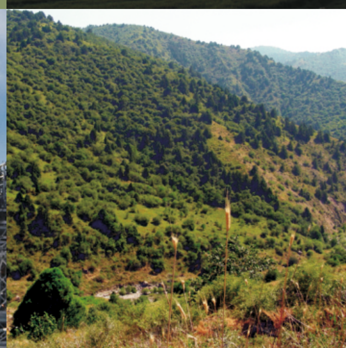
GEF/UNEP Project «Uzbekistan: Preparation of the Third National Communication under UN Framework Convention on Climate Change (UNFCCC)»

INVENTORY OF ANTHROPOGENIC EMISSIONS SOURCES AND SINKS OF GREENHOUSE GASES IN THE REPUBLIC OF UZBEKISTAN

1990-2012

NATIONAL REPORT



Tashkent 2016

GEF/UNEP Project “Uzbekistan: Preparation of the Third National Communication under UN Framework Convention on Climate Change (UNFCCC)”

NATIONAL REPORT

Inventory of Anthropogenic Emissions Sourses and Sinks of Greenhouse Gases in the Republic of Uzbekistan

1990-2012

Tashkent 2016

Inventory of Anthropogenic Emissions Sources and Sinks of Greenhouse Gases in the Republic of Uzbekistan, 1990-2012. National Report

GEF/UNEP Project "Uzbekistan: Preparation of the Third National Communication under UN Framework Convention on Climate Change (UNFCCC)"

National Focal Point of the UN Framework Convention on Climate Change (UNFCCC) for Uzbekistan:	V.E. Chub Prof.
Project Coordinator:	R.V. Taryannikova PhD
Inventory Team Leader:	Yu.I.Kovalevskaya
Members of the working group:	O.A. Belorussova N.I. Rakhmatova L.Yu. Shardakova S.Kh. Abdullaeva N.V. Panteeva L.V. Usmanova E.V. Juravlyova Yu.S. Goryaeva

Organizations participated in implementation of GHG Inventory:

Centre of Hydrometeorological Service (Uzhydromet) at the Cabinet of Ministers of the Republic of Uzbekistan
State Committee of the Republic of Uzbekistan on Statistics
State Committee for Nature Protection of the Republic of Uzbekistan
Joint-Stock Company "Uzbekenergo"
National Holding Company "Uzbekneftegaz"
Joint-Stock Company "O`zbekko`mir"
National Aircompany "Uzbekistan Airways"
Joint-Stock Company "Uzkimyosanoat"
Joint-Stock Company "O`zqurilishmateriallari"
State Committee of the Republic of Uzbekistan on Land Resources, Geodesy, Cartography and State Cadastre
Scientific-Productional Center of Decorative Gardening and Forestry of the Republic of Uzbekistan
State Research Institute of Soil Science and Agrochemistry
Uzbek Agency "Uzcommunkhizmat"

The project was implemented in the Centre of Hydrometeorological Service (Uzhydromet) at the Cabinet of Ministers of the Republic of Uzbekistan with financial assistance of the Global Environment Facility and the United Nations Environment Program

Centre of Hydrometeorological Service (Uzhydromet)
72, 1st Bodomzor yuli str., Tashkent,
100052, Republic of Uzbekistan
Tel.: (998 71) 235 84 61
Fax: (998 71) 233 20 25
E-mail: raisa.taryanikova@ncsa.uzsci.net

Content

LIST OF TABLES

List of figures

List of abbreviations

INC	**– Initial National Communication**
SNC	**– Second National Communication**
TNC	**– Third National Communication**
FNC	**– Fourth National Communication**
AWMS	**– Animal Waste Management System**
BOD	**– Biochemical Oxygen Demand**
cap.	**– capita**
COD	**– Chemical Oxygen Demand**
CIS	**– Commonwealth of Independent States**
DOC	**– degradable organic carbon**
eq.	**– equivalent**
FAO	**– Food and Agriculture Organization of the United Nations**
GHG	**– Greenhouse Gases**
GPE	**– Gas Processing Enterprise**
GPP	**– Gas Processing Plant**
GWP	**– Global Warming Potential**
HFC	**– hydrofluorocarbon**
IEA	**– International Energy Agency**
IPCC	**– Intergovernmental Panel on Climate Change**
LUCF	**– sector “Land Use Change and Forestry”**
MCF	**– methane correction factor**
MSW	**– municipal solid waste**
NIR	**– National GHG Inventory Report**
NMVOC	**– Non-Methane Volatile Organic Compounds**
PFC	**– perfluorocarbon**
PMS	**– Air, Surface Water and Soil Pollution Monitoring Service**
QA/QC	**– Quality Assurance/Quality Control**
UNDP	**– United Nations Development Program**
UNEP	**– United Nations Environment Program**
UNFCCC	**– United Nations Framework Convention on Climate Change**

Units

c	**– centner**	**kcal**	**– kilocalory**
g	**– gram**	**Mt**	**–megatone (= 10^6 tone)**
Gg	**– gigagram (10^9 g or 1000 tons)**	**m^2**	**– square meter**
ha	**– hectar**	**m^3**	**– cubic meter**
GJ	**– gigajoule (10^9 joule)**	**mg**	**– milligram**
hectoliter	**– 100 litres**	**PJ**	**– picojoule (10^{-12} joule)**
dal	**– decalitre (=10 litres)**	**TJ**	**– terajoule (10^{12} joule)**
kg	**– kilogram**	**t**	**– tone**

Chemical formula

C	**– carbon**	**H_2SO_4**	**– sulphuric acid**
CH_4	**– мethane**	**N**	**– nitrogen**
CH_2F_2	**– HFC-32**	**NH_3**	**– ammonia**
C_2HF_5	**– HFC-125**	**N_2O**	**– nitrous oxide**
CH_2FCF_3	**– HFC-134a**	**NOx**	**– nitrogen oxides**
$C_2H_3F_3$	**– HFC-143a**	**S**	**– sulphur**
CO	**– carbon monoxide**	**SF_6**	**– sulphur hexafluoride**
CO_2	**– carbon dioxide**	**SO_2**	**– sulphur dioxide**
HNO_3	**– nitric acid**		

Preface

Being responsible body on the implementation of the UN Framework Convention on Climate Change in Uzbekistan, the Centre of Hydrometeorological Service (Uzhydromet) has prepared National Greenhouse Gas Inventory for 2010 within the framework of the Third National Communication on Climate Change.

This Report was prepared in accordance with the decision 17/CP.8, item 1a, Article 4 and item 1a, Article 12 of the UN Framework Convention on Climate Change and also in compliance with the *Reporting on Climate Change User Manual for the Guidelines on National Communications from non-Annex 1 Parties* [1]. The draft report was brought up for discussions and comments to different Ministries and Agencies.

The Report presents Greenhouse Gas Inventory in the Republic of Uzbekistan for 2010 and also the review of the GHG emission trends for the period 1990-2012. The emissions and sinks in 2010 are given in Tables 1 and 2 for Gases and Sectors identified by the IPCC (Annex 1 and 2) and also in the Sectoral Tables (Annex 3). The trend for each sector is provided in the relevant chapter.

Inventory comprises the following direct Greenhouse Gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) as well as the indirect greenhouse gases, such as carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2).

To recalculate emissions into CO_2 equivalent in accordance with the recommendations [1], the Global Warming Potentials were used: for CO_2 -1, CH_4 -21, N_2O -310.

In accordance with the IPCC methodology and the standard Software, the Greenhouse Gas Inventory was conducted in 5 sectors. The sector “Solvent Use” was not considered.

Structure of Report

The report includes Introduction, 9 Specific Chapters and 12 Annexes.

Introduction describes institutional structure and Inventory process itself.

The Specific Chapters present the emission estimates in 2010 and emission trends for certain gases and sectors for the period 1990-2012 and estimation of emissions uncertainty. Annexes generalize Inventory tables, Analysis of the Key Sources, documentation on calculation of National emission factors, quantitative estimates of Uncertainties for separate Gases and Sectors.

1. INTRODUCTION

1.1 National Greenhouse Gas Inventory System. Institutional mechanism for Inventory preparation

GHG Inventory was carried out within the framework of preparation of National Communications. The Initial GHG Inventory for the period 1990-1994 was carried out within the framework of Phase 1 of the Initial National Communication, estimation of GHG emissions was made during the Phase 2 for the period 1990-1999.

During 2003-2006 the Republic of Uzbekistan took part in the Regional Project "Capacity Building for Improving the Quality of National Inventories" (Eastern Europe/CIS region).

The UNEP Project "Implementation of UNFCCC Article 6 in Uzbekistan" (2004-2005) and the UNEP/ Uzbekistan Project "Education, Training and Public Awareness" (2005-2006) were implemented in Uzbekistan.

Greenhouse Gas Inventory for the period 1990-2005 was carried out in the Second National Communication (2005-2008) where 2000 was presented in detail. In the framework of the Second National Communication:

- list of gases and source/sink categories was expanded;
- recalculations were made in some source categories;
- elements of Good Practice were used:
  - Quality Assurance/Quality Control Plan was developed;
  - National Manual on GHG Inventory was developed;
  - System of documentation and archiving of all Inventories related data was created.

GHG Inventory set out in this document was prepared within the framework of the Third National Communication (2012-2015). The document covers the Inventory for the period 1990-2012, and 2010 is given in detail. The paper shows estimates of anthropogenic emissions and removals of greenhouse gases, not controlled by the Montreal Protocol, previously calculated or revised estimates of emissions for the period 1990-2005, as well as new sources of emissions. For calculations in the separate categories of sources, national factors were used which are more appropriate to national conditions and directed to reduce uncertainty.

To carry out GHG Inventory in the framework of the Third National Communication, the positive experience was used resulting from:

- implementation of the above mentioned projects;
- studying new methodological approaches given in the IPCC Guidelines;
- participation in expert meetings of the IPCC on National Inventory;
- reference to GHG Inventories of other countries.

GHG Inventory was carried out in the Centre of Hydrometeorological Service at the Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet), which is a responsible body for implementation of the commitments of Uzbekistan under the UN Framework Convention on Climate Change.

National Inventory team was built up on the base of Air, Surface Water and Soil Pollution Monitoring Service, one of Uzhydromet's divisions, which was assigned to be the project coordination body. In this Service all information on GHG Inventory is collected, compiled and stored.

In order to address the specific objectives, the experts were recruited from other organizations, agencies and industrial companies, who provided information on the activity data, emission factors, and other Inventory related information; they also made calculations and prepared documents.

In the preparation of GHG Inventory, cooperation of interested and involved ministries and agencies in the country was carried out according to the scheme given in Figure 1.1.

Issues related to implementation of the provisions of Articles 4 and 12 of the UN Framework Convention on Climate Change related to Greenhouse Gas Inventories are directly or indirectly regulated by the current legislation of the Republic of Uzbekistan.

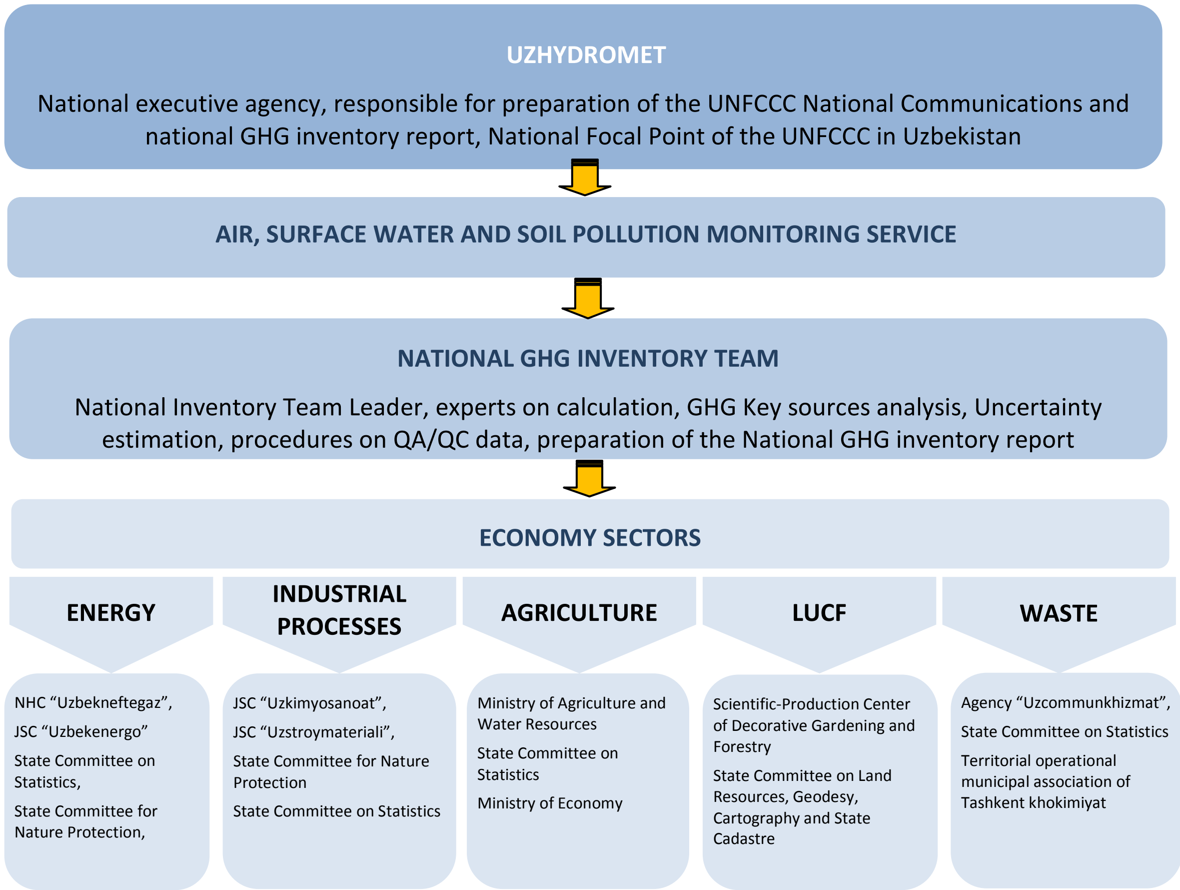


Figure 1.1 Organizational structure of National Inventory System

The list of regulatory legal acts that directly regulate this issue includes:

- Law of the Republic of Uzbekistan dated December 27, 1996 #253-1 "On Air Protection";
- Resolutions of the Cabinet of Ministers of the Republic of Uzbekistan:
  - #469 dated October 20, 1999 "On Environmental Action Program for 1999-2005", and #212 dated September 19, 2008 "On Environmental Action Program for 2008-2012";
  - #389 dated October 9, 2000 "On Issues of Implementation of the Environmental Action Program of the Republic of Uzbekistan for 1999-2005";
  - #183 dated April 14, 2004 "On Improvement of Hydrometeorological Service of the Republic of Uzbekistan".

Resolution of the Cabinet of Ministers dated October 9, 2000 #389 fixed solution for implementation of the systematic Inventory of Emissions and Sinks of Greenhouse Gases in consultation with the UNFCCC Secretariat.

In addition there is a number of legal documents indirectly related to greenhouse gases, the main of which are the laws of the Republic of Uzbekistan:

- dated December 9, 1992 #754-XII "On Nature Protection";
- dated December 15, 2000 #171-II "On State Inventory";
- dated December 12, 2002 #441-II "On State Statistics".

1.2 Description of methodologies and data sources used

The scheme on the process of preparing the national Inventory is given in Figure 1.2. The estimates of emissions/ removals of greenhouse gases and gases with indirect greenhouse effect were made in accordance with the requirements of:

- Revised IPCC Guidelines for National Greenhouse Gas Inventories, 1996 [2-4];
- Guidelines for users reporting on Climate Change to the Guidelines for the preparation of National Communications of countries not included in Annex 1, 2004 [1].

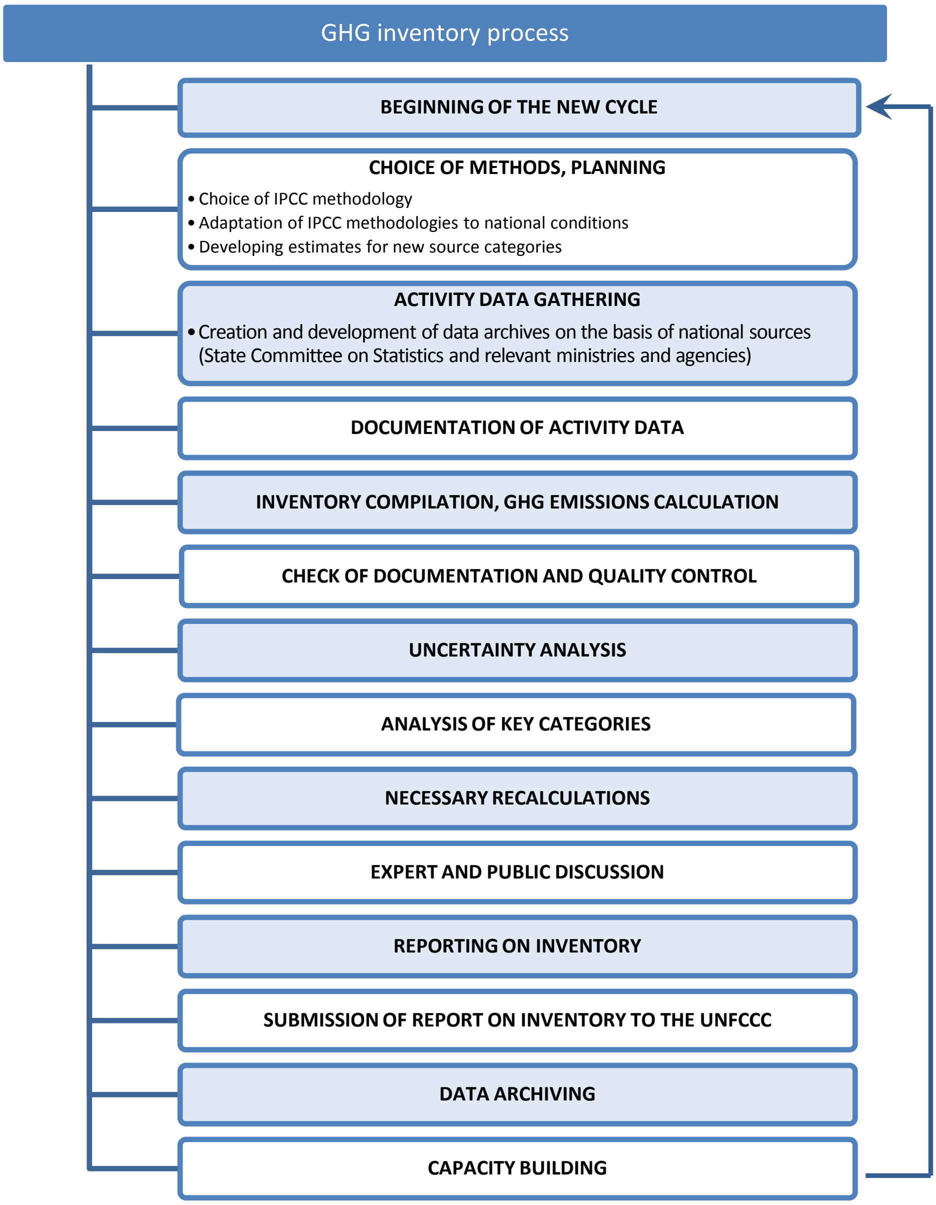


Figure 1.2 GHG Inventory program and process

In order to address intersectoral issues, in the process of quality assurance/quality control, estimation of key categories and uncertainty calculations, the following was used:

- Guide on Good Practice and Uncertainty Management in National Greenhouse Gas Inventories, IPCC, 2000 [5];
- Guidelines for National Greenhouse Gas Inventories, IPCC, 2006 (Volumes 1 - 5). [7]

National regulatory and technical documents, the results of previous studies, cartographic materials were used in calculations by separate categories [9-36].

In future, to create opportunities to use modern IPCC methodologies for calculation of emissions/removals in most categories, it requires development of public accountability, research and collection of additional information.

The official statistical data on manufacturing activity in various sectors of the economy, data of the separate large public companies, expert estimates, as well as data of international statistical databases of the International Energy Agency (IEA), the Food and Agriculture Organization of the United Nations (FAO) were used as the Activity data [14,37].

To calculate the emissions, national emission factors and other parameters, and default values were used.

Emission calculation was made on the basis of the 1996 IPCC standard software with some modifications in the separate worksheets that were made in accordance with national conditions.

1.3 Quality Assurance / Quality Control

The QA/QC procedures were implemented as an element of good practice for improving the quality of National Inventory. Quality control was performed according to Tier 1 – common procedures, mainly in Uzhydromet. The organizations and companies participated in the quality assurance in relevant source categories.

Quality Control

Quality control was conducted in a while after the activity, from several days to 1-2 months, depending on the type of check. In some cases checks repeated if changes in the process of making changes and additions occur regardless of the quality control plan.

The following quality control procedures were implemented for all sectors:

- check for transcription errors of newly obtained data;
- check for transcription errors in data input;
- check of calculations for filling gaps in the activity data with employing mathematical methods;
- check that emission units, parameters or conversion factors are correctly recorded;
- check that greenhouse gas emissions are calculated correctly;
- check for consistency in input and calculations in time series if changing the method, emission factors/ other parameters or data;
- check that formulas are correctly recorded, calculations are correctly made and etc. in the worksheets modified in accordance with the national circumstances;
- check for correction of calculations in developing national factors;
- check that emission sources are properly documented (assumptions and criteria for the selection of activity data, calculation method, emission factors and other parameters);
- check of the documentation on national factors development;
- check of all references related to the data, factors, etc.

Quality Assurance

Quality assurance was performed after completion of all Inventory calculations.
External reviewers were given the Draft National GHG Inventory Report that included all necessary information for quality check of:

- calculation method;
- activity data;
- factors and other parameters;
- emission data;
- data on quality control performed.

Organizations and agencies to perform quality control

Organizations and companies that reviewed the Inventory Report:

- State Committee of the Republic of Uzbekistan on Statistics;
- Joint-Stock Company “UZBEKENERGO”;
- National Holding Company “UZBEKNEFTEGAZ”;
- Joint-Stock Company “UZKIMYOSANOAT” (Uzkhimprom);
- Republican Scientific-Production Center of Decorative Gardening and Forestry;
- Agency “Uzcommunkhizmat”.

1.4 Key sources of GHG emissions

According to IPCC definition, *key category* – a category that is prioritized within National Inventory System because its estimate has a significant influence on a total national Greenhouse Gas Inventory in calculation of the absolute level, the tendency (trend) in emissions and removals, or both of them.

Some *key categories* may be identified only if there is an impact on their National Inventory trend. The purpose of assessing the trends in the analyzed period of time is to determine the categories, not large enough to be identified according to level assessment, but which have a trend (to a significant increase or decrease in GHG emissions) different from the trend of total Inventory.

The key sources to GHG Inventory are considered to be sources, which in total make up 95% of at least one of the criteria (level or trend), arranged in descending order of their percentage contribution to total cumulative emissions. Key sources are determined according to level of emissions for the beginning and end of the analyzed period [5].

Desaggregation and key sources analysis was conducted with the use of Tier 1 method in accordance with [5], Chapter 7, Methodological Choice and Recalculation.

The analysis included:

- Greenhouse gases: CO_2, CH_4, N_2O and HFCs (PFCs and SF_6 were not included as there is no data available to estimate these gases emissions).
- All estimated source categories were analyzed excluding emissions and removals in the LUCF sector in accordance with [5].

Disaggregation and identification of emission sources were conducted in accordance with [5] (Chapter 7, Methodological Choice and Recalculation, Table 7.1).

The emission level and trend were estimated for 2010 and 2012. The base year was 1990. The key sources analysis is given in Annex 4.

Table 1.1 shows the key sources of GHG emissions according to level of emissions in 2010 (excluding LUCF sector) and emission trends for the period 1990-2010.
As shown in Table 1.1, 22 key sources cover 97.7% of GHG emissions (excluding LUCF sector).
Of them:

- 12 - key sources at the same time by level and trend;
- 1 - only by level;
- 7 - only by trend.

The biggest key categories, the share of which together accounts for 63% of emissions in 2010, are:

- 1.B.2 Emissions in the form of leakage when working with oil and gas;
- 1.A.4 Stationary Fuel Combustion. Residential sector. CO_2 emissions from natural gas combustion;
- 1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 emissions from natural gas combustion.

22 identified key sources were divided into sectors in the following way:

- 17 – Energy sector;
- 3 – Industrial Processes sector;
- 2 - Agriculture sector;
- 1 –Waste sector.

In all categories, which are the key ones only by trend, there is a significant reduction in GHG emissions compared to 1990.

Table 1.2 presents 23 sources of GHG emissions identified as the key ones, by the emission level in 2012 and by the emission trend - for the period 1990-2012.

- 13 - key sources by the emission level and trend at the same time;
- 1 - only by level;
- 8 - only by trend.

23 identified key sources were divided into sectors in the following way:

- 17 – Energy sector;
- 3 – Industrial Processes sector;
- 2 – Agriculture sector;
- 1 – Waste sector.

In 2012, the category 1A4 Solid Fuel Combustion in the Commercial/Institutional sector entered into category of the key ones (by trend to a significant reduction in CO_2 emissions).

The biggest key categories remained the same as in 2010:

- - 1.B.2 Fugitive Emissions from Oil and Gas Activities;
- - 1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from natural gas combustion;
- - 1.A.4 Stationary Fuel Combustion. Residential sector. CO_2 Emissions from natural gas combustion.

Total contribution to the total emissions of the above mentioned categories in 2012 amounted to 57.7%, i.e. decreased slightly compared to 2010.

The most notable changes compared to 2010 when estimating emission level took place in two key categories:

- Contribution of the category 1.A.4 Natural Gas Combustion to total emissions increased from 4.7% to 9.2% in Commercial/Institutional sector;
- Contribution of the category 1.A.4 Natural Gas Combustion in Residential sector decreased from 15.8% to 11.2%.

Table 1.1Key GHG emission sources, 2010

IPCC Category	Gas	Level	Trend	Mt CO_2-eq.	% of Total emissions
1.B.2 Fugitive Emissions from Oil and Gas Activities	CH_4	●	●	67.95	34.1
1.A.4 Stationary Fuel Combustion. Residential Sector. CO_2 Emissions from Natural Gas Combustion	CO_2	●	●	31.50	15.8
1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Natural Gas Combustion.	CO_2	●	●	26.16	13.1
4.A Methane Emissions from Enteric Fermentation of Livestock.	CH_4	●	●	11.10	5.6
1.A.4 Stationary Fuel Combustion. Commercial Sector. CO_2 Emissions from Natural Gas Combustion.	CO_2	●	●	9.30	4.7
4.D N_2O Emissions (Direct and Indirect) from Agricultural Soils.	N_2O	●	●	7.60	3.8
1.A.2 Stationary Fuel Combustion. Manufacturing Industries and Construction. CO_2 Emissions from Natural Gas Combustion.	CO_2	●	●	6.95	3.5
1.A.3 Mobile Fuel Combustion. CO_2 Emissions from Road Transportation.	CO_2	●	●	6.91	3.5
6.A CH_4 Emissions from Solid Waste Disposal on land.	CH_4	●		6.39	3.2
1.A.3 Mobile Fuel Combustion. CO_2 Emissions from Pipeline Transport.	CO_2	●	●	5.35	2.7
2.A Mineral Products. CO_2 Emissions from Cement Production.	CO_2	●		2.92	1.5
1.A. Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Solid Fuel Combustion (Sub-bituminous coal).	CO_2	●	●	2.30	1.2
2.B Chemical Industry. N_2O Emissions from Nitric Acid Production.	N_2O	●		1.79	0.9
2.B Chemical Industry. CO_2 Emissions from Ammonia Production.	CO_2	●	●	1.76	0.9
1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Liquid Fuel Combustion (Crude Oil).	CO_2		●	1.56	0.8
1.A.4 Stationary and Mobile Fuel Combustion in Agriculture. CO_2 Emissions from Liquid Fuel Combustion	CO_2		●	1.31	0.7
1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Liquid Fuel Combustion (Fuel Oil)	CO_2	●	●	0.75	0.4
1.A.4 Stationary Fuel Combustion. Commercial Sector. CO_2 Emissions from Liquid Fuel Combustion.	CO_2		●	0.73	0.4
1.A.2 Stationary Fuel Combustion. Manufacturing Industries and Construction. CO_2 Emissions from Liquid Fuel Combustion	CO_2		●	0.51	0.3
1.A.3 Mobile Fuel Combustion. CO_2 Emissions from Railways	CO_2		●	0.43	0.2
1.A.4 Stationary Fuel Combustion. Commercial/Institutional Sector. CO_2 Emissions from Solid Fuel combustion	CO_2		●	0.42	0.2
1.A.4 Stationary Fuel Combustion. Residential Sector. CO_2 Emissions from Solid Fuel Combustion	CO_2		●	0.31	0.2
Total GHG emissions by Key Sources				**197.10**	**97.7**

Table 1.2 Key GHG emission sources, 2012

IPCC Category	Gas	Level	Trend	Mt CO_2-eq.	% of Total emissions
1.B.2 Fugitive Emissions from Oil and Gas Activities	CH_4	●	●	68.12	33.2
1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Natural Gas Combustion.	CO_2	●	●	27.36	13.3
1.A.4 Stationary Fuel Combustion. Residential Sector. CO_2 Emissions from Natural Gas Combustion.	CO_2	●	●	23.04	11.2
1.A.4 Stationary Fuel Combustion. Commercial Sector. CO_2 Emissions from Natural Gas Combustion.	CO_2	●	●	18.80	9.2
4.A Methane Emissions from Enteric Fermentation of Livestock.	CH_4	●	●	12.04	5.9
4.D N_2O Emissions (Direct and Indirect) from Agricultural Soils.	N_2O	●	●	8.25	4.0
1.A.3 Mobile Fuel Combustion. CO_2 Emissions from Road Transportation.	CO_2	●	●	7.79	3.8
1.A.2 Stationary Fuel Combustion. Manufacturing Industries and Construction. CO_2 Emissions from Natural Gas Combustion.	CO_2	●	●	7.42	3.6
6.A CH_4 Emissions from Solid Waste Disposal on land	CH_4	●	●	6.65	3.2
1.A.3 Mobile Fuel Combustion. CO_2 Emissions from Road Transportation.	CO_2	●	●	4.10	2.0
1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Solid Fuel Combustion (Sub-bituminous coal).	CO_2	●	●	3.07	1.5
2.A. Mineral Products. CO_2 Emissions from Cement Production.	CO_2	●		2.79	1.4
1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Liquid Fuel Combustion (Crude Oil).	CO_2	●	●	2.00	1.0
2.B Chemical Industry. CO_2 Emissions from Ammonia Production.	CO_2	●	●	1.78	0.9
2.B Chemical Industry. N_2O Emissions from Nitric Acid Production.	N_2O	●		1.78	0.9
1.A.4 Stationary and Mobile Fuel Combustion in Agriculture. CO_2 Emissions from Liquid Fuel Combustion.	CO_2		●	1.23	0.6
1.A.1 Stationary Fuel Combustion. Energy Production. CO_2 Emissions from Liquid Fuel Combustion (Fuel Oil).	CO_2		●	0.80	0.4
1.A.4 Stationary Fuel Combustion. Residential Sector. CO_2 Emissions from Solid Fuel Combustion.	CO_2		●	0.66	0.3
1.A.4 Stationary Fuel Combustion. Commercial/Institutional Sector. CO_2 Emissions from Liquid Fuel Combustion.	CO_2		●	0.63	0.3
1.A.2 Stationary Fuel Combustion. Manufacturing Industries and Construction. CO_2 Emissions from Liquid Fuel Combustion.	CO_2		●	0.55	0.3
1.A.4 Stationary Fuel Combustion. Commercial/Institutional Sector. CO_2 Emissions from Solid Fuel Combustion.	CO_2		●	0.49	0.2
1.A.3 Mobile Fuel Combustion. CO_2 Emissions from Railways.	CO_2		●	0.43	0.2
1.A.4 Stationary Fuel Combustion. Residential Sector. CO_2 Emissions from Liquid Fuel Combustion.	CO_2		●	0.16	0.1
Total GHG emissions by Key Sources				**199.94**	**97.5**

1.5 Total uncertainty estimation

GHG uncertainty estimation was made in accordance with the Guide on Good Practice and Uncertainty Management in National Greenhouse Gas Inventories, IPCC, 2000 [5], using the methodology of Tier 1. Uncertainty was estimated by separate source categories, by gases and sectors, and as a whole by the Inventory, in accordance with the calculation algorithm given in Table 6.1, p. 6.18 (ibid).

Uncertainty values of the activity data and emission factors were determined:

1. by default - in accordance with [3,5,7];
2. by expert judgements;
3. using method of calculation (for national factors).

Expert judgements on activity data uncertainties are documented in the form of Stanford/SRI protocol in accordance with the requirements [7].

The combined uncertainty was calculated according to Equation 6.4, p. 6.14 [5]. The calculation results related to uncertainty estimation are given in Annex 12.

Below, there are estimates of uncertainty for 2010. Uncertainty estimates for 2012 are detailed in Annex 12.

Inventory uncertainty for 99.81% of GHG emissions was estimated, including all key sources. The amount of emissions by category with the performed estimation of uncertainty amounted to 198869.2 Gg CO_2-eq. The level of uncertainty as a percentage of total national emissions in the current year amounted to ± 8.1%, uncertainty introduced into the trend of total emissions amounted to ± 8.4%.

Estimated uncertainties by separate greenhouse gases are as follows:

- 99.87% of CO_2 emissions (101,630.58 Gg), the level of uncertainty of which amounted to ± 6.4%, uncertainty of trends is ± 7.7%;
- 99.76% of CH_4 emissions (86,764.42 Gg CO_2-eq), the level of uncertainty of which amounted to ± 9.8%, uncertainty of trends is ± 9.6%;
- 99.94% of N_2O emissions (10,474.20 Gg CO_2-eq), the level of uncertainty of which amounted to ± 116.2%, uncertainty of trends is ± 61.0%.

Uncertainties were estimated by separate sectors of Inventory.

In the “Energy” sector, 99.84% of GHG emissions were estimated, which amounted to 163,798.26 Gg CO2-eq, the level of uncertainty was ± 5.2%; uncertainty of trends was ± 6.5%.

In the “Industrial Processes” sector, 99.68% of GHG emissions were estimated, which amounted to 7,847.44 Gg CO_2-eq, the level of uncertainty was ± 11.3%; uncertainty of trends was ± 2.6%.

In the “Agriculture” sector, 99.61% of GHG emissions were estimated, which amounted to 19,873.60 Gg CO_2-eq, the level of uncertainty was ± 65.5%; uncertainty of trends was ± 73.1%.

In the “Waste” sector, 100.0% of GHG emissions were estimated, which amounted to 7,349.90 Gg CO_2-eq, the level of uncertainty was ± 59.7%; uncertainty of trends ± 31.3%.

CO_2 emissions from fuel combustion are characterized by the smallest uncertainty (about 10%) in energy production, in the processing industry, in cement clinker and ammonia production, as well as CH_4 emissions associated with production, processing and natural gas trunk transmission.
The biggest uncertainty (more than 100%) was obtained for N_2O emissions in the category “Agricultural soils” of “Agriculture” sector associated with the IPCC default emission factors and the lack of detailed data on the activities.

In general, uncertainty of GHG Inventory of the Republic of Uzbekistan is associated with:
- using mainly in calculation of GHG emissions of Tier 1 methodologies and default emission factors;
- using expert judgements of quantitative characteristics on the activity data and emission factors;
- the lack of information on activity data;
- using the average values of the activity data and emission factors for the whole country.

The minimum uncertainty values were obtained for the categories in which statistics and national emission factors have been used.
In the future it is expected to estimate uncertainty of national GHG Inventory in accordance with [7].

1.6 Total estimation of Inventory completeness

In accordance with the IPCC requirements, the Inventory should include estimation of the input data completeness, as well as greenhouse gases emissions and removals, coverage of the national territory.

Inventory covers the whole territory of Uzbekistan, the main sources of emissions and removals in the country (approximately 90% of the sources).

Inventory includes the following gases:

– With direct greenhouse effect:

  CO_2 – carbon dioxide;
  CH_4 – methane;
  N_2O – nitrous oxide;
  HFCs – hydrofluorocarbons;

SF_6 - sulphur hexafluoride and PFCs - perfluorocarbons are not included to the Inventory due to lack of public reporting on their use.

– With indirect greenhouse effect:

NOx – nitrogen oxides;
CO – carbon monoxide;
NMVOC – non-methane volatile organic compounds;
SO_2 – sulphur dioxide.

Table 1.3 presents categories of greenhouse gas sources (classification is given in accordance with the Revised Guidelines for National Greenhouse Gas Inventories, IPCC, 1996 [3]), which are not covered by Inventories for one reason or another.

Table 1.3 Estimation of Inventory completeness

IPCC Source Category	Category	The reason according to which the category was not covered by Inventory
1 A 4 c	Off-road Transport	Lack of data
1 B 2 a i	Oil Production	Lack of data on wells drilled
1 B 2 a iii	Transport in Tankers	Not found
1 B 2 a v	Distribution of Oil Products	Lack of data
1 B 2 c i	Venting and Flaring – Oil	Lack of data
2A 3	Limestone and Dolomite Use	Lack of data
2A 5	Asphalt Roofing	Research and data collection is required
2A 6	Road Paving with Asphalt	Research and data collection is required
2 A 4 1	Soda Ash Production	Uzbekistan uses Solvay-process for soda production of when no CO_2 emissions occur
2B 3	Adipic Acid Production	No production
2B 4 1	Silicon Carbide Production	Lack of data
2C 2	Ferroalloys Production	No production
2C 3	Aluminum Production	No production
2C 4	SF_6 Used in Aluminum and Magnesium Foundries	No production
2D 1	Pulp and Paper Production	Research on production methods and data collection is required
2E	Halocarbons and Sulphur Hexafluoride Production	No production
3	Solvent and Other Products Use	Research and data collection is required
4E	Prescribed Burning of Savannas	Not available
4F	Field Burning of Agricultural Residues	This activity is prohibited by law in the country since 2005 (GHG emissions from this type of activity before 2005 are included in the Inventory)
5B	Forest and Grassland Conversion	Presently there is no practice of forest and grassland conversion into tillage
6C	Waste Incineration	Lack of data

“Solvent and Other Products Use” sector is not included in the Inventory in connection with the need for additional research on the Inventory of existing industries using solvents and lubricants, as well as collection of data on use of nitrous oxide for medical purposes.

Inventory includes a new large source of methane emissions – Shurtan Gas Chemical Complex, which put into operation in 2006. One of the calculated categories – “Field Burning of Agricultural Residues” in the “Agriculture” sector is excluded from calculation due to introduction of a legislative ban on stubble burning (since 2005).

2. GHG EMISSIONS IN 2010

In the Third Inventory, 2010 is given in details. According to results of the Inventory in Uzbekistan, total greenhouse gas emissions with direct greenhouse effect:

- excluding removals in LUCF sector in 2010, amounted to 199.2 Mt CO_2-eq.;
- including removals in LUCF sector in 2010 amounted to 196.2 Mt CO_2-eq.

As compared to base year, total greenhose gases emissions in 2010 increased to 10.4%.

The following changes of the main GHG emissions in comparison with 1990 were observed:

- Reduction of:
  - CO_2 – 10.1%;
  - N_2O – 20.0%.
- Growth of:
  - CH_4 – 60.5%.

Table 2.1 presents emissions and specific emissions of gases with direct and indirect greenhouse effect in 2010.

As follows from Figure 2.1, gases which make the largest contribution to total emissions are:

- CO_2 – 51.1%;
- CH_4 – 43.7%.

The analysis shows that in 2010 specific emissions decreased to 20.5% compared to the base year.

Estimates of GHG emissions in 2010 by sectors are given in Table 2.2 and in Annexes 1 and 2.

The largest contribution to total greenhouse gas emissions is made by the Energy sector (82%) (Figure 2.2). The contribution of other sectors is as follows:

- Agriculture – 10%;
- Industrial Processes – 4%;
- Waste – 4%.

Contribution of HFCs to total GHG emissions is insignificant and amounts to 0.011%.

The highest values of total emissions per capita of 5.7 t CO_2-eq./person accounts for the Energy sector.

