, horses, donkeys and mules, and buffalos. There are no camels and lamas in Armenia (except those in zoo). Methane emissions from enteric fermentation of poultry are not calculated as IPCC Guidelines do not provide for any recommendation or methodology for calculation of factors or quantities of emission from this category of animals.

4.3.6 Methodology Issues

4.3.6.1 Methodology Used for Emission Calculation

Emission of methane from animal enteric fermentation is calculated in compliance with Tier 1 and Tier 2 methodologies - recommended by 2006 IPCC and previous Guidelines. Methane emissions from cattle as key source was calculated by Tier 2 Methodology based on baseline data specific for cattle in Armenia (calculations are made for both emission factors and emission quantities). Tier 1 Methodology or Reference Approach was applied for calculation of emissions from enteric fermentation of other animals (Calculation by using Reference Approach are done by “IPCC Inventories Software” [Gen 7]). The fraction of emissions from these animals in the total quantity of methane emissions is insignificant.

4.3.6.2 Calculation Methodology of the Number of Animals

According to classification in GHG National Inventories 2006 Guidelines cattle is grouped by the following categories: *3A1-2ai dairy cows and calves raised for milk, and 3A1-2aii non-dairy cattle and calves raised for meat (See Table 4.3.5)* which creates certain difficulties in regard to calculation of animal population. National Statistical Service of RA calculates the number of cattle and publishes information by following cattle groups: “Cattle”, “Cows” and “Bulls”. In other words it is practically impossible to separate calves raised for milk from calves raised for meat.

Table 4.3.5 Classification of Livestock Type by [Gen-1]

3 A1-2 Livestock	
3A1-a Cattle	
3A1-2ai Dairy cows and calves raised for milk	
3A1-2aii Non-dairy cattle and calves raised for meat	
	3A1b Buffalos
	3A1c Sheep
	3A1d Goats
	3A1e Camels
	3A1f Horses
	3A1g Mules and donkeys
	3A1*h* Pigs
	3A1i Poultry
	3A1j Other

Break-down for young animals by the required format would be possible by using data from almost a 100 commercial organizations should animals in said organizations represent any specific weight in the total population of livestock. However, given the insignificant number of animals held in said organizations in the total population of livestock (1.2% in early 2010 and 1.3% by end of the year), extrapolational recalculation would result in great uncertainties and mistakes.

Calculation of young animals was conducted without required format - by simply deducting the number of cows and bulls from the total number of livestock which was provided by NSS of RA.

Table 4.3.6 Cattle Livestock Population in Armenia as of January 1, 2007-2011 (1000 heads[10])

	2007	2008	2009	2010	2011
Cattle, of which	**620.2**	**629.1**	**584.8**	**570.6**	**571.4**
In commercial organizations	*5.3*	*5.2*	*6.2*	*6.6*	*7.2*
In individual farms	*614.9*	*623.9*	*578.6*	*564.0*	*564.2*
Cows, of which	**307.1**	**310.6**	**283.0**	**273.9**	**272.6**
In commercial organizations	*2.2*	*1.8*	*2.4*	*2.4*	*2.5*
In individual farms	*304.9*	*308.8*	*280.6*	*271.5*	*270.1*

The data of this table show that during the reference period the number of cattle kept in commercial organizations account for 0.9-1.3%% of the total, and cows - from 0.7% to 0.9%.

Data on cattle and on other livestock are taken from Yearbooks, Statistical Digest and Reference Books of NSS of RA. Data on the number of bulls, buffalos, donkeys and mules for 2000-2011 is taken from Agriculture Statistics Department of NSS of RA.

Given the reality that official information from NSS of RA on livestock population is published every year as of January 1, therefore the following year's -January 1, 2007 - indicator was used for calculation of 2006 National Inventory. This approach, naturally, does not reflect the annual average population indicator for livestock.

- For the year under consideration there are two figures - as of year beginning and year ending - on the number of livestock. According to recommended methodology for "Emissions from animals and manure collection, storage and handling" Sector instead year-end data the simple arithmetic average of the two figures must be used in National Inventories.
- For calculation of annual average livestock population the Methodological Guidelines for GHG Inventories warn that "Seasonal birth and slaughter during various periods of year may result in increase or reduction in livestock population which will require making respective adjustments in annual livestock population", and the method for recalculation or assessment of population must

[10] Statistical Yearbook of Armenia, 2011,RA NSS, Ye. -2011, page 311.

again be based on national statistical of administrative information and should be duly documented[11].
- Information on exports and imports of animals and meat is ignored in calculation of livestock population.

Moreover, the additional sources of information for adjustment of annual number of livestock, and especially cattle, can be: data published by NSS of RA on the net difference in living weight and slaughter weight of slaughtered animals by types and categories; information from the Ministry of Agriculture of RA, professional literature, entities (e.g. regional agricultural extension centers, national union of farmers) involved in development of methodological guidelines for sector development and analysis, livestock breeders (individual farmers) and butchers (butcheries and stores) on average slaughter weights, birth plans, birth rates, losses and other indicators.

Such recalculation is also important given the fact that the majority of livestock specially produced for meat (calves, lambs under 1 year of age, pigs, poultry) stay alive during a certain period in a year and their number is reflected in neither year-beginning nor in year-ending indicators. In such cases Methodological Guidelines recommend using formulas for calculation of annual average number of livestock. For example, the annual average population of cattle can be calculated by the formula as follows:

$$AAP = (\text{life expectance, day}) \cdot \frac{NAPA}{365}$$, where:

AAP - annual average population,
NAPA - number of animals born during said year[12].

Unfortunately, it is impossible to use this or other formulas (except the one for poultry population sold for meat) as animal population calculation practices in Armenia does not require collection of documented information.

Due to that fact, the method for calculation of average annual population of animals relies on available data and expert assessments by using information from sources as described above.

4.3.6.3 Calculation Methodology for Annual Average Livestock Population

Below is the information on livestock collected and published by RA NSS.

- Livestock population as of January 1 of each year, including those in commercial organizations and individual farms,
- Animals and poultry sold for slaughter, total living weight, in thousand ton,
- Animals and poultry sold for slaughter by slaughter weight, in thousand ton, by main types - including commercial organizations and individual farms ,
- Exports and imports of living animals (quantity, living weight, and price in USD),
- Cow milk yield rate,
- Milk production.

In the context of development of GHG Inventories the most important information for livestock part in “Agriculture” Subsector comes from calculation of possibly complete and reliable data on livestock population which was actually done by categories based on above described information.
Population data as of January 1, 2010 and 2011 as well as data on annual and monthly volumes of animals and poultry sold for slaughter in slaughter weight of meat were used for calculation of year 2010 annual average livestock population.

[11] 2006 IPCC Guidelines for Nationl Greenhouse Gas Inventories, Volume 4, Chapter 10, Emission for Livestock and Manure Management, p. 10.8. Руководящие принципы национальных инвентаризаций парниковых газов, МГЭИК, 2006, Глава 10 Выбросы скота и в результате уборки, хранения и использования навоза, ст. 10.8.
[12] Ibidem.

Table 4.3.7 Production of Main Livestock Products[13], 2006-2010 (thousand tonne)

	2006	2007	2008	2009	2010
Animals and poultry sold for slaughter (in living weight)	117.1	122.2	125.9	126.2	124.3
Animals and poultry sold for slaughter (in slaughter weight)	66.8	69.7	70.9	70.7	69.5
Of which - veal and beef	40.4	43.3	49.3	49.6	48.0
Pork	14.1	13.3	7.5	7.2	7.9
Lamb and goat's meat	7.2	7.3	7.4	8.9	8.2
Poultry meat	5.1	5.8	6.7	5.0	5.4
Milk	620.0	641.2	661.9	615.7	600.9

One of the reasons of change in livestock population in 2010 was imports and exports of livestock. Given the fact that the quantity of imports is already reflected in the calculation indicator then the indicator of exported animals is added for calculations of annual average population.

Table 4.3.8 Exports and Imports of Animals, in 2010[14]

	Year 2010			
	Exports		Imports	
	Quantity	Weight, kg	Quantity	Weight, kg
Pedigree calves [15]	0	0	412	173000
Cows	0	0	64	35900
Lambs (under 1 year of age)	1936	83500	483	13500
Sheep	6292	269800	700	32000
Goat	78	3100	142	200
Poultry				
1-day chicks form laying hens	400000	16000	16240	700
Chicken from laying hens, other	0	0	811900	42500
Other poultry	0	0	54031	13900
Other domestic poultry	10000	10000	0	0
Ducks	0	0	653	300
Guineafowl	3	1.5	1000	500

As we can see from data in Table 4.3.9 during year 2010 the country has exported 1936 lambs (up to one year of age), 6292 sheep and 78 goats. The quantity of these livestock is included in calculations. 400,000 birds are not included in exported poultry calculations as they were 1-2 day-old chicks, and the indicator of 10 000 poultry of about one kg living weight was added to calculated population.

Data as follows describe categories for all livestock derived from assessment results.

[13] Agricultire in Armenia, 2006-2010, Satatistical digest, NSS of RA, Ye. 2011, page 128 RA Statistical Yearbook, 2011, page. Also see Statistical Yerabook of RA, 2011, page 310-313.

[14] Foreign Trade of RA, 2010, (according to 8-digit classification for Commodity List of Foreign Economic Activities), Statistical Digest, NSS of RA, Ye., 2011, page 7.

[15] Classified by "Year 2007, Commodity List of Foreign Economic Activities" claissifier, see http://www.armstat.am/am/?nid=38

Table 4.3.9 Population of Domestic Animals by Categories According to National Inventory Modality

		As of 01.01. 2010	As of 01.01. 2011	Year 2010 annual average as of 01.01. 2010 and 01.01.2011	Year 2010 recalculated annual average	Difference as compared with January 1, 2011, in % *
3A	Cattle	570633	571357	570995	**669717**	117.2
3A1-2 ai	Dairy cows	273854	272572	273213	**273213**	100.2
3A1-2 aii	Non-dairy cattle and young animas raising for milk and slaughter	296779	298785	297782	**396504**	32.7
	Bulls	*16834*	*18518*	*17676*	***17676***	*-4.5*
	Young animals (calves and hiefers)	*279945*	*280267*	*280106*	***377986***	*34.9*
3A1b	Buffalos	455	460	458	**458**	-0.5
3A1c-3A1d	Sheep and goats	511029	532515	521772	**695024**	30.5
3A1c	*Sheep*	*481342*	*503624*	*492483*	***654018***	*29.9*
3A1d	*Goats*	*29687*	*28891*	*29289*	***41006***	*41.9*
3A1 e	Camels	0	0	0	**0**	0
3A1 f	Horses	10777	10042	10410	**10410**	3.7
3A1 g	Mules and donkeys	4890	3999	4445	**4445**	11.1
3A1 h	Pigs	112608	114777	113693	**159744**	39.2
3A1i	Poultry	4134600	3462500	3798550	**4541153**	31.2
3A1 j	Other					

** - Recalculated data are compared with results as of January 1, 2011, in compliance with methodology applicable for development of 2006 National Inventory.*

4.3.6.4 Livestock Enteric Fermentation

According to [Gen-1 - Gen-4] EF factor (kg of methane/head/year) for methane emission from enteric fermentation is directly proportional to total energy (GE) from feed received during a day and Y_m conversion factors.

$$EF = \left[\frac{GE \bullet \left(\frac{Y_m}{100} \right) \bullet 365}{55.65} \right]$$

Where:
GE_i - is all energy received by i category animals expressed in MJ daily units and is calculated by [Gen-4] 10.16 equation,
Y_m - is the part of all energy, which is converted into methane,
365 - is number of days in a year,
55.65 - is conversion factor of MJ/kg methane.

For developing countries the value of Y_m factor may be 0,06 to 0,07 depending on raising conditions and manner of feeding [Gen-4]. Given the fact that in Armenia cattle is raised in confinement conditions for 210 days and graze for 155 days [as informed by the Ministry of Agriculture of RA] Y_m for 155 days is accepted 0.06 and for 210 days it is 0.07.

In energy calculations the activity energy (NEa) [Gen-4] for grazing animal and animals raising in confinement conditions is different. Hence, the total energy value is also different for specific category of animals.

Thus, the total energy value for specific category of animals is calculated by using the following formula:

$$EF_i = 210 \bullet GE_{ង} \bullet 0.07 + 155 \bullet GE_{ɯ} \bullet 0.06$$

Where $GE_{con.}$ is total energy received by animals raising in confinement conditions, and $GE_{grazing}$ is total energy received by animals in grazing lands.

$$GE = \left[\frac{\left(\frac{NE_m + NE_a + NE_1 + NE_{work} + NE_p}{REM} \right) + \left(\frac{NE_g + NE_{wool}}{REG} \right)}{\frac{DE\%}{100}} \right]$$

Where:
GE is total energy, MJ/day
NEm is net energy required for maintaining relevant physiological conditions of animals, MJ/day [Gen-4, calculated by 10.3 equation],
NEa is the energy required for maintaining vitality of animal [Gen-4, calculated by 10.4 equation], MJ/day,
NE_l is the net energy required for lactation [Gen-4, calculated by 10.8 and 10.9 equations], MJ/day,
NEw is net energy required for work [Gen-4, calculated by 10.11 equation], MJ/day,
NEp is net energy required for pregnancy [Gen-4, calculated by 10.13 equation], MJ/day,
REM is the ratio of net energy in food to consumed digestion energy [Gen-4, calculated by 10.14 equation],
DE is digestion energy expressed in net energy percent.

Calculations are made for 3 subcategory animals:

- Cows,
- Bulls,
- Young animals

Basic data used for calculation of emission factors are presented in Tables 4.3.11 -4.3.13

Table 4.3.10 Baseline Data for Calculation of GHG Emission Factors from Cows

Indicator	Year 2010	Source
Animal population, head	273213	Expert assessment
Average living weight, kg	430	Ministry of Agriculture od RA
Fat in milk, %	3.7	Ministry of Agriculture od RA
Lactation, kg milk/head	2035	RA Statistical Yearbook[16]
Digestion energy, % DE	61	Ministry of Agriculture od RA
Raising regime, of which in confinement, day	210	Ministry of Agriculture od RA
Grazing regime, day	155	Ministry of Agriculture od RA
Cows used for work	X	Cows are not used for work
Weight loss kg/day	0	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines [Gen-1], [Gen-3]
Methane generation factor for cows (Y_m) confinement regime	0.07	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines, [Gen-3], Table 4.8
Methane generation factor for cows (Y_m) grazing regime	0.06	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines [Gen-3], Table 4.8

[16] RA Statistical Yearbook, 2011, RA NSS, Ye., 2011, page 313.

Table 4.3.11 Baseline Data for Calculation of GHG Emission Factors from Bulls

Indicator	Year	Source
Animal population, head	17676	Expert assessment
Average living weight, kg	500	Ministry of Agriculture od RA
Digestion energy, % DE	57	Ministry of Agriculture od RA
Raising regime, of which in confinement, day	210	Ministry of Agriculture od RA
Grazing regime, day	155	Ministry of Agriculture od RA
Bulls used for work	X	Bulls are not used for work
Weight loss kg/day	0	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines [Gen-1], [Gen-3]
Methane generation factor for bull (Y_m) confinement regime	0.07	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines [Gen-3], Table 4.8
Methane generation factor for bull (Y_m) grazing regime	0.06	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines [Gen-3], Table 4.8

Table 4.3.12 Baseline Data for Calculation of GHG Emission Factors from Young Animals

Indicator	Year	Source
Animal population, head	377986	Expert assessment
Average living weight, kg	180	Ministry of Agriculture od RA
Mature (reference) weight, kg	350	Ministry of Agriculture od RA
Average weight increase kg/head	0.42	Ministry of Agriculture od RA
Digestion energy, % DE	59	Ministry of Agriculture od RA
Raising regime, of which in confinement, day	210	Ministry of Agriculture od RA
Grazing regime, day	155	Ministry of Agriculture od RA
Methane generation factor for young animals (Y_m) confinement regime	0.07	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines, [Gen-3], Table 4.8
Methane generation factor for young animals l (Y_m) grazing regime	0.06	2006 National Inventories, Fundamental Principles of Greenhouse Gas Inventories, IPCC Guidelines, [Gen-3], Table 4.8

Information from the Ministry of Agriculture of RA was received in reply to letter (*October 26, 2012, $_N$ $_2$/07/2143-12*) sent by the Ministry of Nature Protection.

Reference approach and Tier 1 method was used for calculation of methane emission from enteric fermentation of other animals. Emission factors are taken from 2006 IPCC Revised Guidelines values intended for developing countries.

4.3.6.5 2000-2010 Time Series

Years 2000-2010 methane emission from enteric fermentation of cattle is calculated by Tier 2 Methodology as it is the *key source* of emissions. Emissions from enteric fermentation of other animals are calculated by Reference Approach (Tier 1 Methodology). Values from 2006 IPCC Guidelines intended for developing countries are taken as emission factors.

Below are basic data for calculation of years 2000-2010 emission factors from enteric fermentation of cattle (See Tables 4.3.13-4.3.16).

Table 4.3.13 Main Indicators for Calculation of GHG Emission from Animals, 2000-2010

Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total population of cattle, head	**571936**	**592739**	**615291**	**645554**	**667515**	**682882**	**710387**	**728898**	**708957**	**676051**	**669717**
Annual average population of cows, head	**263501**	**267503**	**275447**	**285880**	**290532**	**293565**	**302075**	**308845**	**296829**	**278451**	**273213**
Average living weight of cows, kg	425	425	425	425	425	425	425	425	425	425	430
Fat in milk, %	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.7
Lactation, kg milk/head (annual average)	1668	1685	1708	1728	1772	1877	1890	1957	1992	2027	2035
Lactation, kg milk/head (per day)	4.57	4.62	4.68	4.73	4.85	5.14	5.18	5.36	5.46	5.55	5.58
Digestion energy of cows Digestion energy , % DE	61	61	61	61	61	61	61	61	61	61	61
Annual average population of bulls, head	**5597**	**6903**	**8115**	**9166**	**10745**	**12809**	**15300**	**17182**	**17886**	**17464**	**17676**
Average living weight of bulls, kg	485	485	485	485	485	485	485	485	485	490	500
Digestion energy of bulls, % DE	57	57	57	57	57	57	57	57	57	57	57
Young animals annual average population, head	**302838**	**318333**	**331729**	**350509**	**366238**	**376508**	**393013**	**402871**	**394242**	**380136**	**377986**
Average living weight of young animals, kg	170	170	170	170	170	170	170	170	170	170	180
Average weight of young animals, kg/head	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.370	0.390	0.420
Average reference weight of young animals, kg	350	350	350	350	350	350	350	350	350	350	350
Digestion energy of young animals % (feed digestion factor)	59	59	59	59	59	59	59	59	59	59	59
Raising regime, of which confinement regime, day	210	210	210	210	210	210	210	210	210	210	210
Grazing regime, day	155	155	155	155	155	155	155	155	155	155	155
Use of cows, bulls, young animals for work	X	X	X	X	X	X	X	X	X	X	X
Weight loss, kg/day								0	0	0	0
Methane generation factor from cows, bulls, young animals (Y_m) confinement regime	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Methane generation factor from cows, bulls, young animals (Y_m) hay grazing regime	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Buffalos, head	461	512	506	433	397	401	463	512	469	448	458
Sheep and goats, head	724035	755752	793948	814059	813334	792021	811670	845654	796606	712660	695024
Sheep, head	662610	688572	725125	747593	750272	729676	749957	791486	749305	671315	654018
Goats, head	61425	67180	68823	66466	63062	60219	61713	54168	47301	41345	41006
Horses, head	11450	11750	12100	12150	12050	12100	12450	12202	11533	11034	10410
Mules and donkeys, head	7108	7312	7460	7350	7201	7089	6905	6567	6040	5308	4445
Pigs, head	98162	97147	136137	154333	118696	123824	191136	167547	120486	138680	159744
Poultry, head	4897045	4221849	4608462	5741036	5881873	5840401	5386059	4852671	5021008	4846332	4541153

Table 4.3.14 Factors and Volume of Methane Emission from Enteric Fermentation of Cows by Tier 2 Calculation Methodology, 2000-2010

Baseline data	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Living weight, kg	425	425	425	425	425	425	425	425	425	425	430
DE, digestion ,%	61	61	61	61	61	61	61	61	61	61	61
Fat in milk ,%	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.037
Lactation, kg head/day	4.57	4.62	4.68	4.73	4.85	5.14	5.18	5.36	5.46	5.55	5.58
Maintenance											
NEm (MJ/day) =Cfi x (Weight) 0.75	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.63
activeness											
NEa(MJ/day) = Ca x NEm, confinement	0	0	0	0	0	0	0	0	0	0	0
Grazing	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.39
Lactation											
NEl(MJ/day) =kg milk/day x (1.47+0.4 x fat content)	13.3	13.4	13.6	13.8	14.1	15.0	15.1	15.6	15.9	16.2	16.5
Pregnancy											
NEp (MJ/day)=C pregnancy x NEm	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.16
NEm/DE											
NEm/DE=1.123-(4.092 x 10-3x DE) + [1.126 x 10-5 x (DE)2]-25.4/DE)	0.4989	0.4989	0.4989	0.4989	0.4989	0.4989	0.4989	0.4989	0.4989	0.4989	0.4989
Net energy											
GE=[(NEm+NEa+NEl+NEp)NEma/DE]/ (DE/100), confinement	157.04	157.52	158.09	158.57	159.72	162.49	162.97	164.60	165.55	166.41	168.43
Grazing	194.14	194.61	195.19	195.67	196.81	199.59	200.06	201.69	202.65	203.51	205.85
Emission factor											
EF=GE x Ym x 365 day/year)/ (55.65 MJ/kg CH4)	**73.93**	**74.13**	**74.38**	**74.59**	**75.08**	**76.28**	**76.48**	**77.18**	**77.36**	**77.97**	**78.89**
Annual average population of cows, head	263501	267503	275447	285880	290532	293565	302075	308845	296829	278451	273213
Emission, Gg methane /total/year	**19.5**	**19.8**	**20.5**	**21.3**	**21.8**	**22.4**	**23.1**	**23.8**	**23.0**	**21.7**	**21.6**

Table 4.3.15 Factors and Volume of Methane Emission from Enteric Fermentation of Bulls by Tier 2 Calculation Methodology, 2000-2010

Baseline data	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Weight, kg	485	485	485	485	485	485	485	485	485	490	500
DE -digestion	57	57	57	57	57	57	57	57	57	57	57
Maintenance											
NEm (MJ/day) =Cfi x (Weight) 0.75	33.28	33.28	33.28	33.28	33.28	33.28	33.28	33.28	33.28	33.54	34.05
Activeness											
NEa(MJ/day) = Ca x NEm, confinement	0	0	0	0	0	0	0	0	0	0	0
Grazing	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	12.07	12.26
NEm/DE											
NEma/DE=1.123-(4.092 x 10-3x DE) + [1.126 x 10-5 x (DE)2]-25.4/DE)	0.4807	0.4807	0.4807	0.4807	0.4807	0.4807	0.4807	0.4807	0.4807	0.4807	0.4807
Net energy											
GE = [(NEm+ NEa) NEma/DE] /(DE/100), confinement	121.448	121.45	121.45	121.45	121.45	121.45	121.45	121.45	121.45	122.39	124.25
Grazing	165.17	165.17	165.17	165.17	165.17	165.17	165.17	165.17	165.17	166.44	168.99
2. Emission factor											
EF=GE x Ym x 365 day/year)/ (55.65 MJ/kg CH4)	**59.68**	**59.68**	**59.68**	**59.68**	**59.68**	**59.68**	**59.68**	**59.68**	**59.68**	**60.14**	**61.06**
Annual average of population of bulls, head	**5597**	**6903**	**8115**	**9166**	**10745**	**12809**	**15300**	**17182**	**17886**	**17464**	**17676**
Emission, Gg methane /total/year	**0.3**	**0.4**	**0.4**	**0.5**	**0.6**	**0.8**	**0.9**	**1.0**	**1.1**	**1.1**	**1.1**

Table 4.3.16 Factors and Volume of Methane Emissions from Enteric Fermentation of Young Animals by Tier 2 Calculation Methodology, 2000–2010

Baseline data	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Weight, kg	170	170	170	170	170	170	170	170	170	170	180
Mature weight, kg	350	350	350	350	350	350	350	350	350	350	350
Weight increase, kg	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.37	0.39	0.42
DE - digestion	59	59	59	59	59	59	59	59	59	59	59
Maintenance											
NEm (MJ/day) =Cfi x Weight)0.75	15.16	15.16	15.16	15.16	15.16	15.16	15.16	15.16	15.16	15.16	15.82
Activeness											
NEa(MJ/day) = Ca x NEm, confinement	0	0	0	0	0	0	0	0	0	0	0
Grazing	5.46	5.46	5.46	5.46	5.46	5.46	5.46	5.46	5.46	5.46	5.70
Growth											
NEg(MJ/day) =4.18 x {0.0635 x [0.891 x (BW x 0.96) x (478/(C x MW))]0.75 x (WG x 0.92)1.097}	3.53	3.53	3.53	3.53	3.53	3.53	3.53	3.53	3.76	4.03	4.32
NEma/DE											
NEma/DE=1.123-(4.092 x 10-3x DE) + [1.126 x 10-5 x (DE)2]-25.4/DE)	0.4903	0.4903	0.4903	0.4903	0.4903	0.4903	0.4903	0.4903	0.4903	0.4903	0.4903
NEg/DE											
NEg/DE=1.164-(5.160 x 10-3x DE) + [1.308 x 10-5 x (DE)2]-37.4/DE)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Net energy											
GE = [(NEm+NEa)/(NEma/DE)+NEg/ (NEg/DE)]/(DE/100)] confinement	74.49	74.49	74.49	74.49	74.49	74.49	74.49	74.49	75.88	77.62	81,68
Grazing	93.36	93.36	93.36	93.36	93.36	93.36	93.36	93.36	94.75	96.49	101.37
Emission factor											
EF=GE x Ym x 365 day/year)/ (55.65 MJ/kg CH4)	**35.28**	**35.28**	**35.28**	**35.28**	**35.28**	**35.28**	**35.28**	**35.28**	**35.88**	**36.63**	**38.36**
Annual average population of young animals, head	302838	318333	331729	350509	366238	376508	393013	402871	394242	380136	377986
Emission, Gg methane /total/year	**10.7**	**11.2**	**11.7**	**12.3**	**12.9**	**13.3**	**13.4**	**14.2**	**14.1**	**13.9**	**14.5**

4.3.7 Emissions from Manure Storage and Handling (3A2)

4.3.7.1 Description of Source Category

Storage and handling of manure of animals (cattle, pigs, sheep, horses, donkey, goats, and poultry) generate methane (CH_4) and nitrous oxide (N_2O) emissions. Management of such waste includes various systems (storage in liquid, solid or other conditions). Methane is released from microbial decay of organic substances in manure while nitrous oxide is generated as result of nitration - de-nitration processes.

4.3.7.2 Selection of Factors of Methane Emissions from Manure Storage and Handling

Given the fact that according to information provided by the Ministry of Agriculture factors required for calculations have undergone minor changes (almost all of them are insignificantly decreased compared with year 2006) therefore we can apply the method and factors used in the Second National Inventory Report. Methane emission factors for manure storage and handling, as well as for 2006 Second National Inventory Report, will be selected in terms as follows:

- Data for cattle, buffalos and pigs were initially taken from those intended for Asian countries as animal raising practices of this region is the closest to Armenian conditions: annual average rate of cow milk yield in 2010 amounted to 2035 kg/head; animals graze in grasslands and the collected manure is used as fuel (30% as per assessment), and the rest is used as fertilizer; the main stock is stored in solid and dry condition and a minor part - in liquid condition (manure from 1200 -1500 animals is stored and handled at commercial organizations), etc.
- Factors intended for developing countries will be applied for other animals.

The annual mean temperature in the Republic of Armenia is below10^{o}C[17], and it is classified as a country with cold climate. Thus, data will be selected to comply with those intended for cold countries.

4.3.7.3 Selection of Factors of Nitrous Oxide Emissions from Manure Storage and Handling

Nitrogen flow values, as well as for the case of 2006 Second National Inventory Report, will also be selected from values intended for Asia.

The Table below describes manure storage and handling systems fractions. Data on fractions are received from the ministry of Agriculture of Armenia and from research materials (Evaluation of Biogas Generation and CDM Potential of Large and Medium Animal and Poultry Farms in Armenia, 2010, UNDP). Nitrous oxide factor was taken from 2006 IPCC Guidelines.

Table 4.3.17 Factors Used for Calculation of Nitrous Oxide Emissions from Storage and Handling of Manure

	Generated N kg/gl/ton	Liquid systems, fraction	EF	Storage in solid condition fraction	EF	Grasslands fraction (parts of E)	EF	Used as fuel and as fertilizer, fraction (parts of E)	EF
A	B	C	D	E	F	G	H	I	J
Cows	60	0.02		0.98		0.3		0.7	0.007
Other large animals	40	0.02		0.98		0.3		0.7	0.007
Buffalos	25					0.3		0.7	0.007
Pigs	16	0.1	0.001	0.99					
Sheep	12			0.3	0.02	0.7	0.02	0.3	
Goats	25			0.3	0.02	0.7	0.02	0.3	
Horses	25			1	0.02				
Mules and donkeys	25			1	0.02				
Poultry	0.6	0.35		0.65	0.02				

[17] Environment and Natural Resources in the Republic of Armenia, Statistical Digest, RA NSS, 2012, 15 10.

4.3.8 Quality Assurance/Quality Control

IPCC 2000 Good Practice Guidance [Gen-3] invites to pay special attention to calculation of enteric fermentation.

The use of various approaches for emissions calculation is an important measure for quality assurance and control. Enteric fermentation of large cattle and manure management is the key source of GHG emission for livestock production therefore emission calculation in terms of that category of animals was conducted by both Tier 1 (reference) and Tier 2 (detailed) approaches. Moreover, in contrast with previous reports, for assessment of the level of uncertainty deviations years 2000-2006 indicators and emission factors have been recalculated thought recalculated animal population indicators instead using population data as of January 1 of each consecutive year. Same approach was also applied to calculate years 2000-2010 indicators.

In order to make uncertainty corrections, a comparison of results derived from calculations made by reference and detailed method was conducted.

4.3.9 Overview of GHG Emissions from Livestock Production

The specific weight of methane emissions from enteric fermentation of cattle and manure management in methane emissions structure for year 2010 amounted to 90.2% (the specific weight for years 2000-2009 was 88%-90%).

The table below describes methane emission quantities for years 2000-2010 from enteric fermentation of animals.

Table 4.3.18 Emission of Methane from Enteric Fermentation of Animals and Manure Management, 2000-2011 (Gg)

Inventory years	Methane										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
3.A - Livestock	**37.47**	**38.60**	**40.14**	**41.91**	**43.14**	**44.08**	**45.86**	**47.31**	**45.99**	**44.13**	**44.22**
3.A.1 - Enteric fermentation	**34.46**	**35.54**	**36.91**	**38.51**	**39.75**	**40.64**	**42.20**	**43.62**	**42.52**	**40.81**	**40.92**
3.A.1.a - Large cattle	**30.43**	**31.35**	**32.48**	**33.97**	**35.25**	**36.26**	**37.63**	**38.91**	**38.12**	**36.83**	**37.03**
3.A.1.a.i - Dairy cows	19.50	19.80	20.38	21.16	21.79	22.31	22.96	23.78	22.86	21.72	21.58
3.A.1.a.ii - Other animals	10.94	11.56	12.10	12.82	13.46	13.95	14.67	15.13	15.27	15.11	15.44
3.A.1.b - Buffalos	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.03
3.A.1.c - Sheep	3.31	3.44	3.63	3.74	3.75	3.65	3.75	3.96	3.75	3.36	3.27
3.A.1.d - Goats	0.31	0.34	0.34	0.33	0.32	0.30	0.31	0.27	0.24	0.21	0.21
3.A.1.e - Camels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.A.1.f - Horses	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.21	0.20	0.19
3.A.1.g - Mules and donkeys	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.05	0.04
3.A.1.h - Pigs	0.10	0.10	0.14	0.15	0.12	0.12	0.19	0.17	0.12	0.14	0.16
3.A.1.j - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.A.2 - Manure management	**3.02**	**3.06**	**3.24**	**3.40**	**3.39**	**3.43**	**3.66**	**3.69**	**3.47**	**3.32**	**3.30**
3.A.2.a - Large cattle	**2.68**	**2.73**	**2.82**	**2.93**	**2.99**	**3.03**	**3.13**	**3.20**	**3.08**	**2.90**	**2.85**
3.A.2.a.i - Dairy cows	2.37	2.41	2.48	2.57	2.61	2.64	2.72	2.78	2.67	2.51	2.46
3.A.2.a.ii - Other animals	0.31	0.33	0.34	0.36	0.38	0.39	0.41	0.42	0.41	0.40	0.40
3.A.2.b - Buffalos*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.c - Sheep	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.08	0.07	0.07	0.07
3.A.2.d - Goats	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3.A.2.e - Camels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.A.2.f - Horses	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3.A.2.g - Mules and donkeys*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.h - Pigs	0.20	0.19	0.27	0.31	0.24	0.25	0.38	0.34	0.24	0.28	0.32
3.A.2.i - Poultry	0.05	0.04	0.05	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05

**Emission for this animal group is smaller than 0.001.*

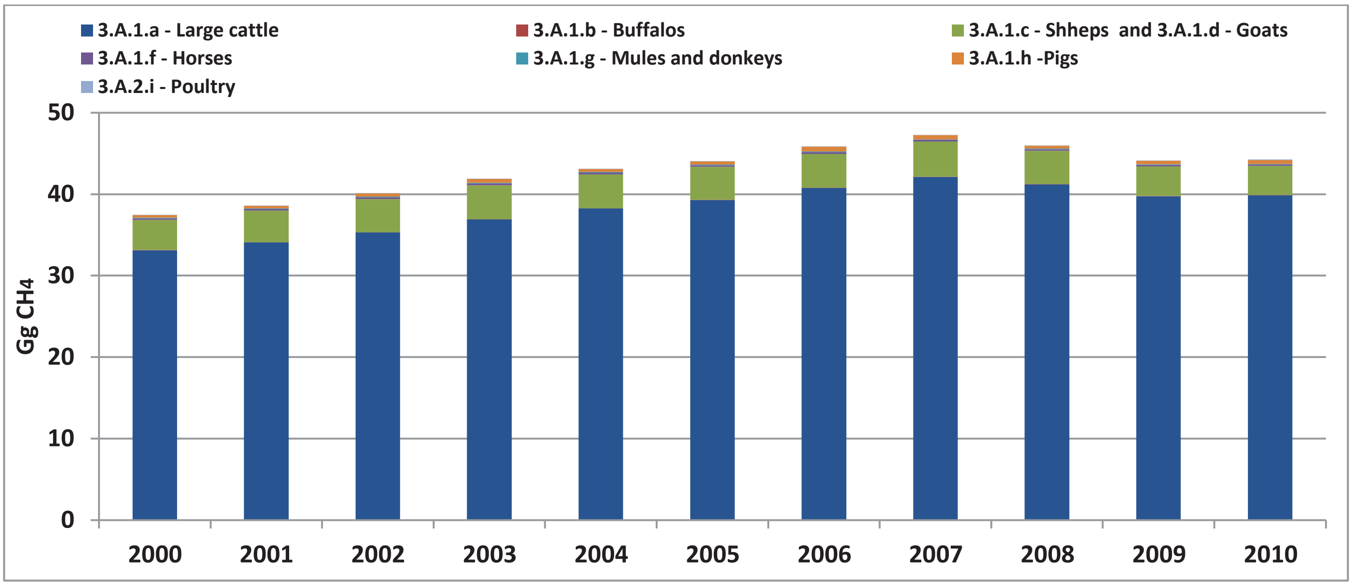

Figure 4.3.4 Values of Methane Emission from Enteric Fermentation of Animals and Manure Handling Calculated by Reference Approach, for 2000-2010, Gg

Emission for years 2000-2010 have tended to grow in the beginning - from 37.5Gg by Reference Approach and 38.4Gg by detailed method in year 2000 - reaching to their maximum level - 47.3Gg and 48.5Gg respectively in 2007, and afterwards there was a decline - 44.2Gg and 43.6Gg respectively in 2010 Inventory year.

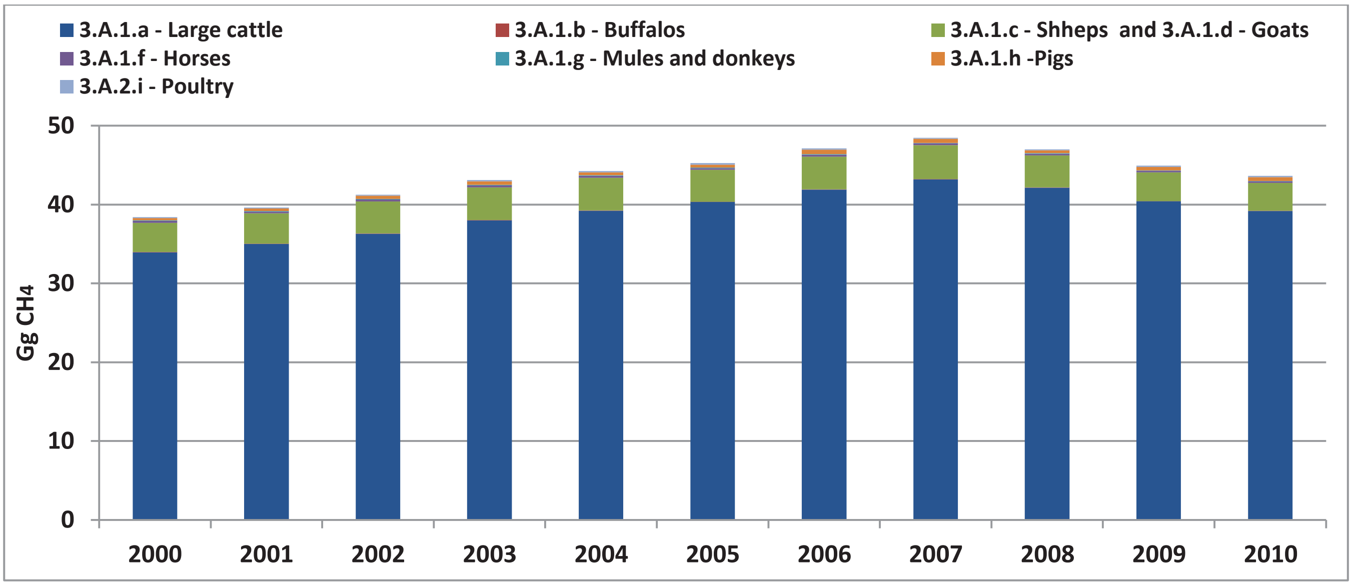

Figure 4.3.5 Yearly Values of Methane Emission from Enteric Fermentation of Animals and Manure Management, 2000-2010 (Gg)

Such dynamics of methane emission quantities is due to the following factors: changes in animal population, milk yield and particularly changes in large cattle weight in year 2010.

The other peculiarity is the differences of results derived from the use of two methods which over the period under consideration varies in the rage from minimum 0.5% in 2010 to maximum 2.9% in 2003. The difference between indicators was calculated by comparing indicators derived by detailed method (Tier 2) to those derived by reference approach. This comparison is also intended to identify the level of probable incorrectness if data are calculated by means of IPCC Inventories Software [Gen 7] by using some data estimations on emission factors and livestock.

Insignificant difference in data calculated by two methods is due to the fact that instead of factors recommended in Reference Emission factors calculated on the base of characteristics of livestock is entered in software.

2006 IPCC National Inventory Guidelines [Gen 1] recommend a fixed factor for calculation of methane emissions for the period under consideration. For calculation by detailed approach, however, the factor changes as in 2000-2010 according to data from NSS of RA milk-yield average rate per cow has increased substantially in Armenia which made certain impact on differences between calculation results derived by two methods. The results are described in Figure 4.3.6.

When considering this by categories it becomes apparent that population of cows and young animals have the greatest influence on the structure of large cattle.

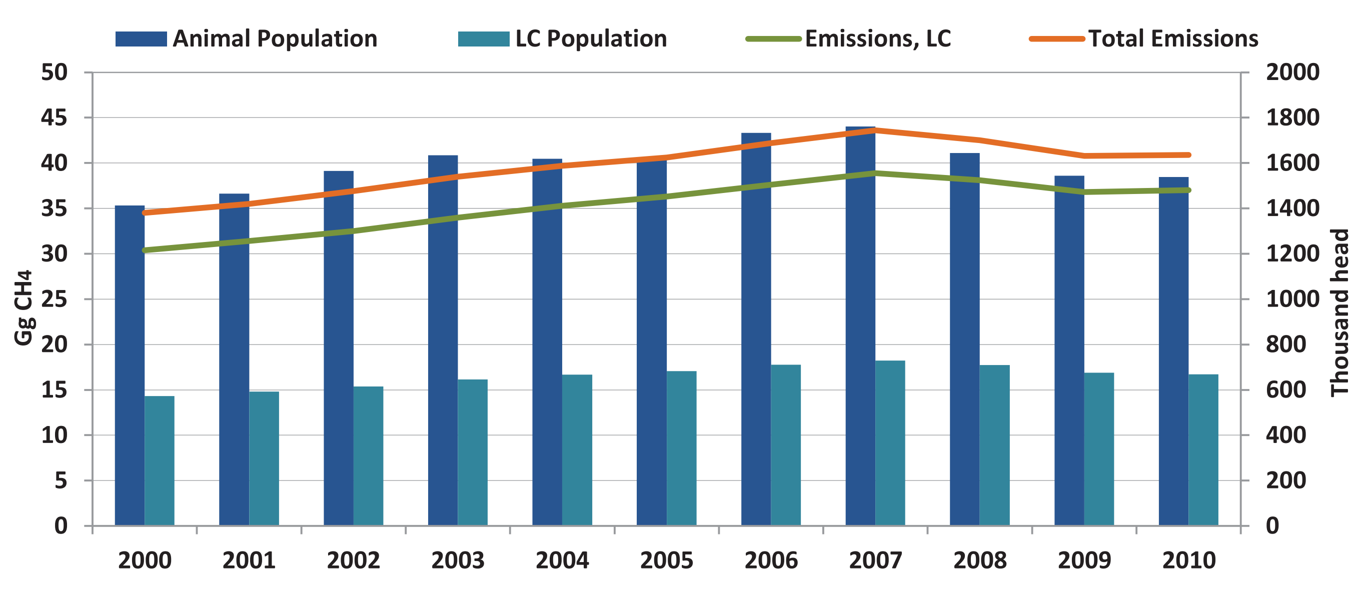

Figure 4.3.6 Dynamics of Agricultural Animal and Cattle Population and Emission Volume, 2000-2010

The comparison of results calculated by two methods show that although minor incorrectness between them in case of more detailed and large -scale data calculation emission volumes come to be somehow higher than in the case of respective situational factors in similar regions (Asia) and calculation by using data (Reference Approach).

In comparing these two it is worth to note that deviation in emission volumes from enteric fermentation of cows and other large animals and manure management derived by using two methods is basically due to differences in manure emissions where uncertainties have relatively high impact on applicable indicators and factors used for said emissions. Because of different manure management practices and absence of compete and reliable information we have mostly used assessments obtained though inquiries.

Application of calculated by Tier 2 factors in the IPCC Inventories Software 2006 improved essentially emission assessment from cattle entering fermentation.

In methane emissions structure from enteric fermentation of animals and manure management the fraction of emission from cattle in general structure of emissions has increased from 88.4% in 2000 to 90.2% in 2010.

The latter is emissions from enteric fermentation of sheep and goats which specific weight in contrary has decreased during 2000-2010 time-period from 9.9% to 8%. The next is specific weight of emissions from pigs which fluctuated cyclically - reaching from 0.8% up to 1.1%, etc.

Current social and economic conditions in Armenia, high poverty level of rural communities and the peculiarities of animal manure management respectively (manure is used as fuel and fertilizer) have made definite impact on the quantities of nitrous oxide emissions. The quantity of nitrous oxide in $CO_{2\ equivalent}$ is almost equal to methane emission from manure management.

Table 4.3.19 Volume of Nitrous Oxide Emissions from Storage and Handling of Manure, 2000-2010 (Gg)

	N_2O										
Inventory years	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
3.A.2 - Manure management	**0.191**	**0.196**	**0.206**	**0.216**	**0.217**	**0.220**	**0.231**	**0.234**	**0.223**	**0.211**	**0.213**
3.A.2.a - Cattle	0.143	0.146	0.152	0.158	0.163	0.166	0.172	0.176	0.171	0.162	0.163
3.A.2.a.i - Dairy cows	0.106	0.107	0.110	0.115	0.117	0.118	0.121	0.124	0.119	0.112	0.111
3.A.2.a.ii - Other animals	0.037	0.039	0.041	0.044	0.046	0.048	0.051	0.052	0.052	0.050	0.052
3.A.2.b - Buffalos*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.A.2.c - Sheep	0.032	0.034	0.035	0.036	0.037	0.036	0.037	0.039	0.037	0.033	0.032
3.A.2.d - Goats	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002
3.A.2.f - Horses	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
3.A.2.g - Mules and donkey	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
3.A.2.h -Pigs	0.007	0.006	0.009	0.010	0.008	0.008	0.013	0.010	0.007	0.008	0.010
3.A.2.i - Poultry	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004

** Emission for this animal group is smaller than 0.001*

4.3.10 Completeness of Data and Uncertainty Analysis

Observations, inquiries and calculations as described above have been conducted on annual average population of animals, milk-yield rates, raising regimes and on other indicators in order to ensure completeness of data. In addition, we have also used information from the Ministry of Agriculture of RA and regional agricultural extension centers of RA.

We focused on analyses of data uncertainties or deviations in calculation indicators. We have considered factors effecting data uncertainties as follows:

1. Limitations in official statistical data collection methodology and collection process which makes certain impact on data completeness and reliability.

2. Specialized entities still use Soviet-time professional reference books in terms of calculation of specific indications such as, in particular: on milk-yield rates, digestion, feed base, raising regimes, weight increase, large animal breeds, manure volumes and on other indicators. Based on tolerance range recommended by 2006 Guidelines of GHG National Inventories and with the help of inquiry conducted among livestock producers and meat dealers an effort was made to minimize the value of real deviations.

In regard to cattle, emission factors and quantities are calculated by detailed (Tier 2) method and said factors are used instead factors recommended by Guidelines.

4.3.11 Data Archiving

Data were archived in 2006 IPCC database attached to 2006 Guidelines of GHG National Inventories as well as in hard and electronic carriers.

4.3.12 Agricultural soils (3B2-6)

4.3.12.1 Description of Source Category

"Land Use and Land Use Change" (LULUC) Sector includes GHG emissions and removals that are released from land use and land use change. This Inventory assessment is based on requirements/provisions relevant to LULUC Sector of 2006 IPCC Guidelines [Gen-1].

This Subsector includes five of six main land use categories: 3B2-Croplands, 3B3-Grasslands, 3B4-Wetlands, 3B5-Settlements, 3B6-Other land.

CO_2 gas emissions and removals, non-CO_2 gases (CH_4, N_2O, $N0_x$ and CO) caused by land use change and, in contrast to the previous report, nitrous oxide direct and indirect emissions from agricultural soil management are calculated in this study. GHG emissions and removals are calculated for all subcategories, for years 2000-2010.

4.3.12.2 Estimation of Emissions

Below is the estimation of GHG net flows for LULUCF Sector for 2000 and 2010 baseline years, expressed in $CO_{2\ equivalent}$. GHG removals are indicated by negative sign, and emissions -by positive sign.

Table 4.3.20 Estimation of GHG Net Flows from LULUCF, for 2000 to 2010 (Gg $CO_{2\ eq.}$)

Categories	GHG net flows	
	2000	2010
3.B. 1-6 Forestry, land use and land use change, total	**-451.8**	**- 537**
3.B - C Forestry, land use and land use change, total	**-107.8***	**-216.1***
3.B.1. Forest land	**-470.8**	**-557.1**
3.B.1.a Forest land remaining forestland	-470.8	-552.9
3.B.1.b Land converted to forest land	0.0	-4.2
3.B.2 Cropland	**0.7**	**0.7**
3.B.2.a Cropland remaining cropland	0.7	0.7
3.B.2.b Land converted to cropland	0.0	0.0
3.B.3 Grassland	**13.5**	**13.5**
3.B.3.a Grassland remaining grassland	13.5	13.5
3.B.3.b Land converted to grassland	0.0	0.0
3.B.4 Wetlands	**0.0**	**0.0**
3.B.4.ai Wetland remaining wetland	0.0	0.0
3.B.4.b Land converted to wetland	0.0	0.0
3.B.5 Settlements	**0.0**	**0.0**
3.B.5.a Settlement remaining settlement	0.0	0.0
3.B.5.b Land converted to settlement	0.0	0.0
**3.B.6 Other land ** **	**NO**	**NO**
3.B.6.b Land converted to other land	NO	NO
3.C.1 Field burning of agricultural residues	**4.8**	**5.0**
3.C.3-6 Aggregate sources and non-CO2 emissions sources on land	**348.9**	**326.0**

It should be noted, that indicators for year 2000 are recalculated by using data from Land Balances of RA and through the interpolation and extrapolation method.

4.3.13 General Methodological Issues

4.3.13.1 Methodology for Presentation of Land Use Areas

LULUCF GPG requires presentation of six main land use categories - forest lands, croplands, grasslands, wetlands, settlements and other lands - for estimation of GHG emissions and removals by separating lands that over the period under consideration have not undergone changes from those that have changed as a result of land use change. LULUCF GPG recommends three different approaches that vary in intensiveness of required data and respective accuracy. However, for purposes of this GHG Inventory management we have applied GPG recommended Tier 1 and Tier 2 approaches to LULUCF Sector for presentation of proposed lands. In the case of Tier 1 approach, without availability of additional data it is impossible to make complete assessment of land use change in the matrix option which is used in Tier 2 approach. Generally, there was a shortage of necessary data required for identification of land use change. In developing GHG Inventories there were also some difficulties in subdividing land use category activities data into climatic zones and soil types as many of data were either missing or there were limited access to such data.

4.3.13.2 Data Collection Sources

Main information on land use and soil types is received from Land Balances of RA - annually approved by the Government of RA. However, in contrast to years 2007-2010, there have been some difficulties in comparing soil types before year 2001 and after it as according to Land Code of RA adopted in 2011 soils in Armenia must be classified by nine categories instead formerly used seven categories. Moreover, there was no Land Balances for year 2000 and in GHG Inventories we have used data derived by calculation method.

For purposes of this Inventory we have used years 1990, 2007, 2008, 2009 and 2010 Land Balances indicators and studies, statistical data and articles on agriculture, land use, environment and water sector published by local and international organizations and experts.

4.3.13.3 Matching of Land Use Definitions

Due to national and international processes matching of land use definitions (IPCC GPG, 2003) is of utmost importance in regard to GHG Inventories management of Land Use and Land Use Change Subsector which allows avoiding double accounting and probable gaps in data. Matching was conducted for five of six main categories as defined by GPG for LULUCF, as follows: croplands, grasslands, wetlands, settlements and other lands. For data collection we have used different sources of information along with respective definitions and involvement levers applicable to agriculture, water and urban development sectors. However, we have taken soil type definitions used by RA Government for compiling Land Balances as a basis by matching them with LULUCF GPG requirements. In particular, in "Cropland" category - perennial young plant lands (by separating berry plant lands), arable lands and virgin lands; in "Grassland" category - hay-lands, pastures and bush-lands (not included in forest land); in "Wetland" category - water reservoirs, peat mining sites and canals as GHG Inventories estimate only anthropogenic emissions and removals while natural lakes, rivers and swamps are considered as not-managed wetlands and are not included in calculations; in "Settlement" category -developed urban lands, roads, industrial areas; in "Other Land" category - all other areas.

4.3.13.4 Identification of Land Use Change

Identification of land use change is very important for GHG Inventories management. Nevertheless there was a shortage in necessary data especially on soil type area increase or decrease. The best method for identification of land use change is the use of Geological Information System (GIS) which complies with the highest Tier 3 of GPG, 2003 for land presentation. But such data are yet inaccessible and we have used conclusions made by experts in land use change assessment.

4.3.13.5 Filling in Time Series

In order to fill in 2007-2010 time series of emissions and removals for LULUC Sector there is a need to establish data systems of many years, also including years 1990 and 2000. There are some issues emerged in regard to latters as classification of soils applicable until 2001 to Land Balances of RA has undergone changes during following years making it difficult to compare data from different years. Given this fact we have derived comparable data for years 1990 and 2000 through logical analysis of data obtained from different sources. No calculation have been made for filling in 2000-2006 time series, so we have used 2007 data instead due to absence of Land Balances.

4.3.13.6 General Trends and Annual Matrixes of Land Use Change

For assessment of general trends of land use change we have analyzed RA Land Balances of various years as well as statistical data obtained from various sources - including agricultural and other sectors. It should be noted that data on land use and land type in Land Balances are presented in different classifications for various periods (e.g. before independence and after it; before 2001 and after it) which made them difficult to compare. However, in addition to developing land use 2007-2010 time series we have also succeeded in deriving the required indicators for years 2000 and 1990 by using 2000 GHG NlR of the Republic of Armenia.

Land use change matrixes for 2000 and 2010 are presented in tables below.

Table 4.3.21 Land Use Change Matrix, 2000, (thousand ha)

Initial Final	Forest land	Cropland	Grass-land	Wetland	Settlement land	Other land	Total final
Forest lands							
Croplands		523.5					**523.5**
Grasslands		8.7	1014			35.6	**1058.3**
Wetlands				163.6			**163.6**
Settlement lands					151.9	5.8	**157.7**
Other land						721.8	**721.8**
Total initial		**532.2**	**1014**	**163.6**	**151.9**	**763.2**	**2974.3**
Change		**-8.7**	**44.3**	**0**	**5.8**	**-41.4**	**0**

Table 4.3.22 Land Use Change Matrix, 2010, (thousand ha)

Initial Final	Forest land	Cropland	Grass-land	Wetland	Settlement land	Other land	Total final
Forest lands	349.0						**349.0**
Croplands		503.5					**503.5**
Grasslands			2105.2				**2105.2**
Wetlands							
Settlement lands							
Other land	0.6		427.8		5.0		**433.4**
Total initial	**349.6**	**503.5**	**2533.0**				**3391.1**
Change	**0.6**	**0**	**427.8**		**5.0**		**433.4**

In comparison with 2000 there have been some changes in land structure which is clearly visible in the above comparison of land use matrixes. In comparison with tentatively early 2010 there was a decrease in the areas of “Cropland” category, and increase in “Grassland” areas which occurred as a result of conversion of “Other Land”.

4.3.14 Cropland (3B2)

4.3.14.1 Description of Source Category

According to IPCC 2003, GPG, “Cropland” category includes perennial young plant lands, arable lands and virgin lands (uncultivated arable lands). Perennial young plant lands include orchards and vineyards as well as berry plant lands, while GHG emissions and removals by non-wood plants due to their biomass growth and development are not calculated and their value is accepted to be 0. Changes in organic carbon due to land use management regimes and level of application of organic substances are assessed for arable lands and virgin lands.

4.3.14.2 Methodological Issues

Calculations for Cropland category is made for the following subcategories: 3B2a “Cropland remaining cropland” and 3B2b “Land converted to cropland”. In regard to GHG Inventories management we have calculated changes in organic substances of living biomass and soil. In Cropland category we have calculated NO_2 emissions released as a result of mineralization of organic substances in soil caused by land use change. There is no cropland liming practices in Armenia therefore no CO_2 gas emissions are observed.

4.3.14.3 Cropland Remaining Cropland (3B2a)

Calculation of living biomass change in this subcategory includes only perennial young wood plants - orchards and young grapevines. Data on areas under perennial wood plants are received from NSS of RA “Areas under crops and gross yields in 2010” reference book (code 1220-203, Yerevan, 2011), and data for year 2000 is taken from 2000 GHG NIR. The results are as follows: in 2010 the area under orchards totaled to 35586 ha, under vineyards - 17373 ha, under other perennial plants (for example, berry bushes) - 2124 ha. Thus information is entered into 2006 IPCC software [Gen-7] for obtaining output data.

In Cropland Remaining Cropland category carbon change in soil occurred from mineral and organic soils. In Armenia there are no organic soils in "Cropland" category, therefore emissions are calculated only from mineral soils.

By matching local and international soil classifications the factors intended for high clay activity (HCA) soils are applied for local soil types which then are subdivided into three international climatic zones available in Armenia: warm moderate dry, cold moderate dry, and cold moderate humid. Then, in terms of GHG Inventories management, crops are classified by agricultural practices as follows:

- cereals (summer crops and winter crops),
- vegetables and corn (grain and silage), industrial crops, etc.,
- one-year grass, current year sowing of perennial grass,
- perennial grass, last years' sowing,
- virgin lands (uncultivated arable lands).

Calculation of Emissions from and Removals by Arable Lands are Based on Last 20-year Period.

In regard to virgin lands (uncultivated arable lands) experts are of the opinion that under warm moderate, dry, and cold moderate dry climatic conditions soil degradation keeps on even after decommissioning which facilitates rapid mineralization of organic substances. According to methodological requirements such soils are not included in calculations. It is accepted that further accumulation of carbon in soil occurs only in cold moderate, humid climatic zone where the ground is usually under perennial grass.

CO_2 emissions from cultivated organic soils as well as CO_2 generation from liming are not applicable**.**

4.3.14.4 Land Converted to Cropland (3B2b)

No land converted to cropland is observed in 2010 and therefore no emissions and removals are calculated.

4.3.15 Grassland (3B3)

4.3.15.1 Description of Source Category

This category includes hay lands, pastures, as well as bushes (according to land balances) that do not comply with forest classification. Compared with other land use categories the area of grassland category has shown and intensive increase since 1990-reaching from 803.6 thousand ha (in 1990) to 1231.4 thousand ha (in 2010), or has increased by about 54%. During said period classification of soils in Armenia has undergone substantial changes and it is not easy to definitely identify the soil types that contributed to that increase. Therefore, taking advantage of the opportunity provided by 2006 IPCC Guidelines we have applied "Non-Grassland" category converted to "Grassland" category approach.

4.3.15.2 Methodological Issues

GHG emissions and removals from "Grassland" category are assessed for 3B3a "Grassland Remaining Grassland" and 3B3b "Land Converted to Grassland" subcategories. Like in 3B2 "Cropland" category consideration is given to changes in living biomass and GHG emissions from soils in 3B3 "Grassland" category also. In this category emissions caused by liming practices are not calculated as it is not applicable to the country.

4.3.15.3 Grassland Remaining Grassland (3B3a)

According to GPG 2003 Tier 1 requirements we have used the assumption that changes in above ground living biomass is equal to 0 for 3B3a "Grassland Remaining Grassland" category.

Organic carbon change in soil includes GHG emissions from or removals by mineral and organic soils according to GPG 2003 Tier 1 requirements. Soils are subdivided into three climatic zones and by soil types. In addition, based on information from National Atlas of RA published in 2007 hay lands and pastures are classified by degradation (erosion) level. At the same time consideration is also given to emissions from those organic (Mountain meadow sod and peat soils (14682 ha) and terraced river-valley meadow peaty swampy soils (2581 ha) that are included in “Grassland” category. Annual carbon change in organic soils is assessed for calculation of CO_2 emission from pastures - based on standard emission factors. In particular, 598.3 ton/C equivalent emission from this subcategory is calculated for year 2000, while emissions from mineral and organic soils totaled to 4097.8 ton/C in year 2010. For emission calculation we assumed that, for example, for year 2010 hay-land and pasture degradation during the last 20 years persisted to grow from nominal to moderate degradation level, and from moderate degradation to acute degradation level. Removals, in contrary, are due to positive changes in management (average, high) resulting in improvement of moderately degraded soils. Nevertheless, improvements in “Grassland” category are not applicable in year 2010.

Grassland liming is not practiced in the country and therefore it is not included in Inventory calculations.

4.3.15.4 Land Converted to Grassland (3B3b)

For 3B3b “Land Converted to Grassland” category consideration is given to changes in living biomass and GHG emissions from soils. No changes in living biomass is observed in this subcategory, however during 2010 large land areas are converted to “Grassland” category including, as experts assess, perennial young plant lands also. In particular, during said year the area of “Grassland” category has increased by 427800 hectares.

The annual change of carbon in soil (-2568.55 ton C/year) is calculated for other lands converted to grasslands by using standard factors recommended by GPG, 2003 for 20 year time-period.

4.3.16 Wetlands (3B4)

4.3.16.1 Description of Source Category

This category includes the lands that are covered by or saturated with water all year round or during some period in a year (e.g. peat-lands). The “Wetland” category includes both managed and unmanaged groups.

The managed group includes water reservoirs, peat mining sites, while natural rivers and lakes are classified as unmanaged.

4.3.16.2 Methodological Issues

GHG emissions are assessed for 3B4ai “Wetland Remaining Wetland” and 3B4bi “Land Converted to Wetland” subcategories by using standard factors recommended by GPG, 2003 Tier 1. As a result of subdivision peat mining sites of the country are included in lands poor in nutritious substances. For calculation of CO_2 and CH_4 emissions from reservoirs the operation data are subdivided into three different climatic zones applicable to the country.

4.3.16.3 Wetland Remaining Wetland (3B4ai)

For managing GHG of this category it is necessary to calculate emissions from peat mining sites and water covered lands. The area of managed organic soils of peat mining sites is measured by using information obtained from the Ministry of Energy and Natural Resources and Gegharkunik regional government. The area of peat mining sites is estimated 60 ha in year 2000 and 20 ha - in 2010. Based on initial data received from the Ministry of Energy and Natural Resources peat production in 2010 amounted to 162 tons. We have applied the standard factor - 0.45 ton C x year -1 to assess CO2 emissions from managed lands used for peat mining which totaled to 72.9 tons/C x year -1.

GHG calculation was also made for water covered lands from "Wetland Remaining Wetland" category. For calculations it was necessary to have operation data on reservoir classified by climatic zones.

According to GPG 2003 Methodology, for calculation of CO2 emissions by main reference approach lands covered with water during up to 10 year time-period should be considered, while lands covered with water earlier than 10 years are not included in this calculation. In calculations consideration is also given to data on areas flooded by river and lake waters during the year. In 2010 there were minor CO_2, CH_4 and N_2O emissions from water covered lands.

4.3.16.4 Land Converted to Wetland (3B4bi)

In 2010 as well as in 2000 no such conversion was observed, therefore no emissions are calculated.

4.3.17 Settlements (3B5)

4.3.17.1 Description of Source Category

"Settlement" category includes all developed urban lands, roads, and industrial areas. During recent years there have been no changes in "Settlements" category compared with year 2000.

4.3.17.2 Methodological Issues

For purposes of GHG Inventories management 3B5a "Settlement Remaining as Settlement" and 3B5b "Land Converted to Settlement" subcategories are assessed according to 2003GPG Tier 1 requirements. Calculations are made for living biomass change in "Settlement" category**.**

4.3.17.3 Settlement Remaining Settlement (3B5a)

Respective data for year 2010 are received from the Government Decree No.1358-N of RA on 14.10.2010 on "Supply of Land and Distribution report (Land Balances) of the Republic of Armenia". It should be noted that "Settlement" category of GHG Inventory also covers, other than urban and rural settlements, all developed areas including transport, commercial, and industrial infrastructures unless they are included in other categories. Pursuant to Guidelines, land use category in regard to settlements includes grass-covered perennial plant varieties, kitchen garden trees in settlements, gardens, as well as green zones, alleys, parks, and sports ground unless there are calculated in other land category.

In our case, the above described areas are generally calculated in other categories, particularly, settlement lands in RA Land Balances also include homestead lands and gardens (accounting for about 62.5% of settlement lands in 2010) that are calculated for "Cropland" category. Thus, there are no significant emissions from lands included in this category.

4.3.17.4 Land Converted to Settlement (3B5b)

Reference approach recommends to limit only to calculations of annual carbon change in living biomass in lands converted to settlements. Expert assessment accepts that this type of land conversion is applicable neither to year 2000 nor to year 2010.

4.3.18 Other Land (3B6)

4.3.18.1 Description of Source Category

This category includes unusable reserve lands, rocks, icy lands and other unmanageable lands that are not included in previous five land categories. Upon availability of data it will allow to correct the total land areas fitting then in the entire territory of the country.

4.3.18.2 Methodological Issues

Emissions/removals are not assessed in Inventories calculations for “Other Land Remaining Other Land” subcategory, and 3B6b “Land Converted to Other Land” subcategory was not used in GHG Inventory activities.

4.3.19 Forest Lands (3B1)

4.3.19.1 Sector Description

Forests and forest lands in Armenia are currently under the control of two public institutions: the Ministry of Agriculture of RA and the Ministry of Nature Protection of RA. Forestry management, forests preservation and forest use activities are conducted in “Forestry” branches of “Armforest” SNCO under the Ministry of Agriculture of RA as well as in forests included in SPAN system under the Ministry of Nature Protection of RA.

Given this situation, in order to collect information on forests resources of RA by land types (areas under forests, non-adherent forest cultures, rare forests, fired areas, hay-lands, pastures, etc.) as well as on areas (ha) under tree species in other forest lands, on stored stock (cubic m), age, completeness and other data necessary for forest assessment we have studied distribution of forests and forest lands under “Armforest” SNCO as of 2010 by “Forestry” branches [AFOLURef-37, new forest management plans [AFOLURef-33, AFOLURef-53] of “Forestry” branches, and new management plans [AFOLURef-34, AFOLURef-55] of SPANs. Information on “Forestry” branches and SPANs that do not yet have new (approved) management plans is collected from previous wood-building materials [AFOLURef-43 - AFOLURef-45] and data obtained during site visits.

Data collected on forest resources by land types is described in Table 4.3.23.

Table 4.3.23 General Description of the Lands of the Forest Resources in RA

By managing entity	Forest land, ha											Not Forest land, ha						Total
	Forest covered			Non-adherent forest cultures	Nurseries	Non-forest covered					Total forest lands	Hay-land	Pasture	Orchard	Arable land	Other land	Total non-forest land	
									Rare forests									
	Natural	Artificial	Total			Fired areas	Totally logged areas	Forest gaps	Anthropogenic	Biological								
Armforest SNCO	255757.4	21426.9	277184.3	3616.5	73	29.5	1366.1	16022.5	5169.2	10080	313541.1	1622.5	10283.4	477.5	487	18418.6	30850.7	344391.8
SPAN	59924.35	12533.2	72457.55	103.2	62	289.9	31.7	8360.2	608.3	7396	89278	320.6	1365.7	6.4	489.2	21646.8	23859.5	113137.3
Total	315681.8	33960.1	349650	3719.7	135	319.4	1397.8	24382.7	5777.5	17476	402819.1	1943.1	11649.1	483.9	537.9	40065.4	54710.2	457529.1

Areas under tree species in forests of RA and cumulative stock are presented in Figure 4.3.7 and Figure 4.3.8 [AFOLURef-33, AFOLURef-34, AFOLURef-43 - AFOLURef-45, AFOLURef-53, AFOLURef-55].

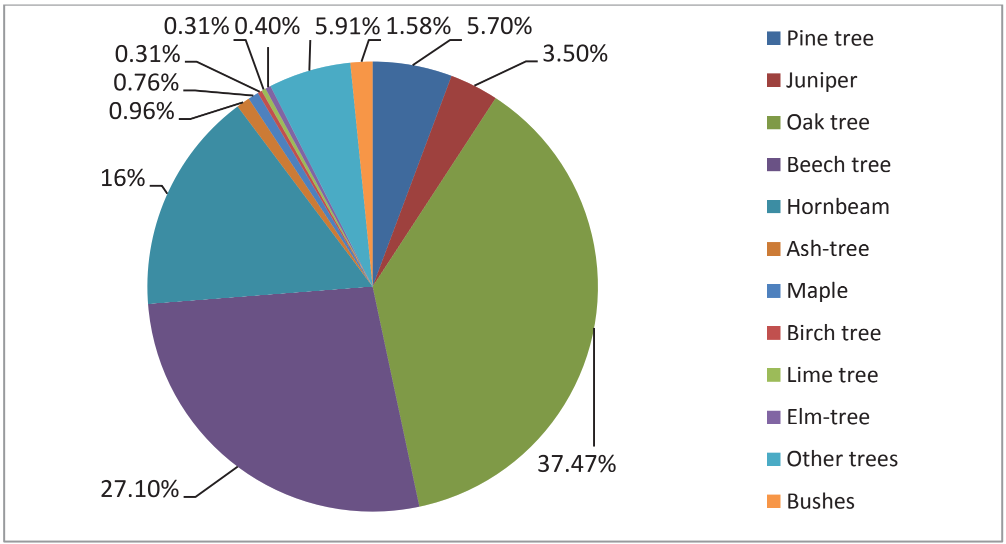

Figure 4.3.7 RA's Forest Spatial Distribution According to Areas under Tree Species

As it is shown in Figure 4.3.7 most of the forest area (130800 ha) is under oak trees- 37.4%, of which about 105000 ha is grown from seeds; beech trees - 27.1% (94830 ha), hornbeam trees cover about 16% (56140 ha), pine-trees - 5.7% (19930ha).

Figure 4.3.8 describes the fraction of other tree species that cover 5.9% (20650 ha) of the total area and generally include the following species: oriental beech, aspen, walnut tree, willow, pear tree, apple tree, etc. Sea-buckthorn, babul acacia, Christ's-thorn, almond, cornelian cherry tree, honeysuckle, etc. prevail among bushes.

Figure 4.3.8 below describes cumulative stock of trees by species. Total stock of wood amounts to 4 427 2000 cubic m.

While 27.1% of forest areas is prevalently under beech trees, the situation with cumulative stock is quite different: in this case 46.2% is prevalently beech trees (20495300 cubic m) while oak trees that cover almost 37.4% of forest areas account for 29% of all cumulative stock (12880200 cubic m) which is due to relatively good growth conditions for beech trees. Hornbeam trees account for 15.5% of cumulative stock.

Pine forests in general are clear plantings and account for about 3.7% of total stock.

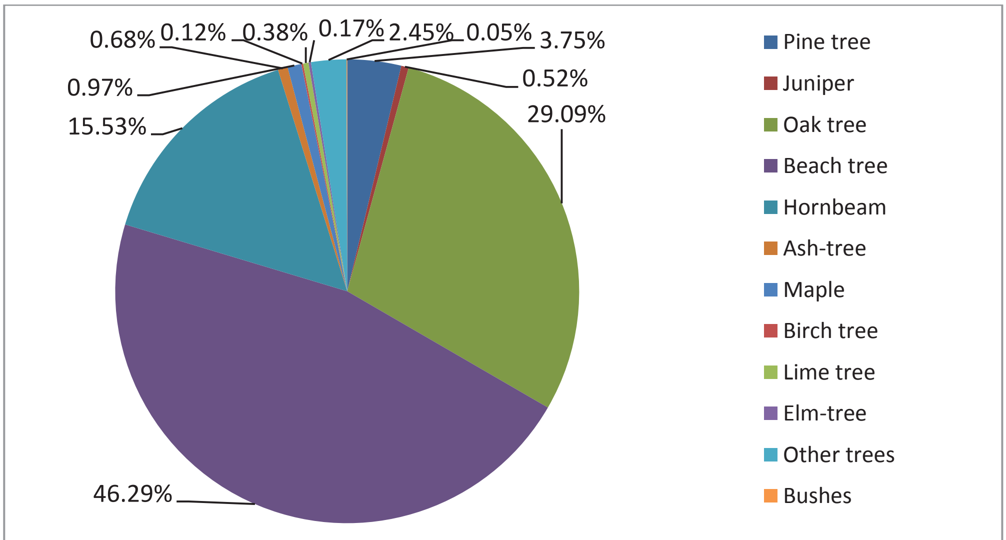

Figure 4.3.8 RA Forest Spatial Distribution According to Cumulative Stock (cubic meter)

In calculation of total wood stock it would be logical to add yearly actual growth by years less the total quantity of wood and brushwood (legally or illegally) removed (cut) from the forests. Calculation would rather be done individually for each "Forestry" branch and SPAN stating from the year following development of management plans. However, given the impossibility of recording the real quantity of illegal harvesting and available brushwood this kind of calculation in current conditions would be quite rough.

4.3.19.2 Description of the Sector

For calculation of GHG emissions and removals "Forest Land" subsector is divided into two subcategories:

- Forest land remaining forest land - these lands (forests) should not have undergone land use change during 20 years prior to accounting year**,**
- Lands converted to forest land - these lands are in transition stage and as a result of land use change during 20 years prior to accounting year they are converted to forest lands.

According to IPCC Good Practice Guidance, forest lands are all lands under wood building materials that comply with forest land criteria as defines in GHGs National Inventories [Gen-1].

According to Forest Code of RA [AFOLURef-35] forest lands are defined as lands covered with forests, and intended for protection of animal and plant kingdom and nature protection as well as lands not under forests but intended for forestry needs which can be:

1. Areas under forests,
2. Non-adherent forest cultures,
3. Young forest plantings,
4. Non-forest areas that are divided into:
    - 4 a. Rare forests - biological or anthropogenic,
    - 4 b. Fired or dead trees,
    - 4 c. Clearly logged areas,
    - 4 d. Forest gaps.

4.3.19.3 Revised Factors

In assessing carbon stock change in living biomass which is based on difference of biomass growth and loss, for calculation we take annual average growth of wood (cubic meter/ha/year) and baseline density (ton of dry matter/cubic meter open volume) factors for wood.

While studying the above referred factors used in previous [Ref-1 - Ref-3] GHG National Inventory we found the necessity to fully revise them and present local factors accepted in and applicable to our region.