GHG emissions changed in the context of separate sectors in 2010 compared to 1990 as follows:

- Increased:
  - Energy - 10.4%;
  - Agriculture - 17.1%;
  - Waste - 78.0%.
- Decreased:
  - Industrial Processes - 2.5%;
  - In the LUCF sector, CO_2 removals increased to 94%.

Table 2.1 GHG emissions in 2010

GHG	Mt CO_2-eq.	t CO_2-eq./capita
Direct GHG		
CO_2	101.8	3.6
CH_4	87.0	3.0
N_2O	10.4	0.4
HFC	0.0	0
Total	**199.2**	**7.0**
Indirect GHG		
Gas	**Gg**	**kg / capita**
CO	1043	36.5
NOx	253	8.9
NMVOC	253	8.9
SO_2	163	5.7

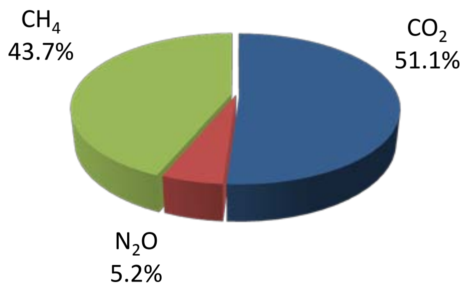


Figure 2.1 Structure of total direct GHG emissions in 2010

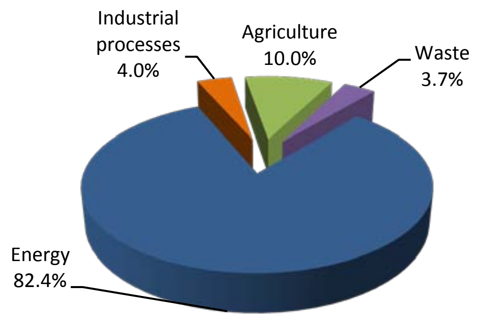


Figure 2.2 Structure of total direct GHG emissions by sectors in 2010

Table 2.2 GHG emissions by Sectors (divided by Gases) in 2010, Gg CO_2-eq.

Sector	CO_2	CH_4	N_2O	Total	CO_2-eq./capita
Energy	95704	68271	87	164062	5.7
Industrial Processes	6059	3	1789	7851	0.3
Agriculture	0	11949	7998	19947	0.7
Waste	0	6749	601	7350	0.3
Total	**101763**	**86972**	**10475**	**199210**	**7.0**

Figures 2.3, 2.4, 2.5 present the contribution of sectors to greenhouse gas emissions.

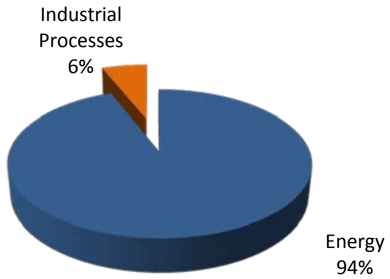


Figure 2.3 Share of Sectors in CO_2 emissions

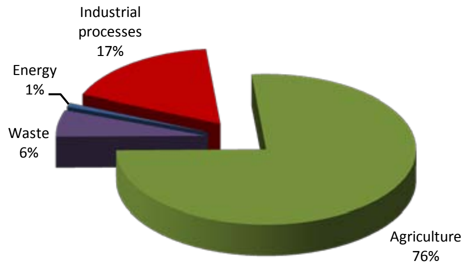


Figure2.4 Share of Sectors in N_2O emissions

The main contribution to CO_2 and CH_4 emissions is made by the "Energy" sector (94% and 78%, respectively). The main contribution to N_2O emissions is made by the "Agriculture" sector – 76%.

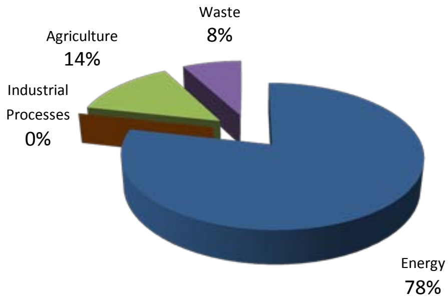


Figure 2.5 Share of Sectors in CH_4 emissions

3. GHG EMISSION TRENDS 1990-2012

Emission trends by direct greenhouse gases

As a result of the Inventory in Uzbekistan, total direct greenhouse gas emissions in 2012 were as follows:

- excluding removals in the LUCF sector - 205.2 Mt CO_2-eq.;
- including removals in the LUCF sector - 201.5 Mt CO_2-eq.

As compared to the base year 1990, total greenhouse gases emissions in 2012 increased to 13.8%.

Greenhouse gases that mostly contribute to total emissions in 2012 (Mt CO_2-eq.) were as follows:

- CO_2 – 105.6;
- CH_4 – 88.4;
- N_2O – 11.2.

Table 3.1 and Figure 3.1 present separate greenhouse gas emissions and values of total emissions for the period 1990-2012, as well as change in total national GHG emissions for each year compared to the base year 1990. The maximum value of total emissions – 227.3 Mt CO_2-eq. took place in 2008, which is caused by the increase in volume of natural gas consumption in Commercial/Institutional and Residential sectors as well as the growth in volume of transit natural gas transmission.

The biggest change in total emissions compared to the base year took place in the period 2006-2009, the maximum value was achieved in 2008. (+ 26%). The minimum value of GHG emissions took place in 1998 (-3.8%).

HFCs emissions are given for the period 2000-2012, as there is the lack of HFCs consumption data for the country for the period before 2000.

Table 3.1 Direct GHG emissions by Gases, Mt CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	113.2	113.3	106.3	106.8	101.4	101.0	104.0	102.3	100.0	104.1	108.6	107.9
N_2O	12.9	13.4	13.3	12.8	11.9	11.5	11.4	11.2	11.2	10.8	10.7	10.3
CH_4	54.2	56.5	56.7	83.5	70.3	71.7	73.6	65.9	62.4	67.3	78.7	81.6
HFCs	-	-	-	-	-	-	-	-	-	-	0.006	0.006
Total	**180.4**	**183.2**	**176.3**	**203.1**	**183.6**	**184.2**	**189.1**	**179.4**	**173.6**	**182.2**	**197.8**	**199.8**
Change in emission by 1990,%	-	1.5	-2.3	12.6	1.8	2.1	4.7	-0.6	-3.8	1.0	9.7	10.7
GHG	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Δ (2012-1990)**
CO_2	111.0	106.8	104.8	100.9	103.6	103.4	113.2	107.6	101.8	105.1	105.6	**-6.7%**
N_2O	10.6	10.5	10.5	9.4	9.1	9.1	9.5	9.9	10.4	11.0	11.2	**-13.8%**
CH_4	82.6	84.4	83.6	85.9	99.0	100.0	104.6	90.0	86.9	87.9	88.4	**63.1%**
HFCs	0.002	0.009	0.038	0.012	0.036	0.011	0.032	0.019	0.022	0.074	0.094	
Total	**204.2**	**201.7**	**198.9**	**196.2**	**211.7**	**212.5**	**227.3**	**207.6**	**199.2**	**204**	**205.2**	**13.7%**
Change in emission by 1990,%	13.2	11.8	10.3	8.8	17.4	17.8	26.0	15.1	10.4	13.1	13.8	

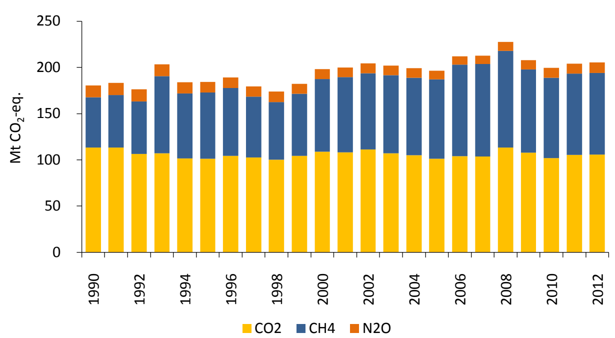


Figure 3.1 Trends of emissions by Gases

For the period 1990-2012, the following changes in emissions were observed:

- decrease in CO_2 emissions excluding the LUCF sector - 6.7%;
- decrease in CO_2 emissions including the LUCF sector - 8.1%;
- decrease in N_2O emissions - 13.5%;
- increase in CH_4 emissions - 63.3%;
- increase in emissions for HFCs for the period 2000-2012 – 15.7 times.

Increase in methane emissions is caused by the increasing share of leakage from the developing oil and gas industry.

Change in contribution of separate gases in the structure of total national GHG emissions during the period 1990-2012 is given in Figure 3.2. For this period, share of CO_2 in total greenhouse gas emissions decreased from 62.8% to 51.4%, share of methane increased from 30.1% to 43.1%. Share of nitrous oxide decreased from 7.1% to 5.5%.

Share of HFCs in total emissions accounted for 0.01% in 2010, 0.04% - in 2012.

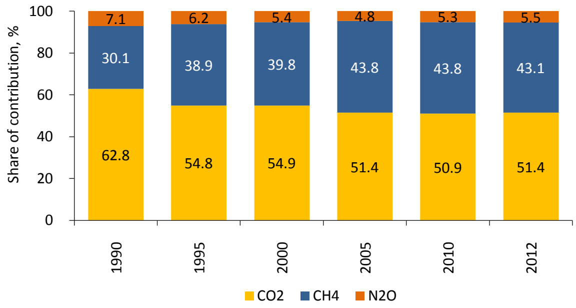


Figure 3.2 Change in structure of Gases in Total emissions

Trends of GHG emissions by sectors

Table 3.2 and Figure 3.3 present direct greenhouse gas emissions by sectors for the period 1990-2012 and the value of total national emissions:

- Including CO_2 emissions/removals in the LUCF sector;
- excluding CO_2 emissions/removals in the LUCF sector.

For the period 1990-2012, GHG emissions by sectors changed as follows:

- increase in emissions observed in the following sectors:
    - Energy - 11.2%;
    - Agriculture - 27.1%;
    - Waste + 87.8%.
- decrease in emissions observed in the following sector:
    - Industrial Processes - 3.7%.

For the period 1990-2012, CO_2 removals by forests increased to 81.3%.

In 2001, 2005 and 2007, not CO_2 removals, but emissions took place in the LUCF sector. This was caused by predominance of CO_2 emissions from agricultural soils as a result of changes in land use over CO_2 removals by forest biomass.

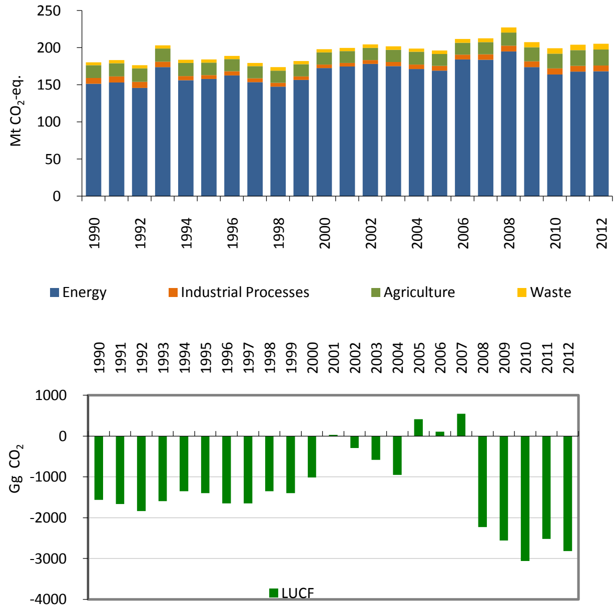


Figure 3.3 Total emission trends by Sectors, 1990-2012

Increase of GHG removals in the LUCF sector in last five years is caused, in general, by increasing the area of desert forests.

Table 3.2 GHG direct emissions by Sectors, Mt CO_2-eq.

Category	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Energy	151.2	153	145.9	173.6	155.9	157.9	162.7	153.4	147.6	156.6	172.4	174.5
Industrial Processes	8.1	8.5	8.2	7.3	5.9	5.3	5.5	5.2	5.1	4.7	4.9	4.9
Agriculture	17.0	17.6	18.0	17.9	17.5	16.7	16.4	16.4	16.4	16.4	16.2	15.9
LUCF	-1.6	-1.7	-1.8	-1.6	-1.4	-1.4	-1.6	-1.6	-1.3	-1.4	-1.0	0.0
Waste	4.1	4.1	4.2	4.3	4.3	4.3	4.4	4.4	4.5	4.5	4.5	4.5
Total **(including removals in the LUCF sector)**	**178.8**	**181.5**	**174.5**	**201.5**	**182.2**	**182.8**	**187.4**	**177.8**	**172.3**	**180.8**	**197.0**	**199.8**
Total **(excluding removals in the LUCF sector)**	**180.4**	**183.2**	**176.3**	**203.1**	**183.6**	**184.2**	**189.0**	**179.4**	**173.6**	**182.2**	**198.0**	**199.8**
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Energy	178.3	175.2	171.4	169.2	184	183.7	195.1	173.9	164.1	167.6	168.1	**+11,2%**
Industrial Processes	5.0	5.3	6.0	6.2	6.6	7.1	7.5	7.6	7.9	7.8	7.8	**-3,7%**
Agriculture	16.3	16.6	16.8	16.1	16.1	16.6	17.6	18.9	19.9	21.0	21.6	**+27,1%**
LUCF	-0.3	-0.6	-1.0	0.4	0.1	0.5	-2.2	-2.6	-3.1	-2.5	-2.9	**+81,3%**
Waste	4.6	4.6	4.7	4.7	5.0	5.1	7.1	7.2	7.3	7.6	7.7	**+87,8%**
Total **(including removals in the LUCF sector)**	**203.9**	**201.1**	**197.9**	**196.6**	**211.8**	**213.0**	**225.1**	**205.0**	**196.1**	**201.5**	**202.4**	**+13,1%**
Total **(excluding removals in the LUCF sector)**	**204.2**	**201.7**	**198.9**	**196.2**	**211.7**	**212.5**	**227.3**	**207.6**	**199.2**	**204.0**	**205.3**	**+13,7%**

Trends of emissions with indirect GHG effect

In the Inventory, indirect greenhouse gas emissions - CO, NOx, NMVOC (non-methane volatile hydrocarbons) and SO_2 were estimated.

The largest contribution to the GHG emissions group is made by the Energy sector, which accounts for:

- 99.9% - CO emissions;
- 99.7% - NOx;
- 85.1% - NMVOC;
- 98.1% - SO_2.

In this sector, the main sources of emissions are:

- Transport - for CO, NOx and NMVOC,
- Fuel Combustion in Energy Production - for SO_2, NOx.

Table 3.3 and Figure 3.4 present the annual indirect greenhouse gas emissions during the period 1990-2012.

The largest volumes of emission is typical for CO – carbon monoxide.

Table 3.3 Indirect GHG emissions, Mt

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	1.93	1.77	1.40	1.24	1.11	0.98	0.96	1.10	1.08	1.17	1.18	1.22
NOx	0.41	0.38	0.35	0.32	0.30	0.29	0.28	0.29	0.27	0.28	0.29	0.29
NMVOC	0.41	0.38	0.31	0.28	0.25	0.22	0.22	0.24	0.24	0.25	0.25	0.28
SO_2	0.65	0.59	0.46	0.38	0.34	0.34	0.34	0.33	0.29	0.28	0.29	0.25
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO	1.17	1.07	1.09	0.94	0.99	1.01	1.05	1.03	1.04	0.97	1.04	**-47.4%**
NOx	0.28	0.27	0.27	0.25	0.26	0.25	0.27	0.26	0.25	0.26	0.28	**-25.0%**
NMVOC	0.24	0.22	0.22	0.23	0.23	0.27	0.25	0.25	0.25	0.25	0.27	**-25.0%**
SO_2	0.25	0.23	0.22	0.18	0.19	0.16	0.18	0.17	0.16	0.18	0.20	**-71.4%**

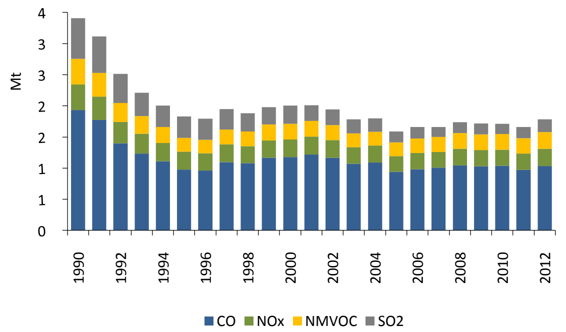


Figure 3.4 Trends of indirect GHG emissions

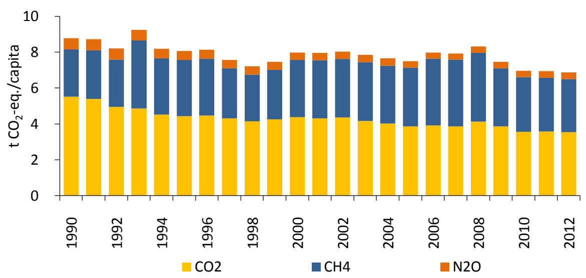


Figure 3.5 Trends of GHG emissions per capita by Gases

For the whole reviewed period, a decrease observed in indirect greenhouse gas emissions of:

- CO - 47.4%;
- NOx - 25.0%;
- NMVOC - 25.0%;
- SO_2 - 71.4%.

Indirect GHG emissions reduction was caused by the increase in the share of gas fuel in total fuel consumption in Energy and Road Transportation.

Trends in specific emissions indicators - GHG emissions per capita

To ensure the comparability of emissions from different countries, it is decided to calculate annual emissions of the main GHG per capita.

Greenhouse gas emissions per capita for the period from 1990 to 2012 changed as follows (Figure 3.5):

- total emissions decreased from 8.8 to 6.9 t CO_2-eq./capita;
- CO_2 emissions decreased from 5.5 to 3.5 t CO_2-eq./ capita;
- N_2O emissions decreased from 0.6 to 0.4 t CO_2-eq./ capita;
- CH_4 emissions increased from 2.6 to 3.0 t CO_2-eq./ capita.

The following changes in emissions per capita by sectors took place (Figure 3.6):

- In the Energy sector - from 7.4 to 5.6 t CO_2-eq./ capita;
- In the Industrial Processes sector - from 0.4 to 0.3 t CO_2-eq./ capita;
- In the Agriculture sector - from 0.8 to 0.7 t CO_2-eq./ capita;
- In the Waste sector - from 0.2 to 0.3 t CO_2-eq./ capita.

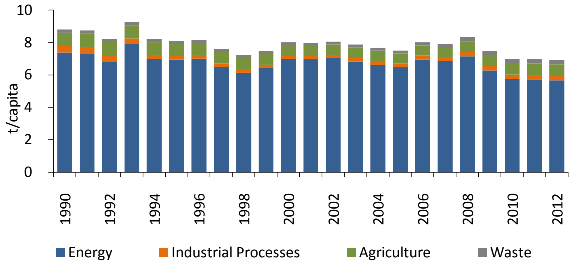


Figure 3.6 Trends of GHG emissions per capita by Sectors

Decrease of specific indicators of per capita greenhouse gas emissions for the period 1990-2012 is explained by the faster population growth in comparison with greenhouse gas emissions growth rate.

The trends of specific indicators of indirect greenhouse gases per capita were also estimated (Figure 3.7).

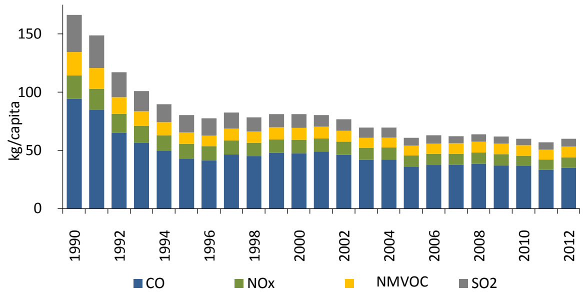


Figure 3.7 Trends of indirect GHG emissions per capita

In 2012, specific CO emissions amounted to 4.8 kg/person, specific NOx emissions - 9.3 kg/ capita, specific NMVOC emissions - 9.1 kg/ capita, specific SO_2 emissions - 6.8 kg/ capita.

For the period 1990-2012, specific CO emissions decreased by 2.7 times, specific NOx emissions – by 2.2 times, specific NMVOC emissions – by 2.1 times, specific SO_2 emissions – by 4.7 times.

Reduction of specific emissions of indirect greenhouse gases is caused by the increase in share of natural gas in total fuel consumption.

4. ENERGY – 1

4.1 Sector review

Energy sector has a special place in national economy. It is the largest consumer of fuel and energy and respectively the main source of greenhouse gases.

It should be noted that in accordance with the IPCC procedures in calculation of CO_2 emissions, carbon accumulated from its non-energy use is taken into account for some fuels (natural gas, bitumen, oil coke, coke oven coke, lubricants and other oil products). CO_2 emissions from petroleum oil use are categorized as “Other”, because there is no statistics on oil use by sector.

In the sector, the following was covered by Inventory:
- direct greenhouse gases – CO_2, CH_4, N_2O;
- indirect greenhouse gases – CO, NOx, NMVOC, SO_2.

This section provides estimates of greenhouse gas emissions from energy activities covering production, processing, storage, distribution and use (combustion) of fossil fuels in the “Energy” sector. In this sector greenhouse gas emissions are divided into 2 categories:
- Category 1A - emissions from fuel combustion activities.
- Category 1B - emissions from fuel leakage and evaporation/ fugitive emissions.

Category 1A “Fuel Combustion activities” includes:
- 1A.1 Energy Industries;
- 1A.2 Manufacturing Industries and Construction;
- 1A.3 Transport;
- 1A.4 Other sectors (Commercial/Institutional, Residential, Agriculture);
- 1A.5 Other.

Category 1B. “Fugitive Emissions”:
- 1B.1 Coal Mining and Processing;
- 1B.2 Fugitive Methane Emissions in Oil and Gas sector.

Emissions in the “Energy” sector

Table 4.1 presents direct and indirect greenhouse gas emissions from fuel combustion and fugitive emissions in the “Energy” sector in 2010. Figure 4.1 shows the contribution of each category into the sectoral emission in 2010.

Table 4.1 Direct and indirect GHG emissions in the “Energy” sector, 2010

Direct GHG			Indirect GHG	
GHG	Gg CO_2-eq.	%	Gas	Gg
CO_2	95,704	58.3	CO	1042
CH_4	68,274	41.6	NO_x	252
N_2O	87	0.1	NMVOC	218
Total	**164,065**	**100.0**	SO_2	159

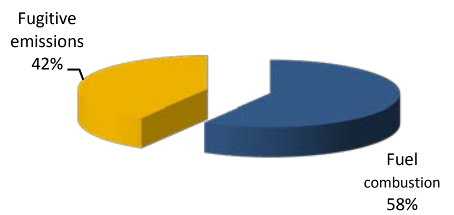


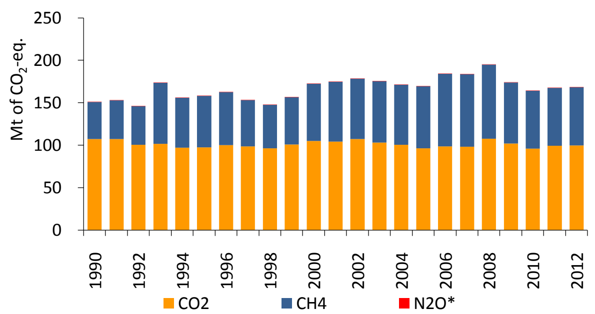
Figure 4.1 Contribution of categories “Fuel Combustion” and “Fugitive Emissions” into the sectoral emissions (2010)

4.1.1 *Total emission trends*

In 2010, contribution of the Energy sector in total GHG emissions (excluding removals) amounted to 82% (in 1990 – 83.8%). Carbon dioxide and methane make the main contribution to the sectoral emission.

Figure 4.2 and Table 4.2 show emission trends in the “Energy” sector divided by gases for the period 1990-2012.

The most significant sources of greenhouse gas emissions in the Energy sector are the following:



**Note:* Nitrous oxide emissions are not practically seen due to their marginal amount

Figure 4.2 Trends of GHG emissions in the “Energy” sector

- for CO_2 - Fuel Combustion from Energy Industries, Road Transportation, Residential and Commercial/Institutional sectors;
- for CH_4 - Fugitive Emissions from Gas activities;
- for N_2O - Energy Industries and Road Transportation.

Table 4.2 Direct GHG emissions in the "Energy" sector for the period 1990-2012, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	107009	107003	100249	101318	96894	97224	100069	98439	96270	100575	105016	104260
CH_4	44013	45793	45525	72163	58944	60567	62540	54766	51199	55963	67320	70133
N_2O	177	166	138	128	109	105	108	153	110	104	110	103
Total	**151199**	**152962**	**145912**	**173609**	**155947**	**157896**	**162717**	**153358**	**147579**	**156642**	**172446**	**174495**
GHG	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO_2	107260	102848	100236	96088	98656	98068	107444	101712	95704	99149	99581	**-6.9%**
CH_4	70886	72299	71023	73051	85261	85567	87518	72134	68274	68322	68460	**+55.6%**
N_2O	105	98	98	93	96	98	99	94	87	88	94	**-46.9%**
Total	**178251**	**175245**	**171357**	**169232**	**184013**	**183733**	**195061**	**173940**	**164065**	**167559**	**168135**	**+11.2%**

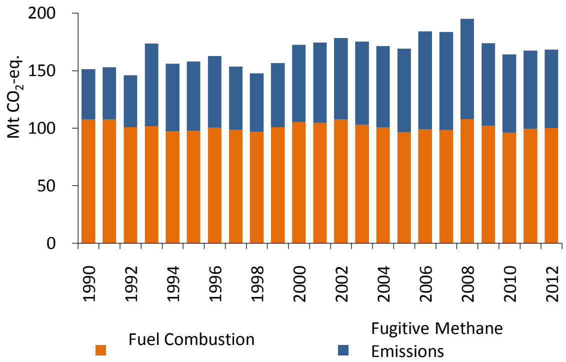


Figure 4.3 Change in contribution of fugitive methane emissions and fuel combustion into sectoral GHG emissions

For the period 1990-2012, total emission from the sector increased to 11.2%, decrease in CO_2 emissions - 6.9% and N_2O - 46.9% and at the same time increase in CH_4 emissions - 55.6% was observed.

Share of the Energy sector accounts for 99% of total estimated CO, NOx and SO_2 emissions and about 93% of NMVOC emissions. Figure 4.3 and Table 4.3 show trends of indirect greenhouse gas emissions for the period 1990-2012.

Table 4.3 Indirect GHG emissions in the "Energy" sector for the period 1990-2012, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	1904	1738	1362	1192	1056	905	874	1000	975	1059	1066	1098
NOx	410	377	344	317	292	283	276	281	270	276	282	281
NMVOC	381	351	281	256	233	206	198	220	218	230	228	232
SO_2	649	581	460	374	341	339	337	328	292	276	290	248
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO	1025	912	927	941	984	1010	1046	1031	1042	973	1034	**-45.7%**
NOx	280	262	263	252	258	251	265	259	252	261	275	**-32.9%**
NMVOC	217	196	197	197	207	214	220	218	218	210	230	**-39.6%**
SO_2	247	225	214	173	187	157	172	171	159	177	198	**-69.5%**

For the period 1990-2012, in the "Energy" sector a decrease in indirect greenhouse gas emissions was observed: CO – 45.7%, NOx - 32.9%, NMVOC – 39.6% and SO_2 - 69.5%.

Thus, for all indirect GHG in the "Energy" sector there is a tendency to reduce emissions that can be explained by implementation of measures to reduce emissions of polluting substances.
As In 2010 GHG emissions by categories accounted for:

- 1 A Fuel Combustion - 95966 Gg CO_2-eq.;
- 1 B Fugitive Methane Emissions – 68,100 Gg CO_2-eq.

Table 4.4 and Figure 4.4 present GHG emissions from fuel combustion (including CO_2, CH_4, and NO_2 emissions) and emissions from fugitive methane emissions in coal mining and oil and gas industries.

As seen from Table 4.4, for the period 1990-2012 in the "Energy" sector emissions from fuel combustion decreased to 7.1%, and emissions from fugitive methane emissions increased to 56.4%.

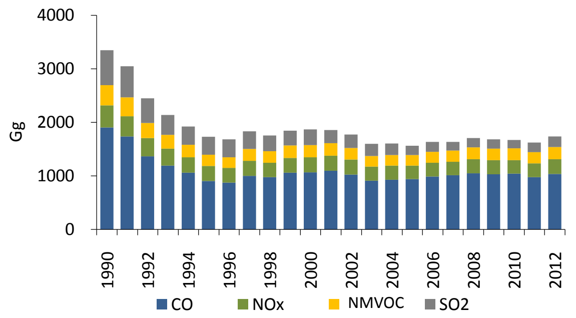


Figure 4.4 Trends of indirect GHG emissions in the "Energy" sector

Table 4.4 GHG emissions from fuel combustion and leakage, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Fuel combustion	107556	107543	100691	101669	97199	97468	100316	98729	96516	100822	105273	104507
Methane leakage	43628	45419	45222	71930	58748	60429	62401	54630	51063	55819	67174	69988
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Fuel combustion	107510	103088	100471	96326	98912	98321	107729	101981	95966	99448	99898	**-7.1%**
Methane leakage	70741	72157	70887	72906	85101	85404	87332	71960	68100	68112	68237	**+56.4%**

4.1.2 Key sources in the "Energy" sector

Analysis of key sources was made for the "Energy" sector. The key sources of greenhouse gas emissions in the "Energy" sector in 2010 are listed below in the order of decreasing emission volumes, according to criteria on emission level and/or trend estimation:

1. Fugitive CH_4 Emissions from Oil and Gas activities – level, trend.
2. Other sectors: Residential sector, CO_2 Emissions from Natural Gas Combustion – level, trend.
3. Energy Industries, CO_2 Emissions from Natural Gas Combustion – level, trend.
4. Other sectors: Commercial/Institurional sector, CO_2 Emissions from Natural Gas Combustion – level, trend.
5. Manufacturing Industries and Construction, CO_2 Emissions from Natural Gas Combustion – level, trend.
6. Mobile sources: CO_2 Emissions from Road Transportation – level, trend.
7. CO_2 Emissions from Pipeline Transport – level.
8. Energy Industries, CO_2 Emissions from Sub-bituminous Coal Combustion – level, trend.
9. Energy Industries, CO_2 Emissions from Crude Oil Combustion – trend.
10. Other sectors: Agriculture, CO_2 Emissions from Liquid Fuel Combustion – trend.
11. Energy Industries, CO_2 Emissions from Fuel Oil Combustion – trend.
12. Other sectors: Commercial/Institutional sector, CO_2 Emissions from Liquid Fuel Combustion – trend.
13. Other sectors: Commercial/Institutional sector, CO_2 emissions from Solid Fuel Combustion – trend.
14. Other sectors. Residential sector, CO_2 Emissions from Liquid Fuel Combustion – trend.
15. Manufacturing Industries and Construction, CO_2 Emissions from Liquid Fuel Combustion – trend.
16. Mobile sources: CO_2 Emissions from Railways – trend.

Analysis of key sources in 2010 showed that:

- compared with the Inventory of 2000, the following categories were excluded from the key sources:
  - o "Manufacturing Industries and Construction, CO_2 Emissions from Solid Fuel Combustion";
  - o "Residential sector, CO_2 Emissions from Liquid Fuel Combustion".
- compared with the Inventory of 1990, the category "Energy Industries, CO_2 emissions from Crude Oil Combustion" was included into the key ones.

4.2 Fuel combustion – 1A

4.2.1 Description of source categories

CO_2, CH_4, N_2O, CO, NOx, NMVOC and SO_2 emissions were estimated in the category "Fuel Combustion".

The emissions were estimated by the following sub-sectors:

- A1 Energy Industries;
- 1A2 Manufacturing Industries and Construction;
- 1A3 Transport (according to type of transport 1A3 a (I и ii), 1A3 b, 1A3 c, 1A3 d ii, 1A3 e i);
- 1A4 a Commercial/Institutional;
- 1A4 b Residential;
- 1A4 c Agriculture (I and ii).

CO_2 emissions from fuel combustion were also estimated according to Reference approach, a comparison of Reference and Sectoral approaches was made to estimate CO_2 emissions from fuel combustion.

Energy Industries. The category "Energy Industries" accounts for 34% of GHG emissions from fuel combustion. The category includes greenhouse gas emissions from the production of both electric power and heat.

JSC "Uzbekenergo" is practically a major manufacturer and supplier of electric power in the country. The structure of JSC "Uzbekenergo" includes 39 power plants with a total installed capacity of about 12.5 mil. KW, Including 10 thermal power plants with capacity of 11.0 mil. KW and 29 hydropower plants with capacity of 1.4 mil. KW which are mostly combined in cascades and work on the watercourses.

The share of institutional power plants in the structure of generating capacity is 3.8% (475.5 MW). The installed capacity of power plants in Uzbekistan is about 50% of generating capacity across the united energy system (UES) of Central Asia.

The power system of Uzbekistan is based on thermal power plants which include the largest in Central Asia Syrdarya thermal power plant with installed capacity of 3000 MW, Novo-Angren thermal power plant (2100 MW), Tashkent thermal power plant (1860 MW), Navoi hydropower plant (1250 MW), Talimarjan thermal power plant (800 MW), Takhiatash thermal power plant (730 MW) and others. Heat supply of some cities and towns of the republic is carried out from thermal power plants.

In the structure of primary energy used in thermal power plants for the production of electricity and heat, the share of gas fuel accounts for 93.3%, fuel oil - 1.2%, coal - 5.2%. The main source of greenhouse gases in the electric power industry is the process of fuel combustion to produce heat and electricity.

In 2012 electric power production in Uzbekistan amounted to 52.534 billion kW.h, of which 51.54 billion kW.h were generated at the enterprises of JSC "Uzbekenergo", and the remaining electric power was generated by autonomous thermal power enterprises and hydroelectric power plants belonging to the Ministry of Agriculture and Water Management.

The amount of heat released to consumers in 2012 amounted to 18.876 mil. Gcal.

The length of electric networks of JSC "Uzbekenergo" is more than 250 thous. km, which makes it possible to involve all consumers of the republic in the area of centralized electric power supply.

Extensive work on introduction of new technologies for the electric power generation on the basis of modern steam and gas turbines (SGP and GTP) is carried out in thermal power plants of the joint-stock company [38].

Manufacturing Industries and Construction. This category accounted for 8% of greenhouse gas emissions from fuel combustion. In the category, greenhouse gas emissions from fuel use in industrial processes are reviewed. The main industries of Uzbekistan, which generate greenhouse gases are:

- ferrous and non-ferrous metals;
- construction (cement, lime, glass production);
- ammonia production and others.

Greenhouse gases are formed in the process of fuel combustion in technological ovens to produce high-temperature heat.

Transport. Uzbekistan has the developed transport sector, the structure of which includes road, railway, air and pipeline types of transport. Transport accounts for 13% of GHG emissions in Fuel Combustion category. Functioning of the transport complex is accompanied by CO_2, CO, CH_4, N_2O, NOx and NMVOC emissions.

Road and pipeline transport provides the highest emissions by category.

Pipeline transport is reviewed in the category "Fuel Combustion", as when pumping at gas compressor stations, natural gas is burned as a fuel and in the result carbon dioxide is emitted into air. Leakage of natural gas during its transmission is recorded in the sector "Methane Leakage".

The total length of roads in the Republic of Uzbekistan as of 2012 is 77 thous. km, hard surface roads length amounted to 49.7 thous. km. In terms of development, the road network in Uzbekistan is a leader among the CIS countries and currently provides the current demand for freight and passenger traffic within the country [39].

The length of railways is 5.9 thous. km, including electrified ones - 0.7 thous. km.

National Aircompany “Uzbekistan Airways” provides international air travel to dozens of countries, and also operates a domestic airline. In Uzbekistan, there are 10 airports, half of them accept international flights.

In order to reduce GHG emissions from transport, actions are being taken by the government to update the fleet of cars, railway locomotives, aircrafts, to improve the quality of motor fuels, to use alternative fuels (LPG and CNG), shifting of certain railway pieces to the electric traction. In 2008-2012, more than 161 thousand motor vehicles in the republic were shifted to gas fuel. The implemented Programs on construction and reconstruction of roads of international and national importance also contribute to GHG emissions reduction [40].

Transmission and transit of natural gas to consumers by the gas-main pipeline system is carried out by the joint-stock company “Uztransgaz”. As of 2010, JSC “Uzgransgaz” serves more than 13.6 thous. km of gas-main pipelines and includes 24 compressor stations. In general, the system operates 252 gas-compressor units. Natural gas transmission is provided by the departments of gas-main pipelines and main stations of underground gas storage in the north, south and east, which provide natural gas supply to consumers of the Republic of Uzbekistan, for export and transit. The gas distribution system of JSC “Uztransgaz” consists of more than 127.7 thous. km of gas distribution networks and 96.3 thousand units of high and medium pressure gas distribution stations. During the period of 1990-2012, the length of the gas-main pipelines increased by 1.4 times; the length of gas distribution networks – by 3 times, and the level of gasification of the population - by 2 times, from 44.1 to 85.3% (89% - in urban areas and 80% - in rural areas) [41].

Residential and Commercial/Institutional sector. Residential and Commercial/Institutional sector accounts for 44% of emissions from fuel combustion. Due to deterioration of the significant part of engineering infrastructure, poor insulation and other issues, energy consumption in buildings is 2-2.5 times higher than the corresponding figures in the developed countries.

Low energy efficiency and low energy saving in the Residential sector are also linked to the relatively low price of energy, the prevalence of inefficient in terms of energy-saving home appliances, shortcomings in the system of energy consumption accounting [42].

Agriculture. Agriculture and other activities (forestry) accounts for 1% of GHG emissions from fuel combustion in the “Energy” sector. At the same time, according to expert estimates, the stationary fuel combustion accounts for 95% of total fuel consumption in this category. Stationary sources of GHG emissions include greenhouses, pumps, grain drying, livestock farming and other agricultural activities. Mobile sources of GHG emissions include specialized agricultural machinery (tractors, etc.).

Other. The category includes emissions from petroleum oil. Contribution of emissions from the category to total emissions from fuel combustion is 0.1%.

Emissions from Biomass Burning. Total emissions does not include CO_2 emissions from biomass burning.

International Bunkers. Total emissions does not include CO_2 emissions from international bunkers. In Uzbekistan, there is only international aviation bunker.

GHG emissions from fuel combustion in 2010

Table 4.5 presents direct and indirect greenhouse gases emissions from fuel combustion in 2010.

In 2010 CO_2 emissions from biomass burning amounted to 54.0 Gg; and emissions from international aviation bunker amounted to 1010.8 Gg CO_2-eq.

Table 4.5 Share of direct and indirect GHG emissions in the category “Fuel combustion”, 2010

Direct GHG			Indirect GHG	
Gas	**Gg CO_2-eq.**	**%**	**Gas**	**Gg**
CO_2	95704	99.7	CO	1041
CH_4	175	0.2	NOx	252
N_2O	87	0.1	NMVOC	191
Total	**95966**	**100.0**	SO_2	86

4.2.2 Comparison of reference and sectoral approaches to assess CO_2 emissions from fuel combustion

CO_2 emissions were calculated with employing the reference and sectoral approaches.

The reference approach is a calculation of emissions in the total consumption of primary and secondary fuels in the country. Calculations were made by approaches of the IPCC Tier 1, using national values of the lowest fuel efficiency. The calculations used the estimated fuel balances compiled according to expert estimates (in connection with the confidentiality of official data).

The sectoral approach involves calculation of emissions using information on final consumption of fuels in the sectors of economy.

The results of calculations of CO_2 emissions from fuel combustion, obtained on the basis of reference and sectoral approaches are summarized in Table 4.6.

In 2010, CO_2 emissions from fuel combustion, calculated:

- employing the reference approach, amounted to 85457 Gg;
- employing the sectoral approach, amounted to 95704 Gg.

The difference between the amount of annual emissions in 2010 calculated with employing different approaches was 11.2%.

The most significant differences between the reference and sectoral approaches of calculating CO_2 emissions were reported in the period 2009 – 2012. The maximum deviation of the calculated values was obtained for 2012. Difference in the obtained estimates of CO_2 emissions depends on the fact that fuel and energy balances for the Third National Communication for the period 2006-2012 were calculated by the estimation data. Data on fuel consumption were used for calculations, which can be agreed not in all cases.