Table 4.3.24 Baseline Density Factors for Wood

Tree Species	Baseline density factor for wood (ton d.m./ cubic meter moist)			
	Previous	Revised 2000	Revised	
			2010	Reference
Pine-tree	0.525	0.42	0.415	[AFOLURef-52]
Juniper	0.524	0.425	0.447	[AFOLURef-49]
Yew	0.584	0.465	0.474	[AFOLURef-41]
Fir-tree	-	-	0.365	[AFOLURef-52]
Oak-tree	0.729	0.58	0.57	[AFOLURef-52]
Beech	0.665	0.58	0.538	[AFOLURef-40]
Hornbeam	0.760	0.63	0.64	[AFOLURef-52]
Ash-tree	0.743	0.57	0.648	[AFOLURef-48]
Maple	0.703	0.52	0.557	[AFOLURef-47]
Elm-tree	0.673	0.52	0.535	[AFOLURef-48]

Lime-tree	0.495	0.43	0.366	[AFOLURef-46]
Birch-tree	0.616	0.51	0.459	[AFOLURef-41]
Plane-tree	-	-	0.522	[AFOLURef-51]
Walnut tree	0.594	0.53	0.49	[AFOLURef-52]
Pear tree	0.710	0.552	0.564	[AFOLURef-41]
Poplar	0.459	0.35	0.423	[AFOLURef-50]
Willow	0.416	0.45	0.38	[AFOLURef-52]
Acacia	0.824	0.672	0.65	[AFOLURef-52]
Hackberry	-	-	0.53	[AFOLURef-42]

Table 4.3.25 Mean Value of Wood Density of Tree Species, in t/cubic meter

Tree species	P_{15}	P_{12}	P_0	Baseline density factor for wood m_0/Vmoist (t/cubic meter)
Pine-tree	0.511	0.505	0.48	0.415
Juniper	0.55	0.543	0.514	0.447
Yew	0.59	0.584	0.559	0.474
Fir-tree	0.45	0.445	0.42	0.365
Oak-tree	0.7	0.69	0.655	0.57
Beech	0.67	0.663	0.635	0.538
Hornbeam	0.803	0.795	0.76	0.64
Ash-tree	0.807	0.799	0.765	0.648
Maple	0.685	0.677	0.64	0.557
Elm-tree	0.656	0.65	0.62	0.535
Lime-tree	0.45	0.445	0.421	0.366
Birch-tree	0.572	0.566	0.542	0.459
Plane-tree	0.65	0.644	0.616	0.522
Walnut tree	0.596	0.59	0.56	0.49
Pear tree	0.702	0.695	0.665	0.564
Poplar	0.52	0.514	0.486	0.423
Willow	0.46	0.455	0.425	0.38
Bastard Acacia	0.808	0.8	0.77	0.65
Hackberry	0.66	0.653	0.625	0.53

Annual average growth factors for wood is derived from data collected through research work conducted during recent years in North-Eastern forests areas of Armenia [AFOLURef-38], and from management plans of “Forestry” branches and SPANs [AFOLURef-33, AFOLURef-34, AFOLURef-43 - AFOLURef-45, AFOLURef-53, AFOLURef-55], where the growth is defined by cumulative stock by tree species and by average age of trees. We have identified annual average growth factors for dominating tree species in various growth conditions, and we have estimated annual average growth rate.

Table 4.3.26 Annual Average Growth of Wood

Dominating tree species	Annual average growth of wood (cubic meter/ha year)		
	First National Inventory [Ref-2]	Revised 2000	2010
Coniferous trees			
Pine-tree	2.29	4.30	1.97
Juniper	0.83	0.49	0.19
Yew	-	0.62	0.48
Broad-leaved trees			
Seed oak-tree	1.04	1.33	1.18

Stump-sprig oak	1.04	1.44	0.43
Beech	1.84	1.91	1.76
Seed hornbeam	1.61	2.14	1.58
Stump-sprig hornbeam	-	-	1.09
Ash-tree	1.52	1.54	1.4
Maple	1.6	1.56	0.99
Elm-tree	1.47	1.92	0.9
Bastard acacia	1.6	1.28	0.35
Birch tree	0.89	1.27	0.16
Lime-tree	1.71	2.76	1.5
Aspen	-	-	1.46
Poplar	2.52	5.19	2.1
Willow	2.46	2.34	0.25
Oriental beech	-	1.44	0.87
Pear-tree	-	0.79	0.37
Apple tree	-	-	0.39
Walnut tree	-	2.27	0.78
Plane-tree	-	-	1.1
Almond tree	-	-	0.06
Oleaster	-	-	0.52
Apricot tree	-	-	0.05
Plum tree	-	-	0.8
Other species	1.2	1.33	-
Average (RA forests)	**1.44**	**1.86**	**1.5**

GHG emissions from and removals by forest lands and other lands are presented in Table 4.3.20.

4.3.19.4 Key Categories

4.3.19.4.1 Forest Land Remaining Forest Land

The key source in Forestry Sector is Forest Land Remaining Forest Land subcategory which accounts for 99.8% of annual total carbon removals, and almost 100% of annual loss.

Carbon loss refers to underground and aboveground biomass where about 91.7% is fuelwood, 7.9% is commercial harvest, 0.4% is burnt areas.

Table 4.3.27 Annual Change in Living Biomass and Carbon Accumulated in it (with aboveground and underground biomass)

	2010
Category	3.B.1 forest land
Subcategory	3.B.1.a forest land remaining forest land
Covered area (ha)	349050
1 ha yearly average growth (cubic m)	1.5
Annual carbon removal (C t/year)	172076
Annual volume of harvested fuelwood (cubic m)	59350
Annual volume of commercial harvest (cubic m)	5175
Burned areas (ha)	775
Loss of wood caused by wild fire (cubic m)	100
Annual carbon loss (C t/year)	21273

4.3.19.4.2 Land Converted to Forest Land

In regard to lands converted to forest lands (LCFL) this subcategory was not included in the previous GHG National Inventory Report [Ref-1 -Ref-3]. According to Guidelines [Gen-1] developed for GHG Inventory national experts the LCFL subcategory refers to lands not under forests as well as to non-forest lands (hay lands, pastures, etc.) converted to lands under forests as a result of forestation and natural reforestation during 20-year period prior to the accounting year (2010 in this case).

By studying forest culture resources and conversion to forest lands during recent 20-year period we have identified the following picture for said subcategory as described in Table 4.3.28 [AFOLURef-33, AFOLURef-34, AFOLURef-43 - AFOLURef-45, AFOLURef-53, AFOLURef-55].

Table 4.3.28 Lands Converted to Forest Lands by the Area of Tree Species and Cumulative Stock

N/N	Species	Covered area, ha	Cumulative stock, cubic m
1	Pine-tree	368	9800
2	Seed oak-tree	45	520
3	Ash-tree	22	200
4	Maple	28	470
5	Birch tree	3	40
6	Poplar	5	160
7	Pear tree	30	240
8	Apple tree	59	530
9	Walnut tree	16	500
10	Sea-buckthorn	3	0*
11	Bastard acacia	3	30
12	Babul acacia	10	0*
13	Plum tree	1	10
14	Other bushes	7	0*
15	**Total**	**600**	**12500**

** Accumulated carbon is close to 0*

As we can see from data in Table 4.3.28, 61% of LCFL area and 78% of cumulative stock is the fraction of pine tree plantings, hence the derived factors mainly refer to pine trees which is reflected in calculations of carbon stock change in living biomass.

As it was indicated before, the history of LCFL subcategory is under 20 years which already means that these areas do not yet have the status which would assume harvesting that might turn into carbon loss source. Hence, calculation for said subcategory is made only for removals which accounts for about 0.2% of annual total removals by all forest lands.

Table 4.3.29 Annual Change in Carbon Stock of Living Biomass in Lands Converted to Forest Lands (with aboveground and underground biomass)

Description of parameters	2010
Category	3.B.1 Forest land
Subcategory	3.B.1.b (i) Lands converted to forest lands
Covered area (ha)	600
1 ha yearly average growth (cubic m)	1.5
Annual carbon removal (C t/year)	300
Annual volume of harvested fuelwood (cubic m)	0
Annual volume of commercial harvest (cubic m)	0
Fired areas (ha)	0
Loss of wood caused by wild fire (cubic m)	0

4.3.20 2007-2010 Time Series

Given the fact that the majority of Management Plans are developed during the period of 2006-2009, changes of forest covered area are not recorded in 2007-2010. Therefore, 2007-2010 time series for carbon removal by forest lands can't be developed.

Therefore, the existing changes (forest area/ha, cumulative wood stock/cubic m, and annual incremental growth) could be recorded when making the new forest management plans (in 10 years following the previous one).

For our case 2007-2010 time series will refer to losses in living biomass (documented harvest -both legal and illegal) which is presented by calculation of wood stock (fuelwood or commercial harvest) removed from forest, as well as to the quantity of trees before reaching to the end-of-growth age damaged by wild fires in forest lands (Figure 4.3.8-4.3.12; Table 4.3.30).

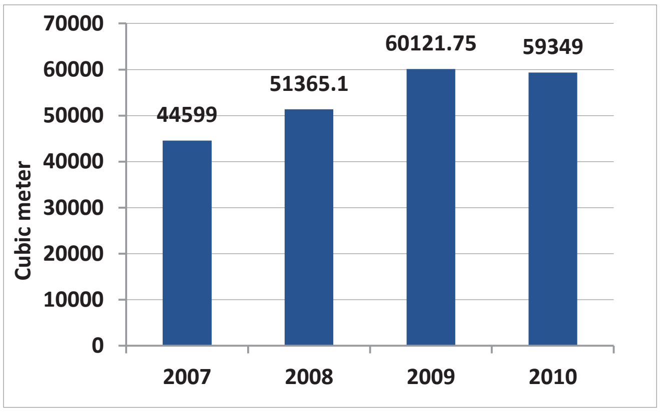

Figure 4.3.9 Quantity of Harvested Fuelwood, 2007 - 2010 (cubic meter)

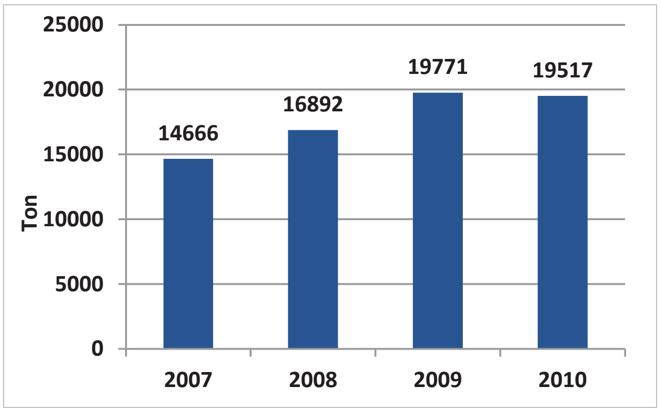

Figure 4.3.10 Loss of Carbon as a Result of Harvested Fuelwood (with the loss of underground biomass), 2007-2010 (ton)

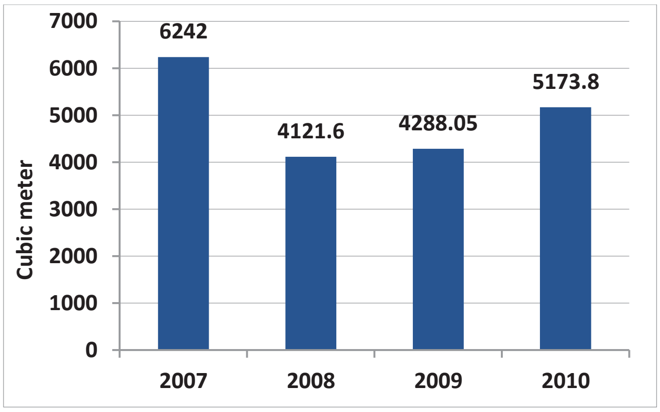

Figure 4.3.11 Quantity of Commercial Harvest, 2007-2010 (cubic meter)

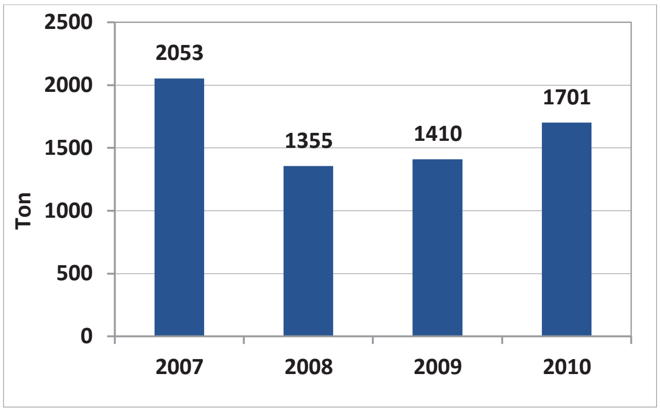

Figure 4.3.12 Carbon Loss as a Result of Commercial Harvest (with the loss of underground biomass), 2007-2010 (ton)

For calculation of wood removed from forests during 2007 -2010 period, we have studied the quantity of actual harvest by "Armforest" SNCO ("Forestry" branches) and SPANs ("Sevan National Park", "Dilijan National Park"), as well as information from various public entities (such as "Forest State Monitoring Center" SNCO, "Armforest" SNCO, "MNP" of Ministry of Nature Protection) on illegal harvest found as a result of annual inspections [AFOLURef-36, AFOLURef-53 - AFOLURef-55].

Table 4.3.30 Information on Wildfires in Forest Lands, for 2007-2010

Year	Wildfire occurrence (number)	Forest land (ha)	Areas not under forest (ha)	Total (ha)	Quantity of damaged wood (cubic meter)
2007	1	12.5	0	12.5	-
2008	8	16	4	20	1.5
2009	17	7.5	11	18.5	-
2010	49	775	35	810	100

As we can see from date presented in Table 4.3.30, the majority of wildfire events have occurred in areas under forests. However, in most cases wild fires inflicted damage only to recently established forest cultures as well as to grass cover in forest areas and, as a result, the trees remained undamaged. A major damage to wood (about 100 cubic meters) caused by wildfires is recorded in 2010.

4.3.21 Emissions from Agricultural Soils and Forest Lands

There have been significant changes in the quantity and content of emissions over the period of 2007-2010 as compared with the previous period as a result of changes in the structure of agricultural soils and forests lands, and as a result of recalculation of indicators and factors used for emissions calculation. In particular, on the one hand during 1990-2006 there have been emissions regularly recorded from agricultural soils (See the former GHG NIR), and on the other hand there have been removals recorded over the period under consideration.

Table 4.3.31 Net Emission Volume of Carbon Dioxide, 2000 - 2010 (Gg $CO_{2\ eq.}$)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Forest land remaining forest land	-470.8	-451.5	-462.5	-454.0	-497.1	-526.8	-527.1	-569.6	-564.0	-553.3	-552.9
Direct N_2O emission from managed soils	257.7	256.4	303.3	258.9	310.6	302.2	331.2	203.0	184.9	207.7	191.2
Indirect N_2O emission from managed soils	63.3	111.7	129.3	117.0	134.6	131.8	143.2	94.9	86.7	90.3	84.6
Pasture remaining pasture	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Urea application	NO	NO	NO	NO	NO	NO	0.4	0.7	0.7	0.6	1.0
Emission from biomass burning *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Cropland remaining cropland	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.0	0.0	0.7	0.7

** The value is smaller than 0.001 if it is 0.0 in this category*

As we can see from the data in this Table, there have been removals for all years in Forest Land Category which quantity has shown minor changes as a result of harvesting, wildfires, and forestry activities. Dramatic reduction in removals from agricultural soils in 2010 was due to the conversion of about 427 thousand ha area from “Other Land” subcategory to “Grassland” category which was reflected only in 2010 indicators as the Third GHG National Inventory is being developed for year 2010.

4.4 Waste

4.4.1 Description of the Sector

"Waste" Sector of GHG National Inventory of Armenia includes the following subcategories of emission sources:

- Methane emission from solid waste, (4A),
- Incineration and open burning of solid waste, (4C), which also includes:
  - Open burning (4C2) source:
- wastewater (4D), which also considers the following sources:
  - Methane emission from domestic and commercial wastewater, (4D1)
  - Methane emission from industrial wastewater, (4D2)
  - Nitrous oxide emission from liquid waste.

Other sources described in 2006 IPCC Guidelines do not exist in Armenia.

4.4.2 Key Categories

Key sources of emissions in this sector include: methane emission from solid waste (SW) (70.49% of emissions of this sector); methane emission from domestic and commercial wastewater (11.91%); nitrous oxide emissions from wastewater (8.6%); and methane emission from open burning of SW (3.7%). The first two of these sources are also included in the list of key sources of the General Inventory.

4.4.3 Quantitative Review

Emissions from this sector are presented in Table 4.4.1 below.

Table 4.4.1 Emissions in "Waste" Sector, 2010 (Gg)

Categories	Emissions		
	Net CO_2	CH_4	N_2O
Waste	7.64	27.77	0.20
4.A - Solid waste disposal	NA	22.40	NA
4.B - Biological treatment of solid waste	NO	NO	NO
4.C - Incineration and open burning of waste	7.638	1.100	0.020
4.D - Wastewater treatment and discharge	NA	4.270	0.182
4.E - Other	NO	NO	NO

Total emissions from this sector in 2010 amounted to 655.47 Gg $CO_{2\ equivalent}$ which is 9% of all emissions.

4.4.4 Solid Waste

4.4.4.1 Methane Emission from Solid Waste, (4A)

4.4.4.1.1 Selection of Calculation Methodology

According to 2006 IPCC Guidelines [Gen-1] for development of GHG National Inventories the estimation of emissions from solid waste considers, in general, methane emission from solid waste disposal sites (SWDS). Given the availability of data, emissions from industrial solid waste, dangerous and hospital waste, as well as from sludge are also considered. For calculation purposes the Guidelines recommend 3 levels of methodology: Tier 1, Tier 2, and Tier 3. Given the fact that methane emission from SWDSs is the main source of GHG emissions for overwhelming majority of countries, IPCC Guidelines encourage application of higher - Tier 2 or Tier 3 Methodologies.

In terms of calculation, all three methodologies are based on the use of so called SW "first order decay" (FOD) equations and degradation reaction (**k**) coefficient.[18]

It is known, that emissions of anaerobe methane from SWDS shift in the course of time: in the initial stage (up to 3-5 years) they show minimum value, later they grow to reach to their maximum constant value, and further - over 25 - 30 year period they go down. The use of FOD non-linear approach enables to calculate changes in methane emission quantities generated by SW degradation. Formerly, the lineal approach of "mass balances" was in use.

The three methodologies for calculation of methane emissions from SWDSs recommended by 2006 IPCC Guidelines vary only in selection of details of baseline data and calculation range values about operations. Thus, Tier 1 Methodology provides for the use of default values of calculation parameters recommended by 2006 IPCC. Tier 2 Methodology provides for the use of default values of the parameters (e.g. - **k**) of FOD method but with the use of local values of baseline data about operations. Finally, Tier 3 Methodology provides for the use of both local values of the parameters of FOD method and the accurate local values of the baseline data about operations.

The practices established in Armenia during the last two decades prove, that methane emissions can be considered only from SWDSs as information on other solid wastes is incomplete. Furthermore, the results of former studies proved that methane emission from SWDSs is the main source of GHG NI of RA [WRef- 1]. In this regard, in the country there are local data available on SW quantities and composition (morphology) as well as on the list of SW disposal sites available in the country and their description and data on types of operation. Given this fact we have applied Tier 2 approach for estimation of emissions from SWDS Subsector.

FOD calculation is based on 3.1, 3.2, 3.4-3.7, 3.A1.6 equations from 2006 IPCC Guidelines (see [Gen-1], volume 5).

2006 IPCC GHG Inventories software enables to calculate methane emissions from disposal sites by FOD method.

Given that methane generation reaches to its maximum values over 25-35 years it is clear that in order to obtain more or less reliable data during the accounting period we have to start calculation from given period.

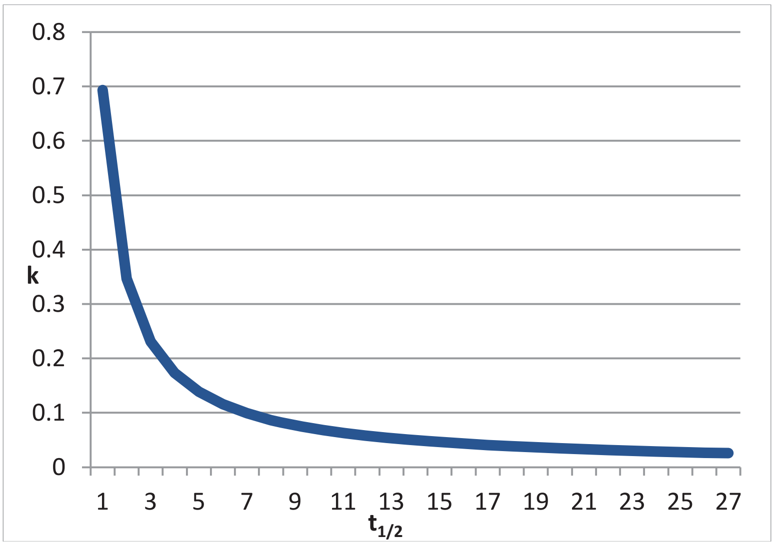

Figure 4.4.1 Half-Decay Period Dependence of Solid Waste Degradation Reaction Coefficient

During the first 10 years even minor change in time will cause very large deviations in final values. Observation of time series for merely 2 decades show that emission results for the first decade are sensitive to applied factor. This means that in order to obtain more or less reliable data for 1990-2010 time series we need to use baseline data from about year 1950. There are no such data for countries like

[18] In the past this parameter was called *methane generation rate.*

Armenia. Consequently, the calculation can be based on expert assessments which is not very reliable and which would increase uncertainties.

This problem - peculiar to the use of FOD method - was discussed during "Capacity Building for Improving the Quality of GHG Inventories, Europe/CIS Region" regional programme that was implemented back in 2004 - 2006. Respective problems have found their reflections in the report of this program [WRef-1 - WRef-4], as well as in National Manual for Preparation of GHG NI of RA [Ref-1].

Given that 2006 IPCC Guidelines provide for the use of FOD method, then calculation of methane emissions from SWDSs are made by using both "lineal methodology" of 2006 IPCC Revised Guidelines, as well as by FOD method of 2006 IPCC Guidelines and by respective 2006 IPCC Software.

4.4.4.1.2 Selection of Emission and Other Calculation Factors

Per capita SW generation factor (MSW_P, kg SW/person/day). According to 2006 IPCC Guidelines we have uses here the value recommended for Russian Federation - 0.34 t/person/year [Gen-1]. This value is multiplied by 0.71 factor recommended by 2006 IPCC for part of SW disposed to SWDSs [Gen - 1]. As a result, we come to 0.2414 t/person/year factor.

The quantity of degradable carbon in SW disposed to SWDSs in a specific year (**DOC**, Gg C/Gg SW). According to provisions in 2006 IPCC Guidelines the value of **DOC** parameters should be considered on the basis of local reliable data on SW morphology. For calculation there will be a need to have time series of DOC parameter values. For that purpose we have generalized the measurement results of morphological composition of SW disposed to the largest in RA "Nubarashen" SWDS [WRef-5, WRef-7], measurement results on SW morphology conducted in 2004 - 2006 in Ararat, Vayots Dzor and Kotayk Marzes [Ref-1, WRef-4, WRef-6], as well the results from the study on methane capture potential from the country's SWDSs conducted in 2012 [WRef-8]. Based on this information we have formed **DOC** parameter value series for 1990 - 2012 time period. They are used for assessment of methane emissions from SWDSs in all calculations as described below (see Table 4.4.2). During the recent decade there is an increase in the fraction of garbage (food waste, paper, cardboard [Ref-1, WRef-8]) containing degradable organic carbon in SWs produced in the country. Let us add, that 2006 IPCC DOC parameter default value is 0.18 which is very close to the parameter value for 2006-2012 time period described in Table 4.4.2.

Table 4.4.2 Amount of Degradable Organic Carbon in the Garbage Disposed to SWDS, 1990-2012

Year	DOC	Year	DOC
1990	0.138	**2001**	0.149
1991	0.132	**2002**	0.149
1992	0.126	**2003**	0.149
1993	0.126	**2004**	0.149
1994	0.126	**2005**	0.149
1995	0.126	**2006**	0.17
1996	0.126	**2007**	0.17
1997	0.126	**2008**	0.17
1998	0.126	**2009**	0.17
1999	0.134	**2010**	0.17
2000	0.141	**2011**	0.17
		2012	0.17

Fraction of DOC to be degraded (DOC_f). 2006 IPCC default value of this parameter is selected - 0.5 [Gen-1].
Fraction of methane in SWD_S gases (F). 2006 IPCC default value of this parameter is selected - 0.5 [Gen-1].

Oxidation factor (OX_T). 2006 IPCC default value of this parameter is selected - 0.0 [Gen-1].

Degradation reaction coefficient (k). 2006 IPCC default value for this parameter of FOD method is selected - 0.05 year $^{-1}$. This complies with 13.86 year period of half-decay of SW degradation life. It is used below only in 2006 IPCC Software calculations.

Degradation delay coefficient (t): For this parameter of FOD method 2006 IPCC default value is selected - 6.0 months [Gen-1]. It is used only in 2006 IPCC Software calculations below.

4.4.4.1.3 Selection and Collection of Data about Operations

Based on the selected calculation logics of IPCC 2006 Methodology activity data in this Subsector are in fact statistical data on urban population of the country. Basically, according to 2006 IPCC provisions data on urban population should be classified by groups, and by peculiarities ($\mathbf{U_j}$) of collection, transport and storage of SW.

Furthermore, SWDSs should also be classified by types to match the classification of urban population. In this regard, the value of methane correction factor (MCF) in terms of SWDS types and definition of their fraction (MCF_i) in calculation scheme should be considered in parallel with selection of data about operations. As a source of input data for calculations in this Subsector we have selected demographic statistical data from NSS of RA summarized in regularly compiled and publish by NSS of RA - Demographic Yearbooks of RA, RA population 2001 final and 2011, as well as the list of RA cities/towns and urban settlements, and Inventories result of solid waste dump fields/landfills operating over the period of 1990-2012 estimated by the Ministry of Territorial Administration of RA and NSS of RA [WRef-9 - WRef-12].

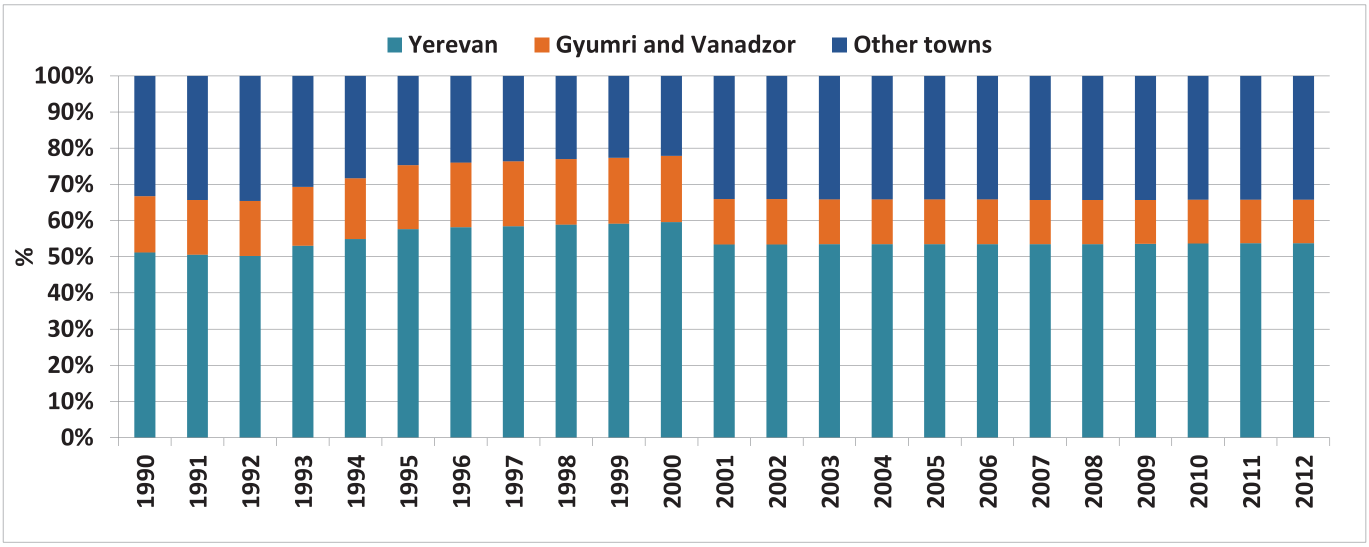

Figure 4.4.2 Classification of Urban Population by Operation of SWDSs (Calculation of MCF)

2006 IPCC Tier 1 Methodology calculation further requires classification of SWDSs by their physical and operational peculiarities (managed SWDSs, unmanaged SWDSs with deep waste layer, unmanaged SWDS with not deep waste layer, unclassified SWDSs). In addition, 2006 IPCC Guidelines recommend full classification of SWDSs in a specific country and possibly to avoid using “unclassified SWDSs” type [Gen-1]. Based on this data we have made the following parallel classification of urban population of RA and SWDSs for calculation of methane emission from SWDS by using default values [Gen-1].

- **The capital city of Yerevan.** Managed SWDS with SW anaerobic degradation (“Nubarashen” SWDS - the largest in the country): **MCF = 1.0**
- **Cities of Gyumri and Vanadzor.** Unmanaged SWDSs with deep[19] layer of SW, **MCF = 0.8**
- **Other 45 cities and towns of the country.** Unmanaged SWDSs with not deep[20] layer of SW, **MCF = 0.4**

[19] 5 meter and deeper.

[20] Up to 5 meters deep.

Figure 4.4.2 summarizes the proportion of urban population of RA by classification, for the period of 1990-2012. This Figure shows change in urban population structure in 2000 - 2001 period which is due to correction and recalculation of demographic data of RA based on 2001 RA Population Census results [WRef-12].

Figure 4.4.3 "Nubarashen" SWDS: Location of Methane Capture Holes, Yerevan

In the framework of activity data collection in terms of methane emissions from SWDSs there is a need to consider operations of methane capture from SWDSs as well. As it is known in December, 2009 an Armenian-Japanese joint project was launched in Nubarashen SWDS (Yerevan city) within the framework of Clean Development Mechanisms under the Kyoto Protocol for methane capture from landfill and burning and incineration (Figure 4.4.3).

According to Project Monitoring Report [WRef-7] from the beginning of year 2010, 85 tons monthly of CH_4 gas was captured under this project which is equivalent to capture of about 1.02 Gg CH_4 annual emissions. Thus, in calculations $\mathbf{R_T}$ = 1.02 Gg CH_4 per year for the period of 2010 - 2012. **The quantity of methane captured from SW emissions for specific T year** is - $\mathbf{R_T}$=1.02 (Gg CH_4/year):

Calculation of the quantity of methane emissions from SWDSs was conducted for the period of 1990-2010 by using the selected values of above indicated calculation parameters and selected baseline data about operations under the 2006 IPCC Methodology. Calculations are made on "mass balances" (MBs) basis by *Excel* software as well as by using 2006 IPCC Guidelines Software - through FOD equations (Figure 4.4.4). In calculations for 1990 - 2010 we have used same input data, while for 1950 -1990 we have used expert assessments.

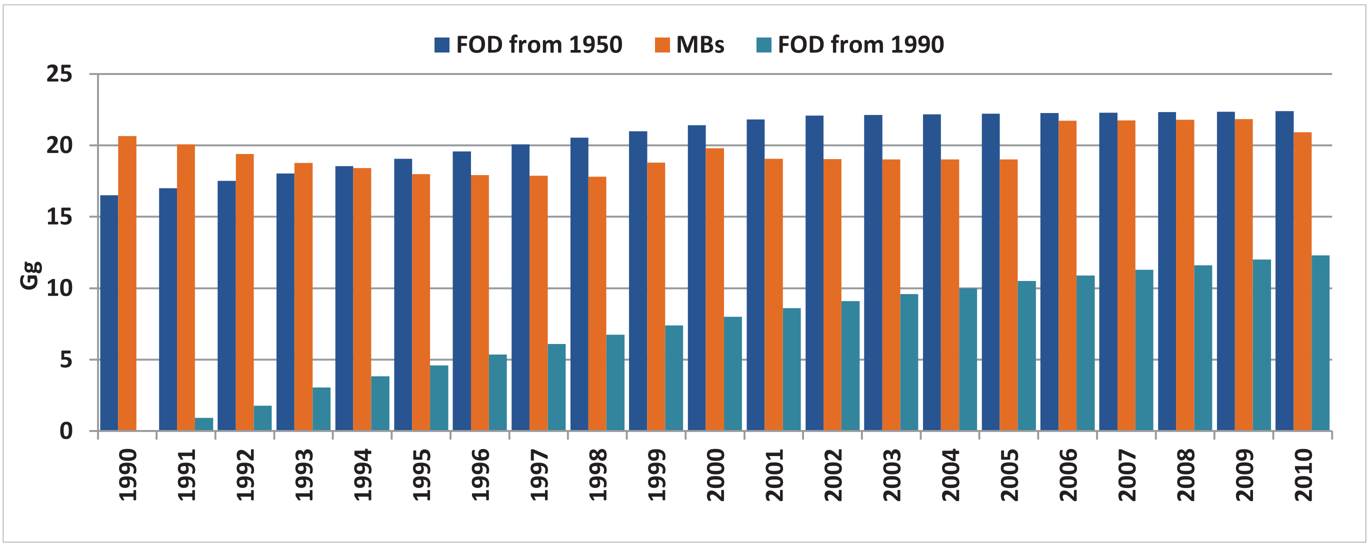

Figure 4.4.4 Calculation of Emission of Methane from Solid Waste by Various Methods, for 1990-2012

As this Graph shows, the annual aggregate quantities of methane over the period under consideration vary around the value range of 20 Gg CH_4. In 90-s, along with decrease in RA population, there was a parallel decrease in aggregate annual emissions. Further increase in annual emissions was due to change in morphological composition of SW as well as to slow population growth.

We can see from the Figure that when activity data entering starts since 1990, methane emissions by FOD method turn to be low for the period of 1990 - 2010. When entering activity data starts since 1950, the results turn to be comparable with those derived by MB method regardless high data uncertainties. It should be noted that the curve derived by FOD method is smoother which is due to the fact that calculation of methane emissions from the waste disposed to SWDSs during former years smooth down fluctuation of waste quantities for the given year.

Figure 4.4.5 describes methane emissions from SWDSs, according to above classification, separately for Yerevan, cities of Gyumri and Vanadzor, and 45 other towns of and urban settlements. In this case, due to absence of detailed information the calculation was merely done by MB method.

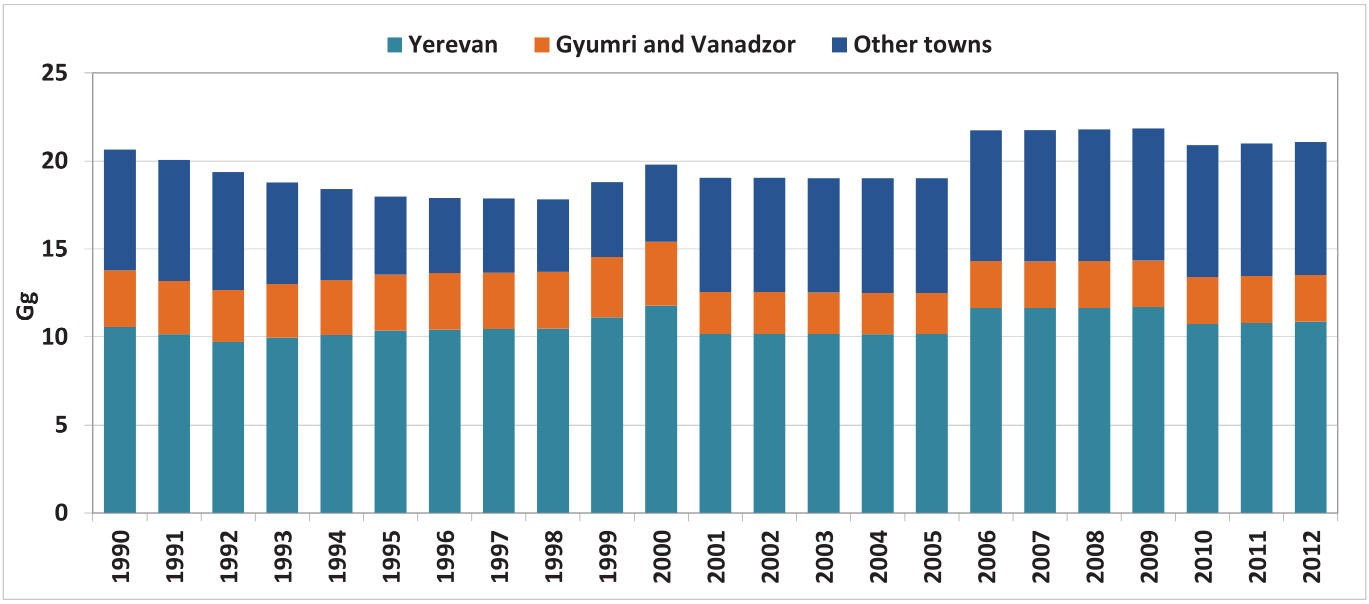

Figure 4.4.5 Emissions of Methane from Solid Waste, 1990-2012

Thus, demographic evolution of RA shows internal migration processes during the period of 2000 - 2010 as a result of which the population of small towns grows at the expense of rural population. This situation result in increasing fraction of methane emissions from SWDSs of 45 small town and urban settlements in aggregate annual emissions. The impact of methane capture project launched in “Nubarashen” SWDS in 2010 is also noticeable.

4.4.4.1.4 Time Series and their Consistency

According to 2006 IPCC Guidelines and 2000 IPCC GPG provisions [Gen-3] the acceptability of calculation results is assessed by their compliance with calculation logics of selected methodology, the realities established in the specific country of a specific activity, and parameter values used, and obtained results.