Table 4.6 CO_2 emissions calculated employing the reference and sectoral approaches, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Reference approach	110495	110035	102905	102497	97909	98511	101114	99157	97755	101353	106060	106306
Sectoral approach	107009	107003	100249	101318	96894	97224	100069	98439	96270	100575	105016	104260
Difference, %	**3.2**	**2.8**	**2.6**	**1.2**	**1.0**	**1.3**	**1.0**	**0.7**	**1.5**	**0.8**	**1.0**	**1.9**
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	
Reference approach	107951	103485	100602	96521	97120	95895	96705	91754	85457	91000	86577	
Sectoral approach	107260	102848	100236	96088	97656	98068	107444	101712	95704	99149	99581	
Difference, %	**0.7**	**0.6**	**0.4**	**0.5**	**-0.6**	**-2.3**	**-11.1**	**-10.8**	**-11.2**	**-9.0**	**-15.0**	

Difference in the calculations of CO_2 emissions with employing the reference and sectoral approaches by type of the primary fuel is given in Table 4.7. The greatest differences in the estimates of CO_2 emissions are observed for oil and natural gas in 2008 -2012.

Table 4.7 CO_2 emissions from primary types of fuels calculated employing the reference and sectoral approaches

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Reference approach, Mt CO_2	Oil	33.37	28.96	23.39	20.32	19.28	18.96	17.97	18.82	17.58	18.98	19.75	18.21
	Coal	13.5	12.86	9.73	5.73	4.64	4.07	4.42	3.71	3.41	3.11	3.73	3.13
	Gas	63.62	68.22	69.78	76.45	73.98	75.48	78.73	76.63	76.76	79.27	82.58	84.96
Sectoral approach, Mt CO_2	Oil	32.44	28.29	22.61	20.31	18.74	18.30	18.05	18.98	17.24	18.71	19.59	17.55
	Coal	13.74	13.07	9.78	5.82	4.73	4.06	4.5	3.8	3.25	3.2	3.85	3.23
	Gas	60.64	65.45	67.66	74.99	73.23	74.67	77.4	75.55	75.68	78.56	81.49	83.46
Difference, %	**Oil**	2.8	2.4	3.4	0	2.9	3.6	-0.4	-0.8	2.0	1.4	0.8	3.8
	Coal	-1.8	-1.6	-1.6	-1.6	-1.9	0.2	-1.8	-2.4	4.9	-2.8	-3.1	-3.1
	Gas	4.9	4.2	3.1	1.9	1.0	1.1	1.7	1.4	1.4	0.9	1.3	1.8
		2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	
Reference approach, Mt CO_2	Oil	17.86	16.98	15.66	14.01	14.48	13.64	13.58	13.46	10.95	12.56	10.96	
	Coal	3.31	2.55	3.39	3.34	3.74	3.14	3.92	3.74	3.10	3.31	4.28	
	Gas	86.78	83.95	81.55	79.16	78.9	79.12	79.2	74.55	71.4	75.13	71.31	
Sectoral approach, Mt CO_2	Oil	17.84	16.77	15.67	14.06	15.24	13.8	13.88	13.59	12.34	11.75	12.24	
	Coal	3.38	2.62	3.39	3.35	3.71	3.13	3.90	3.74	3.09	3.27	4.27	
	Gas	85.97	83.34	81.05	78.55	79.58	81.04	89.58	84.28	80.18	84.04	82.96	
Difference, %	**Oil**	0.1	1.2	-0.1	-0.4	-5.0	-1.2	-2.2	-1.0	-11.3	6.9	-6.7	
	Coal	-2.1	-2.7	0.0	-0.3	0.8	0.3	0.5	0.3	0.3	1.2	0.9	
	Gas	0.9	0.7	0.6	0.8	-0.8	-2.4	-13.1	-13.1	-12.3	-11.9	-16.3	

Trends of emissions by gases

Direct GHG emissions from fuel combustion are given in Table 4.8 and Figure 4.5.

Table 4.8 Direct GHG emissions from Fuel combustion, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	107009	107003	100249	101318	96894	97224	100069	98439	96270	100575	105016	104260
N_2O	177	166	138	119	109	105	108	153	110	104	110	103
CH_4	385	373	303	233	196	139	139	137	136	144	146	144
Total	**107571**	**107542**	**100690**	**101670**	**97199**	**97468**	**100316**	**98729**	**96516**	**100823**	**105272**	**104507**
CO_2 from biomass burning	856	959	1018	1208	1565	2028	2434	2676	2859	2957	3002	3392

GHG	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
CO_2	107260	102848	100236	96088	98656	98068	107444	101712	95704	99149	99581	**-6.9%**
N_2O	105	98	98	93	96	91	99	94	87	88	94	**-46.9%**
CH_4	144	142	137	145	160	163	186	174	175	210	224	**-39.3%**
Total	**107509**	**103088**	**100471**	**96326**	**98912**	**98322**	**107729**	**101980**	**95966**	**99447**	**99899**	**-7.1%**
CO_2 from biomass burning	3902	4316	4506	54	54	54	54	54	54	54	54	**-93.7%**

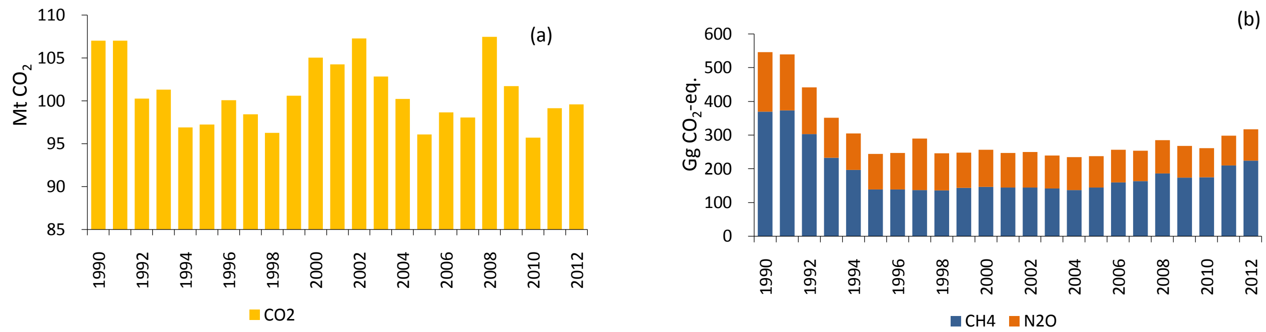


Figure 4.5 Trends of direct GHG emissions from Fuel combustion: (a) CO_2; (b) CH_4; N_2O

The emissions from biomass burning for the period 2005-2012 include only emissions from firewood burning by population. Until 2005, stubble burning of cereals made the main contribution into emissions from biomass burning, which was legally prohibited by Resolutions of the government [43, 44].

For the period 1990-2012, total direct greenhouse gas emissions from fuel combustion decreased to 7.1%: CO_2 emissions reduced to 6.9%, N_2O – 46.9%, CH_4 – 39.3% and CO_2 emissions from biomass burning – 93.7%.

Figure 4.6 and Table 4.9 show the change in indirect greenhouse gas emissions from fuel combustion for all categories.

As seen from Table 4.9, a decrease in the following indirect GHG emissions from fuel combustion for the period 1990-2012 was observed: CO – 45.7%; NOx – 32.9%; NMVOC – 39.2%; SO_2 – 78.8%.

Indirect GHG emissions reduction from fuel combustion depends on the increased share of natural gas in the fuel consumed and measures taken by the government to reduce emissions of polluting substances.

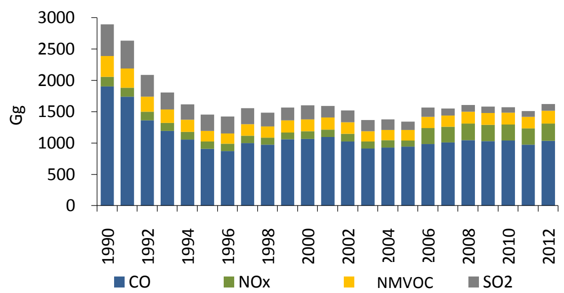


Figure 4.6 Trends of indirect GHG emissions from Fuel combustion

Table 4.9 Indirect GHG emissions from Fuel combustion, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	1903	1738	1361	1191	1056	904	873	999	975	1058	1066	1097
NO_x	410	377	344	317	292	282	275	280	269	276	282	280
NMVOC	337	306	243	215	192	168	162	183	178	192	191	197
SO_2	504	444	345	272	249	258	270	257	220	205	223	182
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO	1025	912	926	941	984	1009	1045	1030	1041	973	1034	**-45.7%**
NO_x	279	261	263	252	258	250	264	259	252	260	275	**-32.9%**
NMVOC	183	164	166	169	178	181	188	187	191	186	205	**-39.2%**
SO_2	191	176	169	132	144	108	111	106	86	91	107	**-78.8%**

GHG emissions by sub-sectors

For all sub-sectors the same emission factors were applied for each type of fuel, therefore all sub-sectors are described in one chapter – Fuel Combustion.

In Table 4.10 and Figures 4.7, 4.8 direct and indirect GHG emissions are given by all categories in 2010.

As seen from Figure 4.7, the most significant amounts of GHG emissions from fuel combustion accounted for the categories "Energy Industries" and "Residential sector".

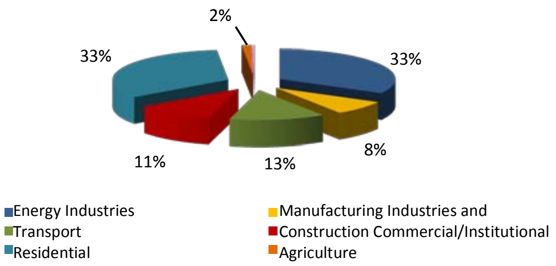


Figure 4.7 Share of separate categories in direct GHG emissions from Fuel combustion in 2010

Table 4.10 Direct and indirect GHG emissions by categories in 2010, Gg CO_2-eq.

Sub-sector	Direct GHG				Indirect GHG			
	CO_2	CH_4	N_2O	Total	CO	NOx	NMVOC	SO_2
Energy Industries	31550	13	33	31596	10	86	3	57
Manufacturing Industries and Construction	7520	14	6	7540	4	22	1	3
Transport	12745	44	16	12805	938	91	172	7
Commercial/Institutional	10453	21	9	10483	17	10	2	10
Residential	31918	81	19	32018	35	29	3	6
Agriculture	1386	2	3	1391	37	15	11	4
Other	132	-	-	132				
Total	**95704**	**175**	**86**	**95965**	**1042**	**253**	**192**	**87**

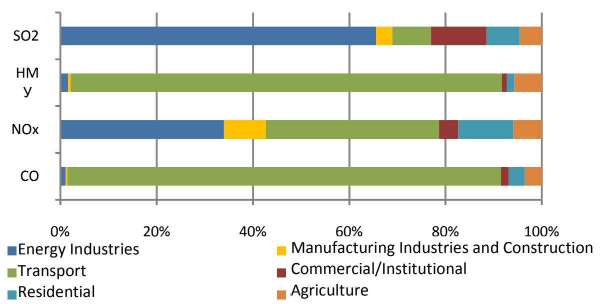


Figure 4.8 Share of separate categories in indirect GHG emissions from Fuel combustion in 2010

Note: In Table 4.10 CO_2 emissions from the consumption of lubricating oils are given under the item "Other", as they are not divided to sub-sectors.

The largest contributors to the indirect GHG emissions (Figure 4.7) are "Transport" and "Energy Industries". The category "Transport" accounts for about 85% of CO emissions, about 90% of NMVOC emissions, about 40% of NOx and 8% of SO_2 emissions. The main indirect GHG in the category "Energy Industries" are SO_2 (61%) and NOx (30%).

Trends of indirect GHG emissions by categories

Table 4.11 and Figure 4.9 present CO_2 emissions from fuel combustion in separate categories for the period 1990-2012.

Table 4.11 CO_2 emissions from Fuel combustion by categories, Gg

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Industries	55100	53981	50432	46921	44952	44916	43249	43057	40965	40916	44284	42250
Manufacturing Industries and Construction	10168	9406	8341	7725	6058	6227	5807	5563	5232	5042	4982	5106
Transport	16491	15168	11274	9803	8720	8134	8358	8571	9096	10385	11132	12941
Commercial/ Institutional	6841	9507	10678	14646	10385	9369	9723	7610	7786	8470	9024	9050
Residential	12239	13041	13986	17420	22587	24492	28961	29762	30272	32408	32696	31696
Agriculture	5667	5399	5117	4445	3855	3870	3757	3620	2687	3151	2693	3004
Other	503	501	420	357	337	216	214	255	232	203	206	213

Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
Energy Industries	44912	41640	43345	36966	35010	32284	33529	32967	31550	33798	33938	**-38.4%**
Manufacturing Industries and Construction	5150	5332	5333	5383	6239	6682	6893	7194	7520	7370	8018	**-21.1%**
Transport	12569	11142	10139	9596	12586	12941	13843	13255	12745	12079	12355	**-25.1%**
Commercial/ Institutional	7968	8338	9773	10687	11475	12670	20558	14173	10453	17001	19919	**+191.2%**
Residential	33833	33893	29467	31099	31399	31876	31084	32588	31918	27476	23856	**+94.9%**
Agriculture	2649	2141	2003	2024	1726	1376	1389	1401	1386	1288	1304	**-77.0%**
Other	179	363	175	334	220	239	148	134	132	138	189	**-62.4%**

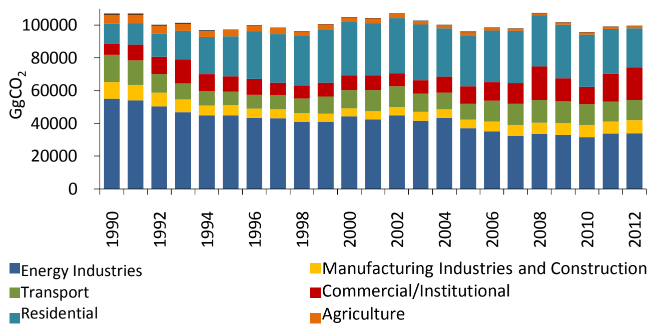


Figure 4.9 Trends of CO_2 emissions by categories

The following changes in CO_2 emissions from fuel combustion were observed for the period 1990-2012:

– emissions decreased in the following categories:

- – Energy Industries – 38.4%;
- – Manufacturing Industries and Construction – 21.2%;
- – Transport – 25.1%;
- – Agriculture – 77.0%;
- – Other (lubricating oils, which were not divided into sub-sectors) – 62.4 %.

– emissions increased in the following categories:

- Commercial/Institutional – 191.2%;
- Residential – 94.9%.

Reducing CO_2 emissions in Energy Industries is caused by replacement of solid and liquid fuels to natural gas.

Considerable rise of CO_2 emissions in Residential sector since 1993 was the result of the State program on gasification of settlements, including rural area.

Other greenhouse gas emissions from fuel combustion - methane and nitrous oxide are given in Tables 4.12 and 4.13 and in Figures 4.10 and 4.11.

Table 4.12 CH_4 emissions from Fuel combustion by categories, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Industries	24.2	23.1	20.9	20.2	19.5	19.8	19.2	19.3	18.1	18.5	20.2	18.6
Manufacturing Industries and Construction	17.6	16.2	14.5	13.7	10.4	11.2	10.5	10.0	9.5	9.1	9.1	9.5
Transport	50.8	45.8	35.7	31.5	27.7	23.5	22.4	26.5	28.8	30.6	31.1	31.9
Commercial/ Institutional	15.4	20.1	22.0	28.5	20.5	18.5	19.4	15.4	15.9	17.3	18.8	18.3
Residential	241.9	234.7	175.9	124.2	108.4	57.4	59.2	59.0	58.9	62.7	62.4	61.0
Agriculture	34.7	33.4	34.0	14.7	9.8	8.4	7.9	6.7	4.5	5.5	4.6	5.1

Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
Energy Industries	20.0	18.7	18.8	15.5	15.0	13.7	14.0	13.8	13.0	13.9	13.9	**-42.6%**
Manufacturing Industries and Construction	9.3	9.9	10.1	10.0	11.4	12.5	13.0	13.9	14.4	14.2	15.5	**-11.9%**
Transport	29.8	27.4	27.7	28.1	30.9	32.8	35.1	37.8	43.8	51.7	65.8	**+29.5%**
Commercial/ Institutional	16.5	17.1	19.9	21.7	22.6	24.7	39.7	27.6	20.6	32.8	38.3	**+148.7 %**
Residential	64.5	65.2	56.8	66.0	77.0	77.0	81.9	78.3	80.6	95.4	88.0	**-63.6%**
Agriculture	4.4	3.5	3.3	3.4	2.9	2.3	2.3	2.3	2.3	2.1	2.2	**-93.7%**

Change in methane emissions from fuel combustion for the period 1990-2012 was as follows:

– Decrease in methane emissions was observed in the following categories:
- Energy Industries – 42.6%;
- Manufacturing Industries and Construction – 11.9%;
- Residential – 63.6% or drop by 2.7 times;
- Agriculture – 93.7% or drop by 15.8 times;

– Increase in methane emissions was observed in the following categories:
- Transport – 29.5%;
- Commercial/Institutional – 148.7%.

Decrease in CH_4 emissions from Residential sector between 1990 and 1995 brought about by less amount of solid fuel.

Table 4.13 N_2O emissions from Fuel combustion by categories, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Industries	80.6	73.5	62.6	53.0	48.8	51.5	52.7	51.8	46.5	48.1	54.3	47.1
Manufacturing Industries and Construction	13.3	11.8	9.3	8.1	6.1	5.9	5.3	5.3	4.7	4.7	4.7	4.3
Transport	31.9	28.5	22.0	19.5	17.4	15.2	14.0	15.2	16.1	16.1	16.1	16.4
Commercial/Institutional	14.9	17.1	13.6	12.1	10.5	9.3	10.5	8.1	8.7	9.0	10.2	9.3
Residential	22.3	22.0	18.0	16.1	17.1	14.6	16.4	16.7	17.1	18.3	18.3	18
Agriculture	14.0	13.3	12.4	10.2	9.0	9.0	8.7	8.7	6.5	7.8	6.5	7.4
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	$\Delta_{(2012-1990)}$
Energy Industries	50.5	46.8	49.3	40.6	40.9	36.0	38.8	38.1	32.9	33.8	38.1	**-52.7%**
Manufacturing Industries and Construction	4.3	4.0	4.0	4.3	5.3	5.6	5.6	5.6	5.6	5.3	5.9	**-55.6%**
Transport	15.5	14.6	14.6	15.2	17.4	17.4	17.7	17.4	16.4	15.2	15.8	**-50.5%**
Commercial/Institutional	9.3	8.1	9.0	10.2	9.6	9.6	14.6	10.5	9.0	12.4	14.3	**-4.0%**
Residential	18.9	19.2	16.7	18.0	18.6	18.9	18.9	19.5	19.2	18.3	16.4	**-26.5%**
Agriculture	6.5	5.3	5.0	5.0	4.3	3.4	34	3.4	3.4	3.1	3.1	**-779.0%**

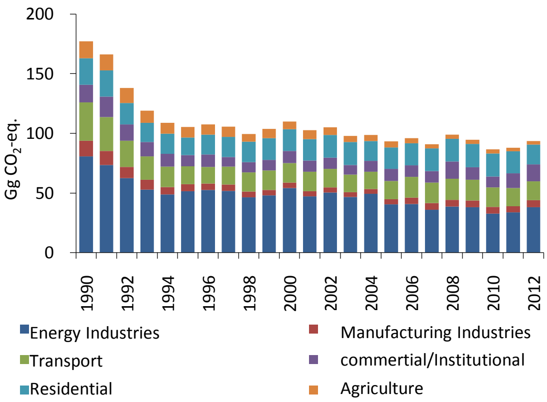


Figure 4.10 Trends of N_2O emissions from Fuel combustion by categories

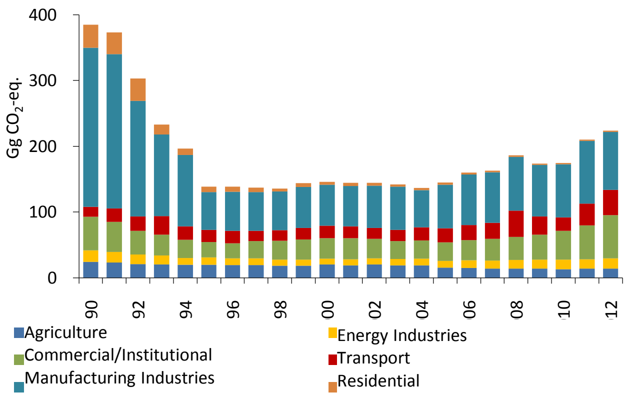


Figure 4.11 Trends of CH_4 emissions from Fuel combustion by categories

Decrease in N_2O emissions from fuel combustion in the following categories was observed for the period 1990-2012:
- Energy Industries – 52.7% or decrease by 2.1 times;
- Manufacturing Industries and Construction – 55.6% or decrease by 2.2 times;

- Transport – 50.5% or decrease by 2 times;
- Commercial/Institutional – 4.0%;
- Residential - 26.5%;
- Agriculture – 77.9% or decrease by 4.5 times.

Trend of N_2O emissions decrease in the "Energy" sector is caused by increase in share of gas fuel consumption in all sectors of economy and environment protection.

Indirect greenhouse gas emissions from fuel combustion by categories for the period 1990-2012 are given in Tables 4.14-4.18 and Figures 4.12 - 4.15.

Table 4.14 CO emissions from Fuel combustion by categories, Gg

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Industries	16.9	16.9	16.2	15.2	14.6	14.4	13.7	13.7	13.2	13.0	14.0	13.7
Manufacturing Industries	5.7	5.2	4.4	4.1	3.1	3.3	3.0	2.9	2.7	2.6	2.6	2.7
Transport	1567.6	1399.6	1090	970.7	854.4	721.4	693.4	832.9	843.3	912.7	928.9	953.2
Commercial/Institutional	41.1	52.0	31.2	25.1	26.2	22.7	25.6	16.1	17.0	16.1	18.7	18.8
Residential	78.6	76.6	58.9	43.9	40.7	25.4	27.4	27.5	27.7	29.5	29.5	28.8
Agriculture	193.6	187.2	160.6	132.4	116.9	117.1	109.9	106.0	70.8	84.1	72.1	80.0
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Energy Industries	14.5	13.4	14	12.1	11.3	10.6	11.0	10.8	10.5	11.3	11.2	**-33.7%**
Manufacturing Industries	2.7	2.8	2.9	2.9	3.4	3.7	3.8	4.1	4.2	4.1	4.5	**-21.1%**
Transport	887.3	796.2	817	825.3	872.7	908.9	933.8	925.8	937.6	862.7	921.4	**-41.2%**
Commercial/Institutional	18.6	11.0	12.1	15.8	16.5	15.9	24.8	18.0	17.5	22.1	27.4	**-33.3%**
Residential	30.5	30.7	26.7	30.1	33.6	33.8	35.1	34.4	34.9	38.2	34.7	**-55.9%**
Agriculture	71.1	57.5	53.7	54.2	46.3	36.5	36.7	37.5	37.1	34.4	34.8	**-82.0%**

Table 4.14 shows that decrease in CO emissions was observed for the period 1990-2012 in the following categories:

- Energy Industries – 33.7%;
- Manufacturing Industries and Construction – 21.1%;
- Transport – 41.2%;
- Commercial/Institutional – 33.3%;
- Residential – 55.9%;
- Agriculture - 82.0%.

The biggest CO emissions are observed in the category "Transport". Drop in CO emissions from transport in this category in early 90-s was brought about by decline in cargo- and passenger transportation, mainly in road and railway transport. Further growth and stabilization of emissions was brought about by increase in the motor car park and at the same time, with constant control of ecological condition of vehicles.

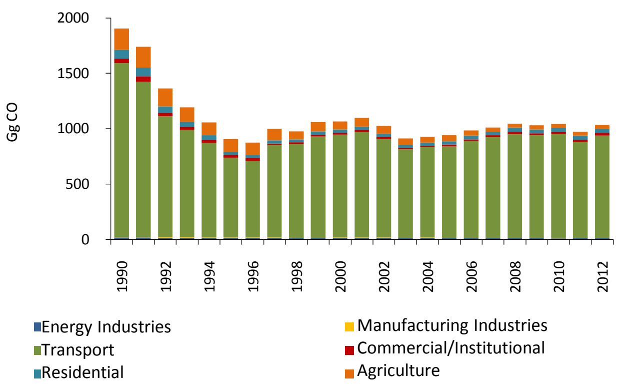


Figure 4.12 Trends of CO emissions from Fuel combustion by categories

Table 4.15 shows the following changes in NOx emissions from fuel combustion for the period 1990-2012:

Decrease in emissions in the following categories:

- Energy Industries – 38.6%;
- Manufacturing Industries. Construction – 21.4%;
- Transport – 33.5%;
- Agriculture – 73.4%.

Increase in emissions in the following categories:

- Commercial/Institutional +149.3%;
- Residential +78.5%.

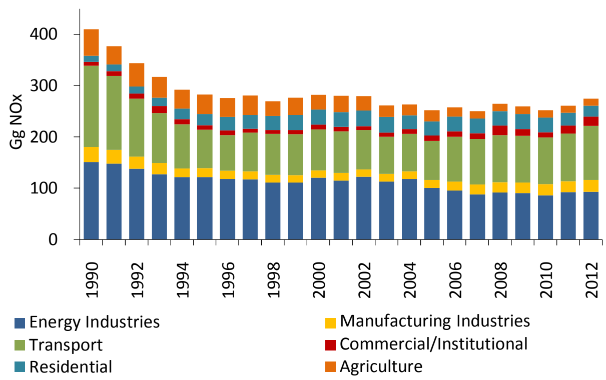


Figure 4.13 Trends of NOx emissions from Fuel combustion by categories

Figure 4.12 shows the trends of NOx emissions from fuel combustion by categories. Decrease in NOx emissions from transport in the first half of the 90-s as well as decrease in the CO emissions was brought about by decline in cargo- and passenger transportation, mainly by road and railway transport. Increase in emissions from transport after 2004 was brought about by growth of motor car park. Reduction in NOx emissions was caused by the government policy to reduce emissions of polluting substances from stationary sources.

Table 4.15 NOx emissions from Fuel combustion by categories, Gg

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Industries	151.0	147.7	137.8	127.2	121.5	121.5	117.4	116.8	111.0	110.9	120.4	114.8
Manufacturing Industries, Construction	29.4	26.9	23.8	22.0	17.0	17.7	16.6	15.9	15.0	14.4	14.3	14.6
Transport	158.12	144.2	112.5	97.1	86.1	74.4	69.4	75.6	79.7	79.8	79.9	81.4
Commercial/Institutional	7.3	9.6	10.5	13.6	9.8	8.8	9.2	7.3	7.6	8.3	8.9	8.7
Residential	12.1	12.7	13.2	16.0	20.5	22.0	26.0	26.7	27.2	29.1	29.3	28.4
Agriculture	51.6	35.5	45.8	41.1	37.0	37.8	36.8	38.0	28.7	33.6	28.7	32.3
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	$\Delta_{(2012-1990)}$
Energy Industries	121.9	112.7	117.8	100.5	95.3	87.9	91.7	90.1	86.0	91.9	92.7	**-38.6%**
Manufacturing Industries. Construction	14.6	15.1	15.1	15.0	17.4	18.8	19.5	20.6	21.5	21.1	23.1	**-21.4%**
Transport	76.5	72.3	72.9	76.4	87.4	88.6	91.6	91.2	91.3	93.4	105.2	**-33.5%**
Commercial/Institutional	7.8	8.1	9.5	10.3	10.8	11.7	18.9	13.1	9.8	15.6	18.2	**+149.3%**
Residential	30.4	30.4	26.5	27.9	28.2	28.7	28.0	29.3	28.7	24.8	21.6	**+78.5%**
Agriculture	28.3	22.8	21.4	21.6	18.4	14.4	14.5	14.7	14.6	13.5	13.7	**-73.4%**

For the period 1990-2012, change in NMVOC emissions from fuel combustion in all categories was observed (Table 4.16):

- Energy Industries – 34.1%;
- Manufacturing Industries and Construction - 20.0%;
- Transport - 32.0%;
- Commercial/Institutional – 33.3%;
- Residential – 55.7%;
- Agriculture – 78.2%.

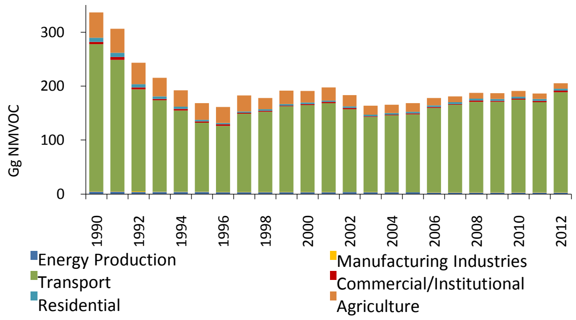


Figure 4.14 Trends of NMVOC emissions from Fuel combustion by categories

Figure 4.13 shows the trends of NMVOC emissions by categories. The largest contribution to total NMVOC emissions from fuel combustion is made by “Transport” category. Decrease in NMVOC emissions from transport in early 90-s was brought about by the same causes as decrease in CO and N_2O emissions, that is, decrease in cargo- and passenger transportation, mainly by road and railway transport. Some growth of NMVOC emissions in the Transport sector over the last decade depends on the increase of motor car park.

Table 4.16 NMVOC emissions from Fuel combustion by categories, Gg

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Industries	4.4	4.4	4.2	3.9	3.8	3.7	3.6	3.6	3.4	3.4	3.6	3.5
Manufacturing Industries	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5
Transport	272.4	243.2	189.3	169.2	150.7	128.2	122.5	144.7	148.7	158.5	161	164.7
Commercial/Institutional	4.2	5.3	3.2	2.5	2.6	2.3	2.6	1.7	1.7	1.7	1.9	1.9
Residential	7.9	7.7	5.9	4.4	4.1	2.5	2.7	2.8	2.8	3.0	3.0	2.9
Agriculture	46.7	44.7	39.8	34.3	30.7	31.0	29.6	29.7	21.1	24.9	21.3	23.9
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	$\Delta_{(2012-1990)}$
Energy Industries	3.7	3.4	3.6	3.1	2.9	2.7	2.8	2.8	2.7	2.9	2.9	**-34.1%**
Manufacturing Industries	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	**-20.0%**
Transport	153.3	138.9	141.8	144.4	156.0	161.9	167.2	167.2	171.7	166.6	185.2	**-32.0%**
Commercial/Institutional	1.9	1.2	1.3	1.6	1.7	1.6	2.5	1.8	1.8	2.2	2.8	**-33.3%**
Residential	3.1	3.1	2.7	3.0	3.4	3.4	3.5	3.5	3.5	3.8	3.5	**-55.7%**
Agriculture	21.0	17.0	15.9	16.1	13.7	10.8	10.8	11.0	10.9	10.1	10.2	**-78.2%**

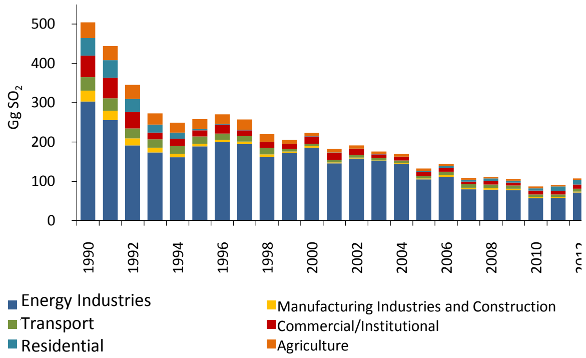


Figure 4.15 Trends of SO_2 emissions from Fuel combustion by categories

Decrease in SO_2 emissions from fuel combustion by categories was observed for the period 1990-2012 (Table 4.17):

- Energy Industries – 76.4%;
- Manufacturing Industries and Construction – 90.6%;
- Transport – 80.1%;
- Commercial/Institutional – 80.7%;
- Residential – 73.6%;
- Agriculture – 89.9%.

Figure 4.15 shows the trends of SO_2 emissions from fuel combustion. The largest contribution to SO_2 emissions is made by the category "Energy Industries". Decrease in SO_2 emissions from the "Energy" sector is caused by increase in share of natural gas in the utilized fuel and State policy to reduce emissions of polluting substances from stationary sources.

Table 4.17 SO_2 emissions from Fuel combustion by categories, Gg

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Industries	302.4	255.3	191.2	172.9	160.6	188.4	199.0	194.4	161.9	172.3	185.3	145.5
Manufacturing Industries	27.6	23.5	17.6	12.1	8.9	7.0	6.1	6.2	6.6	3.6	3.8	2.7
Transport	34.6	32.3	25.2	21.4	20.1	18.3	16.2	14.3	15.9	6.3	6.1	6.1
Commercial/ Institutional	54.8	52.1	41.7	16.9	18.8	15.6	22.7	14.5	14.5	12.1	18.3	17.8
Residential	44.7	44.1	33.6	20.8	15.3	3.1	1.7	1.5	1.2	1.1	0.9	1
Agriculture	39.4	36.1	35.2	28.2	24.9	25.1	24.6	25.8	19.8	9.8	8.3	9.4
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Energy Industries	157.4	150.7	144.7	104.3	110.9	79.5	78.8	77.1	57.0	57.2	71.3	**-76.4%**
Manufacturing Industries	3.1	2.3	1.9	2.7	4.4	4.0	4.0	3.7	2.6	2.4	2.6	**-90.6%**
Transport	5.8	6.1	5.9	6.8	9.1	8.6	8.7	8.1	6.8	6.8	6.9	**-80.1%**
Commercial/ Institutional	15.5	9.1	9.1	9.7	9.1	7.1	9.0	7.3	9.7	8.4	10.6	**-80.7%**
Residential	0.9	1.1	1.0	2.6	5.3	5.1	6.8	5.1	6.1	12.0	11.8	**-73.6%**
Agriculture	8.2	6.6	6.2	6.3	5.3	4.2	4.2	4.3	4.2	3.9	4.0	**-89.8%**

GHG emissions in the category "Transport"

GHG emissions in the category "Transport" were estimated by types of transport and types of greenhouse gases (Tables 4.18 and 4.19).

Table 4.18 GHG emissions in the category "Transport" by types of transport, 2010

Transport	Gg CO_2-eq.	%
Domestic aviation	55.8	0.4
Road transportation	6,907.9	54.2
Railways	433.1	3.4
Navigation	0.0	0.0
Pipeline transport	5,347.7	42.0
Total	**12,744.6**	**100.0**

According to data given in tables, the largest contribution to GHG emission in 2010 was made by road (54.2%) and pipeline (42.0%) transport.

Table 4.19 GHG emissions in the category "Transport" in 2010

GHG	Gg CO_2-eq.	%
CO_2	12,745	99.6
CH_4	44	0.3
N_2O	16	0.1
Total	**12,805**	**100.0**

The main emissions in this category accounted for CO_2 emissions from transport – 99.6% of total GHG emissions from transport.

Table 4.20 shows direct GHG emissions in the category "Transport" for the period 1990-2012.

Table 4.20 GHG emissions in the "Transport" category, Gg CO_2-eq.

Transport	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Domestic aviation	163	107	74	69	63	59	59	51	66	66	71	64
Road transportation	9986	8891	6908	6306	5962	5247	4909	5392	5557	5595	5619	5673
Railways	1754	1801	1430	944	576	439	402	377	386	349	327	374
Navigation	12	12	9	9	9	6	6	0	0	0	0	0
Pipeline transport	4575	4357	2852	2475	2110	2382	2981	2752	3086	4374	5114	6830
Total	**16490**	**15168**	**11273**	**9803**	**8720**	**8133**	**8357**	**8572**	**9095**	**10384**	**11131**	**12941**
Transport	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Domestic aviation	66	64	60	56	56	47	54	53	56	46	41	**-74.8%**
Road transportation	5253	4917	4962	5248	6544	6645	6915	6980	6908	6941	7789	**-22.0%**
Railways	414	436	439	447	431	436	439	452	433	436	430	**-75.5%**
Navigation	0	0	0	0	0	0	0	0	0	0	0	**-100.0%**
Pipeline transport	6835	5725	4678	3845	5555	5813	6435	5770	5348	4655	4095	**-10.5%**
Total	**12568**	**11142**	**10139**	**9596**	**12586**	**12941**	**13843**	**13255**	**12745**	**12078**	**12355**	**-25.1%**

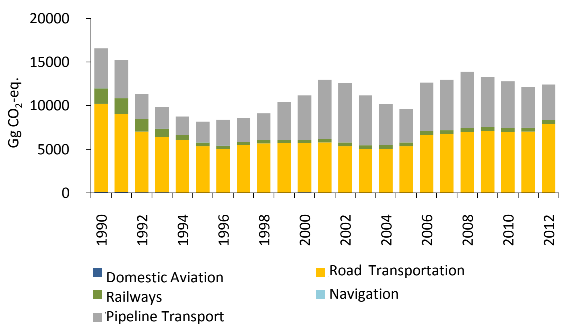


Figure 4.16 Trends of GHG emissions from different types of Transport

During the reviewed period. in the category "Transport" there was a reduction of total direct greenhouse gas emissions to 25.1%. According to Table 4.20, Figure 4.16 the following GHG reduction by the types of transport was observed:

- Domestic Aviation - 74.8%;
- Road Transportation - 22.0%;
- Railways - 75.5%;
- Pipeline Transport - 10.5%;
- Navigation - the amount of emissions reduced to zero by 1997 in the result of Aral Sea degradation.

The reason for reducing emissions from road and railway transport is the purposeful implementation of the following measures:

- maintenance of motor vehicles in good technical condition;
- carrying out mandatory control and measures to regulate the content of pollutants in the exhaust gases of motor vehicles for compliance with regulations;
- modernization of motor vehicles;
- conversion of vehicles to compressed natural gas and liquefied petroleum gas;
- the planned transfer from railways to electric traction.

In oil and gas industry, to transmit gas through pipelines, fuel and energy saving activities, introduction of automation systems, replacement and reconstruction of outdated technical equipment, utilization of associated gases are carried out annualy.

Emissions from "International bunkers"

In Uzbekistan there is only international air bunker. GHG emissions from international air bunker are not included in the National Inventory and are given for information.

Emissions by this category are fully determined by the

Table 4.21 Direct and indirect GHG emissions from International bunker, 2010

Direct GHG, Gg CO_2-eq.			Indirect GHG, Gg			
CO_2	CH_4	N_2O	CO	NOx	NMVOC	SO_2
1001.3	0.2	8.9	1.4	4.2	0.7	0.7

consumption of jet fuel. Emissions are calculated using IPCC default factors. Activity data are provided by National Aircompany “Uzbekistan Airways” and National Holding Company “Uzbekneftegaz”. In the absence of specific statistical data on jet fuel consumption for international routes, as national carrier, and international airlines, assumption of National Aircompany “Uzbekistan Airways” expert that international air bunker is 95% of the total amount of jet fuel used (5% - domestic aviation) was applied.

In 2010 direct GHG emissions from international bunker amounted to 1010.35 Gg CO_2-eq. data on greenhouse gas emissions are given in Table 4.21.

Direct and indirect GHG emissions from international air bunker for the period 1990-2012 are given in Figures 4.18 and 4.19 and Table 4.22.

Table 4.22 Direct and indirect GHG emissions from International air bunkers

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Direct GHG, Gg CO_2-eq.												
CO_2	2818.5	1745.3	1125.1	1078.9	963.5	900.1	885.7	793.3	978.0	1035.7	1116.4	1041.4
CH_4	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
N_2O	24.8	15.5	9.3	9.3	9.3	7.8	6.2	9.3	9.3	9.3	9.3	9.3
Indirect GHG, Gg												
NOx	11.9	7.4	4.8	4.6	4.1	3.8	3.8	3.4	4.1	4.4	4.7	4.4
CO	4.0	2.5	1.6	1.5	1.4	1.3	1.3	1.1	1.4	1.5	1.6	1.5
NMVOC	2.0	1.2	0.8	0.8	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.7
SO_2	1.9	1.1	0.7	0.7	0.6	0.6	0.6	0.5	0.6	0.7	0.7	0.7
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Direct GHG, Gg CO_2-eq.												
CO_2	1144.1	983.7	969.3	894.3	980.9	823.3	951.4	940.8	1001.3	813.5	725.6	**-74.3%**
CH_4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**-75.0%**
N_2O	9.3	9.3	9.3	9.3	9.3	6.2	9.3	9.3	9.3	6.2	6.2	**-75.0%**
Indirect GHG, Gg												
NOx	4.8	4.2	4.1	3.8	4.2	3.5	4.0	4.0	4.2	3.5	3.1	**-73.9%**
CO	1.6	1.4	1.4	1.3	1.4	1.2	1.3	1.3	1.4	1.2	1.0	**-75.0%**
NMVOC	0.8	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.6	0.5	**-75.0%**
SO_2	0.8	0.6	0.6	0.6	0.7	0.5	0.6	0.6	0.7	0.5	0.7	**-63.2%**

For the period 1990-2012 the following decrease in direct and indirect GHG emissions from International air bunker was observed (Figures 4.16, 4.17):
- CO_2 - 74.3%;
- CH_4 - 75.0%;
- N_2O - 75.0%;
- NOx - 74.0%;
- CO - 64.6%;
- NMVOC - 75.0%;
- SO_2 - 63.2%.