IPCC 2006 Guidelines provides for application of FOD Approach. Given the use of detailed data for a greater number of years required for FOD methodology and the absence of such data in Armenia, in this Report we have calculated methane emissions from SWs by using both methods. Figure 4.4.6 describes the population number and methane emissions from SW in Armenia - calculated by FOD and MB methods.

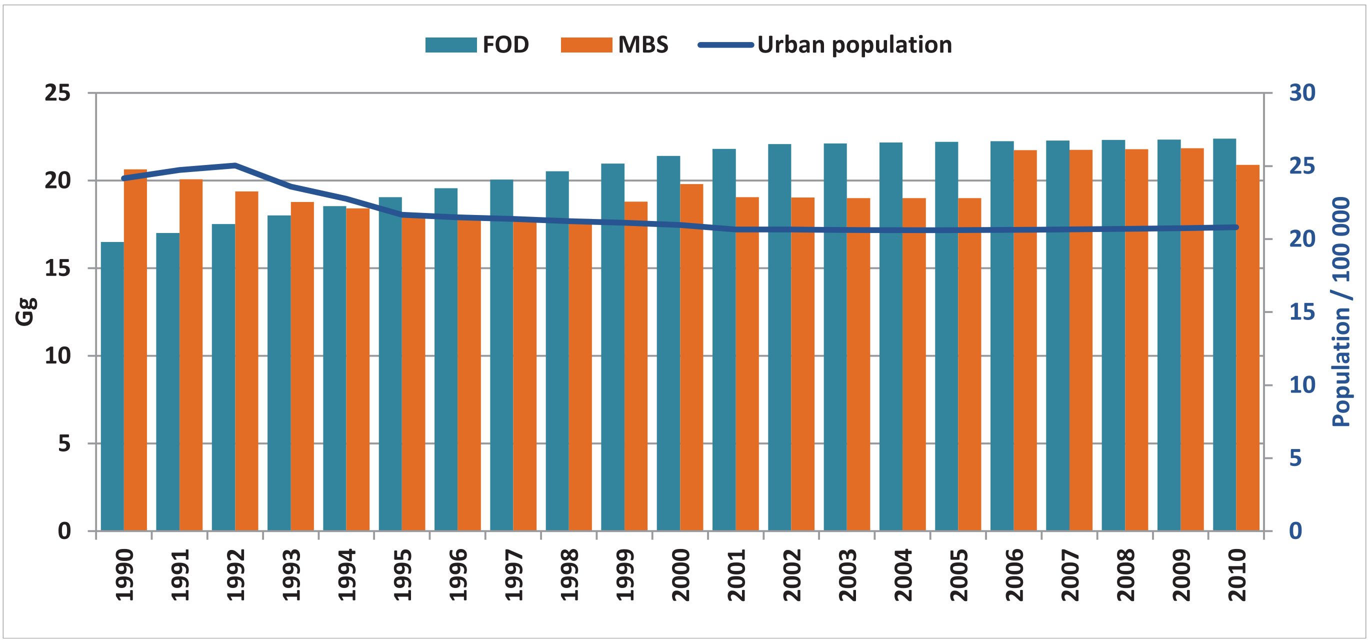

Figure 4.4.6 Emission of Methane from Solid Waste and Urban Population, for 1990-2010

As the curves show, over the period of 1990-2000 MB curve is closer to population number curve than to FOD curve. However, FOD curve for the period of 2000-2010 fully fits in population curve. We can assume that parameter uncertainties accepted for Soviet- time still have a big impact on years 1990-2000 data.

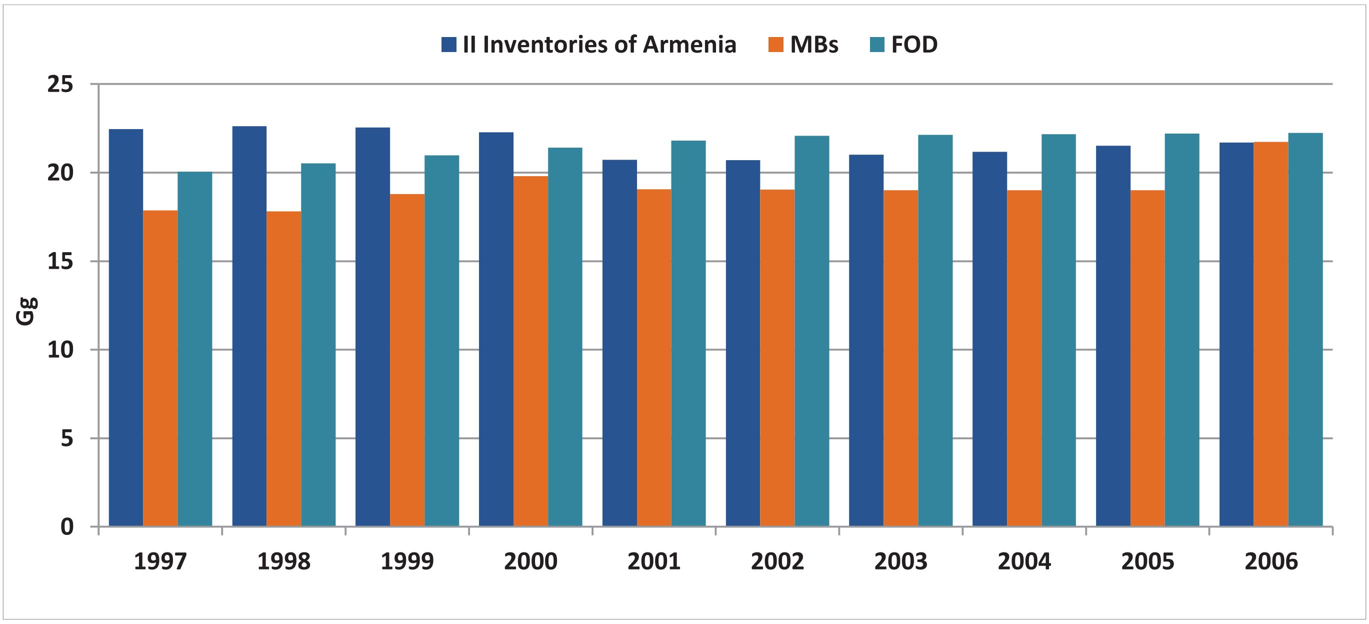

Figure 4.4.7 Methane Emissions for the period of 2010-2000: Calculation of Inventories Time Series

For assessment of time series consistency, IPCC provisions also require that the derived data should be compared with previously made assessments. Figure 4.4.7 describes calculation results of methane emissions from SWDSs of the II Inventory of Armenia for the period of 1997-2006 [WRef-2]. Same Figure also shows respective calculation results herein based on MB and FOD methodologies. As we can see, there are slight differences in said results. Differences in calculations made by MB method compared with 2000 Inventory are due to selection of SW generation factor. At that time said factor was selected as default factor for Armenia (0.79 kg/person/day). Let us remind that this Report has used default factor for Russia (0.661 kg/person/day).

4.4.4.1.5 Uncertainty Assessment

Assessment of uncertainties of calculation results based on methane emission “mass balance” methodology from SWDSs was made by uncertainties “range analysis” method for the entire period under consideration (see Figure 4.4.8.)

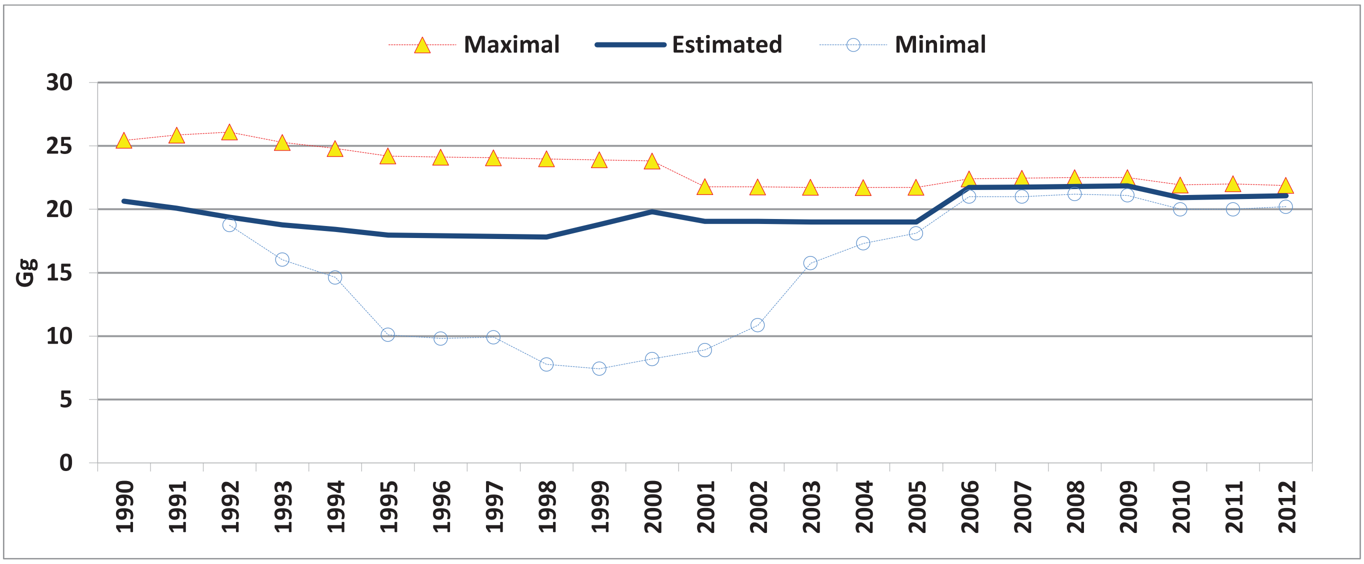

Figure 4.4.8 Comparison of Methane Emissions with Uncertainty Range

During uncertainty assessments we have taken 2006 IPCC Guidelines for uncertainties range specific for DOC calculation parameters, [Ref-1, WRef4 - WRef-8] study results (see Figure 4.4.8), as well as uncertainty assessment of input data for SW generation and disposal into SWDSs identified by studies [WRef-2, WRef-3]. Figure 4.4.9 shows uncertainties ranges of calculation results based on methane emission “mass balance” and FOD methodologies.

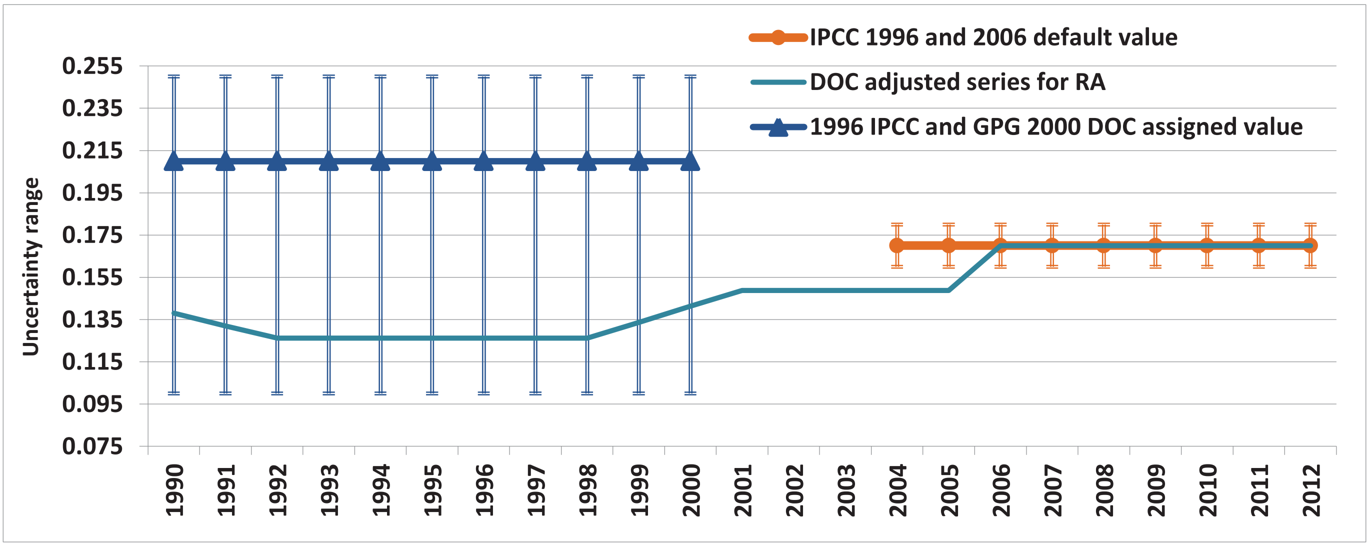

Figure 4.4.9 Uncertainty Rage of DOC Parameters

4.4.4.1.6 Quality Control, Documenting and Archiving

In calculations made for all Subsectors (4A “Solid waste disposal”; 4C2 “Open burning of solid waste”; and 4D “Wastewater treatment and discharge”) in “Waste” Sector we have conducted multiple checks and control on data about operations, definition of main calculation parameter values, as well as on quality and compliance of calculated results.

In each phase of calculations we have controlled the use of default values of main calculation parameters and their compliance with consequences due to realities of the country. We have developed time series of calculation results and checked their internal agreement, made and comparative analysis of results from previous phases.

We have used *Excel* spreadsheet to conduct arithmetical, mathematical and logical control over calculated results. Loading all data into IPCC Inventories Software is an additional specific phase for quality control of baseline data and calculated results after correction of all typos, as well as when certain typos have been found and corrected in IPCC Software.

All selected values of calculation parameters and the logics of this selection have been documented. All sources of baseline data used in calculations have been archived and listed.

4.4.4.2 Open Burning of Solid Waste, (4C2)

4.4.4.2.1 Selection of Calculation Methodology

According to 2006 IPCC Guidelines [Gen -I] in assessing emissions from solid waste in "Waste" Sector the range of "incineration and/or open burning of solid waste" operations should be considered - based on established and existing practices in the specific country (4C). The definition of "incineration" operation (4C1) here means burning of solid waste in special facilities, under controlled conditions, which usually is accompanied with a certain level of capturing of emitted GHG. Such operation is not available in Armenia.

"Open burning of solid waste" operation (4C2) is more peculiar for developing countries and is defined as burning of mostly solid waste (SW) by rural population in a specific country in uncontrolled technological conditions [Gen-1]. Let us note, that 2006 IPCC Guidelines recommend to consider primary GHG emissions (CO_2, CH_4, N_2O) in "incineration and/or open burning of solid waste" operation range. It also recommends to consider the following types under "solid waste", such us: municipal solid waste (MSW), domestic solid waste, sludge removed from wastewater treatment and discharge systems, dangerous waste, hospital waste.

The practices established in Armenia during two recent decades prove that we should consider only the range of operations for "SW open burning". By the way, at present there are no local, reliable and complete data in the country on parameters in regard to calculation of the emission quantities released from open burning of solid waste. There are also no local reliable data on the quantities of production and disposal of solid waste for several decades in regard to industrial solid waste, dangerous waste and hospital waste. Let us note that in Armenia solid waste disposal/treatment systems and the practices of "SW open burning" operations have undergone no changes over the period of 1990 - 2011.

According to 2006 IPCC Guidelines, in term of calculations for "Waste" Sector, assessment of primary GHG emissions from open burning of solid waste under Tier 1 methodology should be conducted by a number of calculation steps that are presented in the Guidelines [Gen-1].

4.4.4.2.2 Selection of Emission and Other Calculation Factors

Under this work only open burning of SW is considered. There are no relevant input data on the quantities of production and burning of other types of solid waste in the country.

Per capita SW generation factor (MSW_P, kg SW/person/day). According to 2006 IPCC Guidelines we should use the value of this factor which is used for assessment of methane emissions from SWDSs (see previous Chapter). **Fraction of SW in which carbon is converted to CO_2 (B_{frac}).** 2006 IPCC Guidelines default value for this parameter is taken - 0.6 [Gen-1].

Dry matter fraction in SW (dm_i). 2006 IPCC Guidelines default value for this parameter is taken - 0.78 [Gen-1].

Carbon fraction in SW dry matter (CF_i). 2006 IPCC Guidelines default value for this parameter is taken - 0.34 [Gen-1].

Fossil carbon fraction in total carbon content (FCF_i). 2006 IPCC Guidelines default value for this parameter is taken - 0.08 [Gen-1].

Oxidization factor (OF_i). 2006 IPCC Guidelines default value for this parameter is taken-0.58 [Gen-1].

4.4.4.2.3 Selection and Collection of Activity Data

Based on selected calculation methodology logics activity data in this Subsector are in fact demographic statistical data on population of the country - classified by urban and rural population.

Fraction of population burning solid waste (P_{frac}). According to provisions of Tier 1 Methodology of 2006 IPCC Guidelines the developing countries are recommended to select rural population of a specific country as such population.

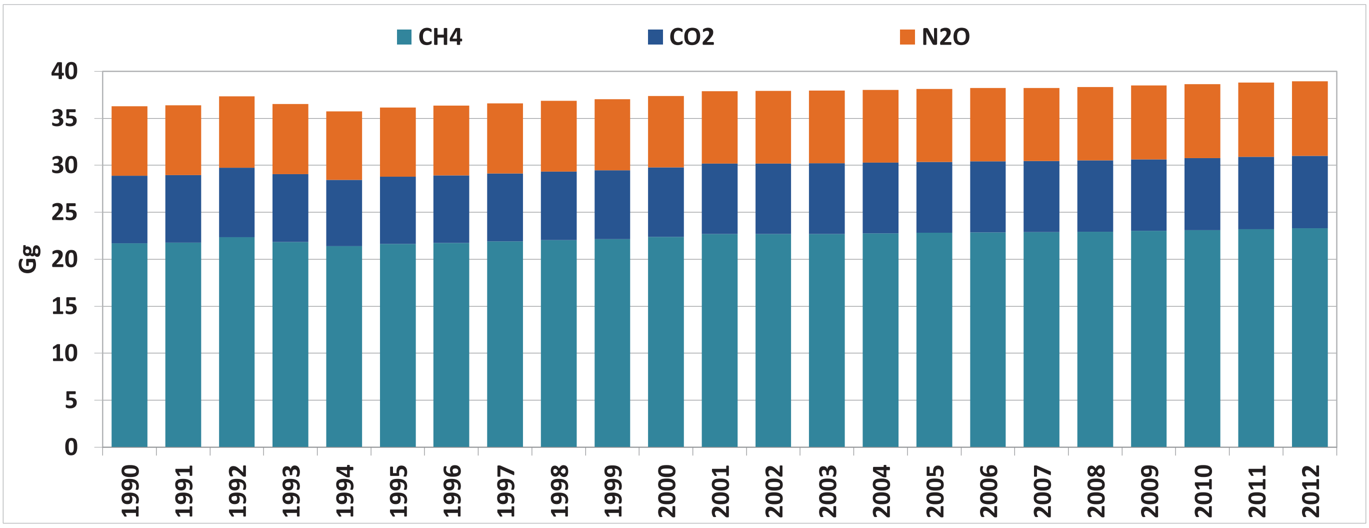

Figure 4.4.10 Primary Emissions of GHG (CO_2, CH_4, N_2O) from Burning of Solid Waste, Gg $CO_{2\ eq.}$

By using default values for above indicated calculation parameters and input data about operations we have calculated the quantity of primary emissions of GHG from SW open burning for the entire period under consideration (1990 - 2010, Gg $CO_{2\ equivalent}$) according to 2006 IPCC Tier 1 Methodology. The results are summarized in Figure 4.4.10. Calculations are made separately by using *Excel* spreadsheet as well as by IPCC Software. Methane emissions account for the greater part (60%) of aggregate quantities of GHG emissions released from open burning of solid waste. Direct CO_2 emissions as well as nitrous oxide emissions amount to about 20% each of the general balances.

4.4.4.2.4 Time Series and their Consistency

According to provisions of 2006 IPCC Guidelines and of IPCC 2000 GPG the acceptability of calculation results is assessed in two main directions in terms of all series of the time-period under consideration. Firstly, the results should comply with calculation logics of the selected methodology - specific for given sector (subsector), and secondly - parameter values used should match the realities established in a specific country for a specific operation.

In terms of methodology, selection of Tier 1 Approach for assessment of GHG primary emissions released from SW open burning fully comply with provisions of 2006 IPCC Guidelines according to which this method is applicable to countries that are lack of complete information about activity data and there is no access to local values of calculation parameters.

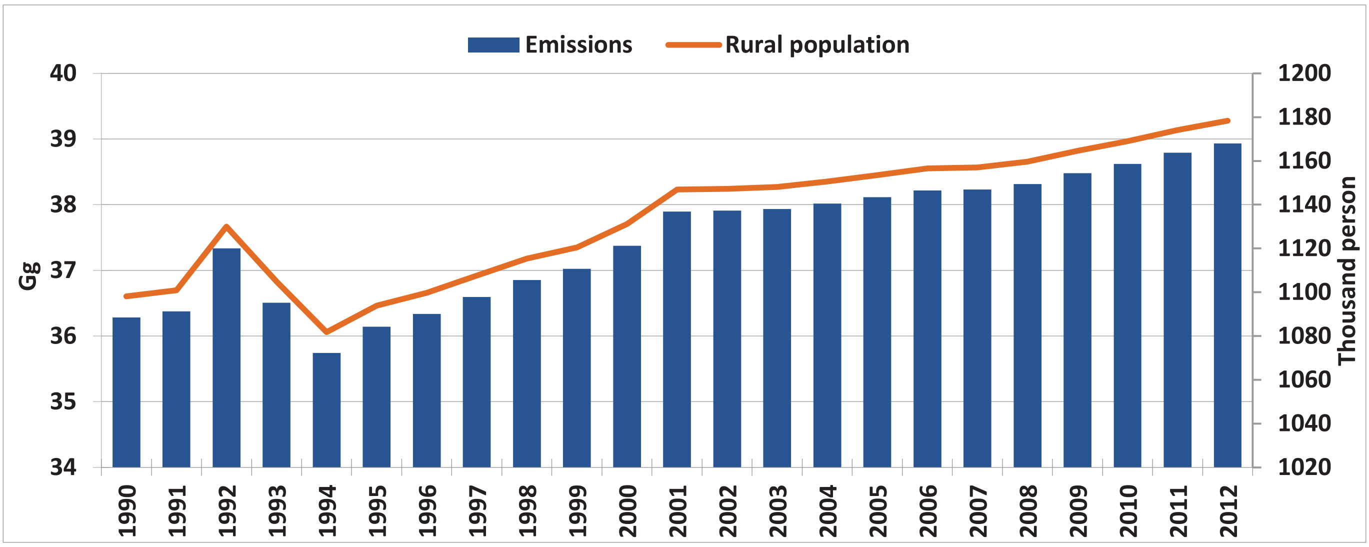

Figure 4.4.11 Rural Population in RA and Primary Emissions of GHGs from Burning of Solid Waste, Gg $CO_{2\ eq.}$

In Figure 4.4.11 GHG primary emissions from SW open burning follow the number of rural population for 1990-2010 time-period and hence the consistency of obtained results of time series cannot be disputed. Moreover, as no calculations of GHG primary emissions released from SW open burning are conducted during previous studies then there is no need of consistency in this phase.

4.4.4.2.5 Uncertainty Assessment

For uncertainty assessment of calculated results for GHG primary emissions (Gg $CO_{2\ equivalent}$) from SW open burning, we have used their default values: +/- 40% for CO_2 emissions from open burning; +/- 10% for CH_4, N_2O emissions from open burning [Gen-1].

4.4.4.3 Wastewaters (4D)

1996 IPCC Revised Guidelines [Gen-2] provided for separated calculation of emissions released from wastewater and sludge to be made by separate equations and in separate data flows. 1996 IPCC Guidelines [Gen-1] provided for unified approach as emissions from both wastewater and sludge are generated by same mechanism and no separate equations are required.

In addition, the new Methodology [Gen-1] provides for a new source - “methane emissions from uncollected wastewater” which is important for Armenia and needs to be considered. This Methodology also introduces the source for “nitrous oxide (N2O) emissions from existing wastewater handling systems” which in fact practically does not exist in Armenia. This refers to assessment of CH_4 emissions from operation of septic tanks and latrines in “domestic and commercial wastewaters” Subsector.

4.4.4.3.1 Methane Emission from Domestic and Commercial Wastewaters, (4D1)

4.4.4.3.1.1 Selection of Calculation Methodology

According to 2006 IPCC Guidelines, assessment of methane emissions from domestic and commercial wastewater and methodology selection should be done for different groups of population (urban, rural and/or high, medium and low income population groups) in terms of types of discharge/treatment systems existing in the country.

The practices established in the Republic of Armenia for discharge/treatment of domestic and commercial wastewaters are not changed over the period of 1990-2012. In small and medium-size towns domestic and commercial wastewaters are discharged into the existing sewer system, in rural areas - into latrines and holes. Over the recent 20 years there has been no centralized biological treatment of domestic and commercial wastewater, sludge removal and methane capturing.

The available, more reliable and complete baseline data sources for estimation of methane emissions from domestic and commercial wastewaters are as follows: publications by the National Statistical Service of Armenia on demographic statistics of the country; Population Census 2001 and 2011; and data from Water Resources Management Agency under the Ministry of Nature Protection of Armenia.

We have selected Tier 1 approach given the scarcity of national reliable information and in accordance with methodology selection diagram [Gen-1] in "Waste' Sector of 2006 IPCC Guidelines for estimation of methane emissions from domestic and commercial wastewaters. Thus, emission calculations are based on default values for emission factors recommended in this Guideline.

According to 2006 IPCC Guidelines, estimation of methane emissions from domestic and commercial wastewaters shall be made in three calculation phases that are based on equations 6.1, 6.2, 6.3 (see:[Gen-1], Volume 5).

4.4.4.3.1.2 Selection of Emission and Other Calculation Factors

We have used the default values for emission and for other factors for calculation of IPCC methane emissions in this subsector.

Maximum Methane Producing Factor: Bo = 0.6 kg **CH_4**/kg BOD = BOD

Discharge factor of organic waste of non-domestic (production and/or industrial) origin in domestic sewer: I = 1.25 for collected and **I** = 1.00 for uncollected domestic and commercial wastewaters.

Country-specific quantity of per capita organic matter in domestic/commercial wastewaters: Bod = 18250 kg/1000 person/year (which is equal to 50 g/person/day). 2006 IPCC Guidelines does not recommend any values for the selection of this calculation parameter for Armenia, South Caucasian countries or former USSR Republics. For that reason default values recommended by 1996 IPCC Revised Guidelines [Gen-2] for former USSR Republics are used.

Sludge removal and methane capturing. **S** = **R** = 0, as in Armenia no sludge is removed and no methane is captured from domestic and commercial wastewaters.

4.4.4.3.1.3 Selection and Collection of Data about operations

Based on the logics of 2006 IPCC Tier 1 calculation methodology, activity data in this Subsector are in fact statistical data on population of the country -classified in parallel by urban and rural population, and by the type of wastewater discharge[WRef-9, WRef-10]. For purposes of calculation in this Subsector the population of Armenia was classified by large cities (Yerevan, Gyumri, Vandzor), other urban population (other 45 town and urban settlements of Armenia), and rural population - as per data received from NSS of RA.

For developing countries 2006 IPCC Guidelines recommend considering urban population with large, centralized and ramified sewer system as population group with high income, urban and other population - as medium income population, and rural population - as low income population [Gen-1].

Further, 2006 IPCC Tier 1 calculation methodology requires classification of domestic and commercial wastewaters discharge/treatment schemes by population groups. Given the default values of the Guidelines and based on practices established in the RA for discharge/treatment of domestic and commercial wastewaters the following classification is made for further calculations:

- **Large Cities** (Yerevan, Gyumri, Vanadzor): sewer system - 0.95 (95%), public and other latrines - 0.05 (5%),
- **Other towns of the country:** sewer system - 0.5 (50%), public and other latrines - 0.5 (50%),
- **Villages:** sewer system - 0.05 (5%), public and other latrines - 0.95 (95%).

In compliance with 2006 IPCC Tier 1 Methodology requirements and given the natural and physical peculiarities of domestic and commercial wastewaters discharge/treatment schemes 0.1 default value of MCF_J factor was selected for removals though sewer system which complies with removal of collected and untreated domestic and commercial wastewaters that are eventually discharged in rivers, lakes and river mouths.

In the case of latrines value 0.1 was also selected for MCF_l factor which complies with areas with arid climate where the level of subterranean water is below the depth of latrines or holes of households of 3-4 residents [Gen-1].

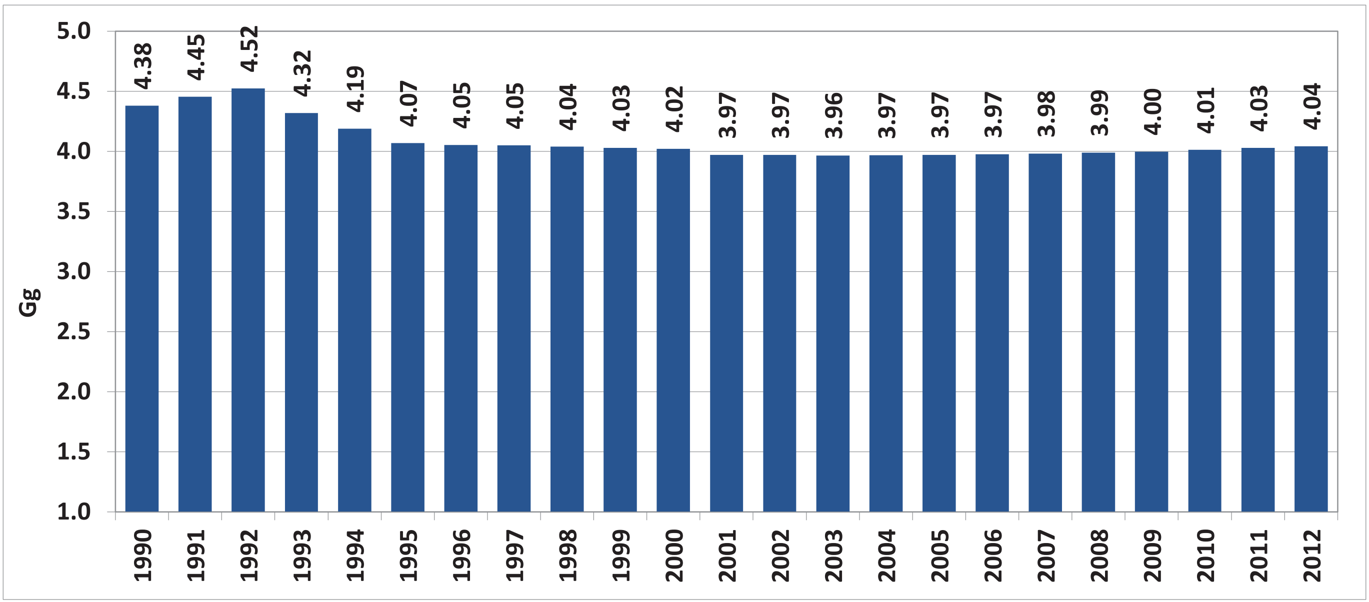

Figure 4.4.12 Emission of Methane from Domestic and Commercial Wastewater, 1990-2012

The results of calculated methane emissions are presented in Figure 4.4.12 for the entire period under consideration (1990-2012). Calculations are done by using *Excel* spreadsheet as well as by special IPCC Software.

Significant changes in the quantity of emissions in early 90s were mainly due to intensive migration processes in the country over that period. Over the period of 1998-2012 methane emission from domestic and commercial wastewaters is stabilized - about 4 Gg CH_4.

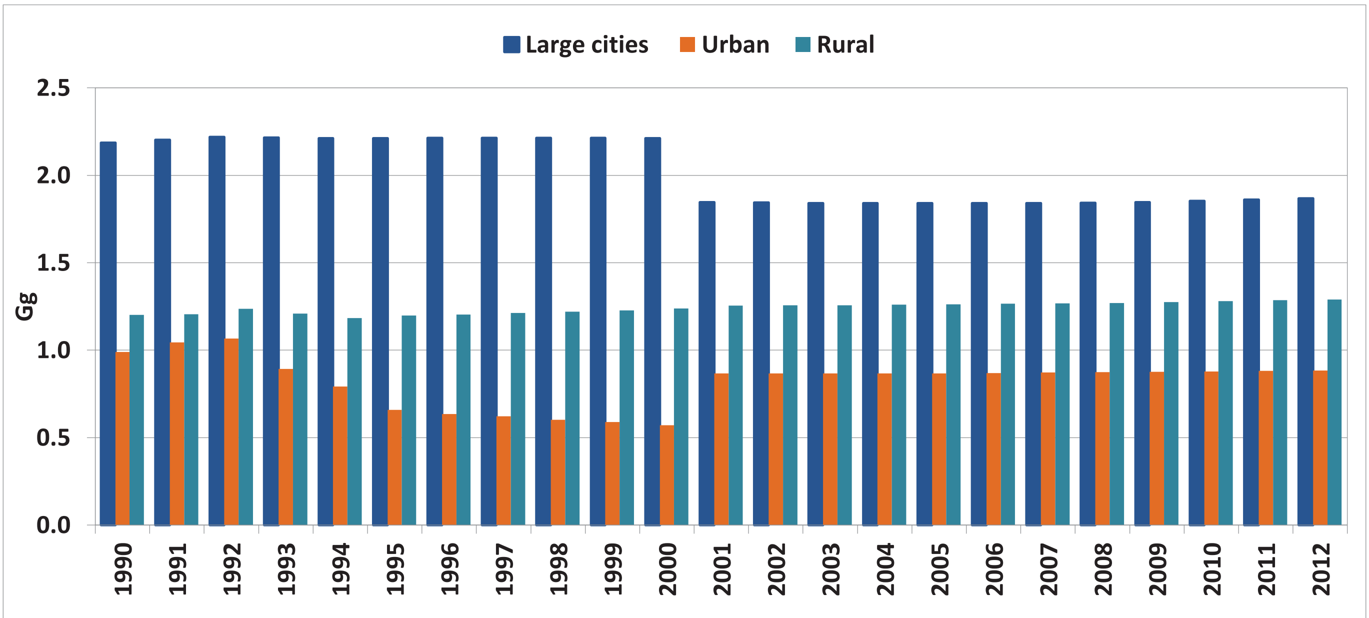

Figure 4.4.13 Methane Emission from Domestic and Commercial Wastewater, by Population Groups, for 1990-2012

The used calculation scheme - done by *Excel* spreadsheet - enables to clearly see the dynamics of methane emission quantities from domestic and commercial wastewaters by the country's population groups: population of large cities (Yerevan, Gyumri, Vanadzor), urban population (other 45 towns and urban settlements of the country), and rural population.

For the entire period under consideration large cities are the key sources of methane emission from domestic and commercial wastewaters, Figure 4.4.13. Rural population of the country is the other important source. Significant changes in the quantity of emissions over 2000 - 2010 period was due to finalization of Population Census results [WRef-9] which corrected the number and structure of population of the country.

Figure 4.4.14 describes break-down of emissions from said sources in annual total methane emissions from domestic and commercial wastewaters. For the entire period under consideration methane emission from urban sewer systems has exceeded 50% threshold of annual total emissions.

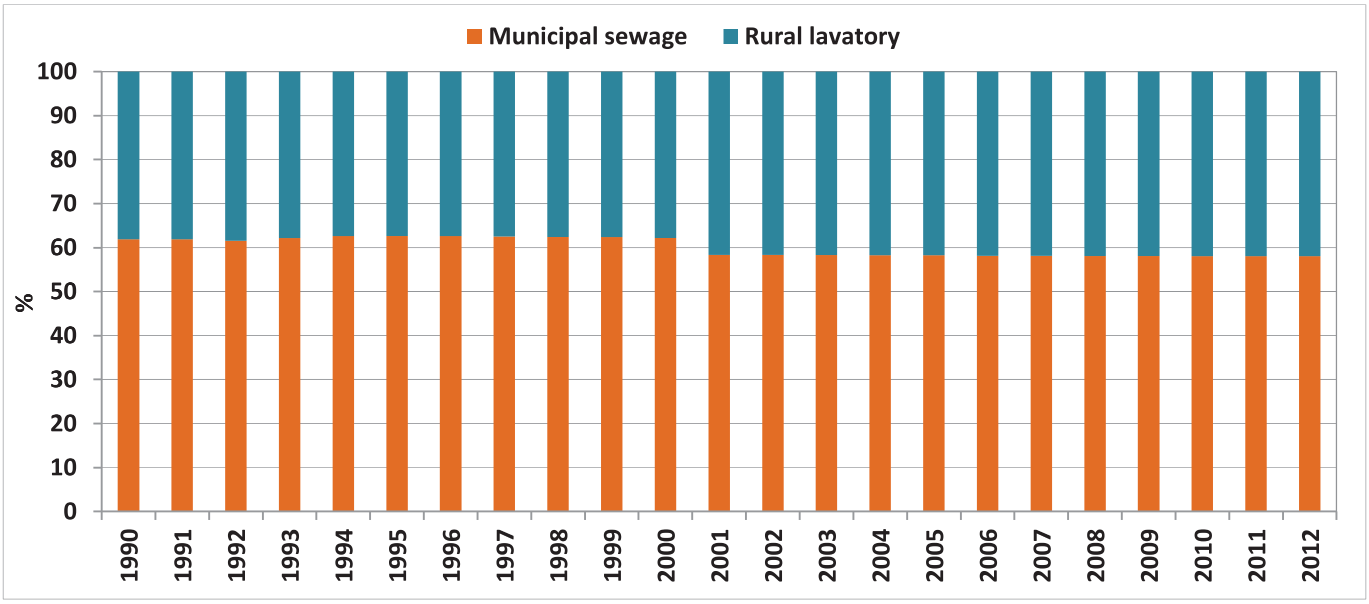

Figure 4.4.14 Methane Emission from Domestic and Commercial Wastewater Sector by Sources

4.4.4.3.1.4 Time Series Consistency

Selection of Tier 1 approach for estimation of methane emissions from domestic and commercial wastewaters fully complies with 2006 IPCC provisions according to which this method is applicable to the countries that are lack of complete information about operations, and there is no access to local values of calculation parameters. This approach was also applied to all former studies conducted in Armenia [Ref-2, Ref-3].