Decrease in both direct and indirect greenhouse gas emissions was caused by the reduction in the number of air carriages in the early 90-s, as well as the constant updating of NJSC “Uzbekistan Airways” air fleet through the purchase of new equipment.

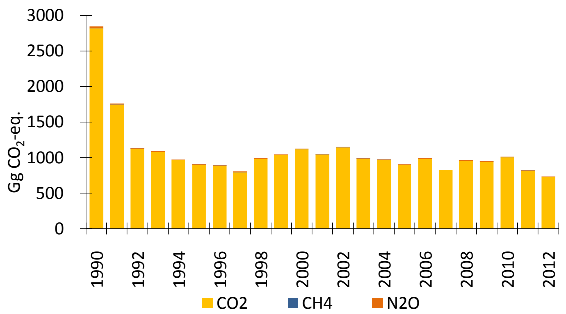


Figure 4.17 Trends of GHG emissions from International air bunker

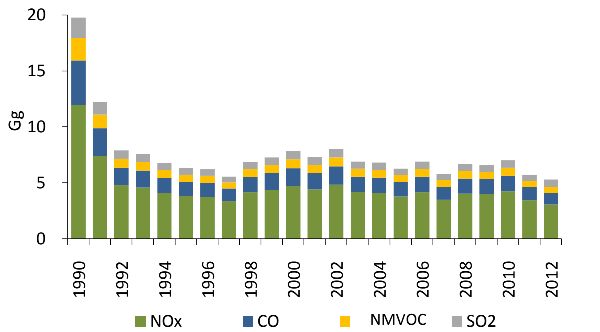


Figure 4.18 Trends of indirect GHG emissions from International air bunker

4.2.3 Methodology

Estimation of CO_2 emissions from fuel combustion was performed in accordance with the Revised 1996 IPCC Guidelines for National GHG Inventories. [3] – Tier 1. Both reference and sectoral approaches were used for calculations. Default factors recommended by the IPCC and national factors were used to calculate emissions.

Carbon accumulated in the products was considered for the following types of fuel: natural gas, bitumen, lubricants, petroleum coke, coke oven coke and other petroleum products. In calculation of cumulative carbon in natural gas, its consumption for recycling process was taken into account.

Estimation of non-CO_2 gases emissions (CH_4, N_2O, NOx, CO, NMVOC, SO_2) was also carried out by Tier 1 in accordance with [3].

Activity data

Data on volumes of production, import and export, total and final consumption of fuel for the period 1990-2005 were provided by:

- Ministry of Economy;
- NHC “Uzbekneftegaz”;
- JSC “O`zbekko`mir”.

These data are confidential, so they are not given in this report. Fuel and energy balances are drawn up according to expert estimates due to official data confidentiality.

The assumption was used that the share of jet fuel consumption is as follows:

- for domestic aviation - 5%;
- for international bunker - 95%.

To calculate CO_2 emissions from biomass burning. data on the amount of fuel wood only from sanitary felling in the forests (see Section 7.2 “Activity data” of “Land-Use Change and Forestry” sector of the report) were used. Data on volume of felling were provided according to Departmental statistics of Main Administration on Forestry. Due to absence of annual statistical data for the period 2009-2012, average expert estimates on the consumption of fuel wood for the period 2005-2008 were used. In 2000 the amount of fuel wood amounted to 35.12 thousand tons.

Data on stubble burning of cereals were excluded from calculation of emissions from biomass burning since 2005, on the basis of Resolutions of the President of the Republic of Uzbekistan # PP-76 dated May 16, 2005 “On organizational measures for harvesting cereal crops” on ban for stubble burning. # PP-865 dated May 13, 2008 “On measures for organization of tillage on land free from cultivation of cereal crops” [43,44].

Emission factors

Both national and default emission factors of the IPCC were used for calculation.

Direct GHG emission factors

CO_2 – carbon dioxide

Energy convertion factors (calorific value) for all fuels – national factors developed in the Second National Communication.

Factors of fuel recalculation from natural values into energy ones for calculation of CO_2 emissions were accepted in accordance with the Instructions on compiling a report on fuel and energy balance for 1990 (Table 4.23) [8]. Calorific value of jet kerosene was accepted on the basis of measurement data provided by JSC “Uznefteprodukt”, that is a part of National Holding Company “Uzbekneftegaz”. Carbon emission factor and carbon oxidation factor for all kinds of fuel are taken from the IPCC Workbook, 1996 [3].

Table 4.23 Energy factors used for calculation of CO_2 emissions from Fuel combustion

Fuel	Calorific value, TJ/thous. t	Carbon emission factor, t C/TJ	Carbon oxidation factor
Solid Fuel			
Uzbek Sub-bituminous Coal	12.414	26.2	0.98
Uzbek Coal	19.929	25.8	0.98
Uzbek Coal Briquettes	22.860	25.8	0.98
Metallurgical Coke	26.377	29.5	0.98

Continued Table 4.23

Fuel	Calorific value, TJ/thous. t	Carbon emission factor, t C/TJ	Carbon oxidation factor
Gas Fuel			
Gas of Underground Gasification (mil. m^3)	3.647	26.2	0.98
Natural and Associated Gas(mil. m^3)	33.997	15.3	0.99
Compressed Natural Gas (mil. m^3)	33.997	15.3	0.99
Refinery Gas	43.961	18.2	0.99
Liquid Fuel			
Oil and Gas Condensate	41.868	20.0	0.99
Gasoline	43.668	19.6	0.99
Jet Kerosene	42.900	19.5	0.99
Other types of Kerosene	43.082	19.6	0.99
Diesel Fuel	42.496	20.2	0.99
Fuel Oil	40.151	21.1	0.99
Stove Domestic Fuel	42.496	20.2	0.99
Liquefied Petroleum Gas	46.013	17.2	0.99
Oil Bitumen	39.565	22.0	0.99
Oil	40.151	20.0	0.99
Oil Coke	31.000	27.5	0.99
Other Oil Products	40.151	20.0	0.99

According to data of JSC “O`zbekko`mir”, in the period 2006-2012 only local subbituminous and coal were used in the country. Import of coal was carried out in small amount of non-energy consumption.

The average calorific value of coal in the Third National Communication was not revised and accepted for all years from 2006 to 2012 as in the Second National Communication (Annex 5). It was the following:

- for subbituminous coal – 12.414 TJ/thous. t;
- for coal – 19.929 TJ/thous. t.

Factors for calculation CO_2 emissions from biomass burning (for the period 1990-2004) are as follows:

- To calculate amount of biomass. dry biomass of agricultural residues are multiplied by the fraction of residues burned on fields - 0.38 (see “Agriculture” sector).
- Energy conversion factor for biomass – 15.5 TJ/thous. t by default (LEAP Program).
- Carbon emission factor – 29.9 t C/TJ by default [3].
- Carbon oxidation factor– 0.90 by default [3], (see “Agriculture” sector).

CH_4 - methane and N_2O – nitrous oxide

CH_4 emission factors **(kg/TJ)** are default values in all sectors [4].
N_2O emission factors **(kg/TJ)** are default values in all sectors [4].

Indirect GHG emission factors

CO – carbon monoxide

CO emission factors **(kg/TJ)** are default values in all sectors, except of road transportation (gasoline, diesel fuel, gas) and mobile sources in the “Agriculture” sector (gasoline, diesel fuel).

Category “Road Transportation”:

- liquefied natural gas - **3694.6 CO kg/TJ,** national factor;
- compressed natural gas – **3580.3 CO kg/TJ**, national factor.

Category “Road Transportation” and “Mobile Sources”:

- gasoline - **13740.0 CO kg/TJ,** national factor;
- diesel fuel - **2353.2 CO kg/TJ**, national factor.

Calculation of factors is given in **Annex 6.**

NOx – nitrogen oxides

NOx emission factors **(kg/TJ)** are default values in all sectors, except of road transportation (gasoline, diesel fuel, gas) and mobile sources in the "Agriculture" sector (gasoline, diesel fuel).

Category "Road Transportation":

- liquefied natural gas - **869.3 NOx kg/TJ,** national factor;
- compressed natural gas – **842.4 NOx kg/TJ,** national factor.

Category "Road Transportation" and "Mobile Sources":

- gasoline - **916 NOx kg/TJ,** national factor;
- diesel fuel - **941.3 NOx kg/TJ,** national factor.

Calculation of factors is given in **Annex 6.**

NMVOC – non-methane volatile organic compounds

NMVOC emission factors (kg/TJ) are default values in all sectors, except of road transportation (gasoline, diesel fuel, gas) and mobile sources in the "Agriculture" sector (gasoline, diesel fuel).

Category "Road Transportation":

- liquefied natural gas - **1304 NMVOC kg/TJ,** national factor;
- compressed natural gas – **1263.6 NMVOC kg/TJ**, national factor.

Category "Road Transportation" and "Mobile Sources":

- gasoline – **2290 NMVOC kg/TJ,** national factor;
- diesel fuel - **706 NMVOC kg/TJ,** national factor.

Calculation of factors is given in **Annex 6.**

Above listed ***national factors*** were calculated based on the Instructions on compiling a report on air protection [12]**.** Calculation is given in **Annex 6**.

SO_2 – sulphur dioxide

To estimate SO_2 emissions from solid fuel combustion. the average weighted factor (calorific value) was calculated taking into account the contribution of different types of solid fuel. For 2010 this factor was **12.841** TJ/thous. tons.

Sulphur content in fuel – all values are national (Table 4.24).

S content in ash was taken equal to **0** due to lack of data.

Emission reduction effect was taken equal to **0%** due to lack of data.

Table 4.24 Content of Sulphur in Fuel

Fuel	Normative document	S, %
Coals	Actual content (in accordance with GOST 829889)	1
Heavy oil fraction (Fuel Oil) M-40, M-100	GOST 10585-75	3.5
Light fraction of oil (Diesel Fuel and Stove Domestic Fuel) Since 1999, after putting into operation of the equipment on sulphur desulfurization at Fergana Petroleum Refinery	Temporary permission until putting into operation the equipment on sulphur desulfurization at Fergana Petroleum Refinery (including until 1998) GOST 305-85, since 1.09.01 O'zb St 989	1.2 0.5
Gasoline (Road Transportation)	Actual content for Bukhara Petroleum Refinery	0.05
Jet Kerosene	GOST 10227-86	0.1
Natural Gas	GOST Uz.39.0-1-95	0.02 g/m^3
Liquefied Petroleum Gas (LPG)	GOST 22985, 20448-90	0.013

4.2.4 *Uncertainty estimation and sequence of time series*

Uncertainties of CO_2, CH_4 and N_2O emissions from fuel combustion by category 1A1 "Energy Industries", 1A2 "Manufacturing Industries and Construction", 1A3b "Road Transportation", 1A3a ii "Domestic Aviation", 1A3c "Railways", 1A3e "Pipeline transport", 1A4a "Commercial/Institutional Sector", 1A4b "Residential" and 1A4c "Agriculture" were estimated in accordance with [5].

To estimate uncertainty of emission factors. the default values was used [5,7]:

Uncertainty associated with activity data in calculation of GHG emissions was estimated as follows:

- *from energy production, railways and pipeline transport* – about 10% that is resulted from the use of expert judgements due to confidentiality of the official data on fuel consumption.
- *from road transportation, commercial/institutional, residential and agriculture sectors* – about 15% (data extrapolation in accordance with the ordinary statistical practice in the country).
- *from manufacturing industries and construction* – 15%. In calculating the emissions this sector was not divided into energy intensive industry where uncertainty of activity data is low (about 1%) and other

industries where the data extrapolation is performed (15%). For all industries the maximum values were accepted.

- *for air transport* - 40%. It was calculated based on data of the National Aircompany "Uzbekistan Airways" according to which fuel consumed by domestic aviation amounts to 3-7% of total fuel amount. This figure can vary within 40%.

Expert judgements on the uncertainties of activity data according to the above are documented and archived in accordance with the Stanford/SRI Protocol [5].

The values of emission uncertainties for CH_4 and N_2O in the category "Fuel Combustion" are in the range of ± 30-50%. Maximum uncertainty values for these GHGs are obtained for the category "Transport", which is associated with high values of emission factors uncertainties, taken by default. Uncertainties associated with CO_2 emissions from fuel combustion amounted to ±5-16%. Calculation of uncertainties is detailed in Annex 12. For all years the same method and the same data sets were used.

4.2.5 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with the general principals of QA/QC and QA/QC plan. There were conducted the checks of:

- input data for calculation;
- data for transcription errors;
- correctness of formulas in the worksheets;
- correctness of entering the coefficients by reference;
- correctness of units from beginning to end of calculation;
- consistency of time series inputs and calculations if data have changed;
- information sources for input data in Program Software were referenced;
- all information related to emission sources was documented.

Comparison (Table 4.25) of CO_2 emissions was also made (employing sectoral and reference approaches) with the respective data of the International Energy Agency (IEA) [14].

Analysis shows that preparation of national estimates of CO_2 emissions from fuel combustion is 3-15% less than the IEA data for different years. The cause of difference in estimation of total CO_2 emissions from fossil fuel combustion is most likely due to employing different national emission factors and default emission factors, as well as of difference in activity data that were used in calculations.

Table 4.25 Comparison of the Inventory results with the IEA Data on CO_2 emissions from Fuel combustion, Mt

Year	Sectoral approach			Reference approach		
	Uzbekistan	IEA	Difference, %	Uzbekistan	IEA	Difference, %
1990	107.0	119.8	-10.7	110.5	119.8	-7.8
1995	97.2	101.6	-4.3	98.5	101.6	-3.0
2000	105.0	118.0	-11.1	106.1	118.0	-10.1
2005	96.1	108.6	-11.5	96.5	108.6	-11.1
2010	95.7	100.2	-4.5	85.5	100.2	-14.7

4.2.6 Recalculations by categories

Recalculation was carried out in the categories of the Reference approach.

The first recalculation was carried out in the category "Petroleum Coke". Earlier in the SNC including the period until 2005. the category "Metallurgical Coke" was used, which was applied as a catalyst from steel production. Since 2006, in the framework of project implementation to replace metallurgical coal coke to petroleum coke, metallurgical coke has ceased to be used in steel industry [45]. Therefore, since 2006, the Inventory includes data on petroleum coke consumption. as well as its characteristics (lowest calorific value. carbon emission factor and carbon oxidation fraction) on default value according to IPCC. Since recalculation by categories was carried out for the period 2006-2012, it did not reflect on time series for the period 1990-2005.

The second recalculation is associated with the introduction of ban on burning stubble crops since 2005. Therefore, the results of calculation from biomass burning for the category "CO_2 Emissions from Biomass Burning" in 2005 were recalculated. Since 2005, "Crop Residues" component has been excluded from the calculations, only component for fuel wood was reviewed. In the result of recalculation CO_2 emissions from biomass burning in 2005, the difference was 98.8%. The value 53.71 Gg CO_2 was used instead of the value 4532.16 Gg CO_2. Since this category is not directly included in the emissions calculation for the "Energy" sector, recalculation does not affect total CO_2 emissions from fuel combustion.

No recalculations were done in other categories.

4.2.7 Planned improvements by category

To clarify and specify activity data on annual consumption of firewood and other types of biomass by population and to calculate CO_2 and other gases emissions from biomass burningfor the period 1990-2012 in accordance with the IPCC methodology given in Vol.3. Section 1.6 [3].

To increase specification of activity data in the "Fuel Combustion" sub-sector in the categories 1A1 "Energy Industries", 1A3b "Road Transportation".

4.3 Fugitive emissions from Fuels – 1B

4.3.1 Summary review

Uzbekistan has significant energy reserves of fossil fuels. 70% of which is the share of natural gas. About 60% of the territory of republic has the potential oil and gas resources. 211 hydrocarbon fields were opened in five oil-and-gas bearing regions of Uzbekistan. 108 of them are gas and gas condensate fields, 103 of them - oil and gas, oil-gas condensate and oil fields. More than 50% of deposits are under development, 35% of them are prepared for exploration, the rest are continued to be explored [46]. The share of the country's oil and gas accounts for 96% of primary energy resources. ensuring the needs of the economy of Uzbekistan.

Uzbekistan is currently ranked the 8th in the world in natural gas production, export capacity of the country is about 10 billion m^3 per year. Annually about 70 billion m^3 of natural gas is produced in the country [46].

Oil and gas industry of Uzbekistan has its own processing base. Processing of oil and gas condensate is carried out at two plants: Fergana and Bukhara refineries.

Oil and gas refining is made at three plants: Mubarek Gas Processing Plant, Shurtan Gas Processing Plant and Shurtan Gas Chemical Complex (put into operation in 2006).

Mubarek GPP is one of the world's largest gas processing plants and is designed for the annual processing of 30 billion m^3 of gas. The company produces several types of products: gas condensate, liquefied natural gas and gaseous sulphur.

Shurtan GPP annually processes 20 billion m^3 of gas. In the plant there are 4 machines of propane-butane mixture that allow to produce liquefied natural gas. propane. butane and natural gasoline.

Activities of Shurtan gas chemical complex consist of natural gas processing with the production of ethylene, co-monomer and polyethylene using Sclairtech technology.

A project for the construction of Central Asia's largest gas-chemical complex on the basis of Surgil deposit on the Ustyurt plateau is implemented, the designed capacity of which will enable to process 4 billion m^3 of natural gas with the production of 362 thous. tons of polyethylene, 83 thous. tons of polypropylene.

Natural gas is exported to Russia, Kazakhstan, Kyrgyzstan, Tajikistan and China. Uzbekistan has a developed gas infrastructure, including gas-main pipelines, networks of low and medium pressure, gas storages. The length of the gas-main pipelines is over 13 thous. km, they are served by 24 compressor stations. In general, the system operates 248 gas pumping units.

Due to limited volume of production, oil is used in Uzbekistan to provide national refineries. In recent years, production volumes were about 7 million tons. However, domestic oil is not enough for the growing needs of the economy and population, therefore it is ought to import oil, while in the country there are long-term plans to increase oil production.

Table 4.26 Methane leakage, 2010

Category	Gg CO_2-eq.	%
1B1a – Coal Mining	146	0.28
1B2a – Oil	25	0.05
1B2b – Natural Gas	67,800	99.42
1B2c – Venting and Flaring	129	0.25
Total	**68,100**	**100.00**

Oil chemical complex "Uzbekneftegaz" – a three-level vertically integrated holding company, which was established in 1988, is responsible for the management of the oil and gas sector of Uzbekistan. Industry brings together more than 190 companies.

Uzbekistan also has explored coal reserves in the amount of 1.9 billion tons, about 70% of total coal are reserves of sub-bituminous coal, or lignite. Coal mining is conducted in three deposits: Angren (sub-bituminous coal). which produces about 80% of coal. Shargun and Baysun (coal).

Table 4.27 Indirect GHG from Oil and Gas Activities, 2010

Gas	Gg
CO	0.43
NOx	0.29
NMVOC	26.45
SO_2	73.09

All produced coal is consumed domestically. The main consumer of coal fuel is the electric energy sector, which accounts for about 90% of total consumption of coal and 100% of gas of underground coal gasification. Joint-Stock Company "O`zbekko`mir" is a monopoly producer of coal in the country. Annually more than 4 mil. tons of coal is produced.

Oil and gas industry of Uzbekistan is the largest source of GHG – it accounts for about 1/3 of total emission in the country. As a result, with the increase in production, transportation and processing of natural gas, the growth of leakage is observed. Share of leakage emission related to gas is 99%. Technological losses of natural gas in Uzbekistan occur mainly due to corrosion of pipelines and use of obsolete equipment, particularly isolation valves.

Fugitive methane emission from coal mining is negligible, since the bulk of coal is under surface mining (Table 4.26).

Under this category, CH_4 and CO, NOx, NMVOC, SO_2 emissions were estimated from production, processing, transportation and storage of fossil fuel (Table 4.26, 4.27). Emissions were estimated under the categories:

- 1B1a Coal Mining;
- 1B2a Oil;
- 1B2b Natural Gas;
- 1B2c Venting and Flaring in oil and gas production.[1]

Trends of fugitive emissions

Change in fugitive methane emissions for the period 1990-2012 is given in Table 4.28.

Table 4.28 Fugitive methane emissions, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Coal Mining	469	424	368	342	274	257	254	226	260	243	225	235
Oil	24	24	24	28	35	43	43	44	46	46	43	41
Natural Gas	43133	44969	44824	71546	58418	60106	62085	54339	50735	55505	66889	69694
Venting and Flaring	2	3	6	13	20	23	19	20	22	25	17	18
Total	**43628**	**45420**	**45222**	**71929**	**58747**	**60429**	**62401**	**54629**	**51063**	**55816**	**67174**	**69988**

Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
Coal Mining	201	165	207	132	197	180	189	196	146	133	121	**-74.2%**
Oil	41	40	37	31	32	31	31	30	25	23	23	**-4.2%**
Natural Gas	70478	71928	70616	72714	84842	85155	87020	71616	67800	67822	67971	**+57.6%**
Venting and Flaring	22	24	26	28	30	38	92	118	129	134	122	**+6000.0%**
Total	**70742**	**72157**	**70886**	**72905**	**85101**	**85404**	**87332**	**71960**	**68100**	**68112**	**68237**	**56.4%**

By 2012 total fugitive emissions grew to 56.4%, and at the same time:

- Increasing methane emissions was observed in the categories:
  - Gas – 57.6% (rise by 1.6 times);
  - Venting and flaring – rise by 61 times.
- Reducing methane emissions was observed in the following categories:
  - Coal Mining - 74.2% (drop by 3.9 times);
  - Oil - 4.0%.

Reducing methane emissions in the category "Coal mining" is caused by total reduction of its production for the considered period. and in particular with the reduction in the volume of underground coal mining.

Increase in natural gas production and processing. as well as increase in volumes of transmission by pipelines has led to a significant increase in methane emissions from natural gas.

Rise of methane leakage from flaring depends on the increased production of associated gas (Figure 4.19).

Fluctuation in the volume of methane emissions in "Natural Gas" category in 1993, 2006-2008 and in 1998 was brought about by the volume of transit gas, an increase in the volume of gas production also had an impact on the situation in 2006-2008 (Figure 4.20).

[1] The category "Venting and flaring in oil and gas production" later in the text will be marked as "Venting and Flaring"

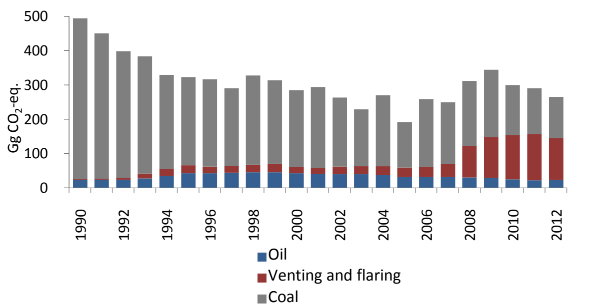


Figure 4.19 Trends of Fugitive methane emissions by categories (Coal, Oil, Venting and Flaring)

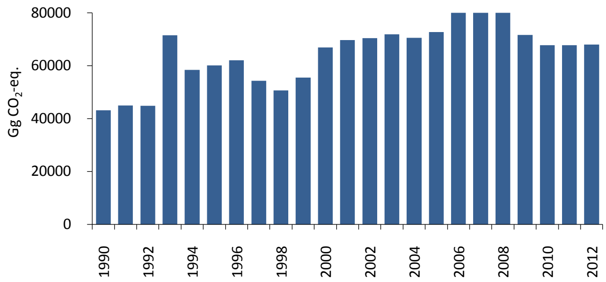


Figure 4.20 Trends of Fugitive methane emissions by "Natural Gas" category

Indirect GHG emissions from oil and gas production are given in Table 4.29.

Table 4.29 Indirect GHG emissions from Oil and Gas Activities, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	0.7	0.7	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
NOx	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
NMVOC	44.3	44.6	37.7	40.8	40.3	37.6	36	36.8	39.7	38.3	36.8	34.3
SO_2	145.5	137.1	115.2	101.4	92.7	81.4	67.1	71.4	72.2	71	67.6	65.1
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	$\Delta_{(2012-1990)}$
CO	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	**-42.9%**
NOx	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3	**-40.0%**
NMVOC	33.3	31.8	31.3	28.6	28.9	32.8	32.9	31.2	26.4	24.2	25.1	**-43.3%**
SO_2	56.7	49.4	45.4	41.1	43.3	49.0	60.9	65.1	73.1	85.9	90.4	**-37.9%**

Table 4.29 shows that for the period 1990-2012 decrease was observed in emissions from oil and gas activities:

- CO - 42.9%;
- NOx - 40.0%;
- NMVOC - 43.3%;
- SO_2 - 37.9%.

CO and NOx emissions are not given in Figure 4.21 due to their insignificance.

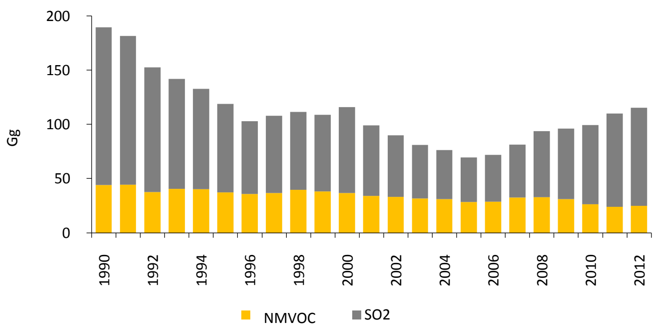


Figure 4.21 Trends of indirect GHG emissions from Oil and Gas Activities

4.3.2 Coal mining – 1B1A

4.3.2.1 Description of source category

The amount of methane adsorbed in coal bed depends on method of mining, variety (coalification degree), porosity, moisture content of coal, as well as the reservoir pressure and temperature. Methane emission factor in underground mining is higher than in the surface mining of coal beds.

Sub-bituminous coal is mined in Uzbekistan by surface way on Angren deposit, coal – by underground way on Shargun and Baysun deposits.

Fugitive emissions of methane were estimated in the following categories of coal mining:

- 1B1ai - Underground Mining activities and Post-Mining activities;
- 1B1aii – Surface Mining activities and Post-Mining activities.

Methane emission from coal mining in 2010 is given in Table 4.30.

Methane emission from coal mining for the period 1990-2012 is given in Table 4.31 and Figure 4.22.

For the period 1990-2012, total decrease in methane emissions from coal mining to 74%, or by 3.9 times was observed, including:

- Underground mining - 95.9%;
- Surface mining - 38.2%.

Table 4.30 Methane emissions from Coal mining, 2010

Category		Gg CO_2-eq.	Total % from all mining activities
Underground Mining	Mining activities	39.5	27.0
	Postmining activities	6.3	4.3
	Total	45.8	31.3
Surface Mining	Mining activities	91.4	62.5
	Post-mining activities	9.0	6.2
	Total	100.4	68.7
Total		**146.2**	**100.0**

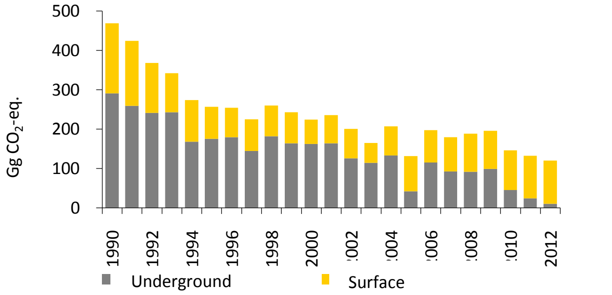


Figure 4.22 Trends of methane emissions from Coal mining

Table 4.31 Methane emissions from Coal mining, Gg CO_2-eq.

Category		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Underground Mining	Mining activities	251	224	208	209	145	151	155	125	157	141	140	141
	Post-mining activities	40	36	33	33	23	24	25	20	25	23	22	23
	Total	291	260	241	242	168	175	180	145	182	164	162	164
Surface Mining	Mining activities	162	150	115	90	97	74	67	73	71	72	56	65
	Post-mining activities	16	15	12	9	10	7	7	7	7	7	6	7
	Total	178	165	127	99	107	81	74	80	78	79	62	72
Total		**469**	**425**	**368**	**341**	**275**	**256**	**254**	**225**	**260**	**243**	**224**	**236**
Category		**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Underground Mining	Mining activities	108	99	115	37	100	80	79	85	40	21	10	**-96.0%**
	Post-mining activities	17	16	18	6	16	13	13	14	6	3	2	**-95.0%**
	Total	126	115	133	43	116	93	92	99	46	24	12	**-95.9%**
Surface Mining	Mining activities	68	46	67	81	74	79	88	88	91	99	100	**-38.3%**
	Post-mining activities	7	5	7	8	7	8	9	9	9	10	10	**-37.5%**
	Total	75	51	74	89	81	87	97	97	100	109	110	**-38.2%**
Total		**201**	**166**	**207**	**132**	**197**	**180**	**189**	**196**	**146**	**133**	**122**	**-74.0%**

4.3.2.2 Methodology

Estimation of CH_4 emissions from coal mining was implemented in accordance with [3] – Tier 1. The resulting volume of methane emissions was defined as the product of volume of coal mining (processing) and corresponding emission factors.

Activity data

Data on volumes of both surface and underground coal mining for the period 2006-2012 were provided by the JSC "O`zbekko`mir". Activity data are confidential, therefore they are not included in the report.

Emission factors

The maximum default emission factors was used (Table 4.32) for calculation [3].

To convert the volume of CH_4 in the weight category, conversion factor of 0.67 Gg CH_4 / mil. m^3 by default was accepted from the Workbook of the Revised Guidelines for National Greenhouse Gas Inventories, IPCC, 1996 Table 1-5, p.1.26, step 2, paragraph 1.

Table 4.32 Methane emission factors from Coal mining, m^3/t

Activity	Way of mining	
	Underground mining	Surface mining
Mining activities	25.0	2.0
Post-mining activities	4.0	0.2

4.3.2.3 Uncertaities and sequence of time series

Uncertainty of CH_4 emissions from coal mining in the categories 1B1a i "Underground coal mining" and 1B1a ii "Surface coal mining" was estimated in accordance with [5]. Uncertainty of activity data from coal mining and uncertainty of emission factors were taken by default. Uncertainty of CH_4 emissions from underground coal mining was ± 35%. Uncertainty of CH_4 emissions from surface coal mining open was ± 300% (Annex 12).

For all years the same method and the same data sets were used.

4.3.2.4 Quality Assurance / Quality Control

The QA/QC procedures were implemented in accordance with the QA/QC total principles and QA/QC plan.
The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for the input data for the program software were referenced.

4.3.2.5 Recalculation by categories

Recalculations in this category were not conducted.

4.3.2.6 Planned improvements by categories

Within the framework of the future Fourth National Communication. it is supposed to estimate activity data and emission factors.

4.3.3 Oil - 1B2A

4.3.3.1 Description of source category

In the category along with leakage of methane and other gases associated with mining, refining, processing (catalytic cracking), transportation and storage of oil, fugitive emissions through the air vents of the oil storage tanks were included. Emissions in the synthesis of petrochemical products in this category are not included because they have to be taken into account in the "Industrial Processes" sector.

Under the category 1B2 Oil and Natural Gas, the estimation was carried out for the following sub-categories:

- 1B2aii Oil Production;
- 1B2aiv Oil Processing and Storage.

In the category. the following was estimated:

- Fugitive Methane Emissions from Oil;
- NOx, CO, NMVOC and SO_2 Emissions from Oil Processing and Storage;
- SO_2 Emissions from Sulphur Production in Oil Refining.

Tables 4.33 and 4.34 present methane emissions by categories and indirect GHG emissions from oil activities in 2010.

Table 4.33 CH_4 emissions from Oil, 2010

Category	Gg CO_2-eq.	%
Production	17.9	72
Processing	5.9	23.7
Storage	1	4.2
Total	**24.8**	**100.0**

Table 4.34 Indirect GHG emissions from Oil, 2010

Gas	CO	NOx	NMVOC*	SO_2**
Gg	0.4	0.3	26.4	4.9

Note:
* - total emission from oil processing and storage
** - total emission from oil processing and sulphur production in the process of oil refining from sulphuric compounds

CH_4 emission from oil for the period 1990-2012 are given in Table 4.35 and Figure 4.23.

Table 4.35 CH_4 emissions from Oil, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Production	12	12	14	18	24	33	34	35	36	36	33	32
Processing	10	10	8	9	9	8	8	8	9	9	8	8
Storage	2	2	1	2	2	1	1	1	2	1	2	1
Total	**24**	**24**	**23**	**29**	**35**	**42**	**43**	**44**	**47**	**46**	**43**	**41**
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Production	32	32	29	24	24	23	22	21	18	16	17	**+41.7%**
Processing	7	7	7	6	7	7	7	7	6	5	6	**-40.0%**
Storage	1	1	1	1	1	1	1	1	1	1	1	**-50.0%**
Total	**40**	**40**	**37**	**31**	**32**	**31**	**30**	**29**	**25**	**22**	**24**	**0.0%**

As a whole, for the period 1990-2012 changes were not observed in the "Oil" category, but decrease in methane emissions was recorded:

- Oil processing – 56.2%;
- Oil storage – 50.0%.

And increase in methane emissions:

- Oil production – 41.7%.

Indirect GHG emissions from oil for the period 1990-2012 are given in Table 4.36 and Figure 4.24.

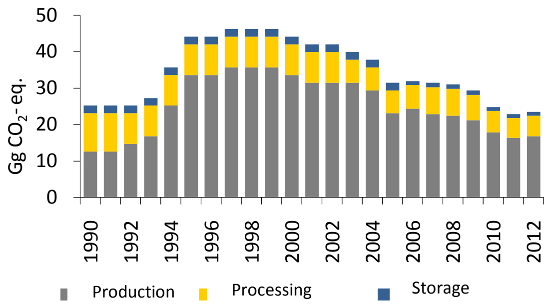


Figure 4.23 Trends of methane emissions from Oil

Table 4.36 Indirect GHG emissions from Oil, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	0.7	0.7	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
NOx	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
NMVOC*	44.3	44.6	37.7	40.8	40.3	37.6	36.0	36.8	39.7	38.3	36.8	34.3
SO_2**	7.5	7.5	6.3	6.9	6.8	6.3	6.1	6.2	6.7	6.5	6.7	6.1
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	**-42.9%**
NOx	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3	**-40.0%**
NMVOC*	33.3	31.8	31.3	28.6	28.9	32.8	32.9	31.2	26.4	24.2	25.1	**-43.3%**
SO_2**	5.7	5.4	5.4	5.2	5.3	5.9	5.9	5.7	4.9	4.4	4.6	**-38.7%**

* total emission from oil processing and storage
** total emission from oil processing and sulphur production in the process of oil desulphurization

As shown in Table 4.36, for the period 1990-2012 there was a reduction of indirect GHG emissions of greenhouse gases:

- CO – 42.9%;
- NOx – 40.0%;
- NMVOC – 43.3%;
- SO_2 – 38.7%.

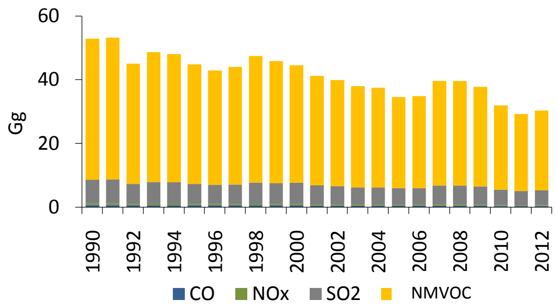


Figure 4.24 Trends of indirect GHG emissions from Oil

4.3.3.2 Methodology

CH_4 emissions from oil were estimated following the Revised Guidelines for National Greenhouse Gas Inventories, IPCC, 1996 [3] – Tier 1. Estimation of the indirect GHG (NOx, CO, NMVOC and SO_2) was also carried out in accordance with [3].

The resulting volume of methane emissions and indirect GHG was calculated as the product of the corresponding emission factors (Table 4.37) on the amount of oil involved in the process.

Activity data

The volumes of oil production and processing for 2006-2012 were provided by the NHC "Uzbekneftegaz". Activity data are confidential.

Emission factors

To calculate methane emissions, maximum default emission factors were used ("Former USSR. Central and Eastern Europe"). To estimate the indirect GHG emissions the default emission factors were also used (Table 4.37) [3].

When converting thous. tons of oil in energy units (PJ), the factor equal to 0.041868 PJ / thous. tons was used.

Table 4.37 Methane and indirect GHG emission factors from Oil

Emission	Category	Factor
CH_4	Oil production	5000 kg CH_4 / PJ
	Oil processing	1400 kg CH_4 / PJ
	Oil storage	250 kg CH_4 / PJ
CO	Oil processing	0.09 kg CO/t oil
NOx		0.06 kg NOx/t oil
NMVOC		0.62 kg NMVOC/t oil
NMVOC	Oil storage	4.9 kg NMVOC/t oil
SO_2	Oil processing	0.93 kg SO_2/t oil
	Sulphur production	139 kg SO_2/t S

4.3.3.3 Uncertainties and sequence of time series

Uncertainty of CH_4 emissions from oil and other gases was not estimated.
For all years the same method and the same data sets were used.

4.3.3.4 Quality Assurance / Quality Control by category

QA/QC procedures were implemented in accordance with QA/QC principals and QA/QC plan. The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for input data for the Program software were referenced.

4.3.3.5 Recalculations by categories

Recalculation of fugitive emissions from oil was not conducted.

4.3.3.6 Planned improvements by categories

Within the framework of the future Fourth National Communication, it is supposed to update the values of emission factors.

4.3.4 Natural Gas - 1B2B

4.3.4.1 Description of source category

Emissions were estimated in the following categories:

1B2bi - Gas Production/Processing;

Gas processing is considered as a separate source. as in this category the methane leakages were estimated from refinement of high-sulfur gas, which in the average amounts to 70% of total amount of gas produced. The respective changes were inserted in the worksheet of the IPCC Program Software.

1B2bii - Transmission/ Distribution;

1B2biii - Other Leakage;

1B2cii - Venting and Flaring - Gas.

In the category there were estimated:

- fugitive methane emissions from gas activities;
- SO_2 emissions from sulphur production in gas treatment from sulphurous compounds (Table 4.40). The data on this source were inserted in the standard worksheet of the IPCC Program Software.

As shown in Table 4.38 and Figure 4.25, the main emissions account for gas transportation and processing - 83.6%, emissions from production are insignificant and amount to 3.3%.

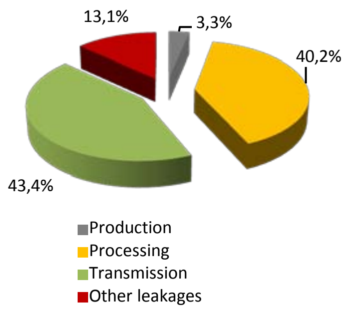


Figure 4.25 Emissions in Natural Gas category

Table 4.38 CH_4 emissions from Natural Gas, 2010

Category		Gg CO_2-eq.	%
Production/preparation		2234.4	3.3
Processing	Mubarek GPP	18398.1	27.1
	GPE "Shurtanneftegaz"	1362.3	2.0
	GCC "Shurtan"	7476.0	11.0
	Total	27236.4	40.2
Transmission		29423.3	43.4
Other leakages	Non-residential sector	6643.8	11.5
	Residential sector	2269.5	3.3
	Total	8913.3	13.1
Total leakages from Gas operation		**67807.3**	**100.0**
Venting and flaring		128.9	

CH4 emissions from natural gas in the specified categories for the period 1990-2012 are given in Table 4.39 and Figure 4.26.