Furthermore, default values used for calculations and other parameters, domestic wastewater removal schemes in particular, and factor values due to their peculiarities comply with the country’s climatic and physical conditions and established practices.

Calculation logics of the applied approach assume that obtained data on the quantity of methane emissions from domestic and commercial wastewaters should follow the evolution of country’s population over the period under consideration. In 1992-1994 there was a decrease in the number of population, while change in population number in 2001 was due to correction made as a result of Population Census. In 2007-2012 there was gradual increase in emissions which was the result on urban population growth.

As we can see, the consistency of obtained results of time series cannot be disputed.

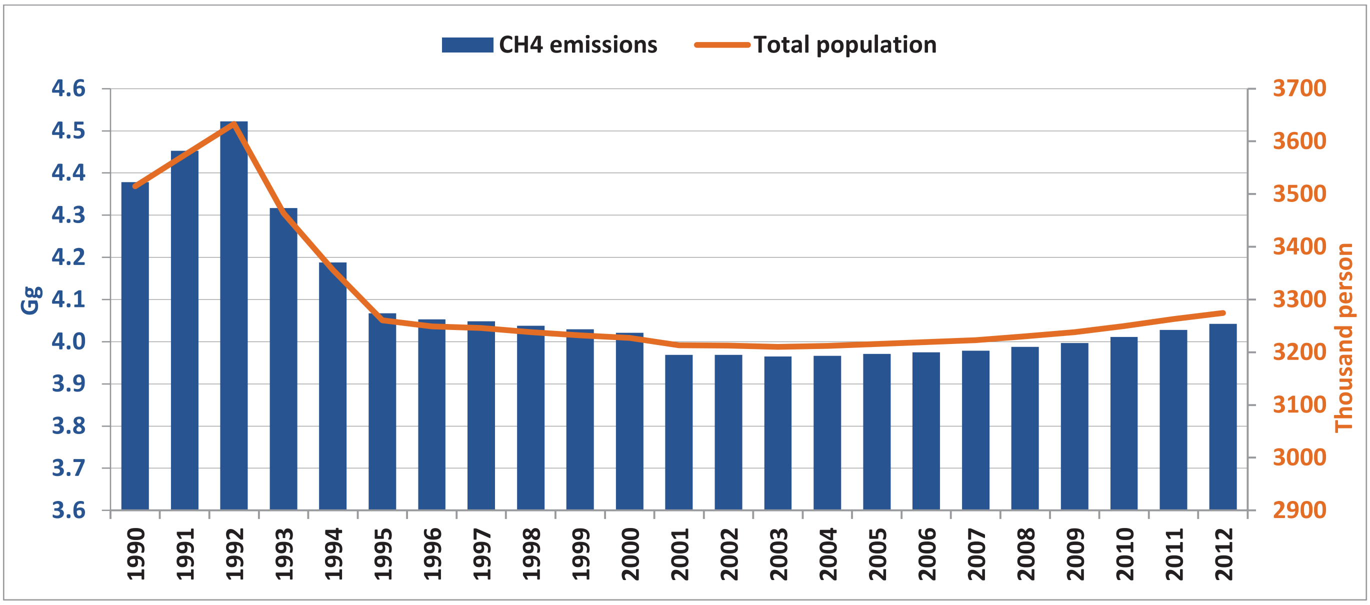

Figure 4.4.15 Evolution in Emission of CH_4 from Domestic and Commercial Wastewater and Population

Table 4.4.3 describes the II National Inventory (2009) result [Ref-3] for methane emissions from domestic and commercial wastewaters for the period of 1997-2006, and calculation results of the study herein. As we can see, the results differ significantly, particularly for the period of 1999-2003. In particular, significant change in annual quantities of emissions over the specific period is peculiar for the result of the former phase. Maximum, peak emissions are recorded in baseline 2000 year (4.21 Gg CH_4).

Table 4.4.3 Emission of Methane from Domestic and Commercial Wastewater (Gg CH_4)

Years	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Estimation	4.048	4.038	4.029	4.021	3.969	3.969	3.965	3.967	3.971	3.975
RA II GHG NI [3.3]	1.95	1.55	2.31	4.21	2.64	3.02	2.26	1.51	1.51	1.51

It should be noted, that we have used respective default values of IPCC Revised Guidelines for the first three calculation parameters - BOD, MCF, Bo. At the same time according to the Work Book of 2006 IPCC Revised Guidelines 0.25 kg CH_4/kg BOD was selected for Bo parameter, while 2006 Guidelines recommend the default 0.6 kg CH_4/kg BOD.

During 2000 Inventory we have used various factors by years for the fraction of wastewater sent for treatment over the time period of 1999 - 2006. These values are in 1996 Revised Guidebook in the range recommended for former USSR Republics, but according to expert assessments they vary from 0.34 to 0.71 which has a serious effect on the values of emission factors. In this Inventory a constant emission factor is more acceptable for recalculation.

Uncertainty assessment of calculated results for methane emissions from domestic and commercial wastewaters was conducted in accordance with uncertainty default values of 2006 IPCC Guidelines [Gen -1](Annex 1, Table A.1.7)

The asymmetry of uncertainty range of emission quantities is mainly the result of asymmetry of uncertainty range peculiar for default value of MCF parameter for sewage flowing into rivers and lakes [Gen-1].

4.4.4.3.2 Methane Emission from Industrial Wastewaters, (4D2)

4.4.4.3.2.1 Selection of Calculation Methodology

According to “Waste” Sector in 2006 IPCC Guidelines [Gen- 1] if industrial wastewater is not treated on-site and is discharged in domestic sewer system then said wastewater should be considered in “domestic and commercial wastewaters” subsector (see previous Chapter).

In the Republic of Armenia, during the last two decades industrial wastewater from a number of large businesses (e.g. Arzni and Lusakert Poultry Farms, Yerevan Wine Factory, “Ararat” Cognac Factory, “Avshar” Wine and Cognac Factory, Artashat Canned Food Plant, etc.) is discharged to isolated sewer system without treatment. Industrial liquid waste from small and medium manufacturing enterprises is discharged either in isolated sewers or to common domestic sewer system. In addition, currently there is no system of collection of reliable and complete data in the country on the quantities, composition and other parameters of generated industrial wastewaters. Industrial wastewater treatment practices have undergone no changes over the period of 1990 - 2011.

The source of more reliable and complete baseline data available in the country for estimation of methane emissions from industrial wastewater is the information collected by NSS on the quantities of manufactured certain product types which are regularly published in NSS Data Sheets since 2002. An additional source for input data is “Water Use and Sanitation” Sector in “Environment and Natural Resourced of Armenia” annual Yearbook published by NSS since 2003.

Tier 1 approach was selected for this Subsector given the absence of information on national values for emission factors, absence of data on detailed operations, and default values in “Waste” Sector of 2006 IPCC Guidelines are used for emission factors.

According to 2006 IPCC Guidelines estimation of methane emissions from industrial wastewaters should be made in three calculation phases that are based on equations 6.4 -6.6 (see:[Gen-1], Volume 5).

4.4.4.3.2.2 Selection of Emission and Other Factors

The following default [Gen- 1] values of emission and other factors are used for calculation of methane emission of this Subsector - by IPCC Tier 1 Methodology:

Methane Correction Factor (MCF) = 0.1, which complies with collected, untreated industrial wastewater discharged in rivers, lakes and river moths.

Maximum Methane Generation Factor: **Bo** = 0.25 kg CH_4/kg COD.

4.4.4.3.2.3 Selection and Collection of Data about Operations

In compliance with 2006 IPCC provision, the quantity of annually manufactured product types in a sector of industry with industrial wastewaters containing organic waste should be used for Tier 1 Methodology as baseline data about operations in “industrial wastewater” Subsector. 2006 IPCC Guidelines recommend considering a number of product types along with their respective calculation factors and default values that are presented in Table 4.4.4 about operations.

Table 4.4.4 Values of Calculation Factor for Emission of Methane from Industrial Wastewaters, by Type of Operation

Product Types	Wastewater generation, Wi, (cubic m/t)	Chemical Oxygen Demand, COD_i , (kg/ cubic meter)
Milk, dairy products, cheese included	7	2.7
Fruit, canned vegetables, juices	20	5.0
Alcoholic drinks, spirits	24	11.0
Paper and cardboard	162	9.0
Meat, meat products, canned meat	13	4.1
Beer	6.3	2.9
Wine, champagne	23	1.5
Detergents and starching substances	9	10.0
Plastics	0.6	3.7
Vegetable or other oils	3.1	0.5
Soap	1.0	0.5
Processed fish, canned food	8	2.5

Source: (2006 IPCC, v.5, Chapter.6, Table 6.9)

Data-sheets on "Manufacturing of Main Product Types by Industrial Enterprises in Real Values" Published by NSS of RA [WRef-15 - WRef-24] are the available and reliable source of information about industrial sector that are regularly published since 2003. We have used NSS [WRef-25 - WRef-28] sources for real quantities of products for years 2000 - 2002.

We have calculated for 2000-2011 the annual manufacturing quantities of 33 product types [WRef-15 - WRef-28] with wastewater containing organic waste for estimation of methane emission from industrial wastewaters.

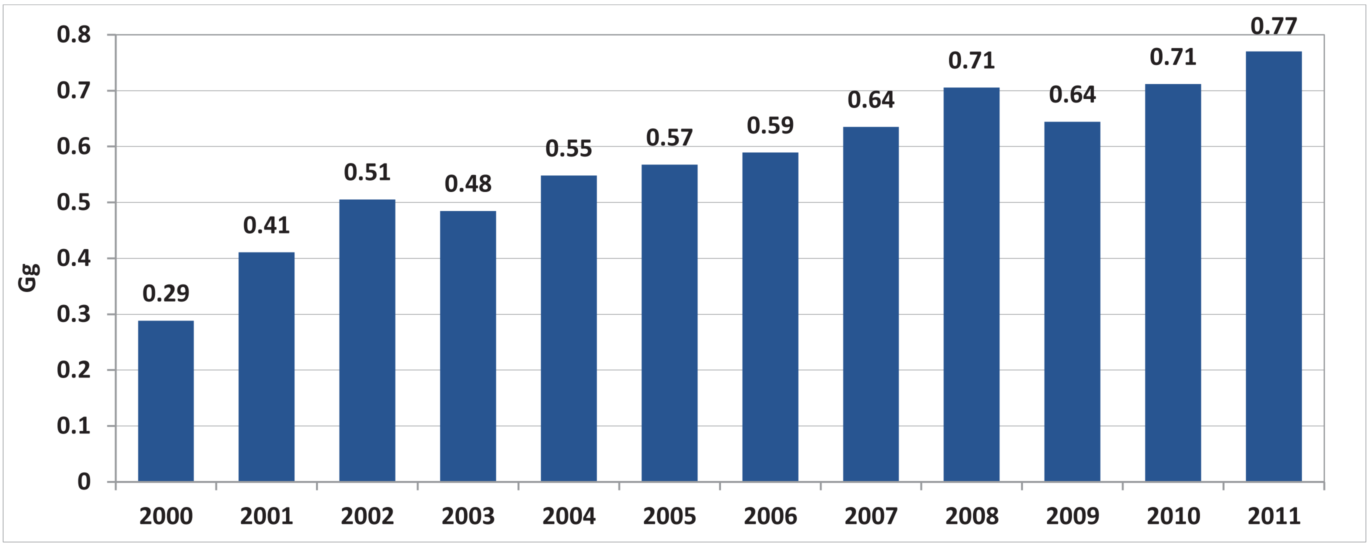

Figure 4.4.16 Methane Emission from Industrial Wastewaters, 2000-2011 (Gg)

Calculation results of methane emissions from industrial wastewater is summarized in Figure 4.4.16.

As we can see from this Figure methane emissions from industrial wastewater for the period of 2000 - 2011 show sustainable growth-from 0.29 Gg CH_4 (in 2000) to 0.77 Gg CH_4 (in 2011).

The exceptions are years 2003 and 2009 where emission values are lower than previous years' indicators. For the former this phenomenon was due to unfavorable years for agriculture and food industries. For the latter - it was due to global financial crisis in 2008-2009. This fact proves that estimations and calculations are consistent with country's existing realities.

Figure 4.4.17 describes fraction of calculated product types in CH_4 total emissions from industrial wastewaters, for 2000-2011.

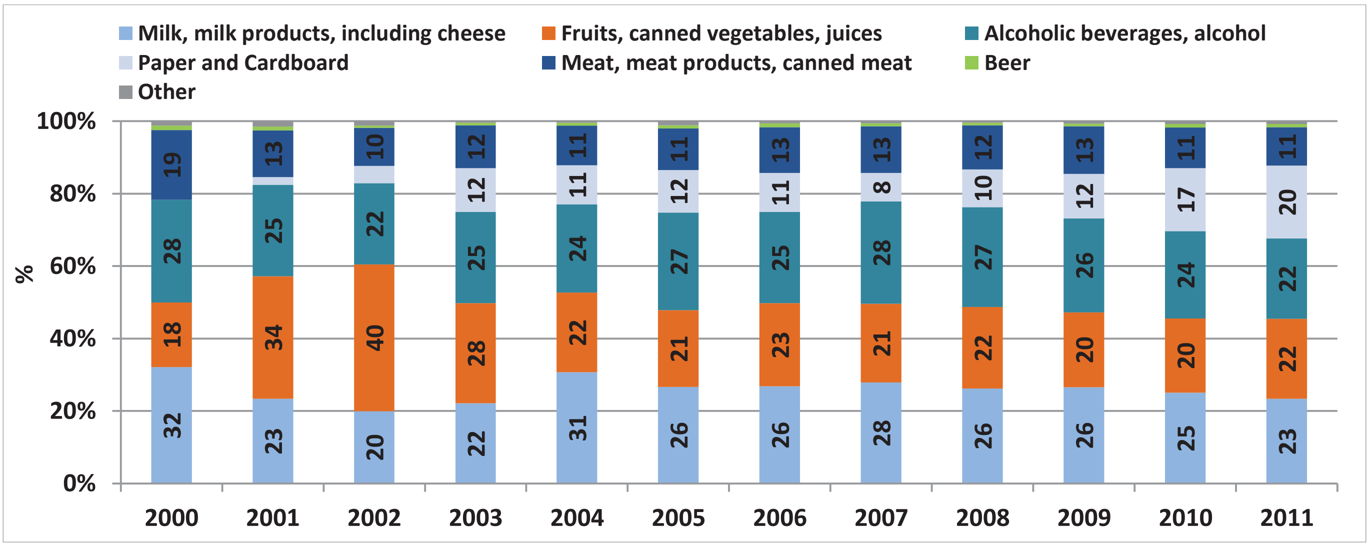

Figure 4.4.17 Fraction of Calculated Product Types in CH_4 Total Emissions from Industrial Wastewaters, 2000-2011 (%)

4.4.4.3.3 Time Series and Their Consistency

According to provisions of "Waste" Sector in 2006 IPCC Guidelines [Gen- 1] and IPCC 2000 GPG [Gen- 3] the consistency of calculation results shall be assessed in two main directions - in terms of all series for the period under consideration.
Tier 1 approach was selected for estimation of methane emissions from industrial wastewaters for the respective sector of GHG NI of RA. Same approach was applied to all former calculations [Ref-2, Ref-3,].
Figure 4.4.18 shows calculated quantities (in Gg) of methane emission from industrial wastewaters in parallel with annual total (in thousand ton) manufacturing of 33 product items for the period of 2000-2011. As we can see from the Figure, the quantities of methane emissions strictly follow the annual total manufacturing rates.

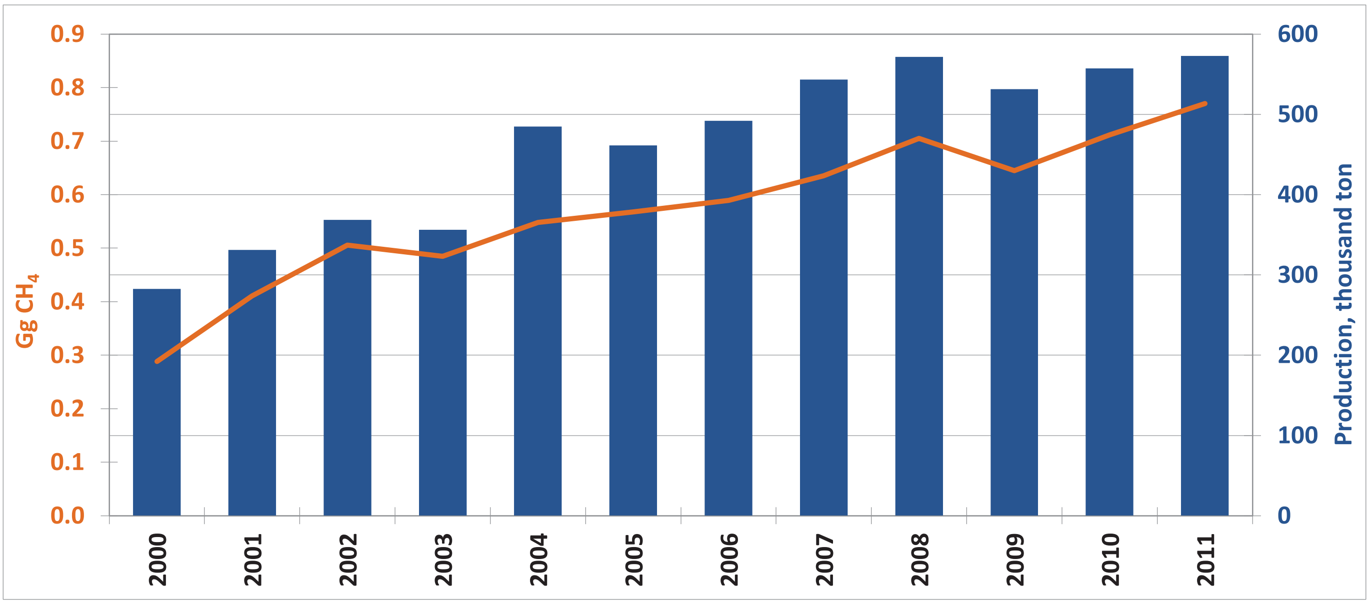

Figure 4.4.18 Methane Emission from Industrial Wastewaters and Annual Total Manufacturing of 33 Product Items under Study

Moreover, input activity data reflect significant general changes (general reduction in manufacturing industry in 2008-2009 caused by global financial crisis, or unfavorable year 2002 for agriculture and food production) in manufacturing industry and economy of the country over the period of 2000-2011.

Besides, input data also consistently reflect local peculiarities, for example: rapid increase in cheese production in 2003-2004 which was the result of the start of counting private small and medium cheese producers, fall of cognac production in 2009 post-crisis year, or rapid paper and cardboard production increase over the period under consideration.

In this case as well as in the case of domestic and commercial wastewater, in calculation of the II Inventory different emission factors are used for each individual year. Therefore, like it was in the case of domestic wastewater, recalculation for said years is justified and delivers more logical data for industrial liquid waste as well.

4.4.4.3.4 Uncertainty Assessment

Uncertainty assessment for calculation results of methane emissions from industrial wastewater is conducted by "range analysis" method for the entire period under consideration (see Figure 4.4.19).

We have used uncertainty range of default values of main calculation parameters as defined in 2006 IPCC Guidelines, Volume 5, Chapter 6.

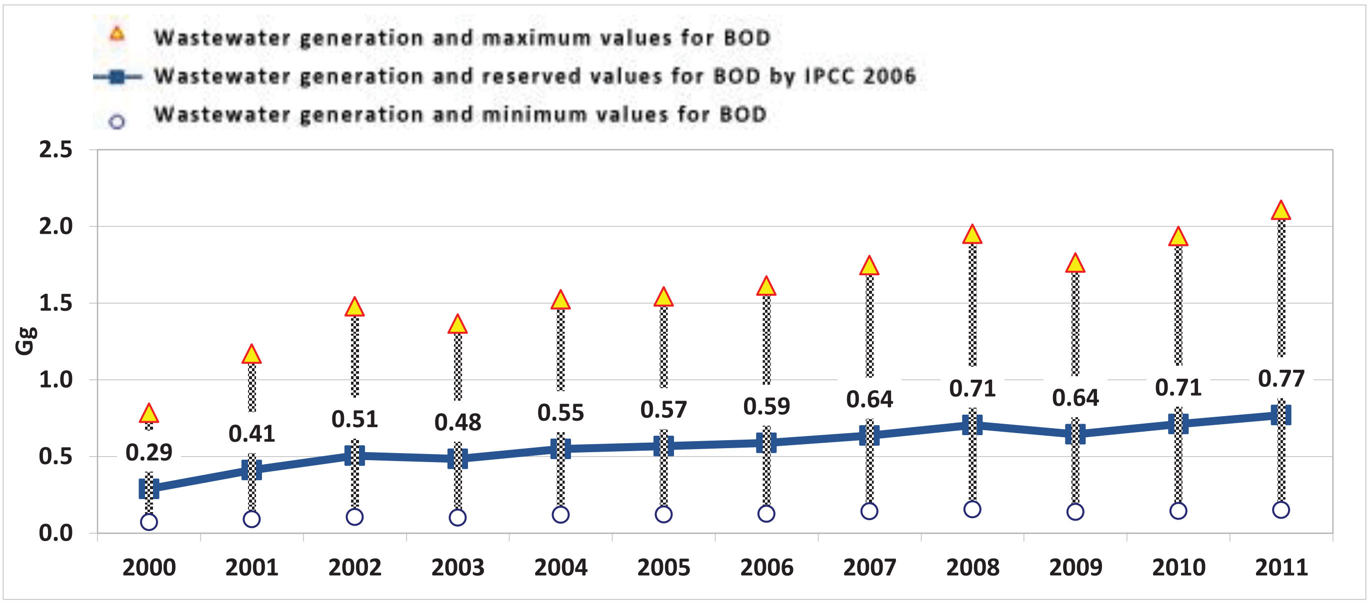

Figure 4.4.19 Uncertainty Rage for CH_4 Emission from Industrial Wastewaters, 2000-2011 (Gg)

The asymmetry of uncertainty rage of emission quantities described in Figure 4.4.19 is mainly the result of asymmetry of uncertainty ranges peculiar for default value of COD (CODi) parameters for industrial wastewater [Gen-1].

4.4.5 Emission of Nitrous Oxide from Liquid Waste

4.4.5.1 Selection of Calculation Methodology

2006 IPCC Guidelines recommends for calculation of N_2O emissions from liquid waste similar approach for both developed and developing countries which are based on total number of population of a country and per capita protein consumption. Thus, there is no methodology selection phase for estimation of emissions in this sector.

For calculation purposes, N_2O emissions from wastewater is estimated by two calculation phases - by using equations 6.7 and 6.8 [Gen-1].

4.4.5.2. Selection of Emission and Other Factors

Default values as follow are selected as calculation and emission factors in calculations herein:

N_2O Emission factor: $EF_{EFFLUENT}$ = 0,005 **kg N2O-N**/ kg **N.**

Fraction of nitrogen in protein: **$F_{NON-CON}$ = 0.16** kg **N**/kg protein).

Fraction of non-consumed protein in wastewaters: F_{NPR} = 1,40. (This default value is recommended for countries with waste collection).

Fraction of protein of industrial and commercial origin discharged in sewer: **$F_{IND-COM}$** = 1,25. **Fraction of nitrogen removed as Sludge**: **N_{SLUDGE}** = 0. Removal of sludge from wastewater is not considered here -as well as in previous two sections on wastewaters.

Per capita protein consumption in a specific country in a specific year: **Protein** (kg/person/year). The value of this calculation factor is of fundamental importance for estimation of N_2O emissions. In calculations this by-emissions-factor (along with the number of population) reflects the peculiarities of a specific country.

In this regard, for estimation of N_2O emissions from liquid waste 2006 IPCC Guidelines recommend the countries to use UN FAO per capita protein consumption factor over a specific period. For Armenia FAO gives averaged figures for the periods of 1990-1992, 1995-1997, 2000-2001, 2006-2008. The data are interpolated for interim years, while they are extrapolated for years 2009 - 2010.

4.4.5.3 Selection and Collection of Data about Operations

Data on the number of population for 1990-2012, fundamental for this Subsector, are collected and analyzed by using more reliable and complete source - demographic report of RA NSS as well as Population Census 2001 and 2011 [WRef-9, WRef-10].

We have calculated the quantity (Gg) of N_2O emissions from liquid waste according to 2006 IPCC Guidelines based on above indicated default values of calculation parameters and baseline data about operations (1990 - 2010). The results are summarized in Figure 4.4.20.

Calculations are made by using *Excel* spreadsheet as well as by special IPCC Software.

4.4.5.4 Time Series and Their Consistency

According to provision provided for in "Waste" Sector of 2006 IPCC Guidelines and IPCC 2000 GPG the acceptability of calculation results is assessed in two main directions in terms of all series of the time-period under consideration.

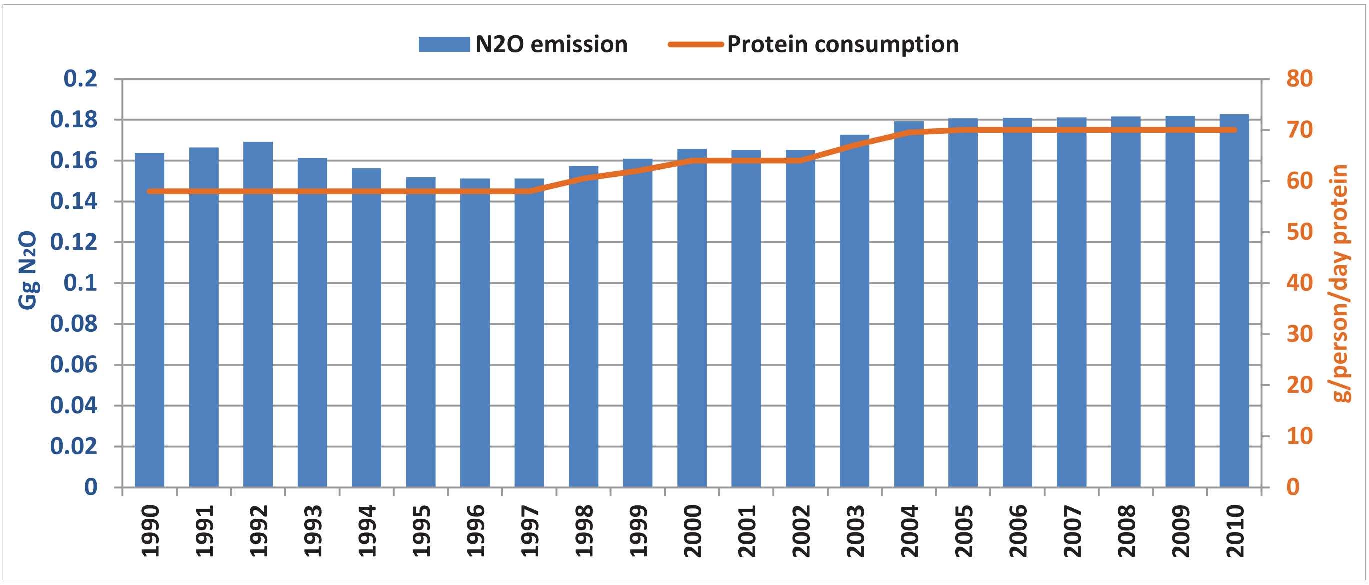

Figure 4.4.20 Emission of Nitrous Oxide from Liquid Waste and Protein Consumption in Armenia

As we can see from the figure, the emission curve fits in protein consumption and the population number curves.

Thus, estimation of N_2O emissions from wastewaters is fully consistent with provisions and calculation logics provided for in 2006 IPCC Guidelines. Due to unavailability of FAO data on protein consumption in Armenia, the indicator for Middle East - 0.76 g/person/day was used in the II Inventory Report of Armenia which is close to global average indicator (0.75 g/person/day). This is already a good ground to do recalculation for the entire time-period, which was done in the study herein.

4.4.5.5 Uncertainty Assessment

Uncertainty assessment of calculated results conducted for nitrous oxide emission from wastewaters is based on default values of basic calculation parameters [Gen -1]. Uncertainty results are described in Annex 1, Table A.1.7.

Bibliography

Gen-1. 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Gen-2. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

Gen-3. 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

Gen-4. 2003 IPCC Good Practice Guidance for Land Use,Land-Use Change and Forestry

Gen-5. International Energy Agency’s balances, www.iea.org

Gen-6. World Bank’s database, www.worldbank.org

Gen-7. 2006 IPCC Inventory Software

Gen-8. Atmospheric emission inventory guidebook, EMEP/CORINAIR, 1999, Second Edition

Gen-9. IPCC Assessment Report. Aerosol Products

Gen-10. IPCC/TEAP Special Report: Safeguarding the Ozone Layer and the Global Climate. Chapter 8: Medical Aerosols.

Gen-11. Customs and Enforcement Officers Information Note. Monitoring trade in HCFCs. UNEP DTIE Ozone Action Proramme, WCO (April 2012)

Gen-12. National Inventory Submissions 2011

Gen-13. What is in an aerosol?

Gen-14. IPCC Emissions Factor Database

Gen-15. The Joint EMEP/EEA Air Pollutant Emission Inventory Guidebook, 2009

National

Ref-1. Greenhouse gas national inventory manual: Yerevan, 2006թ. (in Armenian)

Ref-2. Greenhouse gas national inventory report of Republic of Armenia/UNDP/GEF (2000 (in Armenian)

Ref-3. Republic of Armenia. Second national communication under the UN framework convention on climate change,2009.

Ref-4. Statistical yearbooks of Armenia 2006 - 2010թթ.

Ref-5. Transition to alternative ozone-friendly metered-dose inhalers in Armenia. Stakeholder meetings. Yerevan 2009. Kazaryan Lilith. Scientific Centre of Drug Armenia (in Russian).

Ref-6. HCFC Phase-out Management Plan (HPMP)-Armenia (August 2010)

References for sectoral inventories are mainly from Armenian sources, given below in the language of origin:

Energy

EnRef-1. «Էներգետիկայի գիտահետազոտական ինստիտուտ» ՓԲԸ, «Էներգետիկայի ռազմավարության կենտրոն» մասնաճյուղի տնօրենի նամակի ձևանմուշ՝ ուղղված տարբեր կազմակերպություններին:

EnRef-2. ՀՀ էներգետիկայի և բնական պաշարների նախարարության տեղեկատվություն

EnRef-3. ՀՀ կառավարությանն առընթեր քաղաքացիական ավիացիայի գլխավոր վարչության տեղեկատվություն:

EnRef-4. ՀՀ տրանսպորտի և կապի նախարարության տեղեկատվություն:

EnRef-5. ՀՀ ոստիկանության տեղեկատվություն:

EnRef-6. ՀՀ գյուղատնտեսության նախարարության տեղեկատվություն:ն

EnRef-7. «Հայռուսգազարդ» ՓԲԸ տեղեկատվություն

EnRef-8. ՀՀ ազգային վիճակագրական ծառայության տեղեկատվություն:
EnRef-9. ՀՀ հանրային ծառայությունները կարգավորող հանձնաժողովի տեղեկատվություն
EnRef-10. ՀՀ կառավարությանն առընթեր պետական եկամուտների կոմիտեի տեղեկատվություն
EnRef-11. Հայաստանում վերականգնվող էներգետիկայի զարգացման ուղեցուցային ծրագիր, Հայաստանի վերականգնվող էներգետիկայի և էներգախնայողության հիմնադրամ, մայիս 2011թ.
EnRef-12. ՀՀ տնտեսության զարգացման համատեքստում էներգետիկայի բնագավառի զարգացման ռազմավարությունը, ՀՀ կառավարութուն, 23 հունիսի 2005թ. նիստի N24 Արձանագրային որոշում
EnRef-13. ՀՀ էներգախնայողության և վերականգնվող էներգետիկայի ազգային ծրագիր, ՀՀ կառավարություն, 18 հունվարի 2007թ. նիստի N2 Արձանագրային որոշում
EnRef-14. ՀՀ ազգային անվտանգության ռազմավարության դրույթներով նախատեսված ՀՀ էներգետկայի նախարարության գործունեության ծրագիրը, ՀՀ էներգետիկայի նախարարություն, ՀՀ կառավարութուն, 01 նոյեմբերի 2007թ. նիստի N1296-Ն որոշում
EnRef-15. Կայուն զարգացման ծրագիր, ՀՀ կառավարության 2008թ. հոկտեմբերի 30-ի N 1207 – Ն որոշման հավելված
EnRef-16. Տրանսպորտի բաժինի էներգաարդյունավետության բարձրացման և ջերմոցային գազերի արտանետումների նվազեցման պոտենցիալը Հայաստանում, Գազաշարժիչային ազգային ասոցիացիա, 2006թ.
EnRef-17. ՀՀ էներգետիկական հաշվեկշիռ, 2010թ.
EnRef-18. «Հայանտառ» ՊՈԱԿ տեղեկատվություն:
EnRef-19. ՀՀ բնապահպանության նախարարության տեղեկատվություն:
EnRef-20. ՀՀ էներգետիկայի և բնական պաշարների նախարարի տեղակալի պատասխան նամակ հմ. 2/07/2173-12 առ 20.12.2012
EnRef-21. «ՀայՌուսգազարդ» ՓԲԸ գլխավոր տնօրենի տեղակալ, գլխավոր ճարտարա-գետի պատասխան նամակ հմ. ARG-02-19/70 առ 15.01.2013
EnRef-22. ՀՀ կառավարությանն առընթեր պետական եկամուտների կոմիտեի նախագահի առաջին տեղակալի պատասխան նամակ-տեղեկանք
EnRef-23. ՀՀ տրանսպորտի և կապի նախարարի առաջին տեղակալի պատասխան նամակ հմ. 2/07/2173-12 առ 20.12.2012

Industrial Processes and Product Use

IndRef-1. ՀՀ կառավարությանն առընթեր պետական եկամուտների կոմիտեի նախագահի առաջին տեղակալի պատասխան գրություն հմ. 02/7-1/3692-13 առ 09.04. 2013թ.
IndRef-2. Անկախ պետությունների համագործակցության արտաքին տնտեսական գործունեության ապրանքային անվանացանկ (ԱՏԳԱԱ), հինգերորդ հրատարակություն (ռուսերեն)
IndRef-3. ՀՀ արտակարգ իրավիճակների նախարարի պատասխան գրություն հմ. 8/17.4/4039-13 առ 20.05.2013թ.
IndRef-4. «Արարատցեմենտ» ՓԲԸ տրամադրած տվյալներ
IndRef-5. «Միկա Ցեմենտ» ՓԲԸ տրամադրած տվյալներ

AFOLURef- 1. «Հայաստանի Հանրապետության հողային ֆոնդի բաշխումն ըստ հողային կատեգորիաների, հողօգտագործողների և հողատիպերի» առ 1 նոյեմբերի, 1990թ., ՀՀ գյուղատնտեսության նախարարության հողօգտագործման և հողօգտագործման պլանավորման գլխավոր վարչություն, Երևան 1990թ. :

AFOLURef-2. ՀՀ նախարարների խորհրդի 13.04.1991թ. N 277 որոշումը «ՀՀ հողային ֆոնդի հաշվետվության հաստատման մասին» :

AFOLURef-3. «Գյուղատնտեսության դերը շուկայական հարաբերությունների անցման շրջանում» համաժողովի նյութեր, էջեր 64-88, Երևան 1995թ.:

AFOLURef-4. Հայաստանի գյուղատնտեսության բնագավառի բարեփոխումների տեսություն, Համաշխարհային բանկի ուսումնասիրություններ, էջեր 7, 61, 87, Երևան 1995թ.:

AFOLURef-5. «Գյուղատնտեսությունը Հայաստանի Հանրապետությունում 1990-1999», Վիճակագրական ժողովածու, ՀՀ ԱՎԾ 2001թ.:

AFOLURef-6. ՀԽՍՀ գյուղատնտեսական ատլաս, Մոսկվա-Երևան, 1984թ., :

AFOLURef-7. ՀՀ ազգային ատլաս, ՀՀ կառավարությանն առընթեր անշարժ գույքի կադաստրի պետական կոմիտեի «Գեոդեզիայի և քարտեզագրության կենտրոն» ՊՈԱԿ, Երևան 2007թ.:

AFOLURef-8. ՀԽՍՀ Մինիստրների Խորհրդին առընթեր երկրաբանության և ընդերքի պաշարների պահպանության վարչություն. «ՀԽՍՀ Ապարանի շրջանի Ապարանի (Չիլի-Գելի) տորֆի արդյունահանման տեղամասի ուսումնասիրություն և ծավալների հաշվարկներ 01.01.1961 թ. Դրությամբ», Երևան, 1961թ., :