Table 4.39 CH_4 emissions from Gas, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Production	1512.0	1551.9	1581.3	1650.6	1717.8	1766.1	1787.1	1869.0	1997.1	2022.3	2064.3	2102.1
Processing	14461.9	15016.5	14642.7	14984.3	15174.4	17440.3	17521.1	17347.9	17501.6	17578.7	18273.8	19214.8
Transmission	19422.3	19943.7	19956.3	45515.4	32669.7	32119.5	33944.4	26613.3	22759.8	27140.4	37407.3	38860.5
Other leakages	7737.7	8458.8	8645.7	9395.4	8857.8	8778.0	8832.6	8509.2	8477.7	8765.4	9143.4	9515.1
Total	**43134.6**	**44970.9**	**44826.0**	**71545.7**	**58419.7**	**60103.9**	**62085.2**	**54339.4**	**50736.2**	**55506.8**	**66888.8**	**69692.5**
Venting and flaring	1.9	2.5	5.7	13.2	20.2	22.9	19.1	20.4	22.3	25.0	17.4	17.9
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Production	2179.8	2116.8	2200.8	2194.5	2280.6	2383.2	2379.7	2282.7	2234.4	2107.8	2284.6	**+51.1%**
Processing	19132.5	19155.6	19372.1	19425.2	27416.6	27559.8	27901.4	27776.5	27236.4	26746.7	27232.8	**+88.3%**
Transmission	39408.6	41279.7	39677.4	42140.7	45660.3	46066.9	46322.4	32071.8	29423.3	29295.6	29040.1	**+49.5%**
Other leakages	9756.6	9374.4	9363.9	8954.4	9484.9	9152.6	10416.6	9484.7	8913.2	9671.8	9413.3	**+21.6%**
Total	**70477.5**	**71926.5**	**70614.2**	**72714.8**	**84842.3**	**85162.6**	**87020.2**	**71615.7**	**67807.3**	**67821.8**	**67970.7**	**+57.6%**
Venting and flaring	22.3	23.5	25.6	28.1	29.8	38.0	92.2	118.4	128.9	134.4	122.0	**+6321.1%**

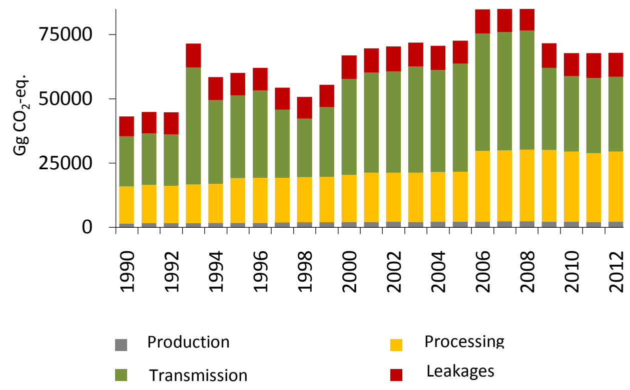


Figure 4.26 Trends of CH_4 emissions from Gas

Data given in Table 4.39 show that for the period 1990-2012 the volume of methane emissions from gas increased to 57.6%, it was caused by the growth of fugitive emissions from:

- Production - 51.1%;
- Processing - 88.3%;
- Transmission - 49.5%;
- Other leakages - 21.6%;
- Venting and flaring - growth by 64 times.

Trends of methane emissions from gas for the period 1990-2012 are given in Figure 4.26, the category "Venting and Flaring" is not shown in the graph due to the marginal values.

Sharp rise in emissions from transmission in 1993, 2006-2008 occurred due to a greater volume of transit gas.

SO_2 emissions from sulphur production in treatment of high-sulfur gas from sulphurous compounds are given in Table 4.40 and Figure 4.27. In 2010 they amounted to 68.2 Gg.

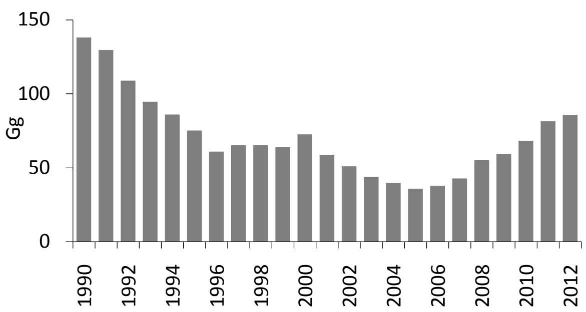


Figure 4.27 Trends of SO_2 emissions from Gaseous Sulfur production

Table 4.40 SO_2 emissions from Gaseous Sulfur (in treatment of high-sulfur gas from sulphurous compounds)

Year	Gg	Year	Gg	Year	Gg	Year	Gg
1990	138.1	**1996**	61.0	**2002**	50.9	**2008**	55.0
1991	129.6	**1997**	65.17	**2003**	43.9	**2009**	59.4
1992	108.8	**1998**	65.2	**2004**	39.8	**2010**	68.2
1993	94.5	**1999**	64.0	**2005**	35.8	**2011**	81.4
1994	85.9	**2000**	72.5	**2006**	37.7	**2012**	85.8
1995	75.1	**2001**	58.9	**2007**	42.8		

4.3.4.2 Methodology

Estimation of CH_4 emissions from gas in the categories 1B2bi "Gas production/processing" and 1B2bii "Transmission" was made in accordance with the Guidelines for National Greenhouse Gas Inventories, IPCC, 2006 [7] – Tier 2 using equations. Estimation of methane emissions from gas in the categories 1B2biii "Other leakages" and 1B2cii "Venting and flaring in oil and gas production" was made in accordance with the Revised Guidelines for National Greenhouse Gas Inventories, IPCC, 1996 [3] – Tier 1.

Estimation of SO_2 emissions in treatment of high-sulphur gas from sulphurous compounds in [3] is not provided. Calculation proposed for estimation of SO_2 is similar to calculation of emissions in oil refining. In connection with the extension of series, national factor of SO_2 emissions from gaseous sulphur production was specified (Annex 8) and the whole time series were recalculated.

Activity data

Data on volumes of gas production, processing, transportation and consumption in the Residential and Non-residential sectors for the period 2006-2012 were provided by the National Holding Company "Uzbekneftegaz".

Almost all amount of associated gas is flared.

Emission factors

To estimate methane emissions from natural gas production, processing (gas desulphurization) and transportation, national methane emission factors were developed and specified. Calculation of factors is given in Annex 7.

To estimate methane emissions from natural gas consumption in Non-residential and Residential sectors, from venting and flaring in oil and gas production, the maximum default emission factors were used ("Former Soviet Union, Central and Eastern Europe") [3].

Emission factors used in calculation of emissions are given in Table 4.41.

Table 4.41 CH_4 and SO_2 Emission factors from Gas, Venting and Flaring

Gas	Activity		Factor
CH_4	Production		52168 kg/PJ
	Processing	Mubarek GPP	919558 kg/PJ
		GPE "Shurtanneftegaz"	153483 kg/PJ
		"Shurtan" GCC	2455949 kg/PJ
	Transmission		664116 kg/PJ
	Other leakages	Non-residential sector	384000 kg/PJ
		Residential sector	192000 kg/PJ
	Venting and flaring		30000 kg/PJ
SO_2	Sulphur production in gas treatment from sulphurous compounds		0.234 t SO_2/t of sulfur

4.3.4.3 Uncertainties and sequence of time series

Uncertainty of CH_4 emissions from gas was estimated in accordance with [5] by categories 1B2b "Production/preparation", "Processing", and1B2bii "Transmission" using national activity data and national emission factors. Uncertainty of activity data was taken at the level of 1% according to expert estimates of NHC "Uzbekneftegaz", uncertainty of emission factors was calculated according to national data.

Uncertainty of CH_4 emissions from gas in the category 1B2b ii "Other leakages" was estimated using national activity data and default emission factors.

Uncertainty of methane emissions from gas in the categories "Production/preparation", "Processing" and "Transmission" in 2012 was in the range 14% - 32%, uncertainty in subcategories "Residential" and "Non-residential" sector, included in the category "Other leakages" amounted to ± 50%.

Uncertainty of CH_4 emissions from gas by category "Venting and flaring" was not estimated. It is planned to estimate uncertainty in this category in preparation of future GHG Inventory.

The detailed uncertainty estimation is given in Annex 12. For all years the same method and the same data sets were used.

4.3.4.4 Quality Assurance/ Quality Control by category

QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for the input data for the program software were referenced.

4.3.4.5 Recalculations by category

Estimation of fugitive emissions from Gas, for which national factors were developed in the framework of preparation of the Third National Communication, is recalculated in the current Inventory.

Time series for the category “Natural gas production/preparation” was recalculated using new revised national emission factor 52168 kg/PJ instead of the factor 56798 k /PJ calculated in the Second National Communication. The results of recalculation in Gg CO_2-eq. are given in Table 4.42

Table 4.42 CH_4 emissions recalculation by category “Natural Gas Production/Preparation” for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	1645.35	1689.45	1720.53	1796.55	1870.47	1923.81	1945.44	2034.48
TNC	1511.16	1551.69	1580.25	1649.97	1718.01	1766.94	1786.89	1868.58
Difference, %	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	2174.13	2201.22	2248.47	2288.58	2372.37	2305.59	2397.15	2388.54
TNC	1997.10	2021.67	2065.14	2102.10	2178.96	2117.64	2201.64	2193.66
Difference, %	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**

The results of CH_4 emissions calculated in the Third National Communication for this category is 8.2% lower than those obtained in the Second National Communication.

Time series for the category “Natural Gas Processing” were recalculated for two plants using new revised national emission factors (Tables 4.43, 4.44):

- For Mubarek GPP - **919558 kg/PJ** instead of the factor 1001098 kg/PJ calculated in the Second National Communication;
- For GPE “Shurtanneftegaz” - **153483 kg/PJ** instead of the factor 71733 kg / PJ calculated in the Second National Communication.

Table4.43 Recalculation of methane emissions by category “Gas Processing” at Mubarek GPP for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	15744.12	16348.08	15941.10	16313.22	16519.86	17480.19	17488.17	17292.66
TNC	14461.86	15016.47	14642.67	14984.34	15174.39	16056.39	16063.74	15884.19
Difference, %	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	17475.99	17594.43	18412.80	19462.38	19480.02	19810.98	19820.85	19851.51
TNC	16052.61	16161.18	16912.98	17877.09	17893.47	18023.67	18206.58	18234.72
Difference, %	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**	**8.1**

CH_4 emission results calculated in the Third National Communication for this category is 8.1% lower than those obtained in the Second National Communication.

Table4.44 Recalculation of CH_4 emissions by category “Gas Processing” at GPE Shurtanneftegaz for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	0	0	0	0	0	647.22	681.45	683.55
TNC	0	0	0	0	0	1384.74	1458.24	1462.65
Difference, %	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	677.46	662.13	635.67	625.38	579.39	529.41	544.74	556.50
TNC	1449.63	1416.66	1359.96	1337.91	1239.84	1132.53	1165.71	1190.49
Difference, %	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**	**113.9**

CH_4 emission results calculated in the Third National Communication in the category “Gas processing” at GPE “Shurtanneftegaz” are 113.9% higher than those obtained in the Second National Communication. The enterprise put into operation in 1995. Factor developed in the SNC is not suitable for calculations. as it was sampled for a small range of data (4-year).

The whole time series for the category "Gas transmission" using new revised national emission factor 664116 kg/PJ were recalculated, instead of the factor 701615 kg/PJ calculated in the SNC. Recalculation results in Gg CO_2-eq. are given in Table 4.45.

Table 4.45 Recalculation of CH_4 emissions by category "Natural Gas Transmission" for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	20519.10	21068.67	21082.74	48084.54	34514.34	33933.27	35860.02	28116.06
TNC	19422.27	19942.65	19955.88	45514.56	32669.70	32119.71	33943.35	26613.30
Difference, %	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	24043.74	28672.14	39520.11	41055.00	41633.76	43609.86	41917.89	44520.84
TNC	22758.75	27139.77	37407.93	38860.92	39408.60	41279.07	39677.61	42141.33
Difference, %	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**

CH_4 emission results calculated in the Third National Communication for the category are 5.3% lower than those obtained in the Second National Communication.

As a result of recalculations by the category "Gas" estimates of the total emissions obtained in the Third National Communication were changed compared with the estimates obtained in the Second National Communication (Table 4.46).

Table 4.46 CH_4 emissions recalculation in "Gas" sector for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	45646.44	47563.95	47389.44	75590.97	61761.00	62762.70	64808.10	56637.42
TNC	43133.37	44968.56	44823.87	71545.95	58418.22	60105.99	62085.24	54339.39
Difference, %	**5.5**	**5.5**	**5.4**	**5.3**	**5.4**	**4.2**	**4.2**	**4.1**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	52848.81	57895.74	69959.82	72947.49	73822.56	75441.87	74045.58	76270.95
TNC	50735.37	55505.52	66888.78	69694.17	70477.68	71928.15	70616.28	72713.97
Difference, %	**4.0**	**4.1**	**4.4**	**4.5**	**4.5**	**4.7**	**4.6**	**4.7**

CH_4 emissions results calculated in the Third National Communications in the category "Gas" are on average 4.7% lower than those obtained in the Second National Communications.

The whole time series were also recalculated by the category "Sulphur production from natural gas treatment from sulphurous compounds" using new revised national emission factor 0.234 t SO_2 / t of sulphur produced. instead of the factor 0.279 t SO_2 /t S calculated in the Second National Communication.

Activity data for 1998-2005 were specified. The results of recalculation in Gg SO_2 are given in Table 4.47.

SO_2 emissions results calculated in the Third National Communication by this category are 16.1% less than the ones obtained in the Second National Communication.

Table 4.47 Recalculation of SO_2 emissions by category "Sulphur dioxide emissions from natural gas treatment from Sulphurous compounds" for the period 1990-2005, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	164.6	154.6	129.7	112.7	102.4	89.6	72.8	77.7
TNC	138.1	129.6	108.8	94.5	85.9	75.1	61.0	65.2
Difference, %	**16.1**	**16.2**	**16.1**	**16.1**	**16.1**	**16.2**	**16.2**	**16.1**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	78.1	76.3	72.5	70.2	60.7	52.3	47.4	42.7
TNC	65.2	64.0	60.8	58.9	50.9	43.9	39.8	35.8
Difference, %	**16.5**	**16.1**	**16.1**	**16.1**	**16.1**	**16.1**	**16.1**	**16.1**

4.3.4.6 Planned improvements by category

In the framework of the future Fourth National Communication. it is supposed to estimate national factors for the category 1B2c "Venting and flaring" and 1B2b ii "Natural gas consumption in Residential and Commercial/Institutional sectors" in the "Methane leakages" sub-sector.

5. INDUSTRIAL PROCESSES – 2

5.1 Sector review

Greenhouse gas emissions that are not associated with fuel combustion in the industrial production and non-energy use of fuel resources (e.g. natural gas) are calculated in the "Industrial processes" sector. In industry, in the course of chemical and physical transformation of materials, the following greenhouse gases are emitted – CO_2, CH_4, N_2O, as well as indirect greenhouse gases such as CO, SO_2, NOx, NH_3, non-methane hydrocarbons.

The sector is divided into 5 main categories:

1. 2A Mineral products;
2. 2B Chemical industry;
3. 2C Metal production;
4. 2D Other production;
5. 2F Consumption of HFCs.

The section presents the major industrial sources of GHG emissions available in Uzbekistan for which there is statistics.

The largest sources of emissions in the sector are production of:

- Cement;
- Nitric acid;
- Ammonia;
- Steel.

In addition, the section includes an assessment of HFCs potential emissions. In Uzbekistan, there is no production of HFCs, PFCs and SF_6. Statistical data for the consumption of PFCs and SF_6 are absent. that did not allow to estimate emissions from the consumption of these GHGs.

Gases and categories in "Industrial processes" sector given in Tables 5.1 and 5.2 were covered by the Inventory.

As seen in Table 5.1, in the "Industrial Processes" sector the share of CO_2 emissions accounts for 77%, share of N_2O – 22.7%, the contribution of HFCs and methane is insignificant. The main categories of CO_2 emis**sion** sources are cement (48.3% of CO_2 emissions in the sector), ammonia (29.1%) and steel (19.3%) production. Ammonia production is the only category of N_2O emission sources in the sector.

In the sector, the emission of gases with indirect greenhouse effect was also calculated. The source of CO emissions in the sector is ammonia and steel production. The sources of NOx emissions is nitric acid and steel production, of SO_2 emissions – cement and sulphuric acid production, NMVOC – beverages, food, ammonia, polyethylene, acrylonitrile and formaldehyde production.

Table 5.1 Share of direct GHG in "Industrial processes" sector, 2010

Gas	Gg CO_2-eq.	%
CO_2	6059	77.0
N_2O	1789	22.7
HFCs	22	0.3
CH_4	3	0.04

Table 5.2 Direct GHG emissions in "Industrial processes" sector, 2010

Category	Gg CO_2-eq.	%
2 A Mineral products	3126.7	39.7
2 B Chemical industry	3553.5	45.1
2 C Metal production	1170.2	14.9
4 D Other production	0.0	0.0
2 F Consumption of Halocarbons	22.3	0.3
Total	**7872.6**	**100.0**

Trends of emissions by gases

Direct GHG emissions in the "Industrial processes" sector for the period 1990-2012 are given in Table 5.3 and Figure 5.1.

Data analysis revealed that comparatively to 1990, contribution of the "Industrial Processes" sector in total emissions decreased from 4.4% to 4.0%. The chemical industry and production of mineral products make the largest contribution to greenhouse gas emissions in the sector.

Table 5.3 Direct GHG emissions in the "Industrial processes" sector, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	6277.3	6298.7	6058.5	5492.0	4476.9	3797.1	3943.3	3827.9	3729.0	3477.9	3589.8	3616.5
CH_4	-	-	-	-	-	-	-	-	-	0.0	0.1	0.2
N_2O	1667.8	2170.0	2092.5	1807.3	1379.5	1457.0	1559.3	1379.5	1441.5	1264.8	1286.5	1329.9
HFCs	-	-	-	-	-	-	-	-	-	-	6.3	6.3
Total	**7945.1**	**8468.7**	**8151.0**	**7299.3**	**5856.4**	**5254.1**	**5502.6**	**5207.4**	**5170.5**	**4742.7**	**4882.7**	**4952.9**
GHG	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO_2	3760.3	3992.0	4587.8	4773.8	4962.9	5378.1	5712.4	5855.4	6058.7	5940.4	5948.3	**-5.2%**
CH_4	0.2	1.5	2.3	2.7	2.9	3.2	2.9	2.9	2.9	3.2	3.2	-
N_2O	1271.0	1326.8	1413.6	1478.7	1550.0	1732.9	1794.9	1760.8	1788.7	1782.5	1782.5	**+6.9%**
HFCs	1.7	9.1	38.2	12.1	35.9	10.5	32.3	19.2	22.3	74.4	94.5	-
Total	**5033.2**	**5329.4**	**6041.9**	**6267.3**	**6551.7**	**7124.7**	**7542.6**	**7638.3**	**7872.6**	**7800.5**	**7828.4**	**-1.5%**

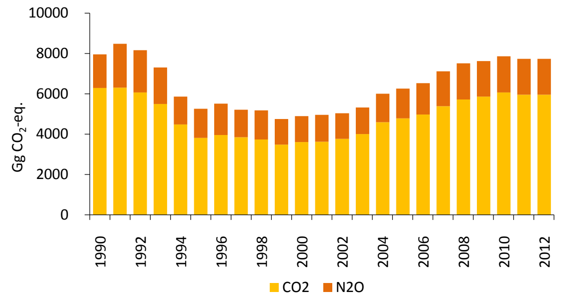
For the period 1990-2012, a decrease in total direct GHG emissions to 1.5% was observed, in particular:

- Reduction of CO_2 emissions - 5.2%;
- Growth of N_2O emissions - 6.9%.

It should be noted that it was impossible to calculate change in emissions for the period 1990-2012 for the following GHG:

- CH_4 – as methanol production has begun since 1999, polyethylene – since 2003;
- HFCs – as data are available only for 2000-2005.

Indirect GHG emissions in the "Industrial processes" sector for the period 1990-2012 are given in Table 5.4 and Figure 5.2.



Note: Trends of CH_4 and HFCs are not given in the diagram due to their marginal amount.

Figure 5.1 Trends of direct GHG emissions in the "Industrial processes" sector

Table 5.4 Indirect GHG emissions in "Industrial processes" sector, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	1.4	1.4	1.3	1.1	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.6
NOx	0.8	1.0	1.0	0.8	0.6	0.7	0.7	0.6	0.7	0.6	0.6	0.6
NMVOC	28.6	27.9	25	24.4	19.6	17.7	17.8	19.2	19.4	23.2	23.4	21.9
SO_2	5.2	5.1	3.8	3.4	3.0	2.4	2.3	2.2	2.2	2.2	2.1	2.0
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.0	1.1	**-21.4%**
NOx	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	**0.0%**
NMVOC	23.3	23.9	24.2	23.3	23.7	28.5	32.9	33.6	35.8	38.4	40.2	**+40.6%**
SO_2	2.3	2.3	2.6	2.5	2.8	3.2	3.3	3.5	3.7	3.6	3.8	**-26.9%**

The bulk of direct GHG emissions accounted for NMVOC. For the period 1990-2012, the following changes in indirect GHG emissions occured:
Reduction:

- CO – 21.4%;
- SO_2 – 26.9%.

Growth:

- NMVOC – 40.6%.

No changes in NOx emissions.

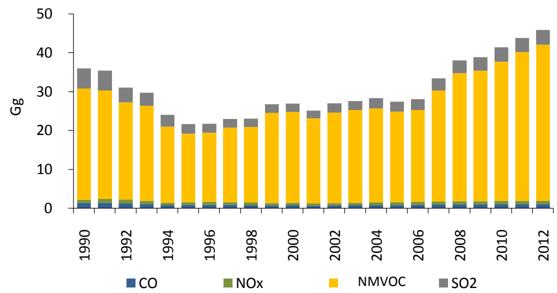


Figure 5.2 Trends of indirect GHG emissions in the "Industrial processes" sector

5.1.1 *Trends of emissions by sub-sectors*

Trends of direct GHG emissions by categories for the period 1990-2012 are given in Table 5.5.

Table 5.5 Direct GHG emissions in "Industrial processes" sector, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Mineral products	3007.3	2967.8	2868.1	2752.3	2411.0	1765.3	1683.6	1718.4	1757.2	1644.5	1633.1	1837.1
Chemical industry	4053.6	4445.0	4181.2	3569.4	2671.0	2901.6	3073.5	2882.6	2842.0	2529.0	2578.7	2395.2
Metal production	998.4	1056.0	1100.8	977.6	774.0	587.2	745.6	606.4	571.4	569.3	664.6	714.1
Consumption of HFCs	-	-	-	-	-	-	-	-	-	-	6.3	6.3
Total	**8059.2**	**8468.7**	**8150.1**	**7299.3**	**5856.0**	**5254.1**	**5502.7**	**5207.4**	**5170.6**	**4742.8**	**4882.8**	**4952.7**
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	$\Delta_{(2012-1990)}$
Mineral products	1834.3	1913.2	2276.8	2405.8	2458.5	2723.2	2936.9	3025.7	3126.7	3049.1	2965.1	**-1.4%**
Chemical industry	2457.6	2630.1	2763.5	2877.7	3048.9	3340.7	3476.1	3422.7	3553.5	3482.3	3568.8	**-9.4%**
Metal production	739.6	777.0	963.5	971.7	1008.5	1050.2	1097.1	1170.7	1170.2	1193.6	1199.9	**+20.2%**
Consumption of HFCs	1.7	9.1	38.2	12.1	35.9	10.5	32.3	19.2	22.3	74.4	94.5	-
Total	**5033.2**	**5329.3**	**6041.9**	**6267.3**	**6551.8**	**7124.6**	**7542.6**	**7638.3**	**7872.6**	**7799.4**	**7828.3**	**-1.5%**

For the period 1990-2012 total emission by sector decreased to 1.5%, in particular, it was observed:

Reduction in GHG emissions by the categories:

- Mineral products – 1.4%;
- Chemical industry – 9.4%.

And growth in GHG emissions by the categories:

- Metal production – 20.2%.

In the category "Consumption of HFCs" – no possibility to calculate changes in emissions as the data are available only for 2000-2005.

Key sources in estimation of emission level or trend in the "Industrial processes" sector are given below in order of emission volumes diminution:

- N_2O emissions from Weak nitric acid production – level, trend.
- CO_2 emissions from Ammonia production – level, trend.
- CO_2 emissions from Iron and steel production – level, trend.

5.2 Mineral products – 2A

5.2.1 *Description of source category*

Under the category, CO_2 emissions were estimated from:

- cement clinker and lime production;
- use of Soda ash (soda is produced in Kungrad soda plant by Solvey process, in which there is no CO_2 emissions).

SO_2 emissions from:

- cement production.

The main source of GHG emissions in the category "Mineral products" is cement clinker production, which is produced by six plants: JSC "Kyzylkumcement", JSC "Akhangarancement", JSC "Kuvasaycement", JSC "Bekabadcement", JSC "Okhangaron rangli cement", JSC "Angren KSM". Between 1990 and 2012, CO_2 emission from clinker production increased to 8% due to increased production volumes and amounted to 2,791 Gg in 2012. Clinker is made from local mineral raw materials – limestone, loess, kaolin clay, iron supplements.

The much smaller scale of carbon dioxide emissions emitted during lime production and use of soda in industry.

Lime is produced in four plants of the republic by decarbonization of lime at a temperature of 750 - 900°C.

Soda ash is widely used in various sectors, namely: chemical, petrochemical, textile, pulp and paper, ferrous and non-ferrous metallurgy, food and dairy industry, production of glass, detergents, used in medicine and for domestic use in cleaning water and brine, etc.

CO_2 and SO_2 emissions from manufacture and use of mineral products in 2010 are given in Table 5.6.

Table 5.6 CO_2 and SO_2 emissions from Mineral products, 2010

Category	Gg CO_2	%	Gg SO_2
Clinker production (cement)	2924.1	93.5	2.04
Lime production	176.6	5.7	
Use of Soda ash	25.9	0.8	
Total	**3126.7**	**100.0**	**2.04**

CO_2 emissions from manufacture and use of mineral products for the period 1990-2012 are given in Table 5.7.

Table 5.7 CO_2 emissions from production and use of Mineral products, Gg CO_2

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Clinker production	2582.87	2554.71	2493.37	2370.33	2101.37	1544.61	1433.4	1502.09	1591.71	1497.71	1481.62	1681.68
Lime production	353.80	342.50	304.20	311.40	239.24	150.10	179.60	145.80	94.90	76.20	80.90	84.85
Use of Soda ash	70.55	70.55	70.55	70.55	70.55	70.55	70.55	70.55	70.55	70.55	70.55	70.55
Total	**3007.22**	**2967.76**	**2868.12**	**2752.28**	**2411.16**	**1765.26**	**1683.55**	**1718.44**	**1757.16**	**1644.46**	**1633.07**	**1837.08**

Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
Clinker production	1692.94	1792.38	2132.33	2266.7	2347.77	2553.99	2826.67	2904.99	2924.08	2791.94	2791.03	**+8.1%**
Lime production	70.78	50.24	73.87	68.57	106.1	150.34	87.14	97.09	176.64	226.41	140.86	**-60.2%**
Use of Soda ash	70.55	70.55	70.55	70.55	4.61	18.82	23.13	23.65	25.93	30.72	33.16	**-53.0%**
Total	**1834.27**	**1913.17**	**2276.75**	**2406.82**	**2458.48**	**2723.15**	**2936.94**	**3025.73**	**3126.65**	**3049.07**	**2965.05**	**-1.4%**

For the period 1990-2012, CO_2 total emission from the category "Minral products" increased to 1.4%, at the same time the following was observed:

Increase in emissions from:

- clinker production – 8.1%.

Decrease in emissions from:

- lime production – 60.2% or drop by 2.5 times;
- use of soda ash – 53.0%.

Decrease in emissions is caused by decline in the whole production in the first half of 90-s.

Trends of CO_2 emissions in the category "Mineral products" is given in Figure 5.3.

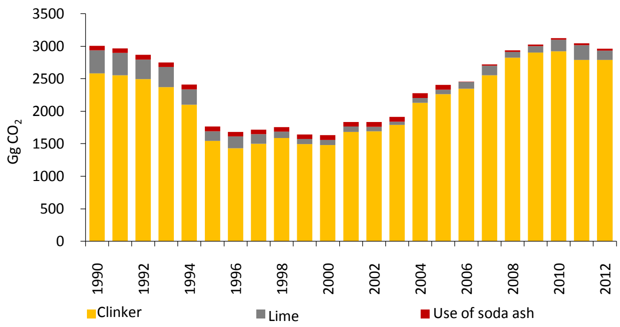


Figure 5.3 Trends of CO_2 emissions from Mineral products

Cement production is accompanied by SO_2 emissions. Data on SO_2 emissions are given in Table 5.8 and Figure 5.4.

Table 5.8 SO_2 emissions from Cement production, Gg

SO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gg	1.92	1.86	1.78	1.58	1.43	1.03	0.98	0.99	1.01	1.00	0.99	1.12

SO_2	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
Gg	1.18	1.22	1.44	1.52	1.67	1.81	1.99	2.06	2.04	2.01	2.05	**+6.8%**

For the period 1990-2012 increase in SO_2 emissions was 6.8%.

As follows from Figure 5.4, in the period 2001-2008 increase in SO_2 emission by 2 times has been observed, which was the result of cement production growth.

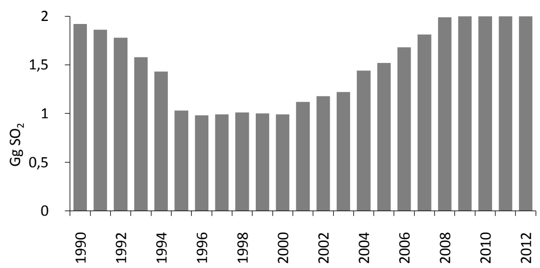


Figure 5.4 Trends of SO_2 emissions from Mineral products

5.2.2 *Methodology*

Estimation of CO_2 emissions from clinker and lime production, use of soda and SO_2 emissions from cement production was carried out according to [3], Tier 1 was chosen for calculation of emissions.

Activity data

Data for estimation of CO_2 emissions from clinker production and SO_2 emission from cement production were provided by the Joint-Stock Company "O`zqurilishmateriallari". Data for estimation of CO_2 emissions from soda ash use were provided by the Joint-Stock Company "Uzkimyosanoat". Data for estimation of CO_2 emissions from lime production were provided by the State Committee on Statistics, as more full, as there are enterprises engaged in production of lime, which are not in the structure of the Joint-Stock Company "O`zqurilishmateriallari".

Table 5.9 provides activity data in this category for 2010.

Table 5.9 Mineral products, 2010

Type	Production	Thous. t
Production	Clinker	5,742.5
	Cement	6,807.8
	Lime	223.6
Use	Soda ash	62.5

Emission factors

In the category "CO_2 emissions from clinker production" – a national emission factor equal to **0.5092 t CO_2 / t of product** was calculated according to updated IPCC methodology 2006, Tier 1 [7] according to updated national data on the average content of lime fraction in the composition of clinker in various cement plants. Calculation of emission factor is given in Annex 9.

In the category "CO_2 emissions from lime production" - **0.79 t CO_2/t of product** [3]. Calculation was made for quick-slaking lime as raw calcite is used.

In the category "SO_2 emissions from cement production" - **0.3 t SO_2/t of product** (default value) [3].

In the category "CO_2 emissions from use of soda ash" - **415 kg CO_2/ t of soda ash used** (default value) [3].

5.2.3 *Uncertainties and sequence of time series*

Uncertainty of CO_2 emissions in the "Mineral products" subsector was estimated in the categories 2A1 "Cement production", 2A2 "Lime production" and 2A4 "Soda ash production and use", according to [5].

Uncertainties of the activity data from clinker and lime production amounted to ± 1-2%, as the government statistics were used. Uncertainty of the activity data from soda ash use in industry, according to expert estimates of JSC "Uzkimyosanoat", amounted to ± 10%.

Uncertainty of national emission factor from clinker production was ± 6% (Annex 9). Uncertainty of emission factors from lime production and soda ash use in industry were taken by default.

Uncertainty of CO_2 emissions in 2012 was as follows:
- for category "Cement production" it amounted to ± 6.1%;
- for category "Lime production" it amounted to ± 2.8%;
- for category "Soda ash production and use" it amounted to ± 100%.

Calculation of the uncertainty for all specified categories is detailed in Annex 12.

Uncertainty of SO_2 emissions from cement production was not estimated.

For all years the same method and the same data set were used.

5.2.4 Quality Assurance/ Quality Control

QA/QC procedures were implemented in accordance with QA/QC principals and QA/QC plan. The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for the input data for the program software were referenced.

5.2.5 Recalculations by category

Time series for the category "Cement production" was recalculated using new national emission factor 0.5092 t CO_2/t of product instead of the default factor 0.5071 t CO_2/t of product used in the Second National Communication. The results of recalculation are given in Table 5.10.

Table 5.10 Recalculation of CO_2 emissions by category "Cement production" for the period 1990-2005, Gg CO_2

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	2572.21	2544.17	2484.08	2360.55	2092.70	1538.34	1427.49	1495.89
TNC	2725.91	2696.19	2632.51	2501.60	2217.74	1630.15	1512.78	1585.28
Difference, %	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	1585.14	1491.53	1475.51	1674.75	1685.96	1784.99	2123.53	2257.36
TNC	1679.86	1580.65	1563.67	1774.82	1786.69	1891.65	2250.42	2392.24
Difference, %	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**

The results of CO_2 emissions calculated in the Third National Communication by this category are 6% higher than those obtained in the Second National Communication.

5.2.6 Planned improvements by category

In the framework of the future National Communication, it is supposed to estimate emissions in accordance with [7].

5.3 Chemical industry – 2B

5.3.1 Description of source category

Under this category the direct GHG emissions were estimated:

- CO_2 emissions from ammonia production;
- N_2O emissions from nitric acid production;
- CH_4 emissions from methanol (since 1999) and polyethylene (since 2003) production.

Indirect GHG emissions were estimated in the following categories:

- Ammonia production;
- Nitric acid production;
- Sulphuric acid production.

The main categories of the subsector:

2B1 "CO_2 emissions from Ammonia production" and 2B2 "N_2O emissions from Nitric acid production".

The chemical industry of Uzbekistan merged into the Joint-Stock Company "Uzkimyosanoat". Companies of this sector produce mineral fertilizers, organic and inorganic matters, synthetic fibers, plastics, chemical reagents for energy industry, gold mining, chemical industry, plant protection chemicals. The raw materials for this industry are natural gas, oil, coal, sulphur, paraffin wax, salt, various non-ferrous metal waste, processing of raw cotton and kenaf.

Ammonia and weak nitric acid are produced at three enterprises: JSC "Maxam-Chirchik", JSC "Navoiazot" and JSC "Ferganaazot".

Technology of ammonia synthesis consists of the following steps: natural gas treatment from sulphurous compounds, steam conversion of methane (reforming), steam-air conversion of residual methane, steam two-stage conversion of carbon oxide, monoethanolamine treatment of the converted gas from carbon dioxide, methanation of residual carbon oxides, ammonia synthesis withdrawal from the "inerts" series (methane, argon), condensation of ammonia formed and its output from the cycle in the storage.

Table 5.11 Direct and indirect GHG emissions from Chemical industry, 2010

Production	Gas	Gg CO_2-eq.	%
Direct GHG			
Ammonia	CO_2	1,761.9	49.6
Nitric acid	N_2O	1,788.7	50.3
Polyethylene	CH_4	2.7	0.1
Methanol		0.1	0.0
Total		**3,553.5**	**100.0**
Indirect GHG			
Production	**Gas**	**Gg**	
Ammonia	CO	1.07	
Nitric acid	NOx	0.80	
Ammonia	NMVOC	6.32	
Acrylonitrile production		0.02	
Formalin production		0.01	
Polyethylene		0.39	
Total NMVOC		**6.74**	
Sulphuric acid production	SO_2	1.58	
Ammonia production		0.03	
Total SO_2		**1.61**	

A method of nitric acid production is combined, each company has operating units, both with high and atmospheric pressure.

Production of concentrated nitric acid is carried out by JSC "Maxam-Chirchik". The process involves dehydration of weak nitric acid (58%) by solution of magnesium nitrate followed by its regeneration, while NOx emissions are practically absent.

Production of sulphuric acid is carried out by JSC "Ammophos", as well as by Almalyk Mining and Metallurgical Plant (data are not available for this production).

Acrylonitrile, methanol (since 1999) and formaldehyde (since 2000) are produced by JSC "Navoiazot". Polyethylene is produced by Shurtan chemical plant since 2003.

Direct and indirect GHG emissions from chemical industry in 2010 are given in Table 5.11.

The main sources of direct GHG emissions are production of ammonia and nitric acid, they accounted for 99.9% of total emissions. The main source of indirect gases – ammonia production, which accounts for the entire volume of CO emission and 93.8% - NMVOC.

Trends of emissions by gases

Change in direct GHG emissions for the period 1990-2012 is given in Figure 5.5 and Table 5.12.

Table 5.12 Direct GHG emissions from Chemical industry, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	2271.70	2274.98	2088.69	1762.12	1291.34	1444.59	1514.21	1503.06	1400.54	1264.20	1292.12	1065.32
N_2O	1667.80	2170.00	2092.50	1807.30	1379.50	1457.00	1559.30	1379.50	1441.50	1264.80	1286.50	1329.90
CH_4	-	-	-	-	-	-	-	-	-	0.02	0.10	0.11
Total	**3939.5**	**4444.98**	**4181.19**	**3569.42**	**2670.84**	**2901.59**	**3073.51**	**2882.56**	**2842.04**	**2529.02**	**2578.72**	**2395.33**
GHG	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	$\Delta_{(2012-1990)}$
CO_2	1186.46	1301.82	1347.58	1396.35	1495.98	1604.66	1678.34	1658.94	1761.85	1696.70	1783.35	**-21.0%**
N_2O	1271.00	1326.80	1413.60	1478.70	1550.00	1732.90	1794.90	1760.80	1788.70	1782.50	1782.50	**7.0%**
CH_4	0.16	1.45	2.34	2.66	2.93	3.16	2.87	2.91	2.96	3.10	2.96	-
Total	**2457.62**	**2630.07**	**2763.52**	**2877.71**	**3048.91**	**3340.72**	**3476.11**	**3422.65**	**3553.51**	**3482.30**	**3568.81**	**-9.0%**

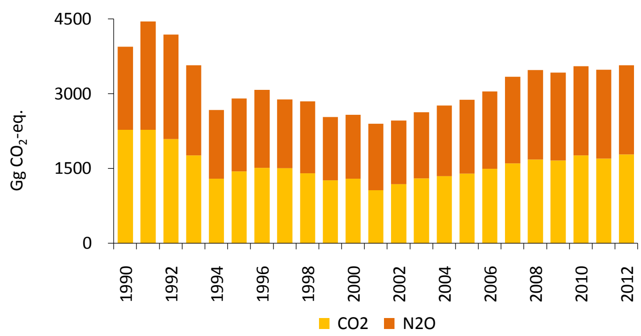


Figure 5.5 Trends of direct GHG emissions from Chemical industry

For the period 1990-2012 total direct GHG emissions in the category "Chemical industry" decreased to 9.4%, including decrease in CO_2 emissions – 21.5%; increase in N_2O emissions – 6.9%.

Change in CH_4 emissions for the period 1990-2012 is not possible to calculate. as methanol production in Uzbekistan started only in 1999, and polyethylene – in 2003.

Indirect GHG emissions for the period 1990-2012 from chemical industry are given in Table 5.13 and Figure 5.6.

Table 5.13 Indirect GHG emissions from Chemical industry, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	1.38	1.38	1.26	1.07	0.78	0.87	0.92	0.91	0.85	0.77	0.78	0.64
NOx	0.74	0.97	0.93	0.81	0.61	0.65	0.70	0.61	0.64	0.56	0.57	0.59
NMVOC	8.16	8.18	7.51	6.34	4.64	5.19	5.44	5.40	5.03	4.54	4.65	3.84
SO_2	3.24	3.2	1.99	1.83	1.59	1.37	1.33	1.17	1.15	1.21	1.11	0.85
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	$\Delta_{(2012-1990)}$
CO	0.72	0.79	0.82	0.85	0.91	0.97	1.02	1.00	1.07	1.03	1.06	-23.2%
NOx	0.57	0.59	0.63	0.66	0.69	0.77	0.80	0.78	0.8	0.79	0.79	6.8%
NMVOC	4.27	4.87	5.18	5.37	5.77	6.20	6.43	6.36	6.74	6.50	6.65	-18.5%
SO_2	1.14	1.08	1.13	1.00	1.13	1.34	1.25	1.38	1.61	1.55	1.72	-46.9%

Change in indirect GHG emissions for the period 1990-2012 was as follows:

Decrease:
- CO – 23.2%;
- NMVOC – 18.5%;
- SO_2 – 46.9%.

Increase:
- NOx – 6.7%.

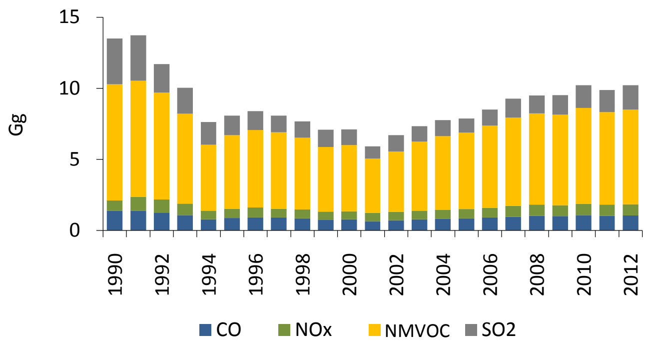


Figure 5.6 Trends of indirect GHG emissions from Chemical industry

5.3.2 Methodology

Direct and indirect emissions in this category were estimated in accordance with the Guidelines for National Greenhouse Gas Inventories, IPCC, 2006 [7].

CO_2 emissions from ammonia production was estimated using the Tier 1B.

Activity data

Estimates of direct and indirect GHG emissions from production of ammonia, nitric acid, methanol, acrylonitrile, formaldehyde were based on data from the Joint-Stock Company "Uzkimyosanoat".

Estimates of direct and indirect GHG emissions from production of polyethylene were based on official statistics from the State Committee of the Republic of Uzbekistan on Statistics.

Chemical production in 2010 was as follows:
- Ammonia – 1,343.9 thous. tons;
- Nitric acid – 1,471.5 thous. tons;
- Methanol – 5.8 thous. tons;
- Acrylonitrile – 16.2 thous. tons;
- Formaldehyde – 2.9 thous. tons;
- Polyethylene (production since 2003) – 129.2 thous. tons.

Emission factors

In calculations both national and default emission factors of the IPCC were used. National factors for this category were developed within the framework of the Third National Communication.

CO_2 emission factor:

from Ammonia production – 1.311 t CO_2/t of product, national emission factor. Calculation of emission factor is given in Annex 9.

N_2O emission factor:

from Nitric acid production – 3.923 kg N_2O/t of product, national emission factor. Calculation of emission factor is given in Annex 9.

CH_4 emission factor:

from Methanol production – 2 kg CH_4/ t of product (by default) [3].
from Polyethylene production – 1 kg CH_4/t of product (by default) [3].

CO emission factor:

from Ammonia production – 0.7936 kg CO/t of product, national emission factor, calculated according to direct measurements in certain industries (expert data of JSC ”Uzkimyosanoat”).

NOx emissions factor:

from Nitric acid production – 0.542 kg NOx/t of product, national emission factor, calculated according to direct measurements in certain industries (expert data of JSC “Uzkimyosanoat”).

NMVOC emission factor:

from Ammonia production – 4.7 kg NMVOC/t of product (by default) [3].
from Acrylonitrile production – 1.0 kg NMVOC/t of product (by default) [3].
from Formaldehyde production – 5.0 kg NMVOC/t of product (by default) [3].
from Polyethylene production (low density) – 3.0 kg NMVOC/t of product (by default) [3].

SO_2 emission factor:

from Sulphuric acid production – 1.325 tons SO_2/t of product, national emission factor. Calculation of emission factor is given in Annex 9.

from Ammonia production – 0.0187 kg SO_2/t of product, national emission factor, calculated according to direct measurements in certain industries (expert data of JSC “Uzkimyosanoat”).

5.3.3 Uncertainty and sequence of time series

Uncertainty in the “Chemical industry” subsector was estimated only for two source categories – 2B1 “Ammonia production” and 2B2 “Nitric acid production”.

Statistical data of JSC “Uzkimyosanoat” for ammonia and weak nitric acid production was used as the activity data. According to expert estimates, their uncertainty does not exceed ± 2%.

Uncertainty of national CO_2 emission factors from ammonia production (± 4.6%) and N_2O emissions from nitric acid production (± 44.9%) were determined by calculation (Annex 9).

Uncertainty of CO_2 emissions in the category “Ammonia production” for 2012 was ± 5%.

Uncertainty of N_2O emissions in the category “Nitric acid production” was ± 45%.

For other categories. included in the sub-sector “Chemical Industry”, uncertainties were not estimated.

Calculation of uncertainties in all estimated Inventory categories is detailed in Annex 12.

5.3.4 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for the input data for the program software were referenced.

5.3.5 Recalculations by category

In this Inventory the emission estimates for which national emission factors were developed or specified are recalculations. Recalculation of time series is made in six categories of the “Chemical Industry” sub-sector. See Tables 5.14 – 5.19.

The whole time series for the category “Ammonia production” was recalculated using new specified national emission factor 1.311 t CO_2/t ammonia, instead of the factor calculated in the Second National Communication 1.317 t CO_2/t ammonia.

The results of CO_2 emissions calculated in the Third National Communication by this category is 0.5% lower than those obtained in the Second National Communication (Table 5.14).

Table 5.14 Recalculation of CO_2 emissions by category "Ammonia production" for the period 1990-2005, Gg CO_2

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	2282.1	2285.4	2098.2	1770.2	1297.3	1451.2	1521.1	1509.9
TNC	2271.7	2274.9	2088.7	1762.1	1291.3	1444.6	1514.2	1503.1
Difference, %	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	1406.9	1269.9	1298.0	1070.2	1191.9	1307.8	1353.7	1402.7
TNC	1400.5	1264.2	1292.1	1065.3	1186.5	1301.8	1347.6	1396.4
Difference, %	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**

The whole time series for the category "Nitric acid production" was recalculated using new specified national emission factor 3.923 kg N_2O/t of nitric acid, instead of the factor calculated in the Second National Communication 4.193 kg N_2O/t of nitric acid (Table 5.15).

Table 5.15 Recalculation of N_2O emission by category "Nitric acid production" for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	1782.5	2318.8	2235.1	1931.3	1475.6	1556.2	1667.8	1472.5
TNC	1667.8	2170.0	2092.5	1807.3	1379.5	1457.0	1559.3	1379.5
Difference, %	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	1540.7	1351.6	1373.3	1419.8	1357.8	1416.7	1509.7	1581.0
TNC	1441.5	1264.8	1286.5	1329.9	1271.0	1326.8	1413.6	1478.7
Difference, %	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**	**6.9**

The results of N_2O emissions calculated in the Third National Communication for this category is 6.9% lower than those obtained in the Second National Communication.

The whole time series for the category "CO emission from ammonia production" was recalculated using new specified national emission factor 7936 kg CO/t of ammonia, instead of the default factor 7.9 kg CO/t of ammonia, which was used in the Second National Communication (Table 5.16).

Table 5.16 Recalculation of CO emission in the category "Ammonia production" for the period 1990-2005, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	13.7	13.7	12.6	10.6	7.8	8.7	9.1	9.1
TNC	1.4	1.4	1.3	1.1	0.8	0.9	0.9	0.9
Difference, %	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	8.4	7.6	7.8	6.4	7.2	7.9	8.1	8.4
TNC	0.9	0.8	0.8	0.6	0.7	0.8	0.8	0.9
Difference, %	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**	**89.9**

The results of CO emissions calculated in the Third National Communication in this category is 89.9% lower than those obtained in the Second National Communication.

The whole time series for the category "NOx emissions from nitric acid production" was recalculated using new specified national emission factor 0.542 kg NOx/t of nitric acid, instead of the factor 0.620 kg NOx/t of nitric acid, which was used in the Second National Communication (Table 5.17).

Table 5.17 Recalculation of NOx emission in the category "Ammonia production" for the period 1990-2005, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	0.85	1.11	1.07	0.92	0.70	0.74	0.80	0.70
TNC	0.74	0.97	0.93	0.81	0.61	0.65	0.70	0.61
Difference, %	**12.9**	**12.6**	**13.1**	**12.0**	**12.9**	**12.2**	**12.5**	**12.9**

	1998	1999	2000	2001	2002	2003	2004	2005
SNC	0.74	0.64	0.66	0.68	0.65	0.68	0.72	0.75
TNC	0.64	0.56	0.57	0.59	0.57	0.59	0.63	0.66
Difference, %	**13.5**	**12.5**	**13.6**	**13.2**	**12.3**	**13.2**	**12.5**	**12.0**

The results of NOx emissions calculated in the Third National Communication under this category are on average 12.8% lower than those obtained in the Second National Communication.

The whole time series under the category "SO_2 emissions from Sulfuric acid production" was recalculated using new specified national emission factor 1.325 kg SO_2/t of sulfuric acid instead of the factor 1.567 kg SO_2/t of sulphuric acid, which was used in the Second National Communication (Table 5.18).

Table 5.18 Recalculation of SO_2 emission in the category "Sulfuric acid production" for the period 1990-2005, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	3.8	3.8	2.3	2.1	1.9	1.6	1.6	1.4
TNC	3.2	3.2	1.9	1.8	1.6	1.4	1.3	1.2
Difference, %	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	1.3	1.4	1.3	0.9	1.3	1.3	1.3	1.2
TNC	1.1	1.2	1.1	0.8	1.1	1.1	1.1	0.9
Difference, %	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**	**15.5**

The results of SO_2 emissions calculated in the Third National Communications under this category are on average 15.5% lower than those obtained in the Second National Communication.

The whole time series under "SO_2 emissions from Ammonia production" was recalculated using national emission factor 0.0187 kg SO_2/t of ammonia, instead of the default factor of 0.03 kg SO_2/t of ammonia, which was used in the Second National Communication (Table 5.19).

Table 5.19 Recalculation of SO_2 emission in the category "Ammonia production" for the period 1990-2005, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	0.052	0.052	0.048	0.040	0.030	0.033	0.035	0.034
TNC	0.032	0.032	0.030	0.025	0.018	0.021	0.022	0.021
Difference, %	**38.5**	**38.5**	**37.5**	**37.5**	**40.0**	**36.4**	**37.3**	**38.2**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	0.032	0.029	0.030	0.024	0.027	0.030	0.031	0.032
TNC	0.020	0.018	0.018	0.015	0.017	0.019	0.019	0.020
Difference, %	**37.5**	**37.9**	**40.0**	**37.5**	**37.0**	**36.7**	**38.7**	**37.5**

The results of SO_2 emissions calculated in the Third National Communication under this category are on average 37.9% lower than those obtained in the Second National Communication.

5.3.6 Planned improvements by category

In the framework of future Fourth National Communication. it is supposed to estimate emissions in accordance with [7].

5.4 Metal production – 2C

5.4.1 Description of source category

Under this category. emissions of the following gases were estimated only from steel production: CO_2, CO, NOx, NMVOC, SO_2.

Iron, ferroalloys, aluminum and magnesium are not produced in the country. Data on non-ferrous metals are not accessible.

The only company of ferrous metallurgy to produce iron and steel in Uzbekistan is "Uzmetkombinat" (Bekabad), which produces steel and articles thereof. The raw material for steel production is scrap metal.

Direct and indirect GHG emissions from metal production in 2010 (Gg gas) are the following:

- CO_2 – 1,170.24;
- CO – 0.00075;
- NOx – 0.029;
- NNVOC – 0.022;
- SO_2 – 0.033.

Trends of emissions by gases

CO_2 emissions from Steel production for the period 1990-2012 are given in Table 5.20 and Figure 5.7.

Table 5.20 CO_2 emissions from Steel production, Gg

CO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gg	998.40	1056.00	1100.80	977.60	774.40	587.20	745.60	606.40	571.36	569.28	664.64	714.10
CO_2	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Gg	739.60	777.02	963.46	971.68	1008.48	1050.24	1097.12	1170.72	1170.24	1193.60	1199.94	**+20.2%**

Change in CO_2 emission for the period 1990-2012 amounted to +20.2%. Decrease in emission in the middle of 90-s was brought about by total decline in steel production in that period. Since 2000's steel production is increasing.

Table 5.21 and Figure 5.8 demonstrate trends in indirect greenhouse gases emissions from Steel production.

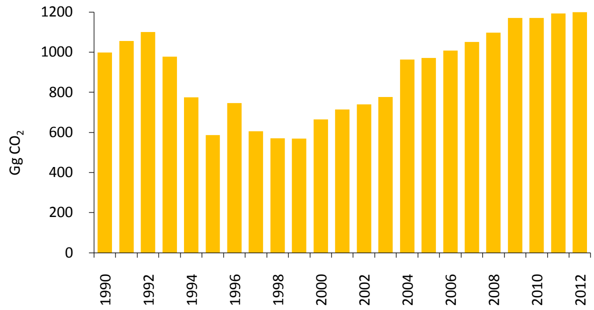


Figure 5.7 Trends of CO_2 emissions from Steel production

Table 5.21 Indirect GHG emissions from Steel production, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NOx	0.025	0.026	0.028	0.024	0.019	0.015	0.019	0.015	0.014	0.014	0.017	0.018
NMVOC	0.019	0.020	0.021	0.018	0.015	0.011	0.014	0.011	0.011	0.011	0.012	0.013
SO_2	0.028	0.03	0.031	0.027	0.022	0.017	0.021	0.017	0.016	0.016	0.019	0.020
Gas	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CO	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	**21.0%**
NOx	0.018	0.019	0.024	0.024	0.025	0.026	0.027	0.029	0.029	0.030	0.030	**20.0%**
NMVOC	0.014	0.015	0.018	0.018	0.019	0.020	0.021	0.022	0.022	0.022	0.023	**18.4%**
SO_2	0.021	0.022	0.027	0.027	0.028	0.030	0.031	0.033	0.033	0.034	0.034	**20.4%**

As seen from Table 5.21 and Figure 5.8, indirect gases emissions are quite insignificant and repeat the dynamics of carbon dioxide emissions. For the period 1990-2012, increase in all indirect greenhouse gases emissions was observed:

- CO – 21.0%;
- NOx – 20.0%;
- NNVOC – 18.4%;
- SO_2 – 20.4%.

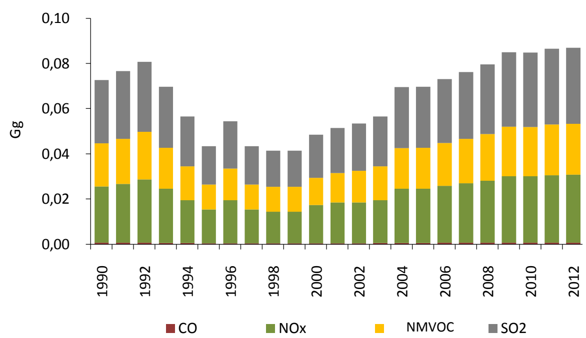


Figure 5.8 Trends of indirect GHG emissions from Steel production

5.4.2 Methodology

Direct and indirect GHG emissions in this category were estimated in accordance with [3]. Emission from Steel production was estimated using the Tier 1.

Activity data

Estimation of direct and indirect emissions from steel production was based on the statistical data of the State Committee of the Republic of Uzbekistan on Statistics.

Volume of steel produced in 2010 amounted to 731.4 thous. tons.

Emission factors

IPCC default emission factors from Steel production were applied for calculations [3]:

- CO_2 emissions – 1.6 t CO_2/t of product;
- CO emissions – 1.0 g CO/ t of product;
- NOx emissions – 40 g NOx/t of product;
- NMVOC emissions – 30 g NMVOC/t of product;
- SO_2 emissions – 45 g SO_2/t of product.

5.4.3 Uncertainty and sequence of time series

Uncertainty of activity data amounted to ± 2%, as statistical data were used for calculations. Uncertainty of CO_2 emission factors from steel production is taken by default ± 25% [3]. Total uncertainty of emissions in the category in 2012 amounted to ± 25%.

Calculation of uncertainty estimation is given in Annex 12.

For all years the same method and the same data sets were used.

5.4.4 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for the input data for the program software were referenced.

5.4.5 Recalculations by category

Recalculations were not performed.

5.4.6 Planned improvements by category

In the framework of the future Fourth National Communication. it is supposed to specify activity data and emissions factors.

5.5 Other production – 2D

5.5.1 Description of source category

Under this category NMVOC emissions from food and drink production were estimated.

Oil and fat and food industry of Uzbekistan is formed by the associations “Maslozhirtabakprom” and “Pisheprom”.

Association “Maslozhirtabakprom” is responsible for production of oil and fat and tobacco products. The Association includes 19 oil and fat enterprises, the largest of them – Kokand and Fergana oil and fat enterprises, 4 joint ventures. Production is based on processing of local agricultural raw materials: technical cotton seeds, large fruits’ seeds, soybeans and others. The main products are refined oil, laundry and toilet soap, margarine, glycerin, cotton cake.

Association “Pisheprom” decides on production of confectionery, tea, beer, soft drinks and other food products, providing saturation of the consumer market of the republic by food items. The association consists of 24 production enterprises.

Meat and dairy industry is formed by the association “Uzmyasomolprom”, which includes associations and enterprises on preparation meat and diary products and fattening animals. Association includes 22 meat-processing and over 150 livestock farms for fattening cattle.

State Joint-Stock Corporation "Uzkhleboproduct" deals with **bread production**. Corporation includes 283 structural economic units. Of these, 118 – open joint stock companies, 34 – state-owned enterprises, 12 – subsidiary companies, 63 – collective enterprises, 49 – private companies, 3 – joint ventures with foreign capital, 4 – limited liability companies.

Bakery industry includes 183 enterprises, production capacity is about 3 thous. tons per day.

Mixed fodder industry has manufacturing capacity to produce more than 3 million tons of mixed fodder for all types of farm animals, birds and fish.

Fruit and vegetable industry. In Uzbekistan a wide choice of fruit and vegetables and grapes is cultivated. Currently, fruit and vegetable complex of the republic operates in the form of Republican company "Uzplodoovoschvinpromholding" and regional associations "Mevasabzavot". The company includes 27 specialized companies on harvesting, storage, processing and sale of fruits and vegetables and grapes, 40 processing, 89 agricultural and 15 joint ventures [47].

NMVOC emissions from food and beverages production in 2010 amounted to 29.04 Gg gas, of them by categories:
- 2D2 Alcoholic beverages production - 17.69 Gg gas, that is 60.9%;
- 2D2 Food production - 11.35 Gg gas, or 39.1%.

The dynamics of NMVOC emissions from food and beverages production for the period 1990-2012 is given in Figure 5.9 and Table 5.22.

Table 5.22 NMVOC emissions from Food and beverages production, Gg

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Alcoholic beverages	9.8	9.6	9.0	8.0	7.6	7.1	7.6	8.5	9.5	10.9	10.9	10.1
Food	10.7	10.1	8.5	10.1	7.3	5.4	4.7	5.4	4.9	7.7	7.9	8.0
Total	**20.5**	**19.7**	**17.5**	**18.1**	**14.9**	**12.5**	**12.3**	**13.8**	**14.3**	**18.6**	**18.7**	**18.1**
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Alcoholic beverages	9.3	9.9	10.5	10.3	10.5	14.0	15.3	16.4	17.7	18.7	20.4	**108.2%**
Food	9.7	9.1	8.5	7.7	7.4	8.3	11.2	10.8	11.4	13.2	13.2	**23.4%**
Total	**19.0**	**19.0**	**19.0**	**17.9**	**17.9**	**22.3**	**26.4**	**27.2**	**29.1**	**31.8**	**33.5**	**63.4%**

For the period 1990-2012 total increase in emissions to 63.4% in the category "Other production" was observed due to increase in production, in particular:
- alcoholic beverages – 108.2%;
- food – 23.4%.

Decrease in emissions in the middle of the 90-s was brought about by total decline of production in that period. Since 2007 an increase in production was observed.

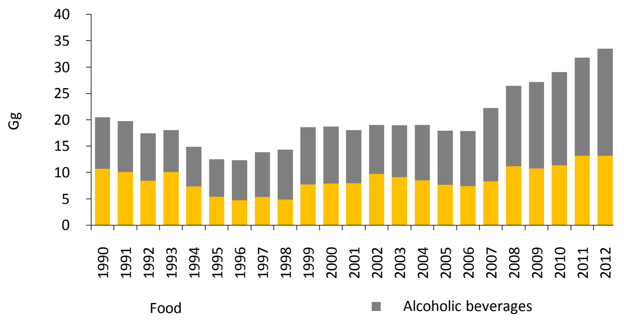


Figure 5.9 Trends of NMVOC emissions from Food and beverages production

5.5.2 Methodology

Indirect GHG emissions in the category "Other production" were estimated in accordance with [3]. Tier 1 was applied for calculations.

Activity data

Estimation of direct and indirect GHG emissions from food and beverages production was based on the statistical data provided by the State Committee of the Republic of Uzbekistan on Statistics.

Food production in 2010 amounted to:
- Meat and meat products. total – 178.5 thous.tons;
- Sugar – 286.1 thous.tons;
- Animal fat – 1.2 thous.tons;
- Animal oil – 5.2 thous.tons;
- Margarine – 16.2 thous.tons;

- Bread and bakery products – 912.9 thous.tons;
- Confectionery (floury) – 118.5 thous.tons;
- Mixed fodder – 892.9 thous.tons;
- Fish products, including canned fish – 6.2 thous.tons.

Alcoholic beverages production in 2010 was the following:

- Vodka – 11,698.5 thous.;
- Cognac – 76.7 thous.;
- Wine – 3,605.8 thous.;
- Beer – 25,760.8 thous.

Emission factors

Default IPCC factors for NMVOC emissions related to food products were used for calculations Tables 2.25 and 2.26, [3]:

- Meat, fish and poultry – 0.3 kg NMVOC/t of product;
- Sugar – 10.0 kg NMVOC/t of product;
- Margarine and food fat – 10.0 kg NMVOC/t of product;
- Cakes, biscuits. etc. – 1.0 kg NMVOC/t of product;
- Bread – 8.0 kg NMVOC/t of product;
- Mixed fodder – 1.0 kg NMVOC/t of product;
- Wine – 0.08 kg/ hectoliter;
- Beer – 0.035 kg/ hectoliter;
- Strong liquors – 15 kg/ hectoliter;
- Cognac – 3.5 kg/ hectoliter.

Uncertainty and sequence of time series

Uncertainty of emissions was not estimated. For all years the same method and the same data sets were used.

5.5.3 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for the input data for the program software were referenced.

5.5.4 Recalculations in category

Recalculations were not performed.

5.5.5 Planned improvements by category

In the framework of future Fourth Third National Communication, it is supposed to update activity data and values of emission factors.

5.6 Consumption of halocarbons/hydrofluorocarbons and sulphur hexafluoride – 2F

5.6.1 Description of source category

HFC production in the country is not available. data on storage and destruction are also not available.

In this category potential hydrofluorocarbons emissions were estimated (HFCs).

In 2010 potential hydrofluorocarbons emissions amounted to 22.3 Gg CO_2-eq.

Potential HFC emissions for the period 2000-2012 are given in Table 5.23 and Figure 5.10.

According to estimation, emissions between 2000 and 2012 have increased by 14.9 times.

Table 5.23 Potential HFCs emissions, Gg CO_2-eq.

HFCs	2000	2001	2002	2003	2004	2005	2006	2007
Gg CO_2-eq.	6.34	6.34	1.69	9.05	38.19	12.12	35.90	10.53
HFCs	**2008**	**2009**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
Gg CO_2-eq.	32.31	19.19	22.27	74.42	94.49	22.27	74.42	94.49

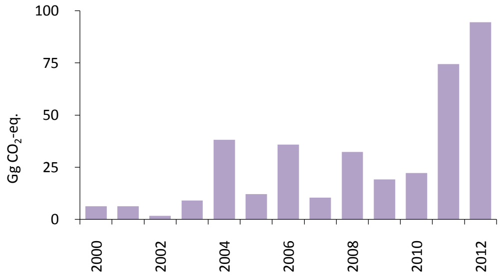


Figure 5.10 Trend of potential HFCs emissions

5.6.2 Methodology

Potential HFC emissions in this category was estimated in accordance with [3], Tier 1a.

Activity data

Estimation of potential HFCs emission was implemented using the data on import of refrigerant mixtures provided by the State Committee for Nature Protection of the Republic of Uzbekistan. Data for the period until 2000 are not available.

Analysis of data obtained from the State Committee for Nature Protection of the Republic of Uzbekistan and the State Customs Committee of the Republic of Uzbekistan has shown that the following hydrofluorocarbons were imported to the republic as refrigerants: R134a, R404A and R407C. As statistics on import of refrigerant mixtures in 2001 was not available, it was suggested that their number matches the number of these mixtures imported in 2000. Share of each HFCs in the composition of imported refrigerant mixtures are given in Table 5.24, composition of refrigerant mixtures is given in Table 5.25.

Table 5.24 Import of fluorocarbons for the period 2000-2012, t

Refrigerant mixture	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
R-407c	0.199	0.199	0.053	0.285	1.203	0.382	3.645	1.018	2.407	2.239	1.447	4.907	0.786
R-404a	0.490	0.490	0.131	0.700	2.954	0.937	3.474	0.992	0.533	1.536	1.261	7.326	14.875
R-134a	3.442	3.442	0.916	1.203	20.743	6.581	14.837	4.482	20.725	8.378	12.35	33.568	35.377

Emissions were estimated assuming that:

1. Composition of HFC for each year is the same.
2. Share of each HFC in total amount remains unchangeable for each year.
3. All amount of HFCs imported this year has been used.

Following these assumptions. the amount of each HFC was calculated for each year (calculation is given in Annex 10).

For 2010 HFCs were estimated in tons of gas and in tons of CO_2-eq. (Table 5.26).

Emission factors

For calculation of potential HFC emissions in CO_2-eq., IPCC GWPs 1995 that are based on greenhouse gases impact for 100 year period were used [4]:

- HFC-32 – 650;
- HFC-125 – 2800;
- HFC-134a – 1300;
- HFC-143a – 3800.

5.6.3 Uncertainty and sequence of time series

Uncertainty of potential HFCs emissions was not estimated. A great number of assumptions was used in calculations, and respectively uncertainty is very high.

Table 5.25 Composition of imported refrigerants

Refrigerant	Composition	Share of components
R-407c	HFC-32	0.23
	HFC-125	0.25
	HFC-134a	0.52
R-404a	HFC-143a	0.44
	HFC-125	0.52
	HFC-134a	0.04
R-134a	HFC-134a	1.00

Table 5.26 Estimated amount of HFC in 2010

HFC	Tons, gas	Tons, CO_2-eq.
HFC-32	0.333	216.3
HFC-125	1.017	2,848.9
HFC-134a	13.115	17,098.7
HFC-143a	0.555	2,108.4

5.6.4 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- that emission sources are properly documented;
- for transcription errors;
- whether all information sources for the input data for the program software were referenced.

5.6.5 Recalculations in category

Recalculations in this category were not performed.

5.6.6 Planned improvements by category

In the framework of the future Fourth National Communication it is supposed to specify activity data.

6. AGRICULTURE – 4

6.1 Sector review

Agriculture plays a significant role in the economy of Uzbekistan, providing 17.6% of GDP, 27% of employment [47] and supports development of the industrial base of the country, including food and non-food processing industries.

Agriculture is based on irrigation.

In Uzbekistan, the strategy of agricultural development aimed at ensuring food security of the country is consistently implemented over the years. For a short period of time in Uzbekistan drastic reforms have been carried out, which allowed almost entirely to diversify agriculture and provide the population with basic food crops, establish their exports.

Since 1997, the country's agriculture demonstrated steady positive growth. which amounted to 6-7% per year. From 1991 to present, the volume of agricultural production increased in whole more than twice. It allowed to increase per capita consumption of meat by 1.3 times, milk and dairy products – 1.6 times, potatoes – 7 times, vegetables – more than twice, fruits – almost 4 times.

In the past decade there is a growing interest in stalled cattle breeding and increase of cattle in dekhkan farms and farms. It was enabled by Resolution of President of the Republic of Uzbekistan dated March 23, 2006 “On measures to stimulate the increase of cattle in private dekhkan farms and farms” [49, 50].

The “Agriculture” sector provides information on estimation of direct greenhouse gases emissions – methane and nitrous oxide. In the “Agriculture” sector the following source categories are given:

- 4A Methane emissions from Enteric fermentation;
- 4B Methane and nitrous oxide emissions from Manure management;
- 4C Rice cultivation;
- 4D Nitrous oxide emissions from Agricultural soils.

Included in the Inventory of 2000, category 4F “Field burning of agricultural residues” is excluded from the calculations since 2005, as a legislative ban on burning the stubble of cereal crops was entered into force (Resolution of President of the Republic of Uzbekistan №76 dated 16 May, 2005 “On organizational measures for reaping grain cereal crops”).

In the sector direct GHG CH_4 and N_2O emissions were estimated., CO_2 emissions from agricultural soils were not estimated.

GHG emissions in 2010 in the “Agriculture” sector was 9.8% of total emission. Contribution of the sector to total emission increased to 0.4% compared with 1990 due to the increase of methane emissions in the “Enteric fermentation” category as a result of significant increase in the number of cattle. Some reduction in nitrous oxide emissions from agricultural soils depends on the reduction in the amount of mineral fertilizers entered in soil.

Direct greenhouse gases emissions in the “Agriculture” sector in 2010 are given in Table 6.1, and contribution of greenhouse gases to sectoral emissions is given in Table 6.2.

The main sources of emissions in the sector are Enteric fermentation and Agricultural soils.

Trends of emissions by gases and categories

Trends of emissions by gases for the period 1990-2012 are given in Table 6.3 and Figure 6.1.

Table 6.1 Direct GHG emissions in the “Agriculture” sector, 2010

Category	Gg CO_2-eq.	%
4A Enteric fermentation	11,099.7	55.6
4B Manure management	1,177.9	5.9
4C Rice cultivation	76.1	0.4
4D Agricultural soils	7,598.1	38.1
4F Field burning of agricultural residues	0	0
Total	**19,951.8**	**100.0**

Table 6.2 Share of direct GHG emissions in the “Agriculture” sector, 2010

Gas	CH_4	N_2O
Emissions, Gg CO_2-eq.	11,948.6	8,003.2
%	59.9	40.1

Table 6.3 Direct GHG emissions by gases in the "Agriculture" sector, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4	6532.9	7027.8	7414.9	7569.4	7521.5	7347.2	7220.4	7200.4	7285.2	7324.2	7347.9	7390.9
N_2O	10517.1	10530.0	10599.3	10310.4	9980.4	9334.2	9122.3	9238.6	9137.4	9010.0	8799.8	8427.2
Total	**17050.0**	**17557.8**	**18014.2**	**17897.8**	**17501.9**	**16681.4**	**16342.7**	**16439.0**	**16422.6**	**16334.2**	**16147.7**	**15818.1**
GHG	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CH_4	7632.1	8023.6	8503.6	8769.2	9275.5	9871.1	10553.0	11265.6	11948.6	12636.0	12946.1	**+98.2%**
N_2O	8702.0	8464.9	8379.7	7298.5	6864.8	6729.9	7070.7	7548.8	8003.2	8479.4	8701.6	**-17.3%**
Total	**16334.1**	**16488.5**	**16883.3**	**16067.7**	**16140.3**	**16601.0**	**17623.7**	**18814.4**	**19951.8**	**21115.4**	**21647.7**	**+27.0%**

For the period 1990-2012 total emission of the "Agriculture" sector was increased to 27%. The following was observed:

- Increase in CH_4 emissions – 98.2%;
- Decrease in N_2O emissions – 17.3%.

Direct GHG emissions by source categories in the "Agriculture" sector for the period 1990-2012 are given in Table 6.4 and Figure 6.2.

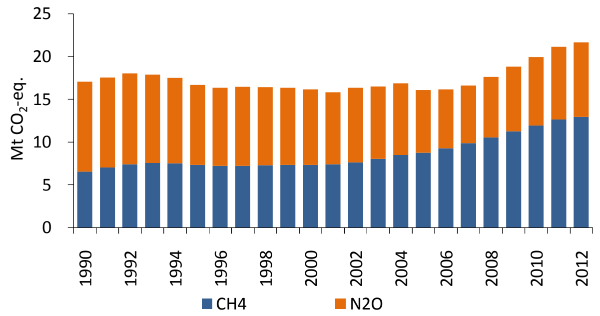


Figure 6.1 Trends of direct GHG emissions by gases in the "Agriculture" sector

Table 6.4 Direct GHG emissions in the "Agriculture" sector by categories, Gg CO_2- eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Enteric fermentation	5830.4	6277.1	6619.9	6754.7	6706.4	6525.5	6379.2	6362.1	6447.2	6514	6592.1	6673.5
Manure management	704.1	740.7	761.9	762.0	744.4	714.5	689.9	685.1	693.6	701.4	709.4	717.8
Rice cultivation	261.7	273.5	292.5	296.7	287.7	290.2	305.9	296.1	284.4	248.9	187.9	132.1
Field burning of agricultural residues	31.9	36.1	38.4	46.2	60.7	79.4	95.9	105.7	113.6	117.6	119.4	135.2
Agricultural soils	10221.9	10230.3	10301.3	10020.1	9702.7	9071.7	8871.9	8990	8883.7	8752.3	8538.9	8159.6
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Enteric fermentation	6891.1	7232.3	7684.0	8087.1	8573.6	9143.9	9800.0	10456.9	11099.7	11735.1	12041.6	**+106.5%**
Manure management	740.4	775.6	821.7	865.0	914.8	973.8	1035.4	1105.0	1177.8	1241.6	1271.3	**+80.6%**
Rice cultivation	125.9	140.9	134.1	100.4	90.2	79.8	70.2	82.0	76.1	94.2	83.5	**-68.1%**
Field burning of agricultural residues	155.8	172.6	180.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-100.0%**
Agricultural soils	8420.9	8167.2	8063.1	7015.2	6561.7	6403.4	6718.1	7170.5	7598.1	8044.5	8251.2	**-19.3%**

The following changes were observed for the period 1990-2012:

Increase in emissions for the categories:

- Enteric fermentation – 106.5%;
- Manure management – 80.6%;

Decrease in emissions for the categories:

- Rice cultivation – 68.1%;
- Field burning of agricultural residues since 2005 – 100%;
- Agricultural soils – 19.3%.

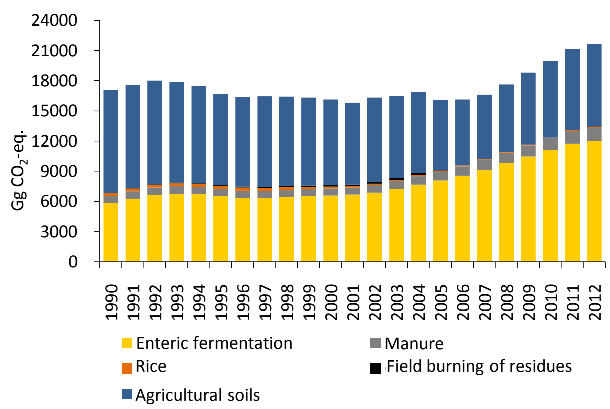


Figure 6.2 Trends of direct GHG emissions in the "Agriculture" sector by categories

6.2 Enteric fermentation – 4A

6.2.1 Description of source category

Natural climatic and feeding conditions of Uzbekistan have their own specific features. On this basis, four zones of animal breeding were formed:

I. Irrigated agriculture – mainly engaged in dairy cattle breeding.
II. Dry farming – meat and dairy cattle.
III. Foothill zone – meat cattle breeding, meat and wool, meat and fat sheep breeding, wool and down goat breeding, as well as horse breeding.
IV. Desert and semidesert – karakul sheep breeding and camel breeding.

In 2012 livestock was mainly concentrated in private households – 93.8%, 5.2% of livestock is concentrated in farms [48].

To achieve better cattle breeding, great attention is paid to natural qualities of animals. Cattle is mainly represented by black-and-marked, red, brown, kazakh white-headed and bushuyev breeds. In the republic, there are 24 breeding factories and 238 breeding farms which serve to improve breeding and increase productive qualities of cattle.

Due to lack of natural and cultivated pastures in the republic. there is a tendency of stalled cattle breeding. Almost all year round animals are kept in the barnyards depending on age groups. Depending on weather conditions, the way of animal breeding is combined. In the housing it is tethered, and at sites it is loose. The average live selling weight of one head of cattle is 306 kg.

The basis of feeding of cattle – rough and succulent feed, hay, haylage and silage. The animals are provided with the concentrated feed to a less extent.

The main forage of sheep, goats, horses and camels is grazing [49].

Methane emissions were estimated according to IPCC categories given in Table 6.5.

In 2010 methane emissions from enteric fermentation of livestock amounted to:
- 5.6% of total emissions;
- 55.6% of sectoral emissions.

Table 6.5 CH_4 emissions by categories, 2010

Category	Gg CO_2-eq.	%	Category	Gg CO_2-eq.	%
4A1 Cattle	9,330.9	84.1	4A5 Camels	17.4	0.2
4A1a Including diary	4,379.6	39.5	4B6 Horses	71.0	0.6
4A1b non-diary	4,951.3	44.6	4B7 Mules and asses	69.7	0.6
4A3 Sheep	1,339.4	12.1	4B8 Swine	2.0	0.0
4A4 Goats	269.2	2.4	**Total**	**11,099.7**	**100.0**

Distribution of methane emissions from enteric fermentation of livestock by regions in 2010 is given in Table 6.6 and Figure 6.3. Calculation of emissions was performed with application of the standard method in accordance with [3] in a separate file.

Table 6.6 CH_4 emissions from Enteric fermentation by regions 2010, Gg CO_2-eq.

Region	Gg CO_2-eq.	%	Region	Gg CO_2-eq.	%
Republic of Karakalpakstan	862.3	7.8	Samarkand	1,420.1	12.8
Andijan	833.4	7.5	Surkhandarya	899.9	8.1
Bukhara	1,083.2	9.8	Syrdarya	316.7	2.9
Djizak	776.4	7.0	Tashkent	746.8	6.7
Kashkadarya	1,434.0	12.9	Fergana	812.7	7.3
Navoi	551.7	5.0	Khorezm	753.3	6.8
Namangan	591.2	5.3	**Total**	**11,081.7**	**100.0**

Total emission for the regions due to rounding differs from the value calculated for the whole country by 18 Gg CO_2-eq. (which corresponds to difference in 0.87 Gg of methane).

The largest contribution to methane emissions from enteric fermentation of livestock is made by Kashkadarya and Samarkand regions of Uzbekistan.

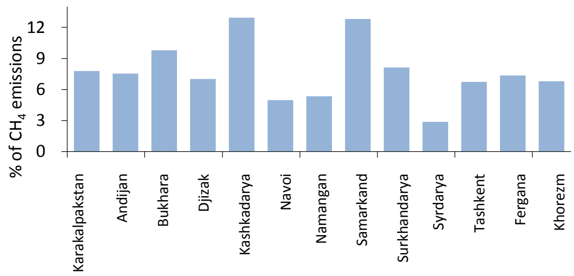


Figure 6.3 CH_4 emissions from Enteric fermentation by regions

Trends of emissions

Methane emissions from enteric fermentation of livestock for the period 1990-2012 are given in Table 6.7 and Figure 6.4.

Table 6.7 CH_4 emissions from Enteric fermentation, Gg CO_2-eq.

CH_4	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gg CO_2-eq.	5830.4	6277.1	6619.9	6754.7	6706.4	6525.5	6379.2	6362.1	6447.2	6514.0	6592.1	6673.5
CH_4	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Gg CO_2-eq.	6891.1	7232.3	7684.0	8087.1	8573.6	9143.9	9800.0	10456.9	11099.7	11735.1	12041.6	**106.5%**

Increase in emission for the period 1990-2012: +106.5% (increased twice). Change in emissions is caused by the increase in livestock, mainly in cattle population.