AFOLURef-9. ՀԽՍՀ երկրաբանության վարչության Սևան-Հրազդանի արշավախումբ. «ՀԽՍՀ Վարդենիսի, Գուգարքի, Ստեփանավանի, Կալինինոյի, Ախուրյանի շրջաններում տորֆի արդյունահանման տեղամասերի նախնական ուսումնասիրության վերաբերյալ հաշվետվություն 1979-80թթ. Համար», Երևան, 1980թ. :

AFOLURef-10. Հայաստանի Հանրապետության ընդերքի պետական վարչության վառելիքաէներգետիկ հումքի հետազոտություններ: «Հաշվետվություն Վարդենիսի շրջանի Մասրիկի տորֆարդյունահանման տեղամասի երկրաբանական ուսումնասիրությունների արդյունքների վերաբերյալ 1992-1994թթ համար՝ ծավալների հաշվարկմամբ առ 01.01.1994թ.»:

AFOLURef-11. Հայաստանի Հանրապետության ջրամբարների վերաբերյալ տեղեկատվական տվյալներ, «Հայջրնախագիծ» ինստիտուտ, 2005թ.,:

AFOLURef-12. ՀՀ հողային օրենսգիրք, Երևան 1991թ.:

AFOLURef-13. ՀՀ հողային օրենսգիրք, Երևան 2001թ.:

AFOLURef-14. Հայաստանի Հանրապետության վիճակագրության պետական կոմիտե «Գյուղատնտեսական մշակաբույսերի ցանքատարածությունները, համախառն բերքի և միջին բերքատվության ըստ շրջանների ժողովածու», 1980 – 1990թթ., Երևան, 1991թ.:

AFOLURef-15. Ա. Գևորգյան, «1990թ.-ի բազային տարվա համար ազգային կլանման գործակիցների, բնափայտի բազիսային խտության և վերափոխման գործակիցների բարելավումը ՀՀՓԱՏ ոլորտի ՋԳ-ների կադաստրի համար», ՋԳ ազգային կադաստրի որակի բարելավման կարողությունների հզորացման տարածաշրջանային ծրագրի հաշվետվություն #5, հունիս 2005թ. (անգլերեն):

AFOLURef-16. Է. Մ. Հայրապետյան, Հ. Պ. Պետրոսյան «Մելիորատիվ հողագիտություն» Երևան, 1987թ.:
AFOLURef-17. «Գյուղատնտեսության էկոլոգիական հիմնախնդիրներ և գործողությունների ստրատեգիա», գիտական կոնֆերանսի նյութեր, Երևան 1997թ.
AFOLURef-18. Ս. Գ. Ղազարյան, Հ. Ս. Զաքոյան «Գյուղատնտեսական հողատեսքերի օգտագործման վիճակը ՀՀ Գեղարքունիքի մարզում»: «Հողօգտագործում և պետական վերահսկողություն» գիտական կոնֆերանսի նյութեր, Երևան 1998թ., էջ 3:
AFOLURef-19. Հ. Ս. Զաքոյան, Ա. Ռ. Զարգարյան «Արոտավայրերի օգտագործման վիճակը և բարելավման ուղիները ՀՀ Գեղարքունիքի մարզում»: «Գեղարքունիքի մարզի գյուղատնտեսական արտադրության արդի հիմնախնդիրները» գիտաարտադրական կոնֆերանսի նյութեր, Երևան 1999թ., էջ 31:
AFOLURef-20. Հայաստանի Հանրապետության հողային հաշվեկշիռն ըստ կատեգորիաների և հողատեսքերի 1995 թ. հունվարի 1-ի դրությամբ, ընդունված է ՀՀ Ազգային Ժողովի կողմից 07.02.1996թ.:
AFOLURef-21. Հայաստանի Հանրապետության հողային հաշվեկշիռն ըստ կատեգորիաների և հողատեսքերի 1996 թ. հունվարի 1-ի դրությամբ, ընդունված է ՀՀ Ազգային Ժողովի կողմից 04.03.1997թ.:
AFOLURef-22. Հայաստանի Հանրապետության հողային հաշվեկշիռն ըստ կատեգորիաների և հողատեսքերի 1997 թ. հունվարի 1-ի դրությամբ, ընդունված է ՀՀ Ազգային Ժողովի կողմից 16.09.1998թ.:
AFOLURef-23. Հայաստանի Հանրապետության հողային ֆոնդի առկայության և բաշխման 2006թ. հաշվետվություն /Հողային հաշվեկշռի/ մասին, ՀՀ կառավարության N 1938-Ն որոշում, 28.12.2006թ:
AFOLURef-24. Հայաստանի Հանրապետության հողային ֆոնդի առկայության և բաշխման 2007թ. հաշվետվություն (հողային հաշվեկշռի) մասին, ՀՀ կառավարության N 7-Ն որոշում, 10.01.2008թ.:
AFOLURef-25. Հայաստանի Հանրապետության հողային ֆոնդի առկայության և բաշխման 2008թ. հաշվետվություն (հողային հաշվեկշռի) մասին, ՀՀ կառավարության N 1544-Ն որոշում, 18.12.2008թ.:
AFOLURef-26. Հայաստանի Հանրապետության հողային ֆոնդի առկայության և բաշխման 2009թ. հաշվետվություն (հողային հաշվեկշռի) մասին, ՀՀ կառավարության N 1095-Ն որոշում, 23.09.2009թ.:
AFOLURef-27. Հայաստանի Հանրապետության հողային ֆոնդի առկայության և բաշխման 2010թ. հաշվետվություն (հողային հաշվեկշռի) մասին՛ ՀՀ կառավարության N 1358-Ն որոշում, 14.10.2010թ.:
AFOLURef-28. Գյուղատնտեսական մշակաբույսերի ցանքային տարածությունների վերաբերյալ ՀՀ ազգային վիճակագրության ծառայության տվյալները 2000-2005թթ, Երևան:
AFOLURef-29. Գյուղատնտեսական մշակաբույսերի ցանքային տարածությունները և համախառն բերքը 2007 թվականին, ԱՎԾ տեղեկագիր (ծածկագիրը՝ 1220-203), Երևան 2008թ.:
AFOLURef-30. Գյուղատնտեսական մշակաբույսերի ցանքային տարածությունները և համախառն բերքը 2008 թվականին, ԱՎԾ տեղեկագիր (ծածկա·իրըª 1220-203), Երևան 2009թ.:

AFOLURef-31. Գյուղատնտեսական մշակաբույսերի ցանքային տարածությունները և համախառն բերքը 2009 թվականին, ԱՎԾ տեղեկագիր (ծածկագիրը՝ 1220-203), Երևան 2010թ.:
AFOLURef-32. Գյուղատնտեսական մշակաբույսերի ցանքային տարածությունները և համախառն բերքը 2010 թվականին, ԱՎԾ տեղեկագիր (ծածկագիրը՝ 1220-203), Երևան 2011թ.:
AFOLURef-33. Անտառկառավարման պլան, ՀՀ Գյուղատնտեսության նախարարության «Հայանտառ» ՊՈԱԿ «Դսեղի անտառտնտեսություն» մասնաճյուղ, Երևան 2009թ., 155 էջ:
AFOLURef-34. Անտառկառավարման պլան, ՀՀ Գյուղատնտեսության նախարարության «Հայանտառ» ՊՈԱԿ «Մեղրիի անտառտնտեսություն» մասնաճյուղ, Երևան 2009թ., 139 էջ:
AFOLURef-35. ՀՀ անտառային օրենսգիրք. 2005թ.
AFOLURef-36. ՀՀ անտառային ոլորտի վերլուծական տեղեկագիր, «Անտառային պետական մոնիտորինգի կենտրոն» ՊՈԱԿ, Երևան, 2008թ., 118 էջ:
AFOLURef-37. 2010 թվականի դրությամբ «Հայանտառ» ՊՈԱԿ-ին ամրագրված անտառների և անտառային հողերի բաշխվածությունը ըստ «Անտառտնտեսություն մասնաճյուղերի». Գյուղատնտեսության նախարարության 04.06.2010թ N 102-Ս հրաման:
AFOLURef-38. Ղուլիջանյան Ա. Հ. Հյուսիս-արևելյան Հայաստանի դենդրոբազմազանու– թյունը և առավել արժեքավոր տեսակների կենսազանգվածի փոփոխության դինամիկան, ՀՀ ԳԱԱ Բուսաբանության ինստիտուտ – դոկտորական աշխատանք, Երևան 2009թ., 266 էջ:
AFOLURef-39. Մացակյան Վ. Գ. ՀՀ Լոռու մարզի Գուգարքի տարածաշրջանի անտառի վերին գոտու հիմնական համակեցությունները և դրանց փոխ-հարաբերությունը// Հայաստանի կենսաբանական Հանդես, 2010, 2, էջ 24-29:
AFOLURef-40. Арзуманян Г. А. Мамиконян М. В. Физико-механические свойства БУКА произрастающего в Армении. ДАН Арм.ССР, 1961, XXXIII, 3, с. 119-127.
AFOLURef-41. Арзуманян Г. А., Хуршудян П. А. Физико-механические свойства древесины тисса, груши и березы, произрастающих в Армении. Изв. Акад. Наук Арм.ССР, 1961, XIV, 5, с. 31-40.
AFOLURef-42. Паланджян В. А. О некоторых свойствах древесины кавказского каркаса. Изв. Акад. Наук Арм.ССР, 1955, VIII, 6, с. 77-85.
AFOLURef-43. Проект организации и развития лесного хозяйства, пояснительная записка; Таксационние описания лесничества Разданского лесхоза. Тбилиси, 1991-1992, 176 с, Апаранского, 160 с, лесхоза.
AFOLURef-44. Проект организации и развития лесного хозяйства, пояснительная записка; Таксационние описания лесничества Ленинаканского лесхоза. Тбилиси, 1982-1983, 150 с.
AFOLURef-45. Проект организации и развития лесного хозяйства, пояснительная записка; Таксационние описания лесничества Апаранского лесхоза. Тбилиси, 1991-1992, 160 с.
AFOLURef-46. Хуршудян П. А. Физико-механические свойства древесины липы из северной Армении. Изв. Акад. Наук Арм.ССР, 1952, V, 6, с. 59-67.
AFOLURef-47. Хуршудян П. А. Физико-математические свойства древесины некоторых видов клена, произрастающих в Армении. Изв. Акад. Наук Арм.ССР, 1953, VI, 7, с. 35-49.

AFOLURef-48. Хуршудян П. А. Физико-механические свойства древесины ясеня остроплодного из южной Армении. Изв. Акад. Наук Арм.ССР, 1954, VII, 10, с. 49-56.

AFOLURef-49. Хуршудян П. А. Физико-механические свойства древесины двух видов древовидных можжевельников, произрастающих в Армении. Изв. Акад. Наук Арм.ССР, 1959, XII, 5, с. 65-76.

AFOLURef-50. Хуршудян, П. А. Физико-механические свойства древесины осины, произрастающей в Армении. Изв. Акад. Наук Арм.ССР, 1960, XIII, 9, с. 51-60.

AFOLURef-51. Хуршудян П. А. Об основных технических свойствах древесины платана из Цавской рощи. Изв. Акад. Наук Арм.ССР, 1962, XV, 11, с. 31-38.

AFOLURef-52. Уголев Б. Н. Древесиноведение и лесное товароведение. 2-е изд., Изд.центр «Академия», М., 2006. - 272 с.

AFOLURef-53. http://hayantar.am

AFOLURef-54. http://forest-monitoring.am

AFOLURef-55. http://www.mnp.am

Waste

WRef-1. Marjanyan, A.H., Methane Emissions from Solid Waste Disposal Sites: Data Collection Strategy and reduction of Data Gaps. Yerevan, December 2003.

WRef-2. Marjanyan, A.H., Republic of Arnenia. Key Source Inventory of Greenhouse Gas Emission. Waste Sector: Methane Emissions from Solid Waste Disposal Sites. Vol.1 1979-2005 Time Series for Assessment of Methane Emissions. Years 1979-2005. June 2005.

WRef-3. Marjanyan, A.H., Republic of Armenia. National Inventory Report on Key Sources. Waste Sector, Solid Waste Disposal on Land. UNDP/GEF Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region) Project RER/01/G31. October 2005.

WRef-4. Marjanyan, A., Pasoyan A., Tsarukyan M., Republic of Arnenia. Final Country Report on Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region). UNDP/GEF Project, RER/01/G31. JUNE 2006.

WRef-5. Study for the utilization of Methane at “Nubarashen” landfill in Yerevan, Armenia. Shimizu Corp., Japan. 1-st Report, March 2002.

WRef-6. Strategic policy advice for the Development of Integrated Sustainable Municipal Solid waste Management Plans for two Pilot Marzes of Ararat and Vayots Dzor. ToR of Policy Advice Program 2004. Yerevan, March 2004.

WRef-7. Nubarashen Landfill Gas Capture and Power Generation Project in Yerevan. No 0069. Monitoring Report, Version 01 - 08/09/2011.

WRef-8. Հայաստանում կենսազանգվածի և կենսաէներգիայի օգտագործման գործարար ծրագիր: ՀՀ Էներգետիկայի և բնական պաշարների նախարարություն/ ՀՎԷԷՀ, Երևան, 2012թ.:

WRef-9. ՀՀ Վիճակագրական Տարեգրքեր. 1995-2011

WRef-10. http://www.armstat.am/am/?nid=420

WRef-11. http://www.armstat.am/am/?nid=288

WRef-12. www.armstat.am/file/doc/99470863.xls

WRef-13. Մարջանյան Ա., Հարավային Կովկասի ժողովրդագրությունը XXI դարի վերջին, «Նորավանք» ԳԿՀ, «21-րդ ԴԱՐ», թիվ 4 (44), 2012թ., էջ 20-44:

WRef-14. Մարջանյան Ա. Հ., ՀՀ 3-րդ Ազգային Զեկույցի Նախապատրաստական Աշխատանքներ ՀՀ ԶԳԱ Կադաստրի «Թափոններ» բաժին: Մեկնարկային Հաշվետվություն: Երևան Սեպտեմբեր, 2012թ.:
WRef-15. Արդյունաբերական կազմակերպություններում հիմնական արտադրատեսակների թողարկումը բնեղեն արտահայտությամբ 2011 թվականի հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 01 Փետրվար, 2012թ.
WRef-16. Արդյունաբերական կազմակերպություններում հիմնական արտադրատեսակների թողարկումը բնեղեն արտահայտությամբ 2010 թվականի հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 02 Փետրվարի, 2011թ.
WRef-17. Արդյունաբերական կազմակերպություններում հիմնական արտադրատեսակների թողարկումը բնեղեն արտահայտությամբ 2009 թվականի հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 04 Փետրվար, 2010թ.
WRef-18. Արդյունաբերական կազմակերպություններում հիմնական արտադրատեսակների թողարկումը բնեղեն արտահայտությամբ 2008 թվականի հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 30 Հունվարի, 2009թ.
WRef-19. Արդյունաբերական կազմակերպություններում հիմնական արտադրությունների թողարկումը բնեղեն արտահայտությամբ 2007թ. հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 31 Հունվարի, 2008թ.
WRef-20. Արդյունաբերական կազմակերպություններում հիմնական արտադրությունների թողարկումը բնեղեն արտահայտությամբ 2006թ. հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 31 Հունվարի, 2007թ.
WRef-21. Արդյունաբերական կազմակերպություններում հիմնական արտադրությունների թողարկումը բնեղեն արտահայտությամբ 2005թ. հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 29 Հունվարի, 2006թ.
WRef-22. Արդյունաբերական կազմակերպություններում հիմնական արտադրությունների թողարկումը բնեղեն արտահայտությամբ 2004թ. հունվար-դեկտեմբերին Ն: ՀՀ ԱՎԾ, Երևան: 30 Հունվարի, 2005թ.
WRef-23. Արդյունաբերական կազմակերպություններում հիմնական արտադրությունների թողարկումը բնեղեն արտահայտությամբ 2003թ. հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 30 Հունվարի, 2004թ.
WRef-24. Արդյունաբերական կազմակերպություններում հիմնական արտադրությունների թողարկումը բնեղեն արտահայտությամբ 2002թ. հունվար-դեկտեմբերին. ՀՀ ԱՎԾ, Երևան: 30 Հունվարի, 2003թ.
WRef-25. Հայաստանի Հանրապետության սոցիալ-տնտեսական վիճակը 2001թ. հունվար-դեկտեմբերին. ՀՀ ԱՎԾ, Երևան: 12 Փետրվարի, 2002թ. Գլ. 1.2.1. Արդյունաբերություն:
WRef-26. Հայաստանի Հանրապետության սոցիալ-տնտեսական վիճակը 2000 թ. հունվար-դեկտեմբերին. ՀՀ ԱՎԾ, Երևան: 12 Փետրվարի, 2001թ. Գլ. 1.2.1. Արդյունաբերություն:
WRef-27. Հայաստանի Հանրապետության սոցիալ-տնտեսական վիճակը 1999 թ. հունվար-դեկտեմբերին: ՀՀ ԱՎԾ, Երևան: 14 Փետրվարի, 2000թ. Գլ. 1.2.1. Արդյունաբերություն:
WRef-28. Արդյունաբերություն, 1998: ՀՀ ԱՎԾ, Երևան: 11 Ապրիլի, 1999թ. Գլ. 6 Արդյունաբերության արտադրանքի կարևորագույն տեսակների արտադրությունը:

ANNEX 1

Contents

Table A.1.1 Summary Table (Exported from IPCC2006 Inventory Software)

Inventory Year: 2010	Emissions (Gg)			Emissions CO_2 equivalents (Gg)					Emissions (Gg)			
Categories	**Net CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Halogenated other gases with CO_2 equivalent conversion factors**	**Halogenated other gases without CO_2 equivalent conver–sion factors**	**NOx**	**CO**	**NMVOCs**	**SO_2**
Total National Emissions and Removals	3911.923	107.672	1.557	121.532	0	0	0	0	17.213	66.784	11.514	0.189
1 - Energy	4231.025	35.641	0.094	0	0	0	0	0	17.213	66.784	11.514	0.189
1.A - Fuel combustion operations	4230.937	3.382	0.094	0	0	0	0	0	17.213	66.784	11.514	0.189
1.A.1 – Energy sectors	827.518	0.015	0.001						2.213	0.295	0.074	0
1.A.2 - Manufacturing industry and construction	531.522	0.010	0.001						1.416	0.283	0.047	0.012
1.A.3 - Transport	1202.622	1.263	0.060						11.831	62.476	10.952	0.057
1.A.4 - Other sections	1669.275	2.095	0.031						1.753	3.730	0.441	0.120
1.A.5 - Not specified	0	0	0						0	0	0	0
1.B - Fugitive emissions from fuels	0.088	32.258	0	0	0	0	0	0	0	0	0	0
1.B.1 - Solid fuel	0	0	0						0	0	0	0
1.B.2 - Oil and natural gas	0.088	32.258	0						0	0	0	0
1.B.3 - Other emissions from energy production	0	0	0						0	0	0	0
1.C - Carbon dioxide transport and storage	0	0	0	0	0	0	0	0	0	0	0	0
1.C.1 - CO_2 transport	0								0	0	0	0
1.C.2 - Injection and storage	0								0	0	0	0
1.C.3 - Other	0								0	0	0	0
2 - Industrial processes and product use	225.964	0	0	121.532	0	0	0	0	0	0	0	0
2.A - Mineral Industry	225.964	0	0	0	0	0	0	0	0	0	0	0
2.A.1 - Cement production	225.964								0	0	0	0
2.A.2 - Lime production	0								0	0	0	0
2.A.3 - Glass production	0								0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0								0	0	0	0
2.A.5 - Other (please specify)	0	0	0						0	0	0	0
2.B - Chemical industries	0	0	0	0	0	0	0	0	0	0	0	0
2.B.1 - Ammonium production	0								0	0	0	0
2.B.2 - Nitric acid production			0						0	0	0	0
2.B.3 - Adipic acid production			0						0	0	0	0
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0						0	0	0	0
2.B.5 - Carbide production	0	0							0	0	0	0
2.B.6 - Titanium dioxide production	0								0	0	0	0
2.B.7 - Soda Ash Production	0								0	0	0	0

2.B.8 - Petrochemical and Carbon Black Production	0	0							0	0	0	0
2.B.9 - Fluorinated chemicals production				0	0	0	0	0	0	0	0	0
2.B.10 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal industries	0	0	0	0	0	0	0	0	0	0	0	0
2.C.1 – Iron and Steel Production	0	0							0	0	0	0
2.C.2 – Ferroalloys production	0	0							0	0	0	0
2.C.3 – Aluminum production	0				0			0	0	0	0	0
2.C.4 – Magnesium production	0					0		0	0	0	0	0
2.C.5 – Lead production	0								0	0	0	0
2.C.6 – Zinc production	0								0	0	0	0
2.C.7 – Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.D – Non-Energy Products from Fuels and Solvent Use	0	0	0	0	0	0	0	0	0	0	0	0
2.D.1 – Lubricant Use	0								0	0	0	0
2.D.2 – Paraffin Wax Use	0								0	0	0	0
2.D.3 – Solvent Use									0	0	0	0
2.D.4 – Other (please specify)	0	0	0						0	0	0	0
2.E – Electronics industry	0	0	0	0	0	0	0	0	0	0	0	0
2.E.1 – Integrated Circuit or Semiconductor				0	0	0	0	0	0	0	0	0
2.E.2 -TFT Flat Panel Display					0	0	0	0	0	0	0	0
2.E.3 – Photovoltaics					0			0	0	0	0	0
2.E.4 - Heat Transfer Fluid					0			0	0	0	0	0
2.E.5 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.F – Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	121.532	0	0	0	0	0	0	0	0
2.F.1 – Refrigeration and Air Conditioning				111.997				0	0	0	0	0
2.F.2 – Foam Blowing Agents				0.224				0	0	0	0	0
2.F.3 – Fire Protection				0.218	0			0	0	0	0	0
2.F.4 - Aerosols				9.092				0	0	0	0	0
2.F.5 – Solvents				0	0			0	0	0	0	0
2.F.6 – Other Applications (please specify)				0	0			0	0	0	0	0
2.G – Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.G.1 – Electrical Equipment					0	0		0	0	0	0	0
2.G.2 - SF6 and PFCs from Other Product Uses					0	0		0	0	0	0	0
2.G.3 - N2O from Product Uses			0						0	0	0	0
2.G.4 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0	0
2.H.1 – Pulp and Paper Industry	0	0							0	0	0	0
2.H.2 – Food and Beverages Industry	0	0							0	0	0	0
2.H.3 - Other (please specify)	0	0	0						0	0	0	0

3 – Agriculture, forestry and other land use	-552.704	44.264	1.261	0	0	0	0	0	0	0	0	0
3.A – Livestock	0	44.221	0.213	0	0	0	0	0	0	0	0	0
3.A.1 – Enteric fermentation		40.917							0	0	0	0
3.A.2 – Manure management		3.304	0.213						0	0	0	0
3.B – Land	-542.959	0	0	0	0	0	0	0	0	0	0	0
3.B.1 – Forest lands	-557.087								0	0	0	0
3.B.2 – Croplands	0.670								0	0	0	0
3.B.3 – Grasslands	13.459								0	0	0	0
3.B.4 – Wetlands	0		0						0	0	0	0
3.B.5 – Settlements	0								0	0	0	0
3.B.6 – Other land	0								0	0	0	0
3.C – Aggregate sources and non-CO2 emissions sources on land	0.969	0.042	1.049	0	0	0	0	0	0	0	0	0
3.C.1 – Emissions from from biomass burning		0.042	0						0	0	0	0
3.C.2 – Liming	0								0	0	0	0
3.C.3 – Urea application	0.969								0	0	0	0
3.C.4 – Direct N2O emissions from managed soils			0.617						0	0	0	0
3.C.5 - Indirect N2O emissions from managed soils			0.273						0	0	0	0
3.C.6 - Indirect N2O emissions from manure management			0.159						0	0	0	0
3.C.7 – Rice cultivation		0							0	0	0	0
3.C.8 – Other (please specify)		0	0						0	0	0	0
3.D - Other	-10.715	0	0	0	0	0	0	0	0	0	0	0
3.D.1 –Harvested Wood Products	-10.715								0	0	0	0
3.D.2 - Other (please specify)	0	0	0						0	0	0	0
4 – Waste	7.639	27.768	0.202	0	0	0	0	0	0	0	0	0
4.A – Solid Waste Disposal	0	22.398	0	0	0	0	0	0	0	0	0	0
4.B – Biological Treatment of Solid Waste	0	0	0	0	0	0	0	0	0	0	0	0
4.C – Incineration and Open Burning of Waste	7.639	1.100	0.020	0	0	0	0	0	0	0	0	0
4.D – Wastewater treatment and discharge	0	4.270	0.182	0	0	0	0	0	0	0	0	0
4.E - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
5 – Other	0	0	0	0	0	0	0	0	0	0	0	0
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NO_x and NH_3	0	0	0	0	0	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
Memo Items (5)												
International bunkers	136.172	0.001	0.004	0	0	0	0	0	0.485	0.539	0.325	0.043
1.A.3.a.i – International Aviation (International Bunkers)	136.172	0.001	0.004						0.485	0.539	0.325	0.043
1.A.3.d.i – International Water-borne Navigation (International bunkers)	0	0	0						0	0	0	0
1.A.5.c – Multilateral Operations	0	0	0	0	0	0	0	0	0	0	0	0

Table A.1.2 Short Summary Table (Exported from IPCC2006 Inventory Software)

Inventory Year: 2010	Emissions (Gg)			Emissions CO_2 equivalents (Gg)				Emissions (Gg)				
Categories	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Halogenated other gases with CO_2 equivalent conversion factors	Halogenated other gases without CO_2 equivalent conversion factors	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	3911.923	107.672	1.557	121.532	0	0	0	0	17.213	66.784	11.514	0.189
1 - Energy	4231.025	35.641	0.094	0	0	0	0	0	17.213	66.784	11.514	0.189
1.A - Fuel combustion operations	4230.937	3.382	0.094						17.213	66.784	11.514	0.189
1.B - Fugitive emissions from fuels	0.088	32.258	0						0	0	0	0
1.C - Carbon dioxide transport and storage	0								0	0	0	0
2 - Industrial processes and product use	225.964	0	0	121.532	0	0	0	0	0	0	0	0
2.A - Mineral Industry	225.964	0	0						0	0	0	0
2.B - Chemical industries	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal industries	0	0	0	0	0	0	0	0	0	0	0	0
2.D – Non-Energy Products from Fuels and Solvent Use	0	0	0						0	0	0	0
2.E – Electronics industry	0	0	0	0	0	0	0	0	0	0	0	0
2.F – Product Uses as Substitutes for Ozone Depleting Substances				121.532	0			0	0	0	0	0
2.G – Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0						0	0	0	0
3 – Agriculture, forestry and other land use	-552.704	44.264	1.261	0	0	0	0	0	0	0	0	0
3.A – Livestock		44.221	0.213						0	0	0	0
3.B – Land	-542.959		0						0	0	0	0
3.C – Aggregate sources and non-CO_2 emissions sources on land	0.969	0.042	1.049						0	0	0	0
3.D - Other	-10.715	0	0						0	0	0	0
4 - Waste	7.639	27.768	0.202	0	0	0	0	0	0	0	0	0
4.A – Solid Waste Disposal		22.398							0	0	0	0
4.B – Biological Treatment of Solid Waste		0	0						0	0	0	0

4.C – Incineration and Open Burning of Waste	7.639	1.100	0.020						0	0	0	0
4.D – Wastewater treatment and discharge		4.270	0.182						0	0	0	0
4.E - Other (please specify)	0	0	0						0	0	0	0
5 - Other	0	0	0	0	0	0	0	0	0	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3			0						0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
Memo Items (5)												
International bunkers	136.172	0.001	0.004	0	0	0	0	0	0.485	0.539	0.325	0.043
1.A.3.a.i – International Aviation (International Bunkers)	136.172	0.001	0.004						0.485	0.539	0.325	0.043
1.A.3.d.i – International Water-borne Navigation (International bunkers)	0	0	0						0	0	0	0
1.A.5.c – Multilateral Operations	0	0	0	0	0	0	0	0	0	0	0	0

Table A.1.3 Energy Sectoral (Exported from IPCC2006 Inventory Software)

Inventory Year: 2010	Emissions (Gg)						
Categories	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SO_2
1 - Energy	4231.025	35.641	0.094	17.213	66.784	11.514	0.189
1.A - Fuel combustion operations	4230.937	3.382	0.094	17.213	66.784	11.514	0.189
1.A.1 - Energy Industries	827.518	0.015	0.001	2.213	0.295	0.074	0
1.A.1.a - Electric and thermal energy generation	827.518	0.015	0.001	2.213	0.295	0.074	0
1.A.1.a.i – Condensing thermal power plants				0	0	0	0
1.A.1.a.ii – Cogeneration (TPP)	827.518	0.015	0.001	2.213	0.295	0.074	0
1.A.1.a.iii – Boiler houses				0	0	0	0
1.A.1.b – Oil refining				0	0	0	0
1.A.1.c - Solid fuel production and other energy industries				0	0	0	0
1.A.1.c.i - Solid fuel production				0	0	0	0
1.A.1.c.ii – Other Energy industries				0	0	0	0
1.A.2 - Manufacturing industry and construction	531.522	0.010	0.001	1.416	0.283	0.047	0.012
1.A.2.a - Iron and steel production	7.944	0.000	0.000	0	0	0	0
1.A.2.b – Non-metal production	39.717	0.001	0.000	0	0	0	0
1.A.2.c - Chemical industries	79.432	0.001	0.000	0	0	0	0
1.A.2.d – Woodwork and paper production				0	0	0	0
1.A.2.e – Food, beverages, tobacco production	105.910	0.002	0.000	0	0	0	0
1.A.2.f – Non-metal mining	213.789	0.004	0.000	0	0	0	0
1.A.2.g – Transport equipment				0	0	0	0
1.A.2.h – Automobile production				0	0	0	0
1.A.2.i – Mining (except fuel)				0	0	0	0
1.A.2.j – Wood and woodworking				0	0	0	0
1.A.2.k - Construction				0	0	0	0
1.A.2.l – Textile industry and leather production	10.592	0.000	0.000	0	0	0	0
1.A.2.m – Other industry	74.137	0.001	0.000	1.416	0.283	0.047	0.012
1.A.3 - Transport	1202.622	1.263	0.060	11.831	62.476	10.952	0.057
1.A.3.a - Civil aviation				0	0	0	0
1.A.3.a.i - International air transport (international bunker)							
1.A.3.a.ii – Domestic air transport				0	0	0	0
1.A.3.b - Road transportation	1202.622	1.263	0.060	11.831	62.476	10.952	0.057
1.A.3.b.i – Light passenger cars				11.831	62.476	10.952	0.057
1.A.3.b.i.1 - Light passenger cars with triple catalyzer				0	0	0	0
1.A.3.b.i.2 - Light passenger cars without triple catalyzer				11.831	62.476	10.952	0.057
1.A.3.b.ii – Light trucks				0	0	0	0
1.A.3.b.ii.1 – Light trucks with triple catalyzer				0	0	0	0
1.A.3.b.ii.2 - Light trucks without triple catalyzer				0	0	0	0
1.A.3.b.iii – Heavy trucks and buses				0	0	0	0
1.A.3.b.iv – Motorcycles				0	0	0	0
1.A.3.b.v – Emissions from transport as steam				0	0	0	0
1.A.3.b.vi – Urea based catalyzer	0			0	0	0	0
1.A.3.c – Railway transport				0	0	0	0
1.A.3.d – Water-borne navigation				0	0	0	0
1.A.3.d.i - International Water-borne navigation (bunker)							
1.A.3.d.ii – Domestic Water-borne navigation				0	0	0	0
1.A.3.e – Other				0	0	0	0
1.A.3.e.i – Pipeline transport				0	0	0	0

1.A.3.e.ii – Non- road				0	0	0	0
1.A.4 - Other sections	1669.275	2.095	0.031	1.753	3.73	0.441	0.12
1.A.4.a – Commercial/institutional	305.895	0.042	0.001	0.273	0.273	0.027	0
1.A.4.b - Domestic	939.536	1.995	0.027	0.900	3.341	0.385	0.041
1.A.4.c – Agriculture/forestry/fishing industry	423.844	0.058	0.003	0.58	0.116	0.029	0.079
1.A.4.c.i – Permanent/Fixed facilities				0	0	0	0
1.A.4.c.ii – Non-road vehicles and other machinery	423.844	0.058	0.003	0.580	0.116	0.029	0.079
1.A.4.c.iii – Fishery (mobile combustion)				0	0	0	0
1.A.5 - Not specified				0	0	0	0
1.A.5.a – Permanent/fixed				0	0	0	0
1.A.5.b – Mobile facilities				0	0	0	0
1.A.5.b.i - Mobile (aviation component)				0	0	0	0
1.A.5.b.ii - Mobile (hydrogen component)				0	0	0	0
1.A.5.b.iii - Mobile (other)				0	0	0	0
1.A.5.c – Multilateral operation							
1.B - Fugitive emissions from fuels	0.088	32.258	0	0	0	0	0
1.B.1 - Solid fuel	0	0		0	0	0	0
1.B.1.a –Coal mining and processing	0	0		0	0	0	0
1.B.1.a.i – Underground mines	0	0		0	0	0	0
1.B.1.a.i.1 – Mineral industry	0	0		0	0	0	0
1.B.1.a.i.2 - Emissions after gas mining	0	0		0	0	0	0
1.B.1.a.i.3 – Abandoned underground mines				0	0	0	0
1.B.1.a.i.4 – Dried methane combustion or methane conversion to CO_2	0	0		0	0	0	0
1.B.1.a.ii - Surface mines	0	0		0	0	0	0
1.B.1.a.ii.1 – Mineral industries	0	0		0	0	0	0
1.B.1.a.ii.2 - Emissions after gas mining	0	0		0	0	0	0
1.B.1.b – Uncontrolled burning and coal burning in disposal sites				0	0	0	0
1.B.1.c - Solid fuel conversion				0	0	0	0
1.B.2 - Oil and natural gas	0.088	32.258	0	0	0	0	0
1.B.2.a - Oil				0	0	0	0
1.B.2.a.i – Air- conditioning				0	0	0	0
1.B.2.a.ii – Combustion				0	0	0	0
1.B.2.a.iii - Other				0	0	0	0
1.B.2.a.iii.1 - Exploration				0	0	0	0
1.B.2.a.iii.2 - Production and Upgrading				0	0	0	0
1.B.2.a.iii.3 - Transport				0	0	0	0
1.B.2.a.iii.4 – Refining				0	0	0	0
1.B.2.a.iii.5 – Distribution of Petroleum products				0	0	0	0
1.B.2.a.iii.6 - Other				0	0	0	0
1.B.2.b - Natural gas	0.088	32.258	0	0	0	0	0
1.B.2.b.i - Air- conditioning				0	0	0	0
1.B.2.b.ii – Combustion				0	0	0	0
1.B.2.b.iii - Other	0.088	32.258	0	0	0	0	0
1.B.2.b.iii.1 - Exploration				0	0	0	0
1.B.2.b.iii.2 - Production				0	0	0	0
1.B.2.b.iii.3 – Processing				0	0	0	0
1.B.2.b.iii.4 – Transportation and distribution	0.088	32.258		0	0	0	0
1.B.2.b.iii.5 – Distribution				0	0	0	0
1.B.2.b.iii.6 - Other				0	0	0	0
1.B.3 - Other emissions from energy production				0	0	0	0

1.C - Carbon dioxide transport and storage	0			0	0	0	0
1.C.1 - CO2 transport	0			0	0	0	0
1.C.1.a – Pipelines	0			0	0	0	0
1.C.1.b - Ships	0			0	0	0	0
1.C.1.c - Other	0			0	0	0	0
1.C.2 - Injection and storage	0			0	0	0	0
1.C.2.a - Injection	0			0	0	0	0
1.C.2.b – Storage	0			0	0	0	0
1.C.3 - Other	0			0	0	0	0
Memo Items							
International bunkers	136.172	0.001	0.004	0.485	0.539	0.325	0.043
1.A.3.a.i - International air transport (international bunker)	136.172	0.001	0.004	0.485	0.539	0.325	0.043
1.A.3.d.i - International water-borne transport (International bunkers)				0	0	0	0
1.A.5.c – Multilateral operations				0	0	0	0
Memo Items							
CO_2 released from biomass burned for energy production	647.827						

Table A.1.4 IPPU Sectoral (Exported from IPCC2006 Inventory Software)