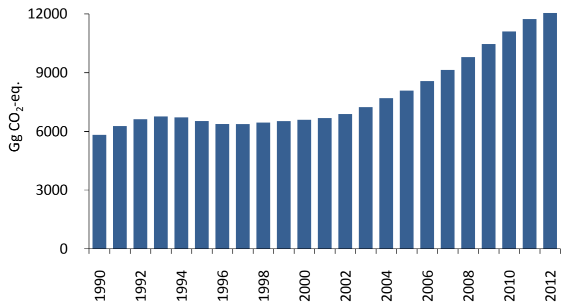


Figure 6.4 Trends of CH_4 emissions from Enteric fermentation

6.2.2 *Methodology*

Estimation of CH_4 emissions from enteric fermentation was made in accordance with [3] for the following types of animals: cattle (including dairy), sheep, goats, horses, asses, camels. Tier 1 approach was applied.

Emissions from poultry were not estimated since the method of calculation is not available in the IPCC Guidelines.

Activity data

The calculations used the national statistics on domestic livestock [39,48]. In accordance with [3], data were averaged over 3 years in calculations. Data on all types of domestic livestock population by the regions of Uzbekistan calculated for 2010 are given in Table 6.8.

Table 6.8 Livestock population by regions 2010, thous. heads

Region	Cattle (non-diary)	Diary cattle	Sheep	Goats	Camels	Horses	Donkeys	Swine	Poultry
Republic of Karakalpakstan	509.03	249.73	479.30	286.47	5.43	18.60	26.30	3.49	1536.40
Andijan	408.50	305.77	883.60	9.40	0.00	6.42	0.79	0.13	4059.87
Bukhara	521.03	360.63	1379.30	169.17	2.55	4.17	51.82	8.99	1904.07
Jizak	395.97	216.53	1071.27	300.10	0.09	19.27	21.27	2.17	1595.73
Kashkadarya	638.47	412.93	2616.30	619.97	1.10	23.06	41.93	1.60	2571.00
Navoi	181.77	149.67	1493.80	257.27	8.66	14.73	45.31	17.68	1367.40
Namangan	332.07	184.40	522.10	88.03	0.00	6.33	4.73	0.38	1636.30
Samarkand	613.73	561.70	1483.63	154.33	0.17	19.77	60.15	9.57	4747.73
Surkhandarya	389.83	300.80	1214.63	473.33	0.00	14.76	14.38	0.58	2055.30
Syrdarya	173.13	111.53	168.77	23.90	0.00	9.43	7.69	7.38	774.37
Tashkent	343.17	286.17	528.27	147.57	0.02	39.98	29.95	35.90	9971.23
Fergana	415.17	305.70	607.57	18.03	0.01	6.34	6.17	5.36	2465.23
Khorezm	413.70	278.50	336.30	16.77	0.03	4.93	21.23	4.85	3183.60

Emission factors

For each animal type ***a default*** factor of methane emissions was used in accordance with the *Revised Guidelines for National Greenhouse Gas Inventories*, IPCC, 1996 [3], Table 4-2, page 4.3, column "Developing countries", table 4-3, page 4.5, line "Asia" – as the most similar in accordance with milk production of dairy cattle from 1875 kg/head/yr in early 90-s to 1642 kg/head/yr in 2010 (data of the State Committee of the Republic of Uzbekistan on Statistics) [3]:

- dairy cattle – 56 kg/head*yr;
- non-dairy cattle – 44 kg/head*yr;
- sheep and goats – 5 kg/head*yr;
- camels – 46 kg/head*yr;
- horses – 18 kg/head*yr;
- mules and asses – 10 kg/head*yr;
- swine – 1 kg/head*yr.

6.2.3 Uncertainty and sequence of time series

Uncertainty of methane emissions in the category 4A "Enteric fermentation" was estimated in accordance with [5].

Uncertainty of statistical information on the number of livestock is in the range of 5%. Uncertainty IPCC default factors is ± 50%. Combined uncertainty of methane emissions in the category "Enteric fermentation" for 2012 amounted to ± 50.3%.

Calculations of uncertainties in all estimated Inventory categories are detailed in Annex 12.

For all years the same method and the same data set was used.

6.2.4 Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- of documentation on emissions sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

6.2.5 Recalculations in category

Recalculations were not performed.

6.2.6 Planned improvements by category

In the framework of future Fourth National Communication. it is supposed to specify the values of emission factors used.

6.3 Manure management – 4B

6.3.1 Description of source category

Dry storage of pets manure dominates in animal husbandry of Uzbekistan. Manure is usually stored directly on the farm and farmsteads.

Methane emissions in manure management was estimated in the following categories:

- 4A1a – diary cattle;
- 4A1b – non-diary cattle;
- 4A3 – sheep;
- 4A4 – goats;
- 4A5 – camels;
- 4A6 – horses;
- 4A7 – mules and asses;
- 4A8 – swine;
- 4B9 – poultry.

Nitrous oxide emissions were estimated in the categories:

- 4B10 – anaerobic storage systems;
- 4B11 – liquid storage systems;
- 4B12 –solid storage and dry lot.

Methane and nitrous oxide emissions from manure management in 2010 are given in Tables 6.9 - 6.11. Methane emissions from manure management by regions are given in Table 6.12.

Table 6.9 Direct GHG emissions from Manure management and share of each gas, 2010

GHG	Gg CO_2-eq.	%
CH_4	772.8	65.6
N_2O	405.1	34.4
Total	**1,177.9**	**100.0**

Table6.10 N_2O emissions from Manure management by categories, 2010

Category	Gg CO_2-eq.	%
Anaerobic storage	6.7	1.5
Liquid systems	4.9	1.5
Dry solid storage	300.4	74.0
Other	93.1	23.0
Total	**405.1**	**100.0**

Table 6.12 CH_4 emissions from Manure management by categories, 2010

Category	Gg CO_2-eq.	%
Cattle	716.8	92.7
Diary	604.4	78.2
Non-diary	112.4	14.6
Sheep	28.3	3.7
Goats	6.5	0.8
Camels	0.5	0.1
Horses	4.5	0.6
Mules and asses	4.3	0.6
Swine	2.1	0.3
Poultry	9.8	1.3
Total	**772.8**	**100.0**

Table 6.11 CH_4 emissions from Manure management by regions, 2010

Region	Gg CO_2-eq.	%
Republic of Karakalpakstan	50.4	6.5
Andijan	56.5	7.3
Bukhara	68.7	8.9
Jizak	44.3	5.7
Kashkadarya	82.7	10.7
Navoi	31.3	4.1
Namangan	35.9	4.7
Samarkand	101.6	13.2
Surkhandarya	115.5	15.0
Syrdarya	21.0	2.7
Tashkent	55.2	7.2
Fergana	55.9	7.2
Khorezm	51.7	6.7
Total	**770.7**	**100.0**

In 2010 GHG emissions from manure management accounted for:
- 0.6% of total emissions;
- 5.9% of sectoral emissions.

For 2010 methane emissions from manure management was estimated for the regions of Uzbekistan. Calculation of emissions was made with application of the standard method offered in [3] in a separate file.

Total emission by regions in the result of rounding differs from that calculated for the whole country to 2.1 Gg CO_2-eq. Calculation results are given in Figure 6.5.

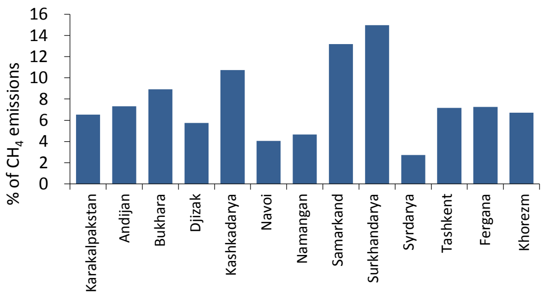


Figure 6.5 CH_4 emissions from Manure management by regions, 2010

Trends of emissions

Trends of GHG emissions from manure management for the period 1990-2012 are given in Table 6.13 and Figure 6.6.

Table 6.13 Direct GHG emissions from Manure management, Gg CO_2-eq.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4	417.4	450.8	474.3	484.1	483.0	473.3	465.1	464.7	470.3	475.1	480.4	486.4
N_2O	286.7	290.0	287.6	277.9	261.4	241.2	224.8	220.4	223.3	226.2	229.0	231.4
Total	**704.1**	**740.8**	**761.9**	**762.0**	**744.4**	**714.5**	**689.9**	**685.1**	**693.6**	**701.3**	**709.4**	**717.8**

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
CH_4	501.0	524.1	553.4	581.6	611.7	647.4	682.8	726.7	772.8	806.6	820.9	**96.7%**
N_2O	239.4	251.5	268.4	283.3	303.1	326.4	352.6	378.3	405.1	434.6	450.4	**57.1%**
Total	**740.4**	**775.6**	**821.8**	**864.9**	**914.8**	**973.8**	**1035.4**	**1105**	**1177.8**	**1241.2**	**1271.3**	**80.6%**

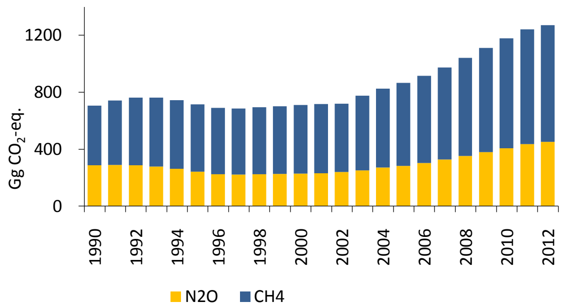


Figure 6.6 Trends of direct GHG emissions from Manure management

Total emission in the category for the period 1990-2012 has increased to 80.6%, increase in emissions was observed:

- CH_4 – 96.7%;
- N_2O – 57.1%.

Increase in GHG emissions in the category depends on increase in livestock, especially on growth of cattle population.

6.3.2 Methodology

CH_4 and N_2O emissions from manure management were estimated using Tier 1 of the Revised Guidelines for National Greenhouse Gas Inventories, IPCC, 1996 [3]. Calculations were performed for the following categories of livestock: cattle, including dairy ones, sheep, goats, horses, camels, donkeys, swine and poultry.

Estimation of CH_4 emissions was conducted separately for Surkhandarya region and the rest territory of Uzbekistan. as they are located in different climatic zones. For each climatic zone, their methane emission factors taken by default were used. Calculated for both climatic zones of the country, total methane emissions were summed up.

Estimation of N_2O emissions in the category "Manure management" was done as follows: total number of nitrogen (N) emitted for each type of animals and in each type of manure management system was multiplied to the emission factor for each type of storage system. After that summing up of emission by all systems and conversion of nitrogen (N) into nitrous oxide (N_2O) was made.

Activity data

Data of the State Committee of the Republic of Uzbekistan on Statistics on domestic livestock population was used for calculation.
See Table 6.8 on livestock population, thous. heads, 2010.
In accordance with [3], data were averaged for 3 years in calculations.

Emission factors

For each animal type a *default* emission factor from [3] was used:

- for CH_4 – Table 4-4, "Developing countries", page 4.6, Table 4-5, region "Asia", p. 4.7;
  - for Surkhandarya region – the column "Temperate climate" (annual average temperature is more than 15°);
  - for the rest regions of Uzbekistan – the column "Cool climate" (annual average temperature is less than 15°);
- for N_2O – formation of nitrogen contained in manure (Nex), Table 4-6, page 4.10, line "Asia and Far East".
  - share of nitrogen contained in manure, fallen on animal waste management system (AWMS). Table 4-7, p. 4.13, region "Asia and Far East";
  - N_2O emission factor for this AWMS – (EF_3), Table 4-8, p. 4.14;
  - conversion factor - 44/28.

6.3.3 Uncertainty and sequence of time series

Uncertainty of CH_4 and N_2O emissions in the category 4B "Manure management" was estimated in accordance with [5].

The same characteristics as in the category "Enteric fermentation" were used to estimate uncertainty of CH_4 emissions from manure management. Uncertainty of statistical information on the number of livestock was in the range of ± 5%. uncertainty of the default CH_4 emission factor amounted to ± 50%.

In estimation uncertainty of N_2O emissions from manure management. according to expert estimates of the Ministry of Agriculture and Water Resources, uncertainty of activity data amounted to ± 50%. Uncertainty associated with distribution of manure by manure management systems makes the greatest contribution to uncertainty of the activity data. Uncertainty of N_2O emission default factors amounted to ± 100%.

Combined uncertainty of CH_4 and N_2O emissions in the category "Manure management" in 2012 amounted to ±51% and 112%, respectively.

Calculations of uncertainties in all estimated Inventory categories are detailed in Annex 12.

For all years the same method and the same data set was used.

6.3.4 Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- of documentation on emissions sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

6.3.5 Recalculations in category

Recalculations in this category were not performed.

6.3.6 Planned improvements by category

In the framework of the future Fourth National Communication, it is expected to use the specified emission factors and national data on distribution of manure by manure management systems.

6.4 Rice cultivation – 4C

6.4.1 Description of source category

In Uzbekistan rice fields occupy a small part of the arable land. their maximum area reaches 182 thousand hectares in 1992. In the last decade, it has been a steady tendency to reduce the areas under rice crops. The minimum area for rice crops in 2011 was 23.1 thous. ha, reduction of the sown area under rice crops occurs due to the lack of water. The traditional rice-growing areas – Khorezm region and Karakalpakstan which cover 82% of area. In most other regions, areas covered by rice takes from 0.2 to 7 thous. ha.

In flooding of rice fields, in the absence of oxygen, an anaerobic decomposition of organic matter takes place in soil, and methane is formed which is emitted into air through water mass. Methane flows from rice production depend on the type and structure of soil, organic and mineral fertilizers, irrigation regime and other factors.

In national practice, rice is cultivated under condition of so-called "shortened flooding" with the application of mineral nitrogen fertilizers. Planting of rice usually begin in late April - early May. Seeding is carried out in large alignment cotters by grain seeding machines or manually. Initially, water layer is created in the field after crop sowing. At the time of plants germination, water is discharged for 1-2 days. Standing water layer is created in the field only after the phase of mass shooting with the appearance of the second - third leave. After the appearance of leaves, a layer of water increases. When rice is ripen, water is discharged from the cotters and rice is ready for harvesting.

The length of vegetation period averages 125-140 days depending on the varieties sown, the amount of effective temperature and other factors. There are varieties of rice – "Nukus-21", "Uzbek-5", which mature in 105-115 days. The average rice yield is 25 c/ha [50].

In 2010, 69.15 thous. ha were occupied by rice crops [48].

Emissions from rice cultivation in 2010 amounted to 76.0 Gg CO_2-eq.

Trends of emissions

CH_4 emissions from rice cultivation for the period 1990-2012 are given in Table 6.14 and Figure 6.7.

Table 6.14 CH_4 emissions from Rice cultivation, Gg CO_2-eq.

CH_4	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gg CO_2-eq.	261.7	273.5	292.5	296.7	287.7	290.2	305.9	296.1	284.4	248.9	187.9	132.1
CH_4	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	$\Delta_{(2012-1990)}$
Gg CO_2-eq.	125.9	140.9	134.1	100.4	90.2	79.8	70.2	82.0	76.1	94.2	83.5	**68.1%**

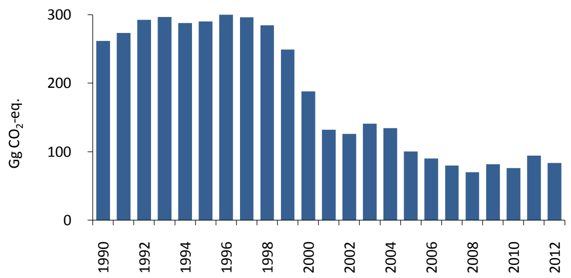


Figure 6.7. Trends of CH_4 emissions from Rice cultivation

For the period 1990-2012, decrease in methane emissions to 68.1%, or by 3.1 times was observed.

Decrease in methane emissions after 1999 was brought about by a sharp decline in areas covered by rice.

6.4.2 Methodology

CH_4 emissions from rice cultivation was estimated in accordance with [3], Tier 1 methodology was used.

In estimation of methane emissions from rice cultivation, the following was taken into account:
- water regime;
- application of organic and mineral fertilizers.

Methane emission factors for calculation were taken by default.

All land occupied by rice cultivation refer to the irrigation water regime intermittently flooded with a number of aeration more than one.

Activity data

State statistics data averaged over 3 years were used on the areas occupied by rice for calculations:
- 2009 – 43.56 thous. ha;
- 2010 – 69.15 thous. ha;
- 2011 – 23.10 thous. ha (statistical yearbook "Totals of final counting of sown area under agricultural crops for the 2010 yield (in all lands)", similar yearbooks for the period 2006-2012).

Emission factors

When ***fertilizers are applied*** to the rice fields, type of flooding is ***intermittently flooded. with multiple aerations***, the relevant ***default*** factors from [3] were employed, such as:
- ***Scaling factor* – 0.2** (Table 4-10, p. 4.21).
- ***Correction factor*** – **2** (p. 4.16, Item 3).
- ***Factor integrated* for vegetation period** – **20 g/m^2** (Table 4-11, p. 4.22, line "Arithmetic average").

6.4.3 Uncertainty and sequence of time series

Uncertainty of methane emissions was not estimated.

The estimated total error of methane emissions from rice fields is ±25-30%, including ±20% due to uncertainty of the emission factor and ±5-10% due to the inaccuracy of statistical information.

For all years the same method and the same data set was used.

6.4.4 Quality control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:
- of documentation on emissions sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

6.4.5 Recalculations by category

Recalculations were not performed.

6.4.6 Planned improvements by category

In the course of further research the following is possible:
- clarification of the factors for calculation of methane emissions;
- a more detailed account of the irrigation regime, farming methods, soil characteristics;
- specification of information on length of the growing season for new varieties of rice.

6.5 Agricultural soils – 4D

6.5.1 Description of source category

Nitrous oxide is formed in the soil permanently by natural way.

For the most agricultural lands. with the change of available carbon in soil, which is regulated by the methods of soil treatment and land use, as well as an additional supply of organic nitrogen to the soil, the rates of nitrification and denitrification are enhanced, thereby the intensity of nitrous oxide formation is raising and its flow into air is increasing.

Currently, mineral fertilizers in agricultural production in Uzbekistan are used in quantities below standard. It depends on their increased cost, as well as dependence on imports. The most common nitrogen fertilizer used is ammonium nitrate, which contains 34% of pure nitrogen [53].

Total direct emissions of nitrous oxide from agricultural fields is obtained by adding the emissions caused by (1) use of mineral fertilizers, (2) inflow of nitrogen from animal waste, from the cultivation of nitrogen-fixing crops, from crop residues and multiplying the amount obtained to the conversion factor 44/28.

Total indirect nitrous oxide emission is obtained by adding (1) emissions resulting from atmospheric deposition of NH_3, NOx, and (2) emissions caused by leaching, and multiplying the amount obtained to the conversion factor 44/28.

Calculation of total nitrous oxide emissions from agricultural soils was conducted on the basis of preliminary calculations of total direct and indirect emissions of nitrous oxide. emission from grazing animals in accordance with [3].

N_2O emissions from agricultural soils in 2010 were the following (Figure 6.8):

- Indirect emission – 2,027 Gg CO_2-eq.;
- Direct emission – 3,038 Gg CO_2-eq.;
- Grazing – 2,533 Gg CO_2-eq.;
- Total emission – 7,598 Gg CO_2-eq.

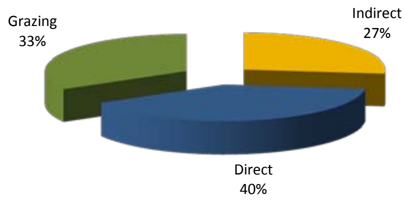


Figure 6.8 Structure of N_2O emissions from Agricultural soils, 2010

Trends of emissions

N_2O emissions from agricultural soils for the period 1990-2012 are given in Table 6.15 and Figure 6.9.

Table 6.15 N_2O emissions from Agricultural soils, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Indirect	3531	3501	3513	3407	3307	3096	3054	3089	3066	3008	2909	2741
Direct	5153	5112	5108	4929	4754	4421	4328	4334	4329	4241	4113	3887
Grazing	1536	1617	1680	1683	1642	1555	1490	1467	1489	1504	1517	1531
Total	**10222**	**10230**	**10301**	**10019**	**9703**	**9072**	**8872**	**8890**	**8884**	**8753**	**8539**	**8159**
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Indirect	2822	2671	2585	2114	1869	1742	1788	1910	2027	2155	2213	**-37.3%**
Direct	4021	3843	3723	3106	2787	2626	2696	2874	3038	3212	3286	**-36.3%**
Grazing	1578	1652	1755	1795	1906	2035	2234	2387	2533	2677	2752	**+79.2%**
Total	**8421**	**8166**	**8063**	**7015**	**6562**	**6403**	**6718**	**7171**	**7598**	**8044**	**8251**	**-19.3%**

Decrease in total N_2O emissions to 19.3% was observed for the period 1990-2012, in particular:
- decrease:
  - indirect emission – 37.3%;
  - direct emission – 36.3%;
- increase:
  - grazing – 79.2%.

Total trend of nitrous oxide emissions from agricultural soils tends to decrease due to the decrease of values of direct and indirect emissions of nitrous oxide. Decrease in the amount of mineral fertilizers applied in the fields affects the decrease in the values of these parameters.

Trend of nitrous oxide emission from grazing tends to increase since 2007.

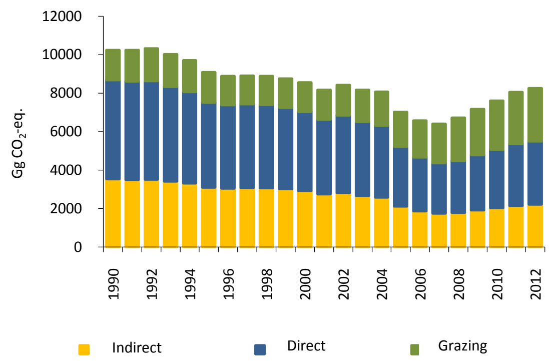


Figure 6.9 Trends of N_2O emissions from Agricultural soils by categories

6.5.2 Methodology

N_2O emissions from agricultural soils were estimated in accordance with [3].

Direct N_2O emissions (kg N/year) were calculated using Equation 7 on p. 4.38 not taking into account N_2O emissions from processing of peat soils (as there are no peat soils on the territory of Uzbekistan).

F_{SN} – flow of nitrogen caused by the use of mineral fertilizers was calculated by Equation 1 on p. 4.33. F_{AW} – flow of nitrogen from animal waste is calculated by Equation 2 on p. 4.33.

Table 6.16 Crop production data, thous. c

Crop	2009	2010	2011
Legumes	256.3	387.3	387.2
Grain crops	69,178.6	69,665.3	67,033.9
Technical	34,135.2	34,143.8	35,087.9
Oil-bearing plants (without soya)	574.8	593.3	445.8
Soya	1.0	0.7	6.8
Vegetables	82,379.5	91,456.7	100,389.4
Feeding crops	38,691.7	38,712.9	36,629.1
Grass (collection for hay)	18,672.0	18,245.7	17,316.2

F_{BN} – total flow of nitrogen from nitrogen-fixing crops. calculated by Equation 5, p. 4.35.

F_{CR} – total flow of nitrogen from crop residues calculated using Equation 6, p. 4.36.

N_2O emissions from grazing on pastures and paddocks were calculated by Equation 8, p.4.38.

Indirect N_2O emissions were calculated in accordance with Equation 9, p.4.40.

Recalculation of the obtained values of kg N/yr in kg N_2O - N/yr was carried our by multiplying of the values obtained to the conversion factor = 44/28.

Total emission of N_2O (kg N_2O - N/yr) was calculated in accordance with Equation 10, p.4.41 as the sum of direct emissions, animal waste emissions and indirect emissions.

Activity data

1. The amount of nitrogen fertilizers applied to soil provided by the State Committee of the Republic of Uzbekistan on Statistics amounted to 421.05 thous. tons in 2010.
2. Data on livestock population – see Table 6.8 (provided by the State Committee of the Republic of Uzbekistan on Statistics).
3. Data on the volumes of plant production (statistical yearbooks of 2006-2012 "Gross yield of agricultural crops in the originally-recorded weight and weight after the 2010 harvest (in all lands)", see Table 6.16.

In order to calculate annual parameters, data were averaged over 3 years in accordance with [3].

Emission factors

The same emission factors were used in calculations as in the preparation of the Second National Communication.

To convert data in the initial recorded weight into dry biomass units, *default factor* (0.85 = 1 – 0.15) from [3] was used (p. 4.36).

Emission factors:

- *nitrogen* EF_1 = 0.0125 (0.0025 – 0.0225) kg N_2O-N/kg N applied, [3], Tables 4-18, p. 4.37.
- EF_4 = 0.01 (0.002 – 0.02) kg N_2O-N/kg emitted NH_3-N+NO_x–N, [3], Tables 4-18, p. 4.37.
- EF_5 = 0.025 (0.002 – 0.12) kg N_2O-N/kg N from leaching /washout [3], Tables 4-18, p. 4.37.
- $Frac_{NCRBF}$ = 0.03 kg N/ kg of dry biomass from [3], Tables 4-17, p. 4.35.
- $Frac_{GASF}$ = 0.1 kg NH_3-N + NOx-N/kg N of mineral fertilizers applied, [3], Tables 4-17, p. 4.35.
- $Frac_{FUEL}$ = 0 kg N / kg N emitted, [3], Tables 4-17, p. 4.35.
- $Frac_{GASM}$ = 0.2 kg NH_3-N+NOx-N/kg N of animal waste, [3], Tables 4-17, p. 4.35.
- $Frac_{NCR0}$ = 0.015 kg N / kg of dry biomass. [3], Tables 4-17, p. 4.35.
- $Frac_{LEACH}$ = 0.3 kg N/kg N of mineral fertilizers and manure used as fertilizers [3], Tables 4-17, p. 4.35.
- *Formation of nitrogen contained in manure* (Nex) [3], Tables 4-6, p. 4.10, line "Asia and Far East".
- *Fraction of nitrogen contained in manure which is in this storage system* (AWMS), [3], Table 4-7, p. 4.13, region "Asia and Far East".
- *Fraction of nitrogen* contained in manure, formed from *grazing animals* = 0.02 kg N/kg N [3], Annex A, Tables A-1, p. 4.47, column "Pastures and paddocks".
- *Fraction of crop residue removed from the field* = 0.75 kg N/kg plant nitrogen (national factor provided by the Research Center at the Interstate Commission for Water Coordination).
- *Fraction of burned residues* = 0.05 kg N/kg plant nitrogen (national factor provided by the Research Center at the Interstate Commission for Water Coordination).
- *Conversion factor* = 44/28 [3].

6.5.3 Uncertainty and sequence of time series

Uncertainties of N_2O emissions in the category 4D "Agricultural soils" were estimated in accordance with [5].

Statistical data, the uncertainty of which does not exceed ± 5%, were used as activity data. Default factors, the uncertainty of which is more than ± 200%, were used as emission factors.

Calculations of uncertainties in all estimated Inventory categories are detailed in Annex 12.
For all years the same method and the same data set was used.

6.5.4 Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- of documentation on emissions sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

6.5.5 Recalculations in category

Recalculations were not performed.

6.5.6 Planned improvements by category

Since the category is key category, in the framework of the future Fourth National Communication, it is expected to specify the values of calculated factors taking into account the peculiarities of the country and activity data.

6.6 Field burning of agricultural residues – 4F

6.6.1 Description of source category

Since 2005, data on burning stubble crops have been excluded from the calculation of emissions from biomass burning. as the following Resolutions of the President of the Republic of Uzbekistan were adopted:

- #PP-76 dated May 16, 2005 "On organizational measures for harvesting grain cereal crops" on banning of stubble burning [43].
- #PP-865 dated May 13, 2008 "On organizational measures for land ploughing, free from seeding grain cereal crops" [44].

In this regard, calculations under the category for the period 2005-2012 were not carried out.

Currently, after harvesting of grains crops, straw residues are removed from the fields, ploughed and prepared for re-seeding of agricultural crops.

In the Second National Communication for the period 1990-2004, Inventory covers burning of cereals stubble – wheat and barley (4 F 1 CEREALS). In the category, the following gases emissions were estimated: methane, nitrous oxide, carbon monoxide and nitrogen oxides.

Trends of emissions

Direct GHG emissions from field burning of agricultural residues for the period 1990-2005 are given in Table 6.17 and Figure 6.10.

Table 6.17 Direct GHG emissions from Field burning of agricultural residues, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	23.2	22.5	28.1	33.8	44.5	58.2	70.1	77.5
N_2O	8.7	9.6	10.2	12.4	16.3	21. 2	25.7	28.2
Total	**31.9**	**36.1**	**38.4**	**46.2**	**60.3**	**79.4**	**95.9**	**105.7**
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	83.2	86.2	87.5	98.9	114.1	126.4	132.1	0.0
N_2O	30.4	31.4	31.9	36.3	41.7	46.2	48.2	0.0
Total	**113.6**	**117.6**	**119.4**	**135.2**	**155.8**	**172.6**	**180.3**	**0.0**

Change in methane and nitrous oxide and total emissions for the period 1990-2012: decrease to 100% due to prohibition on field burning of agricultural residues after 2004.

Indirect GHG emission from field burning of agricultural residues for the period 1990-2005 are given in Table 6.18 and Figure 6.11.

Change in CO and NOx emissions for the period 1990-2012: decrease to 100% due to prohibition on field burning of agricultural residues after 2004.

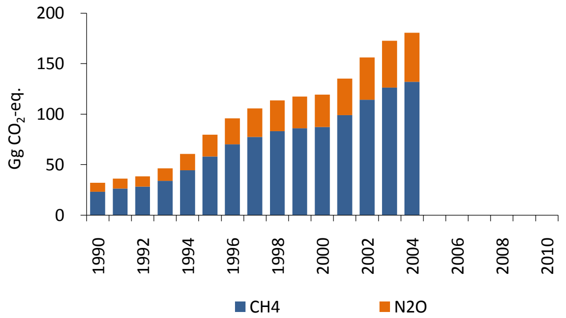


Figure 6.10 Trends of direct GHG emissions from Field burning of agricultural residues

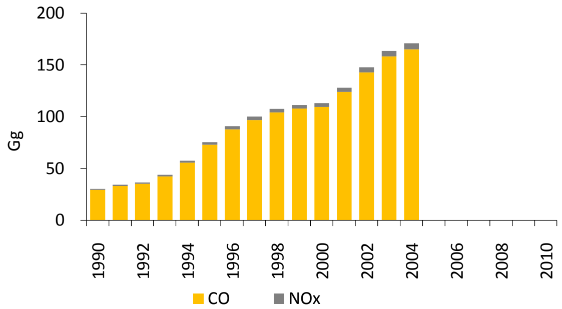


Figure 6.11 Trends of indirect GHG emissions from Field burning of agricultural residues

Table 6.18 Indirect GHG emissions from Field burning of agricultural residues, Gg

Gas	1990	1991	1992	1993	1994	1995	1996	1997
CO	29.3	33.1	35.3	42.3	55.5	72.7	87.8	96.7
NOx	1.0	1.1	1.2	1.4	1.9	2.5	3.0	3.3
Gas	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CO	104.0	107.7	109.3	123.8	142.7	158.0	165.1	0.0
NOx	3.5	3.7	3.7	4.2	4.9	5.4	5.6	0.0

6.6.2 Methodology

GHG direct and indirect emissions excluding CO_2 emissions from field burning of agricultural residues were estimated in accordance with [3].

Activity data

Until 2005 only cereal residues were burnt in the fields – wheat, barley, rye. For calculations of 1990-2004, the data of the state statistics on crop production were used (yearbooks “Gross yield of agricultural crops in the originally recorded weight and weight after harvesting of XXXX (in all lands)”).

Emission factors

Emission factors are given only for wheat (barley and rye residues were burned in the fields too but their share in total cereal crop production is insignificant, so wheat emission factors were applied to all cereal crops).

- Residues/production ratio = 1.575 [16].
- *Dry biomass/total biomass ratio* = 0.83 (in range of 0.78-0.88), [3], p. 4.29, Tables 4-15, line "Wheat".
- Fraction of biomass burned in the fields = 0.38 [16].
- Fraction oxidized while burning = 0.9 [3].
- Fraction of carbon in dry biomass = 0.45 [16].
- *Nitrogen/carbon ratio* = 0.012, [3], p. 4.29, Tables 4-15, line "Wheat".
- *Emission ratios* [3], p. 4.31, Tables 4-16*:*
  - CH_4 = 0.004;
  - CO = 0.06;
  - N_2O = 0.007;
  - NOx = 0.121.

6.6.3 Uncertainty and sequence of time series

Uncertainty of non-CO_2 emission from burning of agricultural residues was not estimated. For all years the same method and the same data set was used.

6.6.4 Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- of documentation on emissions sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

6.6.5 Recalculations by category

Recalculation of emissions by this category was carried out for 2005. Direct and indirect greenhouse gas emissions were calculated in the Second National Communication for that year, as at that time there was no information about the legal banning of burning stubbles of grain cereal crops. Recalculation for 2010 showed the reduction of GHG emissions in CO_2-eq. in the "Agriculture" sector – to 209.5 Gg CO_2-eq., or to 1.0%.

6.6.6 Planned improvements by category

In the framework of the future Fourth National Communication, it is not supposed to estimate emissions in the category.

7. LAND USE CHANGE AND FORESTRY – 5

7.1 Sector review

Land resources of Uzbekistan make up 448.97 km^2, 44.410.3 thous. ha of land including reserve lands are in use of enterprises, organizations, citizens, institutions. In structural terms, the country's Land Fund is divided into eight categories. Land categories and area occupied by them according to data of Goskomzemgeodezkadastr for 2012 are given in Table 7.1

Table 7.1 Land Fund categories of the Republic of Uzbekistan

№	Land Fund categories	Total area		of them, irrigated	
		thous.ha	%	thous.ha	%
1	For agricultural purposes	20481.1	46.1	4211.4	9.5
2	Settlements	214.1	0.5	49.9	0.1
3	Industry, transport, communication, defence, and etc.	914.5	2.1	12.0	0
4	Nature protection, health improving and recreation purposes	75.9	0.2	0.9	0
5	Historical and cultural purposes, occupied with objects of intangible cultural heritage.	6.2	0	-	-
6	Forest Fund	9636.9	21.7	31.4	0
7	Water Fund	831.4	1.9	4.6	0
8	Reserve land	12250.2	27.6	2.0	0
	Total	**44410.3**	**100.0**	**4312.2**	**9.7**

Agricultural land is divided into irrigated and non-irrigated (rainfed) land, arable land, hayfields, pastures, land under fruit plantations and vineyards.

Settlements – land located within boundaries of cities, villages, rural settlements. Their boundaries separate this land from the other land. Suburban areas include land outside urban boundaries that make the city a single social, natural and economic area. In suburban areas, there is land for suburban agricultural production, recreation zones, reserve land for city development.

Forest Fund includes land covered with forest, and not covered with forest, but allocated for forestry needs. Khokim of district in coordination with the State forestry agencies may provide forest land, under the lease, for temporary use to agricultural enterprises, institutions and organizations for agricultural needs.

Water Fund includes land occupied by water bodies (rivers, lakes, reservoirs, etc.), hydraulic facilities and other water facilities, as well as the right of way along the banks of ponds and other water bodies, allocated in the established order for enterprises, institutions and organizations for water management needs.

Reserve land is all land not related to categories of land fund specified in paragraphs 1-7, Article 8 of the Land Code of the Republic of Uzbekistan, and not provided in the possession, use, lease and ownership of legal and physical persons and entities [51].

According to data of Goskomzemgeodezcadastr of the Republic of Uzbekistan for the period 1990-2012:

- agricultural area decreased from 28,080.4 thous. ha to 25,251.5 thous. ha mainly due to allocation of pastures for forestry purposes.
- the area of hayfields and pastures declined from 23,475 thous. ha to 20,650.3 thous. ha.
- forest land area increased over the period from 1,410 thous. ha to 3,219.9 thous. ha.
- the area of gardens and horticultural and vineyard associations increased from 451 thous. ha to 691.7 thous. ha.

Table 7.2 Removals in the sector "Land-use change and forestry", 2010

Category	Removals, Gg CO_2
5 A Changes in forest and other woody biomass stocks	-3,589.5
5 C Abandonment of managed lands	0
5 D CO_2 emissions and removals from Soil	+524.3
Total	**-3,065.2**

The following was estimated in "Land-use change and forestry" sector:

- emissions/sinks in the categories "Changes in forest and other woody biomass stocks";
- CO_2 emissions and removals from Soil associated with land-use change.

Estimates of CO_2 emissions /removals for the sector in 2010 are listed in Table 7.2. Share of sinks in LUCF sector in 2010 was the following:

- 3.0% of total CO_2 emission;
- 1.5% of total GHG emission.

Table 7.3 presents CO_2 emissions/removals in "Land-use change and forestry" sector for the period 1990-2012.

Table7.3 Emissions/removals in "Land use change and forestry" sector, Gg CO_2

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Changes in forest	-421	-421	-421	-399	-399	-399	-399	-399	-751	-751	-751	-751
Land use	-1145	-1246	-1419	-1196	-953	-998	-1248	-1249	-597	-647	-267	781
Total	**-1566**	**-1667**	**-1839**	**-1596**	**-1352**	**-1397**	**-1647**	**-1649**	**-1349**	**-1398**	**-1018**	**30**
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	
Changes in forest	-751	-562	-562	-562	-562	-562	-3590	-3590	-3590	-3590	-3590	
Land use	455	-23	-390	980	671	1106	1355	1029	524	1071	732	
Total	**-296**	**-586**	**-953**	**417**	**108**	**543**	**-2235**	**-2561**	**-3065**	**-2519**	**-2858**	

The categories in this sector were not estimated as the key ones.

Transition of CO_2 removals to sinks from cultivated soils after 2000 is caused by a stable reduction in pasture areas (for the 20-year period by an average of 5%), as well as a significant reduction in the area sown with rice (3 times).

7.2 Changes in Forest and other woody biomass stocks – 5A

7.2.1 Description of source category

The forests of the Republic form a single State Forest Fund, which consists of:

- forests of national importance;
- forests in charge of the State forestry authorities;
- forests which are in use of other agencies and entities (khokimiyat of Tashkent region, shirkats, farms, dekhkan farms, the State Committee for Nature Protection, the State Committee for Geology, the State Enterprise "Uzavtodor", Railways Department, irrigation forestries, the Academy of Sciences).

Main Administration on Forestry (MAF) of the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan is responsible for the forests of the Republic of Uzbekistan in accordance with the law "On Forest" (1999) [52]. In the country there are 16 central forestries, 48 forestries, 5 forest and hunting farms, 6 specialized forestries, 7 scientific and experimental stations, 1 National Park, 5 state reserves and 1 biosphere reserve. There are also 83 arboreta, with a total area of 712 ha. Of them, 33 temporary and 50 permanent arboreta. At the moment, more than 60 species of tree and shrub plantings are grown for the creation of forests.

Total forest area in charge of MAF as of 01.01.2011 amounted to 8.98 mil. ha (20.2% of the republic area and 96% of the total area of forest fund). The area of the State Forest Fund is formed from:

- **forest land** – land for afforestation. Forest land includes such categories as forest covered area, non-closed-up crops, sparse forests, fire-sites, cut sites, and glade abandoned sites. Non-closed plantings form a separate category of forest land – young non-closed-up plantings. All land not covered by forest are intended for afforestation or reforestation. The area of MAF is constantly changing in the direction of increasing.
- **non-forest land** – land which requires the additional reclamation for forest-growing.

Plots covered by forest are irregularly distributed over the territory – 80% of forests are concentrated in Karakalpakstan, Navoi and Bukhara regions, less than 1% - in Syrdarya, Samarkand regions and Fergana valley.

Forest cover of the Republic of Uzbekistan amounted to about 6.7 % as of 01.01.2011. The low level of forest cover is caused by the irrational exploitation of forests and the high percentage of forest plantations' deaths.

Productivity of forests in Uzbekistan is low. The stock of wood per 1 ha of mature and over-mature forest stands on the average amounted to 6 m^3, coniferous forest – 29 m^3, hardwood forest – only 6 m^3, including saxaul – about 3 m^3. It is caused by the general aridity of the country.