Inventory Year: 2010	(Gg)			CO_2 equivalents (Gg)				(Gg)				
Categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO_2
2 - Industrial processes and product use	225.964	0	0	121.532	0	0	0	0	0	0	0	0
2.A – Mineral Industry	225.964	0	0	0	0	0	0	0	0	0	0	0
2.A.1 - Cement production	225.964								0	0	0	0
2.A.2 - Lime production	0								0	0	0	0
2.A.3 - Glass production	0								0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0	0	0	0	0	0	0	0	0	0	0	0
2.A.4.a - Pottery	0								0	0	0	0
2.A.4.b – Soda application (ither)	0								0	0	0	0
2.A.4.c – Non Metallurgical Magnesia Production	0								0	0	0	0
2.A.4.d - Other	0								0	0	0	0
2.A.5 - Other									0	0	0	0
2.B - Chemical industries	0	0	0	0	0	0	0	0	0	0	0	0
2.B.1 - Ammonium production	0								0	0	0	0
2.B.2 - Nitric acid production			0						0	0	0	0
2.B.3 - Adipic acid production			0						0	0	0	0
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0						0	0	0	0
2.B.5 - Carbide production	0	0							0	0	0	0
2.B.6 - Titanium dioxide production	0								0	0	0	0
2.B.7 - Soda Ash Production	0								0	0	0	0
2.B.8 - Petrochemical and Carbon Black Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.8.a – Methanol	0	0							0	0	0	0
2.B.8.b – Ethylene	0	0							0	0	0	0
2.B.8.c - Ethylene dichloride and	0	0							0	0	0	0

vinyl chloride polymer												
2.B.8.d - Ethylene oxide	0	0							0	0	0	0
2.B.8.e - Acrylonitrile	0	0							0	0	0	0
2.B.8.f – Carbon	0	0							0	0	0	0
2.B.9 - Fluorinated chemicals production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.9.a - Emissions by products				0					0	0	0	0
2.B.9.b – Fugitive Emissions									0	0	0	0
2.B.10 - Uյլ									0	0	0	0
2.C - Metal industries	0	0	0	0	0	0	0	0	0	0	0	0
2.C.1 - Iron and steel production	0	0							0	0	0	0
2.C.2 - Ferromolybdenum production	0	0							0	0	0	0
2.C.3 - Aluminum production	0				0				0	0	0	0
2.C.4 - Magnesium production	0					0			0	0	0	0
2.C.5 - Lead production	0								0	0	0	0
2.C.6 - Zinc production	0								0	0	0	0
2.C.7 - Other (please specify)	0								0	0	0	0
2.D – Non-Energy Products from Fuels and Solvent Use	0	0	0	0	0	0	0	0	0	0	0	0
2.D.1 – Lubricant Use	0								0	0	0	0
2.D.2 – Paraffin Wax Use	0								0	0	0	0
2.D.3 – Solvent Use									0	0	0	0
2.D.4 – Other (please specify)									0	0	0	0
2.E – Electronics industry	0	0	0	0	0	0	0	0	0	0	0	0
2.E.1 – Integrated Circuit or Semiconductor				0	0	0		0	0	0	0	0
2.E.2 -TFT Flat Panel Display					0	0		0	0	0	0	0
2.E.3 – Photovoltaics					0				0	0	0	0
2.E.4 - Heat Transfer Fluid					0				0	0	0	0
2.E.5 - Other (please specify)									0	0	0	0
2.F – Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	121.532	0	0	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning	0	0	0	111.997	0	0	0	0	0	0	0	0
2.F.1.a - Refrigeration and non-mobile Air- conditioning				111.997					0	0	0	0
2.F.1.b - Mobile Air- conditioning				0					0	0	0	0
2.F.2 - Foam Blowing Agents				0.224				0	0	0	0	0
2.F.3 - – Fire Protection				0.218	0				0	0	0	0
2.F.4 - Aerosols				9.092				0	0	0	0	0
2.F.5 – Solvents				0	0			0	0	0	0	0
2.F.6 – Other Applications (please specify)				0	0			0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment	0	0	0	0	0	0	0	0	0	0	0	0
2.G.1.a - Electrical Equipment production					0	0			0	0	0	0
2.G.1.b - Electrical Equipment uses					0	0			0	0	0	0
2.G.1.c - Electrical Equipment utilization					0	0			0	0	0	0
2.G.2 - SF6 and PFCs from Other Product Uses	0	0	0	0	0	0	0	0	0	0	0	0
2.G.2.a – For Military purposes					0	0			0	0	0	0

2.G.2.b - Accelerators					0	0			0	0	0	0
2.G.2.c - Other					0	0			0	0	0	0
2.G.3 - N_2O from Product Uses	0	0	0	0	0	0	0	0	0	0	0	0
2.G.3.a – For medical purposes			0						0	0	0	0
2.G.3.b – Propellant for pressure and aerosol products			0						0	0	0	0
2.G.3.c - Other			0						0	0	0	0
2.G.4 - Other (please specify)									0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0	0
2.H.1 - – Pulp and Paper Industry									0	0	0	0
2.H.2 - Food and Beverages Industry									0	0	0	0
2.H.3 - Other									0	0	0	0

Table A.1.5 AFOLU Sectoral (Exported from IPCC2006 Inventory Software)

Inventory Year: 2010	(Gg)					
Categories	Net CO_2 Emissions/ Removals	Emissions				
		CH_4	N_2O	NOx	CO	NMVOCs
3 - Agriculture, forestry and other land use	-552.704	44.264	1.261	0	0	0
3.A - Livestock	0	44.221	0.213	0	0	0
3.A.1 - Enteric fermentation	0	40.917	0	0	0	0
3.A.1.a - Large horned animals	0	37.026	0	0	0	0
3.A.1.a.i - Dairy cows and calves raised for milk		21.584		0	0	0
3.A.1.a.ii - Non-dairy cattle and calves raised for meat		15.442		0	0	0
3.A.1.b - Buffalos		0.025		0	0	0
3.A.1.c - Sheep		3.270		0	0	0
3.A.1.d - Goats		0.205		0	0	0
3.A.1.e - Camels		0.000		0	0	0
3.A.1.f - Horses		0.187		0	0	0
3.A.1.g - Mules and donkeys		0.044		0	0	0
3.A.1.h - Pigs		0.160		0	0	0
3.A.1.j - Other		0		0	0	0
3.A.2 - Manure management	0	3.304	0.213	0	0	0
3.A.2.a – Large cattle	0	2.855	0.163	0	0	0
3.A.2.a.i - Dairy cows and calves raised for milk		2.459	0.111	0	0	0
3.A.2.a.ii - Non-dairy cattle and calves raised for meat		0.396	0.052	0	0	0
3.A.2.b - Buffalos		0.000	0.000	0	0	0
3.A.2.c - Sheep		0.065	0.032	0	0	0
3.A.2.d - Goats		0.005	0.002	0	0	0
3.A.2.e - Camels		0	0	0	0	0
3.A.2.f - Horses		0.011	0.002	0	0	0
3.A.2.g - Mules and donkeys		0.003	0.000	0	0	0
3.A.2.h - Pigs		0.319	0.010	0	0	0
3.A.2.i - Poultry		0.045	0.004	0	0	0
3.A.2.j - Other		0	0	0	0	0
3.B - Land	-542.959	0	0	0	0	0
3.B.1 - Forest lands	-557.087	0	0	0	0	0
3.B.1.a - Forest lands remaining Forest lands	-552.930			0	0	0
3.B.1.b - Lands converted to Forest lands	-4.157	0	0	0	0	0

3.B.1.b.i – Arable lands converted to Forest lands	-4.157			0	0	0
3.B.1.b.ii - Pastures converted to Forest lands	0			0	0	0
3.B.1.b.iii - Wetlands converted to Forest lands	0			0	0	0
3.B.1.b.iv - Settlements converted to Forest lands	0			0	0	0
3.B.1.b.v - Other Lands converted to Forest lands	0			0	0	0
3.B.2 - Croplands	0.670	0	0	0	0	0
3.B.2.a - Cropland remaining cropland	0.670			0	0	0
3.B.2.b - Lands converted to Croplands	0	0	0	0	0	0
3.B.2.b.i - Forest lands converted to Croplands	0			0	0	0
3.B.2.b.ii - Grasslands converted to Croplands	0			0	0	0
3.B.2.b.iii - Wetlands converted to Croplands	0			0	0	0
3.B.2.b.iv - Settlements converted to Croplands	0			0	0	0
3.B.2.b.v – Other Lands converted to Croplands	0			0	0	0
3.B.3 - Grassland	13.459	0	0	0	0	0
3.B.3.a - Grassland remaining Grassland	13.459			0	0	0
3.B.3.b - Lands converted to Grassland	0	0	0	0	0	0
3.B.3.b.i - Forest lands converted to Grassland	0			0	0	0
3.B.3.b.ii - Cropland converted to Grassland	0			0	0	0
3.B.3.b.iii - Wetlands converted to Grassland	0			0	0	0
3.B.3.b.iv - Settlements converted to Grassland	0			0	0	0
3.B.3.b.v - Other Land converted to Grassland	0			0	0	0
3.B.4 - Wetlands	0	0	0	0	0	0
3.B.4.a - Wetlands remaining wetland	0	0	0	0	0	0
3.B.4.a.i – Peat land remaining peat land	0		0	0	0	0
3.B.4.a.ii – Water covered lands remaining water covered lands				0	0	0
3.B.4.b - Lands converted to wetland	0	0	0	0	0	0
3.B.4.b.i - Lands converted to peat mine			0	0	0	0
3.B.4.b.ii - Lands converted to water covered lands	0			0	0	0
3.B.4.b.iii - Lands converted to other wetland				0	0	0
3.B.5 - Settlements	0	0	0	0	0	0
3.B.5.a - Settlements remaining Settlements	0			0	0	0
3.B.5.b - Lands converted to Settlements	0	0	0	0	0	0
3.B.5.b.i - Forest lands converted to Settlements	0			0	0	0
3.B.5.b.ii - Cropland converted to Settlements	0			0	0	0
3.B.5.b.iii - Grassland converted to Settlements	0			0	0	0
3.B.5.b.iv - Wetlands converted to Settlements	0			0	0	0
3.B.5.b.v – Other Lands converted to Settlements	0			0	0	0
3.B.6 –Other land	0	0	0	0	0	0
3.B.6.a - Other land remaining Other land				0	0	0
3.B.6.b - Lands converted to Other land	0	0	0	0	0	0
3.B.6.b.i - Forest lands converted to Other land	0			0	0	0
3.B.6.b.ii - Cropland converted to Other land	0			0	0	0
3.B.6.b.iii - Grassland converted to Other land	0			0	0	0
3.B.6.b.iv - Wetlands converted to Other land	0			0	0	0
3.B.6.b.v - Settlements converted to Other land	0			0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land	0.969	0.042	1.049	0	0	0
3.C.1 - Emissions from biomass burning	0	0.042	0	0	0	0
3.C.1.a - Biomass burning in Forest lands		0.042	0	0	0	0
3.C.1.b - Biomass burning in Croplands		0	0	0	0	0
3.C.1.c - Biomass burning in Grasslands		0	0	0	0	0
3.C.1.d - Biomass burning in Other lands		0	0	0	0	0

3.C.2 - Liming	0			0	0	0
3.C.3 - Urea application	0.969			0	0	0
3.C.4 - Direct N2O Emissions from managed lands			0.617	0	0	0
3.C.5 – Indirect N_2O Emissions from managed lands			0.273	0	0	0
3.C.6 – Indirect N_2O Emissions from Manure management			0.159	0	0	0
3.C.7 – Rice cultivation		0		0	0	0
3.C.8 - Other (please specify)				0	0	0
3.D - Other	-10.715	0	0	0	0	0
3.D.1 - Harvested Wood Products	-10.715			0	0	0
3.D.2 - Other				0	0	0

Table A.1.6 Waste Sectoral (Exported from IPCC2006 Inventory Software)

Inventory Year: 2010	Emissions [Gg]						
Categories	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SO_2
4 - Waste	7.639	27.768	0.202	0	0	0	0
4.A - Solid Waste disposal	0	22.398	0	0	0	0	0
4.A.1 - Managed sources				0	0	0	0
4.A.2 – Not-managed sources				0	0	0	0
4.A.3 – Unclassified soureces				0	0	0	0
4.B – Biological Treatment of Solid Waste		0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	7.639	1.100	0.020	0	0	0	0
4.C.1 – Incineration of Waste	0	0	0	0	0	0	0
4.C.2 – Open burning of waste	7.639	1.100	0.020	0	0	0	0
4.D - Wastewater treatment and discharge	0	4.270	0.182	0	0	0	0
4.D.1 - Domestic Wastewater treatment and discharge		3.558	0.182	0	0	0	0
4.D.2 - Industrial Wastewater treatment and discharge		0.712		0	0	0	0
4.E – Other				0	0	0	0

Table A.1.7 Uncertainty analysis (Exported from IPCC2006 Inventory Software)

Base year for assessment of uncertainty in trend: 2000, Year T: 2010 **2006 IPCC Categories**	**Gas**	**Baseline year emissions or removals ($Gg\ CO_2$ equivalent)**	**Year T emissions or removals ($Gg\ CO_2$ equivalent)**	**Activity Data Uncertainty (%)**	**Emission factor uncertainty (%)**	**Combined Uncertainty (%)**	**Contribution to Variance by Category in Year T**	**Inventory trend in national emissions for year t increase with respect to base year (% of base year)**	**Uncertainty introduced into the trend in total national emissions (%)**
1 - Energy									
1.A.1 - Energy sectors - Liquid fuels	CO_2	6.567	0	5	5	7.071	0	0	0.000
1.A.1 - Energy sectors - Liquid fuels	CH_4	0.005	0	5	5	7.071	0	0	0.000
1.A.1 - Energy sectors - Liquid fuels	N_2O	0.016	0	5	5	7.071	0	0	0.000
1.A.1 - Energy sectors - Gaseous Fuels	CO_2	1667.061	827.518	5	5	7.071	0.599	49.639	2.736
1.A.1 - Energy sectors - Gaseous Fuels	CH_4	0.624	0.310	5	5	7.071	0.000	49.639	0.000
1.A.1 - Energy sectors - Gaseous Fuels	N_2O	0.921	0.457	5	5	7.071	0.000	49.639	0.000
1.A.2 - Manufacturing industry and construction - Gaseous Fuels	CO_2	339.538	529.553	13.229	13.229	18.708	0.061	155.963	0.171
1.A.2 - Manufacturing industry and construction - Gaseous Fuels	CH_4	0.127	0.198	13.229	13.229	18.708	0.000	155.963	0.000
1.A.2 - Manufacturing industry and construction - Gaseous Fuels	N_2O	0.188	0.293	13.229	13.229	18.708	0.000	155.963	0.000
1.A.2 - Manufacturing industry and construction - Solid fuel	CO_2	0	1.969	5	5	7.071	0.000	0	0.000
1.A.2 - Manufacturing industry and construction - Solid fuel	CH_4	0	0.004	5	5	7.071	0.000	0	0.000
1.A.2 - Manufacturing industry and construction - Solid fuel	N_2O	0	0.009	5	5	7.071	0.000	0	0.000
1.A.2 - Manufacturing industry and construction - Liquid fuels	CO_2	107.106	0	5	5	7.071	0	0	0.017
1.A.2 - Manufacturing industry and construction - Liquid fuels	CH_4	0.094	0	5	5	7.071	0	0	0.000
1.A.2 - Manufacturing industry and construction - Liquid fuels	N_2O	0.277	0	5	5	7.071	0	0	0.000
1.A.3.a - Civil aviation - Liquid fuels	CO_2	90.527	136.172	5	4.698	6.861	0.015	150.421	0.030
1.A.3.a - Civil aviation - Liquid fuels	CH_4	0.013	0.020	5	5	7.071	0.000	150.421	0.000
1.A.3.a - Civil aviation - Liquid fuels	N_2O	0.785	1.181	5	5	7.071	0.000	150.421	0.000
1.A.3.b - Road transportation - Liquid fuels	CO_2	587.832	580.302	5	5	7.071	0.294	98.719	0.578
1.A.3.b - Road transportation - Liquid fuels	CH_4	5.081	5.090	5	5	7.071	0.000	100.172	0.000
1.A.3.b - Road transportation - Liquid fuels	N_2O	8.524	8.431	5	5	7.071	0.000	98.915	0.000
1.A.3.b - Road transportation - Gaseous Fuels	CO_2	54.228	622.320	5	5	7.071	0.339	1147.592	0.864
1.A.3.b - Road transportation - Gaseous Fuels	CH_4	1.868	21.432	5	5	7.071	0.000	1147.592	0.001
1.A.3.b - Road transportation - Gaseous Fuels	N_2O	0.899	10.317	5	5	7.071	0.000	1147.592	0.000
1.A.3.b - Road transportation	CO_2	0	0	0	0	0	0	100	0
1.A.4 - Other sections - Liquid fuels	CO_2	115.508	441.799	8.660	8.660	12.247	0.157	382.483	0.367
1.A.4 - Other sections - Liquid fuels	CH_4	0.295	1.248	8.660	8.660	12.247	0.000	423.524	0.000
1.A.4 - Other sections - Liquid fuels	N_2O	0.228	1.088	8.660	8.660	12.247	0.000	477.189	0.000

1.A.4 - Other sections - Solid fuel	CO_2	0.041	0.825	7.071	7.071	10	0.000	1987.159	0.000
1.A.4 - Other sections - Solid fuel	CH_4	0.002	0.051	7.071	7.071	10	0.000	2244.049	0.000
1.A.4 - Other sections - Solid fuel	N_2O	0.000	0.004	7.071	7.071	10	0.000	1861.240	0.000
1.A.4 - Other sections - Gaseous Fuels	CO_2	201.956	1226.652	7.071	7.071	10	0.823	607.384	1.760
1.A.4 - Other sections - Gaseous Fuels	CH_4	0.378	2.296	7.071	7.071	10	0.000	607.384	0.000
1.A.4 - Other sections - Gaseous Fuels	N_2O	0.112	0.678	7.071	7.071	10	0.000	607.384	0.000
1.A.4 - Other sections - Biomass	CO_2	422.997	647.827	7.071	7.071	10	0.361	153.152	0.666
1.A.4 - Other sections - Biomass	CH_4	23.794	40.398	7.071	7.071	10	0.001	169.783	0.003
1.A.4 - Other sections - Biomass	N_2O	4.683	7.951	7.071	7.071	10	0.000	169.783	0.000
1.B.1 - Solid fuel	CO_2	0	0	0	0	0	0	100	0
1.B.1 - Solid fuel	CH_4	0	0	5	0	5	0	100	0
1.B.2.b - Natural gas	CO_2	0.061	0.088	0	0	0	0	143.114	0
1.B.2.b - Natural gas	CH_4	473.346	677.426	0	0	0	0	143.114	0
1.B.2.b - Natural gas	N_2O	0	0	0	0	0	0	100	0
1.C - Carbon dioxide transport and storage	CO_2	0	0	12.247	0	12.247	0	100	0
2 - Industrial processes and product use									
2.A.1 - Cement production	CO_2	119.676	225.964	35	0	35	1.094	188.814	4.018
2.A.2 - Lime production	CO_2	0	0	15	0	15	0	100	0
2.A.3 - Glass production	CO_2	0	0	5	0	5	0	100	0
2.A.4 - Other Process Uses of Carbonates	CO_2	0	0	0	0	0	0	100	0
2.B.1 - Ammonium production	CO_2	0	0	5	0	5	0	100	0
2.B.2 - Nitric acid production	N_2O	0	0	2	0	2	0	100	0
2.B.3 - Adipic acid production	N_2O	0	0	5	0	5	0	100	0
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	N_2O	0	0	10	0	10	0	100	0
2.B.5 - Carbide production	CO_2	0	0	5	10	11.180	0	100	0
2.B.5 - Carbide production	CH_4	0	0	5	10	11.180	0	100	0
2.B.6 - Titanium dioxide production	CO_2	0	0	5	0	5	0	100	0
2.B.7 - Soda Ash Production	CO_2	0	0	5	0	5	0	100	0
2.B.8 - Petrochemical and Carbon Black Production	CO_2	0	0	24.495	0	24.495	0	100	0
2.B.8 - Petrochemical and Carbon Black Production	CH_4	0	0	24.495	0	24.495	0	100	0
2.B.9 - Fluorinated chemicals production	CHF_3	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CH_2F_2	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CH_3F	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	$CF_3CHFCHFCF_2CF_3$	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CHF_2CF_3	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CHF_2CHF_2	0	0	1	0	1	0	100	0

2.B.9 - Fluorinated chemicals production	CH_2FCF_3	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CH_3CHF_2	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CHF_2CH_2F	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CF_3CH_3	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CF_3CHFCF_3	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	$CF_3CH_2CF_3$	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	$CH_2FCF_2CHF_2$	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CF_4	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	C_2F_6	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	C_3F_8	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	C_4F_{10}	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	$c\text{-}C_4F_8$	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	C_5F_{12}	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	C_6F_{14}	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	SF_6	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CHC_{l3}	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CH_2C_{l2}	0	0	1	0	1	0	100	0
2.B.9 - Fluorinated chemicals production	CF_3 I	0	0	1	0	1	0	100	0
2.C.1 - Iron and steel production	CO_2	0	0	10	0	10	0	100	0
2.C.1 - Iron and steel production	CH_4	0	0	10	0	10	0	100	0
2.C.2 - Ferromolybdenum production	CO_2	0	0	5	0	5	0	100	0
2.C.2 - Ferromolybdenum production	CH_4	0	0	5	0	5	0	100	0
2.C.3 - Aluminum production	CO_2	0	0	2	0	2	0	100	0
2.C.3 - Aluminum production	CF_4	0	0	2	0	2	0	100	0
2.C.3 - Aluminum production	C_2F_6	0	0	2	0	2	0	100	0
2.C.4 - Magnesium production	CO_2	0	0	5	0	5	0	100	0
2.C.4 - Magnesium production	SF_6	0	0	5	0	5	0	100	0
2.C.5 - Lead production	CO_2	0	0	10	0	10	0	100	0
2.C.6 - Zinc production	CO_2	0	0	10	0	10	0	100	0
2.C.7 - Other	CO_2	0	0	0	0	0	0	100	0
2.D - Non-Energy Products from Fuels and Solvent Use	CO_2	0	0	14.142	0	14.142	0	100	0
2.E - Electronics industry	C_2F_6	0	0	14.142	0	14.142	0	100	0
2.E - Electronics industry	CF_4	0	0	17.321	0	17.321	0	100	0
2.E - Electronics industry	CHF_3	0	0	10	0	10	0	100	0
2.E - Electronics industry	C_3F_8	0	0	10	0	10	0	100	0
2.E - Electronics industry	SF_6	0	0	14.142	0	14.142	0	100	0
2.E - Electronics industry	C_6F_{14}	0	0	10	0	10	0	100	0

2.F.1 - Refrigeration and Air Conditioning	CH_2F_2	0	0	0	0	0	0	100	0
2.F.1 - Refrigeration and Air Conditioning	CHF_2CF_3	0	0	0	0	0	0	100	0
2.F.1 - Refrigeration and Air Conditioning	CH_2FCF_3	0.267	38.304	5	0	5	0	14358.874	0
2.F.1 - Refrigeration and Air Conditioning	CF_3CH_3	0.296	73.694	0	0	0	0	24889.742	0
2.F.2 - Foam Blowing Agents	CH_2FCF_3	0	0.224	0	0	0	0	0	0
2.F.3 - Fire Protection	CF_3CHFCF_3	0	0.218	0	0	0	0	0	0
2.F.4 - Aerosols	CH_2FCF_3	2.925	8.6905	10	10	14.142	0.000	297.111	0.001
2.F.4 - Aerosols	CH_3CHF_2	0.1351	0.4018	10	10	14.142	0.000	297.409	0.000
2.F.4 - Aerosols	CF_3CHFCF_3	0	0	10	10	14.142	0	100	0
2.F.4 - Aerosols	$CF_3CHFCHFCF_2CF_3$	0	0	10	10	14.142	0	100	0
2.F.5 - Solventsp	$CF_3CHFCHFCF_2CF_3$	0	0	10	50	50.990	0	100	0
2.F.5 - Solventsp	C_6F_{14}	0	0	10	50	50.990	0	100	0
2.F.6 - Other Applications	CHF_3	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CH_2F_2	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CH_3F	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	$CF_3CHFCHFCF_2CF_3$	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CHF_2CF_3	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CHF_2CHF_2	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CH_2FCF_3	0	0	10	50	50.990	0	100	0
2.F.6 - Other Applications	CH_3CHF_2	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CHF_2CH_2F	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CF_3CH_3	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CF_3CHFCF_3	0	0	10	50	50.990	0	100	0
2.F.6 - Other Applications	$CF_3CH_2CF_3$	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	$CH_2FCF_2CHF_2$	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	CF_4	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	C_2F_6	0	0	10	50	50.990	0	100	0
2.F.6 - Other Applications	C_3F_8	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	C_4F_{10}	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	$c-C_4F_8$	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	C_5F_{12}	0	0	10	0	10	0	100	0
2.F.6 - Other Applications	C_6F_{14}	0	0	10	0	10	0	100	0
2.G - Other Product Manufacture and Use	SF_6	0	0	60	58.310	83.666	0	100	0
2.G - Other Product Manufacture and Use	CF_4	0	0	60	58.310	83.666	0	100	0
2.G - Other Product Manufacture and Use	C_2F_6	0	0	60	58.310	83.666	0	100	0
2.G - Other Product Manufacture and Use	C_3F_8	0	0	60	58.310	83.666	0	100	0
2.G - Other Product Manufacture and Use	C_4F_{10}	0	0	60	58.310	83.666	0	100	0

2.G - Other Product Manufacture and Use	c-C_4F_8	0	0	60	58.310	83.666	0	100	0
2.G - Other Product Manufacture and Use	C_5F_{12}	0	0	60	58.310	83.666	0	100	0
2.G - Other Product Manufacture and Use	C_6F_{14}	0	0	60	58.310	83.666	0	100	0
2.G - Other Product Manufacture and Use	N_2O	0	0	0	0	0	0	100	0
3 - Agriculture, forestry and other land use									
3.A.1 - Enteric fermentation	CH_4	723.557	859.266	0	0	0	0	118.756	0
3.A.1 - Enteric fermentation	N_2O	59.199	65.930	0	0	0	0	111.370	0
3.A.2 - Manure management	CH_4	63.325	69.381	0	0	0	0	109.564	0
3.B.1.a - Forest lands remaining Forest lands	CO_2	-470.820	-552.930	0	0	0	0	0	0
3.B.1.b - Lands converted to Forest lands	CO_2	0	-4.157	0	0	0	0	0	0
3.B.2.a - Cropland remaining cropland	CO_2	0.670	0.670	0	0	0	0	100	0
3.B.2.b - Lands converted to Croplands	CO_2	0	0	0	0	0	0	100	0
3.B.3.a - Grassland remaining Grassland	CO_2	13.459	13.459	0	0	0	0	100	0
3.B.3.b - Lands converted to Grassland	CO_2	0	0	0	0	0	0	100	0
3.B.4.a.i - Peatland remaining peatland	CO_2	0	0	0	0	0	0	100	0
3.B.4.a.i - Peatland remaining peatland	N_2O	0	0	0	0	0	0	100	0
3.B.4.b - Lands converted to wetlands	N_2O	0	0	0	0	0	0	100	0
3.B.4.b - Lands converted to wetlands	CO_2	0	0	0	0	0	0	100	0
3.B.5.a - Settlements remaining Settlements	CO_2	0	0	0	0	0	0	100	0
3.B.5.b - Lands converted to Settlements	CO_2	0	0	0	0	0	0	100	0
3.B.6.b - Lands converted to Other land	CO_2	0	0	0	0	0	0	100	0
3.C.1 - Emissions from biomass burning	CH_4	0	0.887	0	0	0	0	0	0
3.C.1 - Emissions from biomass burning	N_2O	0	0	0	0	0	0	100	0
3.C.2 - Liming	CO_2	0	0	0	0	0	0	100	0
3.C.3 - Urea application	CO_2	0.002	0.969	0	0	0	0	42645.161	0
3.C.4 - Direct N2O Emissions from managed lands	N_2O	257.670	191.232	0	0	0	0	74.216	0
3.C.5 – Indirect N_2O Emissions from managed lands	N_2O	48.591	84.650	0	0	0	0	174.208	0
3.C.6 - Indirect N_2O Emissions Manure management	N_2O	42.625	49.153	0	0	0	0	115.316	0
3.C.7 – Rice cultivation	CH_4	0	0	0	0	0	0	100	0
3.D.1 - Harvested Wood Products	CO_2	-12.605	-10.715	0	0	0	0	0	0
4 - Waste									
4.A - Solid Waste disposal	CH_4	449.526	470.350	0	0	0	0	104.632	0
4.B - Biological Treatment of Solid Waste	CH_4	0	0	0	0	0	0	100	0
4.B - Biological Treatment of Solid Waste	N_2O	0	0	0	0	0	0	100	0
4.C - Incineration and Open Burning of Waste	CO_2	7.391	7.639	0	0	0	0	103.344	0
4.C - Incineration and Open Burning of Waste	CH_4	22.361	23.109	0	0	0	0	103.344	0

4.C - Incineration and Open Burning of Waste	N_2O	5.942	6.140	0	0	0	0	103.344	0
4.D - Wastewater treatment and discharge	CH_4	80.262	89.670	0	0	0	0	111.722	0
4.D - Wastewater treatment and discharge	N_2O	49.939	56.422	0	0	0	0	112.981	0
Total			**Sum(D): 7562.526**				**Sum(H): 3.745**		**Sum(M): 11.210**
							Uncertainty in total invent-ory **1.935**		Trend uncertainty **3.348**

Table A.1.8 Recalculated data for 2000

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions and removals	**3,213.704**	**-470.820**	**87.840**	**1.548**	**12.126**	**63.604**	**14.539**	**0.636**
1. Energy	**3,079.899**		**24.077**	**0.051**	**11.967**	**59.277**	**11.081**	**0.561**
A. Fuel combustion (sectoral approach)	3,079.837		1.537	0.051	11.967	59.277	11.081	0.561
1. Energy Industries	1,673.627		0.030	0.003	4.474	0.596	0.149	0.170
2. Manufacturing industries and construction	446.643		0.011	0.001	1.207	0.197	0.038	0.250
3. Transport	642.060		0.331	0.030	5.938	58.270	10.867	0.128
4. Other sectors	317.506		1.165	0.016	0.348	0.214	0.027	0.013
5. Other (please specify)	NO		NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.061		22.540		NO	NO	NO	NO
1. Solid fuels			NO		NO	NO	NO	NO
2. Oil and natural gas			22.540		NO	NO	NO	NO
2. Industrial processes	**119.676**				**NO**	**NO**	**2.538**	**0.075**
A. Mineral products	119.676				NO	NO	NO	0.075
B. Chemical industry	NO		NO	NO	NO	NO	NO	NO
C. Metal production	NO		NO	NO	NO	NO	NO	NO
D. Other production	NO		NO	NO	NO	NO	2.538	NO
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)	NO		NO	NO	NO	NO	NO	NO
3. Solvent and other product use	**NO**			**NO**			**0.920**	
4. Agriculture			**37.471**	**1.316**	**0.159**	**4.327**	**NO**	
A. Enteric fermentation			34.455					
B. Manure management			3.015	0.191			NO	
C. Rice cultivation			NE				NO	
D. Agricultural soils				1.125			NO	
E. Prescribed burning of savannahs			NO	NO	NO	NO	NO	
F. Field burning of agricultural residues			0.042	0.005	0.159	4.327	NO	
G. Other (please specify)			NO	NO	NO	NO	NO	
5. Land-use change and forestry	**14.130**	**-470.820**	**NE,NO**	**NO**	**NO**	**NO**		
A. Changes in forest and other woody biomass stocks	NE	NE						
B. Forest and grassland conversion	14.130	NE	NO	NO	NO	NO		
C. Abandonment of managed lands		NA						
D. CO_2 emissions and removals from soil	NE	-470.820						
E. Other (please specify)	NE	NE	NE	NO	NO	NO		
6. Waste			**26.293**	**0.180**	**NO,NE**	**NO**	**NO,NE**	**NO**
A. Solid waste disposal on land			21.406		NE		NE	
B. Waste-water handling			3.822	0.161	NO	NO	NO	
C. Waste incineration					NO	NO	NO	NO
D. Other (please specify)			1.065	0.019	NO	NO	NO	NO
7. Other (please specify)	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items								
International bunkers	**90.527**		**0.001**	**0.003**	**0.540**	**0.653**	**0.410**	**0.037**
Aviation	90.527		0.001	0.003	0.540	0.653	0.410	0.037
Marine	NO		NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	**362.079**							

Table A.1.9 Recalculated data for 2006

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions and removals	**4,188.076**	**-523.197**	**103.042**	**2.198**	**15.069**	**62.525**	**18.138**	**27.262**
1. Energy	**3,850.163**		**29.727**	**0.063**	**14.892**	**57.882**	**10.298**	**0.160**
A. Fuel combustion (sectoral approach)	3,850.075		1.685	0.063	14.892	57.882	10.298	0.160
1. Energy Industries	960.026		0.017	0.002	2.567	0.342	0.086	0.003
2. Manufacturing industries and construction	682.687		0.013	0.001	1.827	0.351	0.060	0.003
3. Transport	937.461		0.898	0.046	9.162	56.273	10.043	0.062
4. Other sectors	1,269.901		0.757	0.013	1.336	0.916	0.109	0.003
5. Other (please specify)	NO		NO	NO	NO	NO	NO	0.089
B. Fugitive emissions from fuels	0.088		28.042		NO	NO	NO	NO
1. Solid fuels			NO		NO	NO	NO	NO
2. Oil and natural gas			28.042		NO	NO	NO	NO
2. Industrial processes	**323.783**				**NO**	**NO**	**0.363**	**27.102**
A. Mineral products	323.783				NO	NO	NO	0.202
B. Chemical industry	NO		NO	NO	NO	NO	NO	NO
C. Metal production	NO		NO	NO	NO	NO	NO	26.900
D. Other production	NO		NO	NO	NO	NO	0.363	NO
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)	NO		NO	NO	NO	NO	NO	NO
3. Solvent and other product use	**NO**			**NO**			**7.477**	
4. Agriculture			**45.862**	**1.935**	**0.177**	**4.643**	**NO**	
A. Enteric fermentation			42.199					
B. Manure management			3.663	0.231			NO	
C. Rice cultivation			NO				NO	
D. Agricultural soils			NO	1.704			NO	
E. Prescribed burning of savannahs			NO	NO	NO	NO	NO	
F. Field burning of agricultural residues			0.042	0.005	0.177	4.643	NO	
G. Other (please specify)			NO	NO	NO	NO	NO	
5. Land-use change and forestry [1]	**14.130**	**-523.197**	**NO**	**NO**	**NO**	**NO**		
A. Changes in forest and other woody biomass stocks	NE	NE						
B. Forest and grassland conversion	14.130	NE	NO	NO	NO	NO		
C. Abandonment of managed lands		NE						
D. CO_2 emissions and removals from soil	NE	-523.197						
E. Other (please specify)	NE	NE	NE	NO	NO	NO		
6. Waste			**27.453**	**0.201**	**NO,NE**	**NO**	**NO,NE**	**NO**
A. Solid waste disposal on land			22.250		NE		NE	
B. Waste-water handling			4.114	0.181	NO	NO	NO	
C. Waste incineration					NO	NO	NO	NO
D. Other (please specify)			1.089	0.020	NO	NO	NO	NO
7. Other (please specify)	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo items								
International bunkers	**115.784**		**0.001**	**0.003**	**0.512**	**0.548**	**0.330**	**0.039**
Aviation	115.784		0.001	0.003	0.512	0.548	0.330	0.039
Marine	NO		NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	**179.691**							

Table A.1.10 Recalculated data for 2010

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions and removals	**4,471.119**	**-552.704**	**107.630**	**1.463**	**17.213**	**66.784**	**22.890**	**29.439**
1. Energy	**4,231.025**		**35.640**	**0.094**	**17.213**	**66.784**	**11.514**	**0.189**
A. Fuel combustion (sectoral approach)	4,230.937		3.382	0.094	17.213	66.784	11.514	0.189
1. Energy Industries	827.518		0.015	0.001	2.213	0.295	0.074	NO
2. Manufacturing industries and construction	531.522		0.010	0.001	1.416	0.283	0.047	0.012
3. Transport	1,202.622		1.263	0.060	11.831	62.476	10.952	0.057
4. Other sectors	1,669.275		2.095	0.031	1.753	3.730	0.441	0.120
5. Other (please specify)	NO		NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.088		32.258		NO	NO	NO	NO
1. Solid fuels			NO		NO	NO	NO	NO
2. Oil and natural gas			32.258		NO	NO	NO	NO
2. Industrial processes	**225.964**				**NO**	**NO**	**0.486**	**29.250**
A. Mineral products	225.964				NO	NO	NO	NE
B. Chemical industry	NO		NO	NO	NO	NO	NO	NO
C. Metal production	NO		NO	NO	NO	NO	NO	29.250
D. Other production	NO		NO	NO	NO	NO	0.486	NO
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)	NO		NO	NO	NO	NO	NO	NO
3. Solvent and other product use	**NO**			**NO**			**10.890**	
4. Agriculture			**44.221**	**1.261**	**0.000**	**0.000**	**NO**	
A. Enteric fermentation			40.917					
B. Manure management			3.304	0.213			NO	
C. Rice cultivation			NO				NO	
D. Agricultural soils				1.0485			NO	
E. Prescribed burning of savannahs			NO	NO	NO	NO	NO	
F. Field burning of agricultural residues			0.042	0.005	0.000	0.000	NO	
G. Other (please specify)			NO	NO	NO	NO	NO	
5. Land-use change and forestry	**14.130**	**-552.704**	**0.000**	**0.000**	**0.000**	**0.000**		
A. Changes in forest and other woody biomass stocks	NE	NE						
B. Forest and grassland conversion	14.130	NE	NO	NO	NO	NO		
C. Abandonment of managed lands		NE						
D. CO_2 emissions and removals from soil	NE	-552.704						
E. Other (please specify)	NE	NE	NE	NO	NO	NO		
6. Waste			**27.768**	**0.202**	**NE,NO**	**NO**	**NE,NO**	**NO**
A. Solid waste disposal on land			22.398		NE		NE	
B. Waste-water handling			4.270	0.182	NO	NO	NO	
C. Waste incineration					NO	NO	NO	NO
D. Other (please specify)			1.100	0.020	NO	NO	NO	NO
7. Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
Memo items								
International bunkers	**136.172**		**0.001**	**0.004**	**0.539**	**0.485**	**0.325**	**0.043**
Aviation	136.172		0.001	0.004	0.539	0.485	0.325	0.043
Marine	NO		NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	**647.827**							

ANNEX 2

Contents

Reference on the quantity of natural gas imported from the Russian Federation and, since 2009 from the Islamic Republic of Iran.

Տեղեկանք
բնական գազի ներկրման, սպառման, պահեստավորման, կորուստների ծավալների և միջին տարեկան ջերմատվության արժեքի վերաբերյալ
2007-2010թթ

Անվանում	Չափ. միավ.	2007	2008	2009	2010
Բնական գազի ներկրում Ռուսաստանի Դաշնությունից	մլն.խ.մ.	2054,357	2254,365	1628,726	1440,144
Բնական գազի ներկրում Իրանի Իսլամական Հանրապետությունից	մլն.խ.մ.	-	-	183,271	325,355
Բնական գազի արտահանում	մլն.խ.մ.	0,000	0,000	0,000	0,000
Բնական գազի սպառում	մլն.խ.մ.	1869,314	2078,957	1546,931	1323,566
այդ թվում					
Արդյունաբերություն	մլն.խ.մ.	403,630	368,441	259,734	270,835
Գյուղատնտեսություն	մլն.խ.մ.				
Տրանսպորտ	մլն.խ.մ.	285,630	343,943	305,566	318,281
Բնակչություն	մլն.խ.մ.	532,151	589,457	553,217	470,914
Այլ սպառողներ	մլն.խ.մ.	647,903	777,116	428,414	263,536
«Երևանի ՋԷԿ» ՓԲԸ	մլն.խ.մ.			113,837	290,158
Բնական գազի միջին տարեկան ջերմատվությունը, այդ թվում՝					
ՌԴ-ից ներկրված	կկալ/խ.մ.	8023,0	8004,0	8298,0	8333,0
ԻԻՀ-ից ներկրված	կկալ/խ.մ.			8010,0	7974,0

«ՀայՌուսգազարդ» ՓԲԸ
Կենտրոնական կարգավարական
վարչության պետ - գլխավոր կարգավար Ֆ.Այվազյան

The questionnaire sent to “AraratCement” and “Mika-Cement” CJSCs and the reply

The letter sent to “Araratcement” CJSC

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԲՆԱՊԱՀՊԱՆՈՒԹՅԱՆ ՆԱԽԱՐԱՐՈՒԹՅՈՒՆ
ԱՇԽԱՏԱԿԱԶՄԻ ՂԵԿԱՎԱՐ
MINISTRY OF NATURE PROTECTION OF THE REPUBLIC OF ARMENIA
HEAD OF STAFF
МИНИСТЕРСТВО ОХРАНЫ ПРИРОДЫ РЕСПУБЛИКИ АРМЕНИЯ
РУКОВОДИТЕЛЬ АППАРАТА

0010, ք. Երևան, Հանրապետության հր. Կառավարական 3-րդ տուն
3 Government Bldg, Republic Sq, Yerevan, 0010, Armenia
0010, Армения, г.Ереван, Дом правительства, здание N3
էլ.փոստ /E-mail/ эл.почта: e.pirumyan@mnp.am
Web page: www.mnp.am
☎ (374 10) 58 54 19
🖷 (374 10) 54 08 57

№____________________

«   » ____________2012թ.

<<Արարատցեմենտ>> ՓԲԸ գլխավոր տնօրեն
պարոն Լ. Համբարձումյանին

Հարգելի պարոն Համբարձումյան

Ի կատարումն ՀՀ կառավարության 2011 թվականի նոյեմբերի 10-ի <<Մի շարք բնապահպանական միջազգային կոնվենցիաներից բխող՝ Հայաստանի Հանրապետության պարտավորությունների կատարման միջոցառումների ցանկը հաստատելու մասին>> N1594-Ն որոշման հավելվածի երրորդ կետի, ներկայումս իրականացվում են <<Ջերմոցային գազերի մարդածին արտանետումների երրորդ ազգային կադաստրի>> մշակման համար անհրաժեշտ տեղեկատվության հավաքագրման աշխատանքները: Կադաստրի <<Արդյունաբերություն և արտադրանքի օգտագործում>> ենթաբաժնի մշակման համար անհրաժեշտ են ցեմենտի արտադրության հետ կապված հետևյալ ցուցանիշները.

1. Ցեմենտի արտադրության հիմնական հումքատեսակների ցանկը, դրանց քիմիական կազմը և հումքի տեսակարար ծախսի գործակիցը (կգ/տ ցեմենտ) կամ օգտագործված հումքի քանակը, տ/տարի,
2. Ցեմենտի տարեկան արտադրությունը 2006 – 2011թթ.,
3. Կլինկերի տարեկան արտադրությունը 2006 – 2011թթ.,
4. Վառարանի փոշեկլանման համակարգի արդյունավետությունը, %,
5. Որսված փոշու քանակը (տ/տարի):

Խնդրում եմ հնարավորինս սեղմ ժամկետում տրամադրել Ձեր գործարանում առկա տեղեկատվությունը:

Հարգանքով՝

Է. Փիրումյան

Մ. Ծառուկյան
58 39 34

The reply to the letter sent to “Araratcement” CJSC

ԱՐԱՐԱՏՑԵՄԵՆՏ ՓԲԸ
ARARATCEMENT CJSC

N S-01/ 713 01 նոյեմբերի 2012թ

ՀՀ Բնապահպանության նախարարության
աշխատակազմի ղեկավար՝
պարոն Է. Փիրումյանին

Ի պատասխան Ձեր *N 5/07/52931 25.10.2012* թ գրության ներկայացնում ենք «Արարատցեմենտ» ՓԲԸ-ի ցեմենտի արտադրության հետ կապված ցուցանիշների վերաբերյալ տեղեկատվություն:

h/h	Տարի	Չափի միավոր	Տարեկան արտադրություն		Օգտագործված հիմնական հումքի քանակը	
			Ցեմենտ	Կլինկեր	Կավ	Կրաքար
1	2006	տն	425913	373340	164608	630673
2	2007	տն	500076	452148	212992	767492
3	2008	տն	554892	509714	224599	840013
4	2009	տն	347077	296436	117633	463713
5	2010	տն	367332	342780	129755	577757
6	2011	տն	328628	270359	172156	548385

Որսված փոշու քանակը - տ / տարի - 2011 թ.-ին _ 109368

Վառարանի փոշեկլանման համակարգի արդյունավետությունը - % _ 99,7

Հիմնական հումքատեսակների քիմիական կազմը - %			
	Անվանումը	Կավ	Կրաքար
1	SiO_2	40,6÷47,7	1,0 ÷4,8
2	Al_2O_3	12,5÷14,5	0,8 ÷2,6
3	Fe_2O_3	5,0 ÷ 7,0	0,1 ÷0,6
4	Ca0	12,9 ÷16,0	50,5 ÷53,8
5	MgO	1,3 ÷2,6	0,2 ÷1,5
6	SO_3	0,07 ÷0,55	0,06 ÷0,31
7	Շիկացման ժամանակ կորուստներ (ППП)	14,0 ÷18,4	40,6 ÷43,09

Գլխավոր տնօրեն Լ. Համբարձումյան

Գլխավոր հաշվապահ Գ. Գասպարյան

1400 3-1837
07 11 12

http://www.araratcement.am info@araratcement.am (+(374 238) 41220, 44077, 41228 44279

Հայաստանի Հանրապետություն, 0602 ք.Արարատ, Շահումյան 5
ՀՎՀՀ:04000255
Հ/հ: 001-225556-001,Swift: MIDLAM22
Էյչ-Էս-Բի-Սի Բանկ Հայաստան

5,Shahumyan str.,0602 c.Ararat, Republic of Armenia
TIN:04000255
Acc.: 001-225556-001,Swift: MIDLAM22
HSBC Bank Armenia,

The letter sent to “Mika-Cement” CJSC

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԲՆԱՊԱՀՊԱՆՈՒԹՅԱՆ ՆԱԽԱՐԱՐՈՒԹՅՈՒՆ
ԱՇԽԱՏԱԿԱԶՄԻ ՂԵԿԱՎԱՐ
MINISTRY OF NATURE PROTECTION OF THE REPUBLIC OF ARMENIA
HEAD OF STAFF
МИНИСТЕРСТВО ОХРАНЫ ПРИРОДЫ РЕСПУБЛИКИ АРМЕНИЯ
РУКОВОДИТЕЛЬ АППАРАТА

0010, ք. Երևան, Հանրապետության հր. Կառավարական 3-րդ տուն
3 Government Bldg, Republic Sq, Yerevan, 0010, Armenia
0010, Армения, г.Ереван, Дом правительства, здание N3
էլ.փոստ /E-mail/ эл.почта: e.pirumyan@mnp.am
Web page: www.mnp.am
☎ (374 10) 58 54 19
🖷 (374 10) 54 08 57

№____________________

«   » ____________2012թ.

<<Միկա –ցեմենտ>> ՓԲԸ գլխավոր տնօրեն
տիկին Ն. Մարտիրոսյանին

Հարգելի տիկին Մարտիրոսյան

Ի կատարումն ՀՀ կառավարության 2011 թվականի նոյեմբերի 10-ի <<Մի շարք բնապահպանական միջազգային կոնվենցիաներից բխող՝ Հայաստանի Հանրապետության պարտավորությունների կատարման միջոցառումների ցանկը հաստատելու մասին>> N1594-Ն որոշման հավելվածի երրորդ կետի, ներկայումս իրականացվում են <<Ջերմոցային գազերի մարդածին արտանետումների երրորդ ազգային կադաստրի>> մշակման համար անհրաժեշտ տեղեկատվության հավաքագրման աշխատանքները: Կադաստրի <<Արդյունաբերություն և արտադրանքի օգտագործում>> ենթաբաժնի մշակման համար անհրաժեշտ են ցեմենտի արտադրության հետ կապված հետևյալ ցուցանիշները.

1. Ցեմենտի արտադրության հիմնական հումքատեսակների ցանկը, դրանց քիմիական կազմը և հումքի տեսակարար ծախսի գործակիցը (կգ/տ ցեմենտ) կամ օգտագործված հումքի քանակը, տ/տարի,
2. Ցեմենտի տարեկան արտադրությունը 2006 – 2011թթ.,
3. Կլինկերի տարեկան արտադրությունը 2006 – 2011թթ.,
4. Վառարանի փոշեկլանման համակարգի արդյունավետությունը, %,
5. Որսված փոշու քանակը (տ/տարի):

Խնդրում եմ հնարավորինս սեղմ ժամկետում տրամադրել Ձեր գործարանում առկա տեղեկատվությունը:

Հարգանքով՝

Է. Փիրումյան

Մ. Ծառուկյան
58 39 34

Baseline data on quantities of FHC emissions

The letter sent to the Customs Service of State Revenues Committee under the Government of Armenia

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԲՆԱՊԱՀՊԱՆՈՒԹՅԱՆ ՆԱԽԱՐԱՐՈՒԹՅՈՒՆ

ՆԱԽԱՐԱՐԻ ԱՌԱՋԻՆ ՏԵՂԱԿԱԼ

MINISTRY OF NATURE PROTECTION OF THE REPUBLIC OF ARMENIA

FIRST DEPUTY MINISTER

МИНИСТЕРСТВО ОХРАНЫ ПРИРОДЫ РЕСПУБЛИКИ АРМЕНИЯ

ПЕРВЫЙ ЗАМЕСТИТЕЛЬ МИНИСТРА

0010, ք. Երևան, Հանրապետության հր., Կառավարական 3-րդ տուն,
3 Government Bldg, Republic Sq, Yerevan, 0010, Armenia
0010, Армения, г.Ереван, Дом правительства, здание N3
Էլ.փոստ /E-mail/ эл.почта : first_deputy_minister@mnp.am
Web page: www. mnp.am
☎ (374 10) 54 08 61
🖷 (374 10) 54 08 57

№ ____**2/07/2067-13**

'28' ____03___ 2013 թ.

ՀՀ կառավարությանն առընթեր
պետական եկամուտների կոմիտեի
նախագահի առաջին տեղակալ
պարոն Ա. Աֆրիկյանին

Հարգելի պարոն Աֆրիկյան

Ի կատարումն ՀՀ կառավարության 2011թ. նոյեմբերի 10-ի "Մի շարք բնապահպանական միջազգային կոնվենցիաներից բխող՝ ՀՀ պարտավորությունների կատարման միջոցառումների ցանկը հաստատելու մասին" թիվ 1594-Ն որոշմամբ հաստատված միջոցառումների ցանկի I գլխի 3-րդ կետի և II գլխի 1-ին կետի, ներկայումս իրականացվում են "Ջերմոցային գազերի մարդածին արտանետումների երրորդ ազգային կադաստրի" մշակման համար անհրաժեշտ տեղեկատվության հավաքագրման և մուտքագրման աշխատանքները:

Կադաստրի "F- գազեր" բաժնի մշակման համար անհրաժեշտ են մի շարք օզոնաքայքայիչ նյութերի և դրանց փոխարինողների, ինչպես նաև այդ նյութերը պարունակող սարքավորումների ներմուծման 2000-2012թթ. տվյալները: Խնդրում եմ հնարավորինս սեղմ ժամկետում տրամադրել անհրաժեշտ տվյալները:

Վերը նշված նյութերի և սարքավորումների անվանումները և ծածկագրերը կցվում են:

Առդիր՝ 6 թերթ:

Ս. Պապյան

Ս. Ծառուկյան
58 39 34

Data request format sent to the Rescue Service of the Ministry of Emergency Situations of the Republic of Armenia

[1] Անվանումը շարադրված է ռուսերենով՝ անճշտություններից խուսափելու նպատակով. ԱՏՀ ԱՏԳ ԱԱ հինգերորդ հրատարակության հայերեն պաշտոնական թարգմանություն դեռևս գոյություն չունի:

h/h	ԱՏԳ ԱԱ ծածկագիր	Անվանումը (համաձայն ԱՊՀ ԱՏԳ ԱԱ հինգերորդ հրատարակության)[1]	Ներմուծված քանակություն ըստ տարիների													Ծագման երկիրը
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Հիդրոքլորֆտորածխածիններ (ՀՔՖԱ-ներ)																
1	2903 71 000	Хлордифторметаны														
2	2903 72 000	Дихлортрифторэтаны														
3	2903 73 000	Дихлорфторэтаны														
4	2903 74 000	Хлордифторэтаны														
5	2903 75 000	Дихлорпентафторпропаны														
6	2903 79 000	Прочие														
7	3824 74 000	Смеси содержащие гидрохлорфторуглеводороды (ГХФУ), содержащие или не содержащие перфторуглеводороды (ПФУ) или гидрофторуглеводороды (ГФУ), но не содержащие хлорфторуглеводороды (ХФУ)														
Հիդրոֆտորածխածիններ (ՀՖԱ-ներ)																
8	2903.39	Прочие (фторированные, бромированные или йодированные производные ациклических углеводородов)														
9	3824.78	Смеси содержащие перфторуглеводороды (ПФУ) или идрофторуглеводороды (ГФУ), но не содержащие хлорфторуглеводороды (ХФУ) или гидрохлорфтор-углеводороды (ГХФУ)														
Սառնարանային և օդորակման սարքավորումներ																
10	8415	Установки для кондиционирования воздуха, оборудованные вентилятором с двигателем и приборами для изменения температуры и влажности воздуха, включая кондиционеры, в которых влажность не может регулироваться отдельно														
11	8418	Холодильники, морозильники и прочее холодильное или морозильное обору-дование электрическое или других типов; тепловые насосы, кроме установок для кондиционирования воздуха товарной позиции 8415														
12	8419 60 000	Машины для сжижения воздуха или газов														
13	8476 21 000	Автоматы... со встроенными нагревающими или охлаждающими устройст-вами (8476: Автоматы торговые (например, для продажи почтовых марок, сигарет, продовольственных товаров или напитков), включая автоматы для размена банкнот и монет)														
14	8476 81 000	Автоматы...со встроенными нагревающими или охлаждающими устройст-вами (8476: Автоматы торговые (например, для продажи почтовых марок, сигарет, продовольственных товаров или напитков), включая автоматы для размена банкнот и монет)														
15	8476 90 000	Автоматы... Части (8476: Автоматы торговые (например, для продажи поч-товых марок, сигарет, продовольственных товаров или напитков), включая автоматы для размена банкнот и монет)														
16	8601	Железнодорожные локомотивы, с питанием от внешнего источника электро-энергии, или аккумуляторные:														

17	8602	Железнодорожные локомотивы прочие; локомотивные тендеры														
18	8603	Моторные железнодорожные или трамвайные вагоны пассажирские, товарные или багажные, открытые платформы, кроме входящих в товарную позицию 8604														
19	8606	Вагоны железнодорожные или трамвайные, грузовые несамоходные														
20	8703	Автомобили легковые и прочие моторные транспортные средства, предназна-ченные главным образом для перевозки людей (кроме моторных транспорт-ных средств товарной позиции 8702), включая грузопассажирские автомо-били-фургоны и гоночные автомобили														
21	8704	Моторные транспортные средства для перевозки грузов														
		Փրփուր														
22	3909 50	Полиуретаны														
23	3921 11 000	--из полимеров стирола (3921: Плиты, листы, пленка и полосы или ленты из пластмасс, прочие: – пористые)														
24	3921 12 000	--из полимеров винилхлорида														
25	3921 13	--из полиуретанов														
26	3921 14 000	--из регенерированной целлюлозы														
27	3921 19 000	--из прочих пластмасс														
		Կրակմարում														
28	8424 10 000	Огнетушители заряженные или незаряженные														
		Լուծիչներ/աէրոզոլներ														
29	3208	Краски и лаки (включая эмали и политуры) на основе синтетических поли-меров или химически модифицированных природных полимеров, диспер-гированные или растворенные в неводной среде; растворы, указанные в примечании 4 к данной группе														
30	3209	Краски и лаки (включая эмали и политуры) на основе синтетических полиме-ров или химически модифицированных природных полимеров, диспергиро-ванные или растворенные в водной среде														
31	3210 00	Краски и лаки прочие (включая эмали, политуры и клеевые краски); готовые водные пигменты, используемые для отделки кож														
32	3212	Пигменты (включая металлические порошки и хлопья), диспергированные в неводных средах, жидкие или пастообразные, используемые при производстве красок (включая эмали); фольга для тиснения; красители и прочие красящие вещества, расфасованные в формы или упаковки для розничной продажи														
33	3212 90 000	Прочие														
34	3403 11 000	Средства для обработки текстильных материалов, кожи, меха или прочих материалов														
35	3403 91 000	Средства для обработки														
		текстильных материалов, кожи, меха или прочих материалов														
36	3814 00	Растворители и разбавители сложные органические, в другом месте не по-именованные или не включенные; готовые составы для удаления красок или лаков														
37	3824 90	Прочие (3824: Готовые связующие вещества для производства литейных форм или литейных стержней; продукты и препараты химические, химической или смежных отраслей промышленности (включая препараты, состоящие из смесей природных продуктов), в другом месте не поименованные или не включенные)														
38	3824 90 400	Растворители и разбавители сложные неорганические для лаков и аналогич- ных продуктов														
39	3824 90 450	Составы, препятствующие образованию накипи, и аналогичные продукты														

40	3825 30 000	Отработанные органические растворители (3825: Остаточные продукты хи-мической или смежных отраслей промышленности, в другом месте не пои-меннованные или не включенные; отходы городского хозяйства; шлам сточных вод; отходы прочие, указанные в примечании 6 к данной группе)															
41	3825 41 000	Галогенированные (3825: Остаточные продукты химической или смежных отраслей промышленности, в другом месте не включенные)															
		поименованные или не включенные; отходы городского хозяйства; шлам сточных вод; отходы прочие, указанные в примечании 6 к данной группе)															
Աերոզոլներ																	
42	3003	Лекарственные средства (кроме товаров товарной позиции 3002, 3005 или 3006), состоящие из смеси двух или более компонентов, для использования в терапевтических или профилактических целях, но не расфасованные в виде дозированных лекарственных форм или в формы или упаковки для розничной продажи															
43	3004	Лекарственные средства (кроме товаров товарной позиции 3002, 3005 или 3006), состоящие из смешанных или несмешанных продуктов, для ис-пользования в терапевтических или профилактических целях, расфасованные в виде дозированных лекарственных форм (включая лекарственные средства в форме трансдермальных систем) или в формы или упаковки для розничной продажи															
44	3305 30 000	Лаки для валос															
45	3307 20 000	Дезодоранты и антиперспиранты индивидуального назначения															
46	3402 20 900	Моющие и чистящие средства															
47	3402 90 900	Моющие и чистящие средства															

The reply to the letter sent to the Customs Service of State Revenues Committee under the Government of Armenia

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԿԱՌԱՎԱՐՈՒԹՅԱՆՆ ԱՌԸՆԹԵՐ
ՊԵՏԱԿԱՆ ԵԿԱՄՈՒՏՆԵՐԻ ԿՈՄԻՏԵ

ՆԱԽԱԳԱՀԻ ԱՌԱՋԻՆ ՏԵՂԱԿԱԼ

0015, Երևան, Մ. Խորենացու 3, 7
Հեռ. 59 44 44

02/7-1/3692-13
09.04.13թ.

ՀՀ բնապահպանության նախարարի
առաջին տեղակալ
պարոն Ս. Պապյանին

Հարգելի պարոն Պապյան

Ի պատասխան Ձեր 02.04.2013թ. N 2/07/2067-13 գրության տրամադրում եմ տեղեկանք 2001-2012թթ. ընթացքում ՀՀ ներմուծված օզոնաքայքայիչ նյութերի և դրանց փոխարինողների, ինչպես նաև այդ նյութերը պարունակող սարքավորումների ներմուծման վերաբերյալ՝ համաձայն ներկայացված ձևաչափի:

Մ/Ծ գեներալ-մայոր **Ա. Աֆրիկյան**

կատարող՝
Մաքս. վիճ., վերլուծ. և տեղեկատվության
բաժին հեռ.060 544337

The Letter sent to the Rescue Service of the Ministry of Emergency Situations of the Republic of Armenia

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԲՆԱՊԱՀՊԱՆՈՒԹՅԱՆ ՆԱԽԱՐԱՐՈՒԹՅՈՒՆ

ՆԱԽԱՐԱՐԻ ԱՌԱՋԻՆ ՏԵՂԱԿԱԼ

MINISTRY OF NATURE PROTECTION OF THE REPUBLIC OF ARMENIA

FIRST DEPUTY MINISTER

МИНИСТЕРСТВО ОХРАНЫ ПРИРОДЫ РЕСПУБЛИКИ АРМЕНИЯ

ПЕРВЫЙ ЗАМЕСТИТЕЛЬ МИНИСТРА

0010, ք. Երևան, Հանրապետության հր., Կառավարական 3-րդ տուն,
3 Government Bldg, Republic Sq, Yerevan, 0010, Armenia
0010, Армения, г.Ереван, Дом правительства, здание N3
էլ.փոստ /E-mail/ эл.почта : first_deputy_minister@mnp.am
Web page: www. mnp.am
☎ (374 10) 54 08 61
(374 10) 54 08 57

№ 2/07/2097-13

'22' 04 2013 թ.

ՀՀ արտակարգ իրավիճակների նախարարության
փրկարար ծառայության տնօրեն
Փ/Ծ գեներալ-մայոր Ս. Ազարյանին

Հարգելի պարոն Ազարյան

Ի կատարումն ՀՀ կառավարության 2011թ. նոյեմբերի 10-ի "Մի շարք բնապահպանական միջազգային կոնվենցիաներից բխող՝ ՀՀ պարտավորությունների կատարման միջոցառումների ցանկը հաստատելու մասին" թիվ 1594-Ն որոշմամբ հաստատված միջոցառումների ցանկի I գլխի 3-րդ կետի և II գլխի 1-ին կետի, ներկայումս իրականացվում են "Ջերմոցային գազերի մարդածին արտանետումների երրորդ ազգային կադաստրի" մշակման համար անհրաժեշտ տեղեկատվության հավաքագրման և մուտքագրման աշխատանքները:

Կադաստրի "F- գազեր" բաժնի մշակման համար անհրաժեշտ են տվյալներ օզոնաքայքայիչ նյութերին փոխարինող հիդրոֆտորածխածինների (HFCs) և պերֆտորածխածինների (PFCs) արտանետումների վերաբերյալ՝ տարեկան կտրվածքով: Հրդեհաշիճման ոլորտում այդ նյութերը հիմնականում օգտագործվում են կրակմարիչներում և կրակմարման այլ համակարգերում:

Նկատի ունենալով վերը նշվածը՝ խնդրում եմ հնարավորինս սեղմ ժամկետում տրամադրել տվյալներ Ձեր ծառայության տրամադրության տակ գտնվող նշված նյութերը պարունակող կրակմարիչների և կրակմարման այլ համակարգերի քանակի վերաբերյալ՝ ըստ կցվող ձևի:

Առդիր՝ 1 թերթ:

Ս. Պապյան

Մ. Ծառուկյան
58 39 34

Data request format sent to the Rescue Service of the Ministry of Emergency Situations of the Republic of Armenia

Տեղեկանք

ՀՀ արտակարգ իրավիճակների նախարարության փրկարար ծառայության տրամադրության տակ գտնվող հիդրոֆտորածխածիններ (HFCs) և պերֆտորածխածիններ (PFCs) պարունակող կրակմարիչների և կրակմարման այլ համակարգերի քանակի վերաբերյալ

h/h	Միավորի անվանումը	Առկա քանակություն												
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	HFC-23 պարունակող կրակմարիչ													
2	HFC-23 պարունակող կրակմարման այլ համակարգ (համակարգի տեսակի նշմամբ)													
3	HFC-125 պարունակող կրակմարիչ													
4	HFC-125 պարունակող կրակմարման այլ համակարգ (համակարգի տեսակի նշմամբ)													
5	HFC-227ea պարունակող կրակմարիչ													
6	HFC-227ea պարունակող կրակմարման այլ համակարգ (համակարգի տեսակի նշմամբ)													
7	HFC-236fa պարունակող կրակմարիչ													
8	HFC-236fa պարունակող կրակմարման այլ համակարգ (համակարգի տեսակի նշմամբ)													
9	PFC-14 (CF_4) պարունակող կրակմարիչ													
10	PFC-14 (CF_4) պարունակող կրակմարման այլ													
	համակարգ (համակարգի տեսակի նշմամբ)													
11	PFC-31-10 (C_4F_{10}) պարունակող կրակմարիչ													
12	PFC-31-10 (C_4F_{10}) պարունակող կրակմարման այլ համակարգ (համակարգի տեսակի նշմամբ)													

The reply to the letter sent to the Rescue Service of the Ministry of Emergency Situations of the Republic of Armenia

ՀՀ ԱՐՏԱԿԱՐԳ ԻՐԱՎԻՃԱԿՆԵՐԻ
ՆԱԽԱՐԱՐ

«____» ____________ 20

N° 8/17.4/4039-13 20.05.13թ.

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ
ԲՆԱՊԱՀՊԱՆՈՒԹՅԱՆ
ՆԱԽԱՐԱՐԻ ԱՌԱՋԻՆ ՏԵՂԱԿԱԼ
պրն Ս. ՊԱՊՅԱՆԻՆ

Հարգելի պարոն Պապյան

Ի պատասխան Ձեր 2013 թվականի ապրիլի 26-ի թիվ 2/07/2097-13 գրության՝ հայտնում եմ, որ ՀՀ արտակարգ իրավիճակների նախարարության ստորաբաժանումներում օզոնաքայքայիչ նյութերի կամ դրանց փոխարինող հիդրոֆտորածխածինների (HFCs) և պերֆտորածխածինների (PFCs) պարունակությամբ կրակմարիչներ չկան:

Հարգանքով՝

ԺԱՄԱՆԱԿԱՎՈՐ ՊԱՇՏՈՆԱԿԱՏԱՐ

Հ. ՄԽԻԹԱՐՅԱՆ

Կատարող՝ Ս. Մնացականյան
Հեռ.՝ 31-78-37

Հասցե՝ ՀՀ,ք Երևան, 0054, Դավթաշեն 4, Ա.Միկոյան փող. 109/8
Հեռ.՝ (+ 37410)362015,ֆաքս՝(+37410)363949
Էլ.փոստ՝ mes@mes.am, կայք՝ www.mes.am

The correspondence with "IPCC 2006 Inventory Software" designers

07.12.2012

Dear developers of the 2006 IPCC Software for National Greenhouse Gas Inventories!

We use the above software for data collecting in the framework of the "Enabling Activities for the Preparation of Armenia's Third National Communication to the UNFCCC" UNDP/GEF/00060737 Project.
In the process of data input we faced an issue which I hope to solve with your valuable support.
While choosing subcategory "3.B.3.b.ii. Cropland converted to Grassland" in the subcategory "3.B.3 – Grassland" of the category "3 - Agriculture, Forestry, and Other Land Use" we get a working interface "Area Entry Table" with inactive table entitled "Initial land use", "Final land use", "Area (ha)" and "Land Type Manager" button.
When we push the "Land Type Manager" button a "AFOLU Land Types" window opens. Choosing "Grassland" in the "Land Use Subcategories" menu we are enabled to add Land Use Subcategory.
Logically we guess that afterwards the inactive table in the subcategory "3.B.3.b.ii. Cropland converted to Grassland" should allow for data input, however it doesn't happen.
Instead, a data input line is being added in the subcategory "3.B.3.a - Grassland Remaining Grassland" in the "Area Entry Table" tab.
The same is with other subcategories in the 3.B.1.b, 3.B.2.b, 3.B.3.b.
I would appreciate your support and clarification whether this is normal mode or we encounter an error in the process of entering the data into the data base.

Sincerely,
Edvard Martirosyan
--
Edvard Martirosyan
"Enabling Activities for the Preparation of Armenia's Third National Communication to the UNFCCC"
UNDP/GEF/00060737 Project
National Expert on GHG inventory data/documentation management

Dear Edvard,

Many thanks for your enquiry. Sorry for the late reply.
The Area Entry Table (AET) becomes active only if:
a. Land remaining Land categories. At least one land use subcategory for the particular land-use (LU) category (FL, CL etc.) is defined in the LTM.
b. Land converted categories.

i. At least one LU subcategory for both "before" and "after" LU categories is defined in the LTM. For example for "3.B.3.b.ii Cropland Converted to Grassland" you need to define at least one subcategory in both Cropland and Grassland. For example you should have created at least one subcategory (say, CL1) in Cropland and another in Grassland (say, GL1).
ii. The subcategories defined in the "before" and "after" LU categories should have the same climate-soil combination (this essentially means that the conversion should be physically possible). For example, if CL1 has "Tropical Wet" climate type and "High Activity Clay Mineral" soil type, then GL1 should have the same climate and soil types assigned to it in the LTM for the conversion CL1-GL1 to show up in the Area Entry Table.

Please try and follow the above steps and let me know whether your problem is resolved.

Best,
Nalin
--
Nalin Srivastava
Programme Officer, Technical Support Unit IPCC National Greenhouse Gas Inventory Program

Dear Nalin,

Sorry for the late reply.
Thank you for your irrefragable answer.
I did as you recommended and it worked.
Possible with the data entry we will have more questions and I'll let you know.

Regards,
Edvard

Dear Edvard,

Thanks. I am glad we could be of some assistance!

Best,
Nalin

30.01.2013

Dear Nalin,

As I have promised, we now have some new questions. Please, if possible, to help to understand.
We would like to forward you some problems that Armenia GHG Inventory team has encountered when was trying to fill data in 2006 IPCC GHG Inventory software.

Suggestions for improvement of 2006 IPCC GHG Inventory Software

Waste Sector

1. Page «4A Solid Waste Disposal», "Parameter" sheet, row "Country/Region": The default factor selection for Armenia allows to choose only between Asia su-regions "Asia-Eastern", "Asia-South-Central", "Asia-South-East" and "Asia-Western and Middle East". However the default values of DOC parameter – one of the central parameters for methane emission calculations from MSW - for these regions are not very adequate for Armenian circumstances. The same is true for MSW generation rate per capita – another crucial parameter for methane emission calculations from MSW. According to the data collected for Armenia can be concluded that the default values of DOC and MSW generation rate for Eastern Europe or Russia would be more adequate for Armenia. How this issue can be managed.

2. Page «4A Solid Waste Disposal», "Activity Data" sheet, Column "Population [millions]": allows entering data on (urban) population only in integer numbers. For instance, urban population of Armenia in 1992 was 2.50330 mln. The Software round it to 3 mln. The rounding principle for countries with not high population rate such a rounding (by 0.5 mln.) will lead to significant deviations (+/- 20-25%). In addition it should be stressed, that data on urban population is one of the few country-specific parameters for developing counties (and countries in transition) which is typically available in fairly good accuracy. These data could be readily applied for methane emission calculations from MSW and such a robust rounding will reduce the «country-specificity» of used activity data.

3. Page «4C2 Open Burning of Waste», "Open Burning of Waste" sheet, «N2O Gas», column "E – Nitrous Oxide Emission factor [kg N20/Gg dry waste]": Software uses the default emission factor of 0.15 kg N20/Gg dry waste for MSW open burning. However the v.5 Waste, Table 5.6., page 5.22 as a default value suggests **150 g N_20/t dry weight,** which is equal to 150 kgN_20/Gg dry waste in the units used in the software. Thus there is 1000 fold discrepancy.

Best Regards,
Edvard

Dear Edvard,

Thank you for your inquiry.
1. In addition to the default values in the software, users can also use their own values. Therefore, you can enter your national or country-specific values for DOC and MSW generation into the respective cells/columns of the Parameters and Activity data worksheets instead of the default values incorporated.
2. The problem is fixed in the new version of the software (v2.10) which will be available soon on our website.
3. We will correct the value.
Thank you again for pointing out these issues and sorry for the inconvenience. If you have any further questions or concerns please let us know.

Best Regards,
Suren

--
Baasansuren Jamsranjav (Ph.D)
Programme Officer
Technical Support Unit
IPCC National Greenhouse Gas Inventories Programme
C/o Institute for Global Environmental Strategies (IGES)

Dear Suren,

Thanks for fast response.
If we have any questions in the future, I'll appeal you again for help.

Best Regards,
Edvard

30.04.2013

Dear Colleagues,

We again have question about the functionality of the IPCC2006 software.

Page 4.A Solid Waste Disposal.

When we select 1950 year in the column "Starting Year" in "Parameters" tab, and completing the data in the tabs "Methane Correction Factor" and "Activity Data", in "Methane Calculations" tab for unknown reasons, the calculations are starting from 1989 year and not from 1950.

As is clear from the methodology (spreadsheet IPCC Waste Model), calculations in "Methane Calculations" tab must start from the year selected in the column "Starting Year". Printscreens of these tabs is attached.

Please help to understand this problem.

Best Regards,
Edvard

Dear Edvard,

Thank you.

Regarding the problem with the starting year, could you please let me know whether the data entered in the "Parameters" worksheet are saved before moving to next/another worksheet ("Save" button on the bottom of the top-right area) as it might be one of the possible reasons of the problem. If this is not the case, which version of the software are you using?

Best regards,
Suren

Dear Suren,

Thanks for the quick response.

Of course entered data is saved before moving to next worksheet.

We use 2.0.4510.17184 version of the software.

Best Regards,
Edvard

Dear Edvard,

Thank you for your prompt reply. We will look into the problem and get back to you on this later.

Best regards,
Suren

07.05.2013

Dear Edvard,

Regarding the problem with "Starting Year, we could not reproduce the problem. Therefore, in order for us to look into the problem is it possible for you to send your database file to us?

Best Regards,
Suren

Dear Suren,

Find DB file attached.

The data in the DB file are not final.

Thank you,
Edvard

Dear Edvard,

Thank you and will get back to you.

Best Regards,
Suren

10.05.2013

Dear Edvard,

We think that the problem with starting year may happen when data for 4.A have been already initialized for different starting year (and the year is changed after existing data are already in the sheets) or when user missed to enter one of the sheets to review/supply data prior to reviewing a calc sheet.

Solution for this case:

1) go to Activity data sheet
2) review data for both composition types: msw and industrial by selecting MSW or Industrial respectively from dropdown list (missing years will be initialized automatically)
3) Go to calc sheet, all data should be there now

Best Regards,
Suren

Dear Suren,

Thank you, its work!

Regarding the Waste sector population problem (integer value): when you planning place a new version of the software (v2.10)?

Best Regards,
Edvard

15.05.2013

Dear Edvard,

Sorry for not replying sooner. The latest version of the software (v2.11) is now at our website http://www.ipcc-nggip.iges.or.jp/software/index.html

Best,
Suren