Forests in Uzbekistan are significantly differ in their natural composition, therefore they are divided by natural zones:

- Mountain forests;
- Flood plain/tugai forests;
- Desert forests.

Forests of the mountain area occupy about 10.3% of the total forest area. They are located mainly in Jizzakh, Surkhandarya, Kashkadarya, Navoi, Samarkand and Tashkent regions. In the mountainous zone, the forests can be divided into juniper, pistachio, almond, walnut, apple, hawthorn and mixed with wild rose bushes, barberry, cherry plum.

Desert forests make up a large part of the forest fund of the Republic – 86.6% and consist of the saxaul tangles with the presence of other shrubs – psammophytes. In sand-desert zone, there are about 110 species of trees and shrubs. The species composition of the forest vegetation in this zone includes saxaul black (height – up to 12 meters) and white saxaul (height – from 2 to 5 m). The average age of saxaul is 15-18. Saltworts of two types are widespread in sand and desert zone – saltwort of Richter and saltwort of Paletsky, as well as kandims which are about 90 species, they are extremely heat- and drought-resistant and have a height of 1-2 meters, and the arboreous kandims have a height of 3-5 meters. The average age is from 6 to 20, then their lives can be prolonged due to the resumption of the second growth to 10-20 years. In the tangles of shrubs tamarisk can be found. Almost all plants have rough branches and small narrow leaves or thorns. Wood is dense, root system is long.

Forest fund of valley/floodplain area of the republic amounts to more than 3% of total forest area. Lowland forests are mainly an artificially planted forest plantations of poplar, ash, maple, sycamore (plane trees), elm and other fast-growing fruit trees and conifers. The area of floodplain /tugai forests amounts to 1.2% of the total forest area. The largest tugai forests are concentrated along the river banks of plains, especially in the Amudarya river delta, on the banks of Syrdarya and Zarafshan River. Tree species in lowland riparian forests are turanga, wild olive, willow and "tamarisk".

Destruction of forests, cutting of trees are carried out not only by physical persons, but authorized with the permission of local authorities, due to imperfection of State control system. Especially significant damage to forest resources causes excessive and uncontrolled livestock grazing, the destruction of tree and shrub plantings.

In recent years (2003-2012), there are changes in the forest statistical approaches, which affect the GHG Inventory data in the forest sector in particular to assess the areas occupied by the main forest-forming species. In particular, there are the following changes in forest statistical approaches:

- Such forest representatives as persimmon, bird cherry, black cherry, hawthorn, juniper shrub, buckthorn are ceased to be considered as the main forest tree species.
- Data on the distribution of areas of forest species by age classes are doubtful. This applies mainly to the young age class imbalance in the structure of crops, which is dominated by the older age groups.
- No information on the completeness of forest stands, which can be judged on crown density, that is, how thick or thin our forests. The statistics of the previous years showed that the fullness of our forests was mainly low, and this suggests a low potential for use of even land covered by forest.

All these facts indicate the deteriorating quality of forest statistics, increasing data uncertainty on forests of the country.

Forests in Uzbekistan are natural sinks of carbon dioxide. Emissions and sinks in the category "Changes in forest and other woody biomass stocks" were calculated using the methodology of the IPCC Guidelines, 1996 [3] to woody biomass stocks. Estimation of changes in carbon stocks in this category was made for the forest areas that serve as forest land at least for 20 years. Due to lack of data on the history of land converted to forest areas, as well as due to imperfections of the existing forestry inventory system, estimation of carbon stock changes on such lands was not carried out.

According to expert estimates (E.K. Botman, 2015), the most capacious sinks are desert forests of Navoi region, followed by Karakalpakstan, Bukhara, Khorezm regions, i.e. the main sink falls on the desert forests – saxaul and shrub communities, despite their low productivity, but due to large area occupied.

Trends of emissions

Removals in this category are estimated once in every 5 years, in compliance with the frequency of State accounting for forest resources. In the following 4 years estimates are taken equal – the closest in time to 1990 State forest resources Inventories were conducted in 1988, 1993, 1998, 2003 and 2008.

Due to changes in approaches to forest inventory after 2003 there was a significant increase in forest area. According to reports of the State Forest Fund, the following has occurred:

- 5-fold increase in the area occupied by shrubs on the territories of Karakalpakstan and Navoi region;
- increase in the area of floodplain forests, including areas occupied by poplar – 2.2 times, other breeds – 8.3 times;
- increase in the area under juniper (and other conifers) in mountain forests – 1.1 times.

In the result of this, estimation on the absorption of carbon dioxide increased by 8.5 times.

Table 7.4 shows CO_2 removals in the "Change in forests and other woody biomass stocks" category, covering the period 1990-2012 (according to years of forest inventory).

Table 7.4 CO_2 removals in the category "Changes in Forest and other woody biomass stocks",Gg CO_2

CO_2	1988	1993	1998	2003	2008
Gg	-421	-399	-751	-562	-3,590

7.2.2 Methodology

Estimation of changes in the forest biomass and calculation of CO_2 removals in the category was carried out based on Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories [3].

Methodological Tier 1 was used, Changes in carbon stocks in dead organic matter and forest soils are not estimated, if Tier 1 was selected.

Calculations were carried out according to the algorithm specified in the IPCC Software, 1996. The worksheets were modified to carry out calculations.

The example of calculating CO_2 removals by the forest biomass for 2010 is given in Annex 11.

Besides default data, some national factors were used in calculations.
Considerable increase is featured for juniper, saxaul, poplar, tamarisk, saltwort and other shrubs, and for other species increase is within rounding, so plants were grouped by natural zones:

I. Mountain forests:
   1) Juniper arboreal;
   2) Other woody species growing mainly in mountains: (maple, birch, apricot, hackberry, almond, walnut, mountain ash, cherry plum, pistachio, bird cherry tree, apple).

II. Valley/floodplain forests:
   1) Poplar (Asiatic poplar);
   2) Other arboreal species growing mainly in valleys and floodplains: ash tree, elm, locusts, bastard acacia, willow arboreal, mulberry.

III. Desert forests:
   1) Saxaul.

IV. Shrubs.

Biomass gain was calculated with application of national factors in compliance with the instruction on State forest resources Inventory [28, 29].

Activity data

Data on forest areas given in Table 7.5 were taken from the State forest resources Inventory [26-29].

To estimate CO_2 removals in 2010, the data of 2008 were used.

Table 7.5 Area under Forest by prevailing species 2008, thous. ha

Type of vegetation	Species groups	Area, thous. ha
Mountain forests	Juniper arboreal	196.16
	Other arboreal species growing in mountains	44.17
Flood-plain forests	Poplar (Asiatic poplar)	62.62
	Other arboreal species growing in valleys and floodplains	39.9
Desert forests	Saxaul	1,141.48
	Shrubs	1,343.22

Due to lack of statistical reporting for 2006-2012, data on wood produced, wood fuel consumption and other uses of wood are represented by the same numerical values, which are used in calculation of carbon annual losses by forest biomass for the period 2005-2008 in the Second National Communication (Table 7.6).

Table 7.6 Data on wood utilization averaged over 2005-2008, thous. m^3

Wood utilization	Species group	Amount, thous. m^3
Amount of wood produced	Poplar (Asiatic poplar)	3.35
Total wood fuel consumption	Poplar (Asiatic poplar)	4.56
	Saxaul	46.11
Other wood utilization	Poplar (Asiatic poplar)	0.10
	Saxaul	0.36

In the current statistics there are also no data on the species composition of wood produced. Therefore it was accepted that:

- timber is wood of poplar (asiatic poplar);
- firewood is wood of saxaul and poplar.

Emission factors

For the calculation of CO_2 removals the national factors were used.

Average gain in damp wood was calculated based on the data of the State accounting for forests [26-29]. For the conversion of bulk unit of wood measurement (m^3) to weight units. density of dry substance of wood was used. *Density of dry wood matter* is given in Table 7.7. Since density of wood is a dynamic component and depends on many factors – habitat, place of sampling, etc., the results of study conducted in Uzbekistan were used for calculations [30]. At the same time, the following simplifications were made for the selected tree and shrub species groups:

- it is known that the juniper forests form three types of juniper – Zeravshan, Turkestan, and hemispherical. Zeravshan juniper (Juniperus seravshanica Kom.) prevails according to both the occupied area and stock, and therefore density is taken based on it.
- for the other mountain species of trees physical and mechanical properties of walnut (Juglans regia L.) were taken.
- for poplar – properties of bloomy poplar (Asiatic poplar) (Populus pruinosa Schrenk).
- other valley and floodplain forests - properties of Siberian elm (Ulmus pumila L.).
- for saxaul – properties of white saxaul (Haloxylon persicum Bge.), prevailing according to the occupied area and stock.
- for shrubs – the properties of narrow-leaved oleaster (Elaeagnus angustifolia L.).

Table7.7 National factors for CO_2 removals calculations by the category "Changes in Forest and other woody biomass stocks"

Species group	Average gain in damp wood, m^3/ha	Density of dry wood matter, kg/m^3
Juniper arboreal	0.157	440 ± 4.9
Other arboreal species growing in mountains	1.027	545 ± 5.6
Poplar (asiatic poplar)	3.081	395 ± 5.3
Other arboreal species growing in valleys and flood-plains	1.587	710 ± 5.0
Saxaul	0.814	867 ± 9.4
Shrubs	2.019	510 ± 6.7

Share of carbon in the dry biomass was accepted equal to 0.5 by default – Chapter 5.3, step 5, item 8, p.5.17 [3].

7.2.3 Uncertainty and sequence of time series

Uncertainties were not estimated as averaged factors were used and activity data for each year of the forestry inventory is applied over the next 4 years. For all years the same method and the same data set was used.

7.2.4 Quality Assurance/ Quality Control

QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- of documentation on emissions sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

7.2.5 Recalculations by category

Recalculation of emissions by this category was not carried out.

The test calculation of CO_2 removals by this category for the whole set of data for the period 1998-2012 was made in accordance with Good Practice Guidance for Land Use Change & Forestry, IPCC, 2003 [6], that was not included in the Inventory.

The result obtained differs considerably from that calculated in accordance to [3], data are given in Table 7.8.

Table 7.8 Comparison of removals in the category "Changes in forest and other woody biomass stocks", calculated by two methods, Gg CO_2

	1988	1993	1998	2003	2008
Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories	-420.8	-399.4	-751.1	-562.5	-3,589.5
Good Practice Guidance for Land Use Change & Forestry, IPCC, 2003	-981.3	-930.1	-1,750.0	-1,310.0	-8,148.5

As seen from Table 7.8, method of calculation according to LULUCF GPG 2003 gives significantly higher values of CO_2 removals in comparison with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. For further implementation of this methodology the values of national factors are needed to be improved. The current Inventory includes the calculation of the IPCC methodology of 1996.

7.2.6 Planned improvements by category

It is planned to update the values of national factors used in calculations, as well as the detailed activity data, including the number of produced wood and fuel wood.

In the framework of the future Fourth National Communication, it is expected to estimate removals by category in accordance with [7]. It is also planned to calculate emissions of carbon dioxide and other gases from forest fires.

7.3 Abandonment of managed lands – 5C

7.3.1 Description of source category

In the preparation of the Second National Communication it revealed that natural conditions in all abandoned managed land are such that natural reforestation was impossible without additional costly reclamation preparation, even in case when these abandoned lands were previously forest areas. On these lands only herbaceous vegetation is restored. Annual growth rate of surface biomass of herbaceous vegetation is equal to "0" [5]. Removals in this category for Uzbekistan are equal to "0", respectively. Therefore in the future calculations in this category are not envisaged.

Information on land areas by category "Deposits" for the period 1990-2005 was provided by Goskomzemgeodezkadastr of the Republic of Uzbekistan.

7.4 CO_2 emissions and removals from Soil – 5D

7.4.1 Description of source category

While estimating CO_2 emissions and removals in land use change and management, the following land-use systems were taken into consideration:

- Tillable lands;
- Perennial arboreal plants (gardens, garden nurseries, mulberries, vineyards, etc.);
- Fallow lands and lands under meliorative development;
- Hayfields;
- Pastures;
- Household lands and lands of horticultural and vegetable raising farms.

According to [31-34]:

- the majority of soils in Uzbekistan belong to the group of soils containing minerals of highly active alumina (highly active mineral soils according to IPCC classification);
- there are no soils containing minerals of low active alumina in Uzbekistan as well as volcanic and podzol soils in Uzbekistan;
- sandy soils occupy only 3.5% of the total area (they are named *desert sandy soils* according to the classification adopted in Uzbekistan);

- soils of wetlands (*marsh soils* according to the classification adopted in Uzbekistan) occupy small areas and are used for rice cultivation.

Emissions in 2010 in this category amounted to 524.0 Gg CO_2.

Trends of emissions

CO_2 emissions / removals from cultivated soils in land use change for the period 1990-2012 are given in Table 7.9 and Figure 7.1.

Table 7.9 CO_2 emissions/removals from Cultivated soils, Gg CO_2

CO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gg	-1145.4	-1246.2	-1418.6	-1196.1	-953.1	-998.0	-1247.7	-1249.2	-597.5	-646.7	-267.4	781.5
CO_2	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Gg	454.9	-23.3	-390.2	979.9	670.8	1105.5	1354.8	1028.5	524.3	1070.7	731.5	

Transition from CO_2 removals to sinks from cultivated soils after 2000 is caused by a stable reduction in pasture areas (for the 20-year period on the average to 5%), as well as a significant reduction in the area sown with rice (3 times).

7.4.2 Methodology

Estimates of changes in the carbon content of mineral soils in the category were held by the separate land use system in accordance with [3] based on data on changes in land use and management activities for the 20-year period. In accordance with the IPCC methodology, soil carbon stock in the inventory year is compared with the soil carbon stock for 20 years prior to the inventory. The calculation of carbon stock changes in highly mineralized soils by farming systems was conducted in accordance with the algorithm specified in the 1996 IPCC Software.

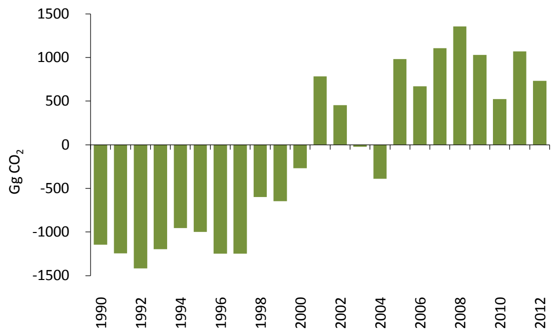


Figure 7.1 Trends of CO_2 emissions/removals from soils under change in Land use

Activity data

The data on lands under different land-use systems were provided by the State Committee on Land Resources. Geodesy, Cartography and State Cadastre of the Republic of Uzbekistan. The 2000 data are given in the Table 7.10. The total lands under all land-use systems per year t and year t-20 are not equal so, following the instructions given in [3], the areas of 1990 were reduced to the total area of 2010.

Table 7.10 Areas of land-use systems 2010, thous. ha

Land-use systems	1990	2010	Reduced Data, 1990
Tillable lands (without area under rice)	4,029.7	4,001.8	3,663.1
Area under rice	146.8	69.2	133.4
Perennial plants	366.8	350.9	333.4
Fallow lands	165.8	153.5	150.7
Hayfields	112.7	106.6	102.4
Pastures	23,362.3	20,649.5	21,236.7
Household land	451.3	698.5	410.2
Total	**28,635.4**	**26,030.0**	**26,030.0**

Emission factors

The territory of Uzbekistan is located in the temperate-warm dry zone with mean annual temperature of 13.4 C°, that is, within the range 10-20°C. Mean annual precipitation is less than 600 mm.

Corresponding to above mentioned climate conditions default magnitudes of carbon stocks under native vegetation were used [6], p. 3.83, and Table 3.3.3. Factors used are as follows: base factor, tillage factor, input factor.

The following factors were used for calculations:

- **The reference carbon stock SOC_{REF}** (Guidance on Good Practice for LULUCF, IPCC, 2003 [6], Table 3.3.3, p. 3.83.):
    - under native vegetation for all land-use systems except waterlogged soils – 38 t C / ha, by default;
    - for waterlogged soils under rice crops – 88 t C / ha.
- **Factors: base factor, tillage factor, input factor** are also taken by default in accordance with the soil tillage practices (Guidance on Good Practice for LULUCF, IPCC, 2003 [6], Table 3.3.4, p. 3.84.). The selected values of the factors are given in Table 7.11.

Table 7.11 Factors for calculation of CO_2 emissions/removals from soils under Land use change

Land use systems	Base factor	Tillage factor	Input factor
Tillable lands (highly active soils)	0.82	1.0	1.34
Tillable lands (waterlogged. under rice crops)	1.10	-	-
Perennial plants	0.82	1.0	1.00
Fallow lands	0.82	1.10	0.92
Hayfield	1.00	-	-
Pastures	1.00	0.95	-
Household land	0.82	1.00	1.07

7.4.3 Uncertainty and sequence of time series

Uncertainty in the category was not estimated. It is assumed of high value, as a choice of factors for a specific land use system is a problem. For example. for the land cultivated under cotton and wheat (main crops, occupying 78% of the total arable land), it is a ordinary practice to remove crop residues from the field. That is why it is necessary to select a low input factor. However, it is also an ordinary practice to apply every year organic fertilizers both to cotton and wheat.

For all years the same method and the same data set was used.

7.4.4 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with QA/QC general principles and QA/QC plan. The check was conducted:

- of documentation on emissions sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

7.4.5 Recalculations by category

Ralculations by the category were not carried out.

7.4.6 Planned improvements by category

In the framework of the future Fourth National Communication it is supposed to use the IPCC methodology, 2006 [6,7]. To do this, it is necessary to clarify and detail the activity data, to obtain data on changes in the management of each of land-use systems for twenty year period. To reduce the errors associated with the estimation of carbon removals / emissions in this category at the national level, it is desirable to calculate the carbon content for the species of cultivated soils on the territory of Uzbekistan, as well as land degradation factors related to change in their management regime.

8. WASTE – 6

8.1 Sector review

"Waste" sector covers CH_4 and N_2O greenhouse gas emissions in the following categories:
6A – Solid waste disposal on land;
6B1 – Industrial wastewater;
6B2 – Domestic and commercial wastewater.
The category 6C "Waste incineration" was not covered with the Inventory due to lack of any data.
GHG emissions in the sector in 2010 and contribution of methane and nitrous oxide are given in Tables 8.1 and 8.2.

Contribution of "Waste" sector to total (combined) emission in 2010 amounted to 3.7%. The main sources of greenhouse gas emissions in the "Waste" sector are solid waste disposal on land, the share of which amounted to 86.7% of sectoral emissions. Contribution to sectoral emissions from "Domestic and commercial wastewater" category amounted to 12.5%, from "Industrial wastewater" category is less than 1%.

Table 8.1 Share of GHG in "Waste" sector, 2010

Gas	CH_4	N_2O
Gg CO_2-eq.	6,748.6	601.3
%	91.8	8.2

Table 8.2 Emissions in "Waste" sector, 2010

Category		Gg CO_2-eq.	%
6A	Solid waste disposal on land	6,378.6	86.7
6B1	Industrial wastewater	55.4	0.8
6B2	Domestic and commercial wastewater	915.9	12.5
	Total	**7,349.9**	**100.0**

Trends of emissions

Table 8.3 and Figure 8.1 show the dynamics of methane and nitrous oxide emissions in the "Waste" sector for the period 1990-2012.

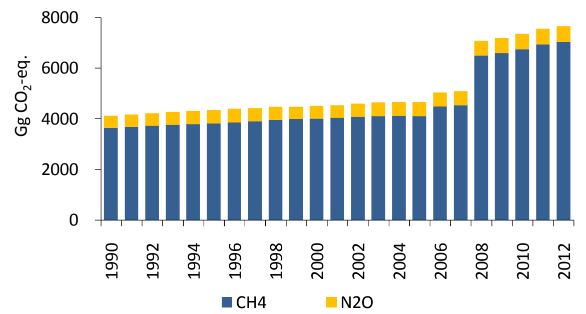


Figure 8.1 GHG emissions trend in the "Waste" sector

Table 8.3 GHG emissions in the "Waste" sector, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4	3642.9	3682.1	3724.3	3761.0	3787.2	3813.6	3860.5	3908.9	3951.6	3992.4	4010.0	4039.7
N_2O	478.6	488.9	500.5	512.0	522.0	531.5	541.8	508.1	516.6	479.0	485.7	491.8
Total	**4121.5**	**4171.0**	**4224.8**	**4273**	**4309.2**	**4345.1**	**4402.3**	**4417.1**	**4468.2**	**4471.4**	**4495.7**	**4531.5**
GHG	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CH_4	4085.3	4107.3	4121.0	4107.9	4483.2	4531.8	6497.2	6596.6	6748.6	6934.8	7033.3	**+93.1%**
N_2O	516.0	540.3	546.5	550.9	557.6	565.6	574.8	584.6	601.3	617.7	626.2	**+30.8%**
Total	**4601.3**	**4647.6**	**4667.5**	**4658.8**	**5040.8**	**5097.4**	**7072.0**	**7181.2**	**7349.9**	**7552.5**	**7659.5**	**+85.8%**

Table 8.4 GHG emissions in the "Waste" sector by categories, Gg CO_2-eq.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Disposal on land	3343.3	3383.8	3427.1	3461.4	3491.6	3522.5	3564.9	3610.5	3654.0	3688.6	3705.1	3729.4
Wastewater	778.3	787.2	797.7	811.6	817.6	822.6	837.5	806.6	814.1	782.8	790.6	802.2
Category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Disposal on land	3752.4	3771.3	3791.6	3786.4	4150.3	4194.5	6152.2	6234.7	6378.6	6553.1	6649.8	**98.9%**
Wastewater	848.9	876.3	875.9	872.5	890.5	902.9	919.7	946.5	971.3	999.4	1009.7	**29.7%**

Contribution of the "Waste" sector to total emission for the period 1990-2012 increased to 0.9%.

For the period 1990-2012, GHG sectoral emissions increased to 85.8 %, including:

- CH_4 emissions – 93.1%;
- N_2O emissions – 30.8%.

GHG trend in the "Waste" sector is given in Figure 8.2 and Table 8.4 by categories.

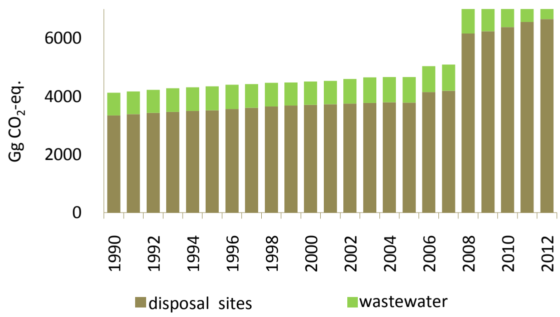


Figure 8.2 GHG trend in the "Waste" sector by categories

For the period 1990-2012, the following increase in emissions by categories was observed:

- "Disposal on land" – 98.9%;
- "Wastewater" – 29.7%.

Category "Methane emissions from solid waste disposal on land" is a key one to estimate the level of emissions and trend.

8.2 Solid waste disposal on land – 6A

8.2.1 Description of source category

Municipal solid waste includes:

- domestic waste;
- waste from parks and gardens;
- from trade and other commercial activities.

Anaerobic decomposition of organic matter on disposal on land takes place under the action of methanogenic bacteria and leads to methane emissions. The amount of methane emitted depends on various factors, such as methods of waste management, and physical factors. Depending on the amount and type of work performed in disposal on land, including for the purpose of correcting the potential methane generation, it is decided to consider two types of solid domestic waste allocation:

- compact sanitary disposal on land;
- open disposal on land.

To calculate methane emissions, it is necessary to know the characteristics of disposal on land – the depth of the disposal on land, waste density, type of soil, humidity, temperature, etc. [53].

As of 2011, according to information provided by "Uzkommunkhizmat", 198 units of disposal on land were put into operation. In Uzbekistan, collection, transportation, neutralization and recycling of municipal solid waste (MSW) from public and other wholesale customers is made by 202 special automobile companies.

Volume weight of municipal solid waste in urban areas varies in a wide range (from 355.6 to 587.6 kg/m^3).

The rate of municipal solid waste accumulation in settlements per 1 resident is on the average 1.17 kg/day (0.003 m^3), or 437.7 kg per year (1.09 m^3 per year).

Food waste (from 35 to 42% depending on the season), paper (19%) and plastic (17%) predominate in the composition of MSW.

Currently, in Uzbekistan there are no detailed reliable data on the amount of waste dumped to disposal on land and characteristics of disposal on land, so to estimate methane emissions from domestic solid waste disposal on land, they use recommended by the IPCC method based on statistical data on the number of urban population [3]. This method is 10-18% overestimates the real amount of methane emissions.

Methane emissions from municipal waste disposal on land of rural population were not taken into account due to their considerable dispersion and lack of conditions for methane generation.

CH_4 emissions from solid waste disposal on land in 2010 amounted to 6378.6 Gg CO_2-eq.

Trends of emissions

Methane emissions from solid waste disposal on land for the period 1990-2012 are given in Table 8.5 and Figure 8.3.

Table 8.5 CH_4 emissions from Solid waste disposal on land, Gg CO_2-eq.

CH_4	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gg CO_2-eq.	3343.3	3383.8	3427.1	3461.4	3491.6	3522.5	3564.9	3610.5	3654.0	3688.6	3705.1	3729.4
CH_4	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Gg CO_2-eq.	3752.4	3771.3	3791.6	3786.4	4150.3	4194.5	6152.2	6234.7	6378.6	6553.1	6649.8	**+98.9%**

Increase in methane emissions for the period 1990-2012 amounted to 98.9%.

Increase in methane emissions was caused by urban population growth. Sharp increase in methane emissions in 2008 is caused by the statistical increase in the number of urban population of the republic.

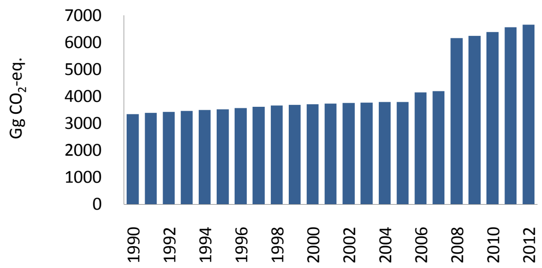


Figure 8.3 Trend of CH_4 emissions from Solid waste disposal on land

8.2.2 Methodology

Estimation of the CH_4 emissions from municipal solid waste disposal on land was made following the Revised IPCC Guidelines, 1996 [3] and the IPCC Good Practice Guidance, 2003 [5].

Industrial waste dumped to disposal on land was not taken into consideration due to lack of the reliable data on its amount.

Calculation of methane emission (Gg / year) was made on the basis of statistical data on the average annual urban population according to Equation 1 (IPCC Guidelines, 1996, p. 6.3).

Activity data

Due to lack of reliable statistical dats on the volume of dumped municipal solid waste, data of the State Committee on Statistics on mean annual urban population was used for calculation of methane emissions from municipal solid waste disposal on land.

In 2010, urban population of the Republic of Uzbekistan amounted to 14,661.7 thous. persons [39, 48].

Emission factors

Municipal solid waste (MSW) national generation rate:

- for the period 2006-2012 was equal to 1.17 kg/person/day – measured in accordance with the Sanitary rules and norms of RUz №0297-11 [55], p. 8, Table 3.
- for the period 1990-2005 was equal to 1.2 kg/person/day in accordance with the normative documents [55]. The values given in the Table 8.6 are based on direct measurements conducted by the Institute of Sanitary and Hygiene.

Share of MSW, land-buried in disposal on land – 1, in accordance with the expert assessments.

Share of waste on each type of disposal on land according to data of Agency "Uzkommunkhizmat" is given in Table 8.6.

Share of waste containing carbon in total amount of garbage disposed to disposal on land is given in Table 8.7.

MCF - Methane correction factor is equal to:

- **0.52** – for the period 1990-2005.
- **0.58** – for the period 2006-2012.

DOC – Share of degradable organic carbon in MSW is equal to 16.35% and was calculated (equation 2, Chapter "Waste", [3]) using the values of the data on morphological composition of waste presented in the normative document [55].

Table 8.6 Share of waste on each type of disposals on land (%)

Type of disposal on lands	1990-2005	2006-2012
Managed	0.17	0.19
Unmanaged - deep (≥5 m of waste)	0.04	0.16
Unmanaged - small (< 5 m of waste)	0.79	0.65

Table 8.7 Share of waste containing carbon in total amount of garbage disposed to disposal sites

Type of waste	% by weight
Paper and textile	22.8
Garden and park waste	0.0
Food waste	38.4
Wood and straw waste	4.9

The values given in Table 8.7 are based on direct measurements that were implemented by the Institute of Sanitary and Hygiene in 2011 [55] (p. 5, Table 1). They coincide with the previously obtained values for the period 1990-2005 presented in [54]. Mean annual data were used for the calculation.

Fraction of DOC, which actually degrades is equal to 0.77 [3], p. 6.10.

Fraction of carbon released as methane is equal to 0.5 [3], p. 6.10.

Conversion factor – 16/12 [3], p. 6.10.

OX – methane correction factor considering the possibility of oxidation of methane part is equal to 0 [3], p. 6.10.

8.2.3 Uncertainty and sequence of time series

Uncertainty of methane emissions in category 6A "Solid waste disposal on land" was estimated in accordance with [5].

Statistical data on the number of urban population. the uncertainty of which does not exceed ± 2%, were used as activity data. The combined uncertainty of the emission factor is not less than ± 50%.

Calculations of uncertainties in all estimated Inventory categories are detailed in Annex 12.

For all years the same method and the same data set was used.

8.2.4 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with the QA/QC principals and QA/QC plan. The check was done:

- of documentation of emission sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

An additional worksheet for the calculation of national DOC was included into sectoral tables of Program software.

8.2.5 Recalculations by category

Recalculation for the period 1990-2005 was not carried out.

For the period 2006-2012 in the calculation of methane emission from domestic solid waste, the value of national waste generation rate MSW equal to 1.17 (kg/pers./day) was used, in accordance to [55].

In the SNC for the period 1990-2006 national rate 1.20 (kg/pers./day) was used which is calculated on the basis of the normative document [54].

Calculation of waste generation rate for the period 2006-2012 was conducted in accordance with the normative document [55].

The change of MSW rate values depends on decrease in the formation of MSW at the national level for the indicated period.

8.2.6 Planned improvements by category

In the framework of the future Fourth National Communication, it is supposed to estimate the emissions in accordance with [7].

8.3 Wastewater handling – 6B

In Uzbekistan, only 30% of wastewater is exposed to various types of treatment.

There are two basic types of wastewater treatment:
- domestic and commercial wastewater;
- industrial wastewater.

Methane formation takes place in the wastewater only under anaerobic conditions, and the main factor in determining the potential methane generation is the amount of organic material in the wastewater flow and physical parameters (temperature).

- For domestic and commercial wastewater and muddy wastes, the amount of methane generation is quantified by the biochemical oxygen demand (BOD) of wastewater, notably the amount of oxygen consumed by the organic material in the wastewater during decomposition.
- For industrial water, they use chemical oxygen demand (COD) rate showing the total amount of carbon suitable for oxidation, both biologically degradable, and resistant to degradation.

In Uzbekistan food and textile industries are developed, the volume of wastewater of which has been analyzed. Methane emissions from industrial wastewater are insignificant. Methane formation takes place mainly on the stage of its processing. In Uzbekistan industrial wastewater is only partially processed and then mixed with wastewater in the treatment system, thus going to surface water. A small value of methane emissions from industrial wastewater depends on incomplete account due to the lack of data for certain types of products [53].

CH_4 emission from industrial, domestic and commercial wastewaters as well as N_2O emission from human waste were estimated in the category 6B "Wastewater". GHG emissions by categories are given in Table 8.8.

Experts estimate that approximately one third of industrial wastewater is disposed to sewage system. Where central sewage system is in place, all domestic/commercial wastewater are disposed to treatment plants.

Table 8.8 GHG emissions from Wastewater, 2010

Category	GHG	Gg CO_2-eq.	%
Industrial wastewater	CH_4	55.4	5.7
Domestic/commercial wastewater	CH_4	314.6	32.4
	N_2O	601.3	61.9
Total		**971.3**	**100.0**

8.3.1 Industrial wastewater – 6B1

8.3.1.1 Description of source category

As follows from Figure 8.4, for the period 1990-2012 the structure of production accompanied by wastewater discharge generating methane, has changed significantly. If in 90-s the main production related to the formation of methane in the wastewater was the production of cotton and silk fabrics. then since 2005 sugar production has made the main contribution to the formation of methane in wastewater. Production of cotton fabrics and meat products makes a significant contribution to methane emission.

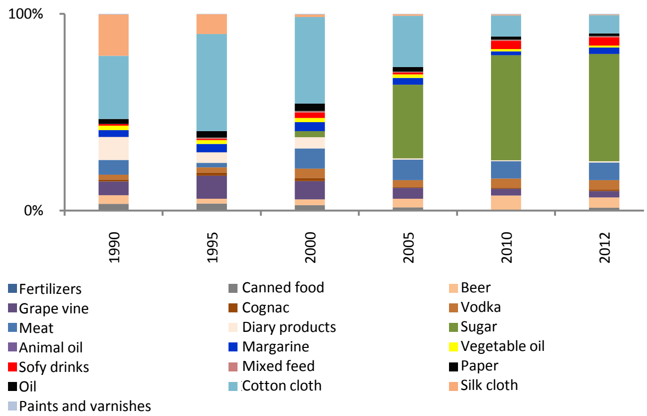


Figure 8.4 Contribution of separate industries in Methane emission from Wastewater

In 2010 the CH_4 emission from industrial wastewater amounted to 55.4 Gg CO_2 -eq.

Trends of emissions

Methane emission from industrial wastewater for the period 1990-2012 is given in Table 8.9 and Figure 8.5.

For the period 1990-2012, increase in methane emission to 2.5% has been observed.

The dynamics of methane emissions from industrial wastewater depends on the dynamics of industrial production, which was included in the calculations.

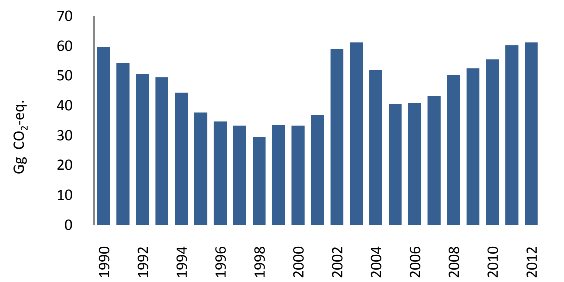


Figure 8.5 Trend of CH_4 emissions from Industrial wastewater

Table 8.9 CH_4 emissions from Industrial wastewater, Gg CO_2-eq.

CH_4	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gg CO_2-eq.	59.6	54.2	50.5	49.5	44.1	37.7	34.6	33.3	29.4	33.5	33.3	36.9
CH_4	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
Gg CO_2-eq.	59.0	61.3	51.8	40.5	40.8	43.1	50.1	52.4	55.4	60.1	61.1	**2.5%**

8.3.1.2 Methodology

The estimation of the CH_4 emission from industrial wastewater was implemented in accordance with [3].

Methane emission from industrial wastewater was calculated not taking into account the amount of organic matter in the muddy waste (due to lack of data).

Activity data

The available national statistics on the production of selected industrial products were used for calculations, data for 2010 is given in Table 8.10.

Table 8.10 Production of the definite types of industrial products in 2010

№	Production	Units	Amount
1	Nitrogen fertilizers	thous. tons	1,134.5
2	Canned food, total	mil. cans	448.44
3	Beer	thous. decalitres	25,760.8
4	Grape vine	thous. decalitres	3,605.8
5	Cognac	thous. decalitres	76.7
6	Alcohol and alcohol beverages	thous. decalitres	11,698.5
7	Meat semi-prepared products	thous. tons	0.524
8	Sausages	thous. tons	23.683
9	Dairy products	thous. tons	27.449
10	Sugar	tons	286,100
11	Mixed feed	tons	892,936.5
12	Animal oil	thous. tons	1.24
13	Animal fat	thous. tons	-
14	Margarine	thous. tons	16.2
15	Vegetable oil	thous. tons	244.2
16	Soft drinks	thous. decalitres	42,967.5
17	Paper	thous. tons	4.2
18	Petrochemical products/refining	thous. tons	4,792
19	Cotton cloth	thous. m^2	145,262
20	Silk cloth	thous. m^2	3,406.3
21	Paints and varnishes	tons	80,500

Emission factors

The amount of organic matter was estimated based on the norms of wastewater formation and COD concentration that are indicated in the document "Increased norms of water supply and water allocation for different industrial sectors", Moscow, 1982 (CMEA, ASRI, VODGEO, GOSSTROY USSR) [36].

Factors used for estimation of CH_4 emission from industrial wastewater show in the Table 8.11.

Fraction of wastewater treated by certain handling system is equal to **0.3** (according to expert judgement)
Methane conversion factor is equal to **0.9** [3], Table 6-8, p. 6.19, line "Other countries of Asia".

Maximum methane producing capacity is equal to **0.25** kg CH_4/ kg BOD [3] **.**

Table 8.11 Factors used for estimation of CH_4 emissions from Industrial wastewater

Product	Norms of Wastewater formation	COD concentration, kgO/ m^3
Nitrogen fertilizers	480 m^3/ t	0.035 (0.02-0.05)
Canned food, total	5.67 m^3/1000 cans	0.233
Beer	76.4 m^3/1000 decalitres	1.5
Grape vine	28.15 m^3/1000 decalitres	13.0
Cognac	164.56 m^3/1000 decalitres	17.0
Alcohol and alcoholic beverages	259 m^3/1000 decalitres	0.6
Meat products	19.3 m^3/ t	1.0
Dairy products	5.2 m^3/ t	1.4
Sugar	16.2 m^3/ t	4.5
Mixed feed	0.38 m^3/ t	0.6
Animal oil and fat	1.74 m^3/ t	0.25
Margarine	3.14 m^3/ t	15.0
Vegetable oil	1.31 m^3/ t	1.5
Soft drinks	38.05 m^3/1000 decalitres	1.0
Paper	43.75 m^3/ t	0.12
Petrochemical products/refining	0.215 m^3/ t	0.6
Cotton cloth	42.6 m^3/1000 m^2	0.675 (0.35-1.0)
Silk cloth	76.5 m^3/1000 m^2	0.8 (0.6-1.0)
Paints and varnishes	58.0 m^3/ t	0.02

8.3.1.3 Uncertainty and sequence of time series

Uncertainty of the CH_4 emission from industrial wastewater was not estimated.

For all years the same method and the same data set was used.

8.3.1.4 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with the QA/QC principals and QA/QC plan. The check was conducted:

- of documentation of emission sources;
- of the data transcription;
- whether all information sources for the input data for the Program software were referenced.

8.3.1.5 Recalculation by category

Recalculation by category was not made.

8.3.1.6 Planned improvements by category

In future Inventories it is expected to estimate methane emissions from a wide range of industries.

8.3.2 Domestic and commercial wastewater – 6B2

8.3.2.1 Description of source category

In this category CH_4 emissions from domestic and commercial wastewater as well as N_2O emissions from human waste was estimated.

Table 8.12 shows the dynamics of methane emission and nitrous oxide emission from domestic and commercial wastewater for 2010.

Table 8.12 Direct GHG emission from Domestic and commercial wastewater, 2010

Category	GHG	Gg CO_2-eq.	%
Domestic and commercial wastewater	CH_4	314.5	34.3
	N_2O	601.4	65.7
Total		**916.0**	**100.0**

The table shows that nitrous oxide accounts for 65.7% of emissions, methane – 34.3%.

For 2010 methane emission was calculated from the treatment of domestic and commercial wastewater by the regions of Uzbekistan (Table 8.13 and Figure 8.6).

Table 8.13 CH_4 emissions from Domestic and commercial wastewater by regions, 2010

Region	Gg CO_2-eq.	%
Republic of Karakalpakstan	6.51	2.1
Andijan	11.76	3.7
Bukhara	9.66	3.1
Djizak	4.20	1.3
Kashkadarya	13.86	4.4
Navoi	10.92	3.5
Namangan	9.03	2.9
Samarkand	21.84	6.9
Surkhandarya	6.09	1.9
Syrdarya	4.41	1.4
Tashkent	24.57	7.8
Fergana	22.89	7.3
Khorezm	5.88	1.9
Tashkent City	162.75	51.8
Total	**314.58**	**100.0**

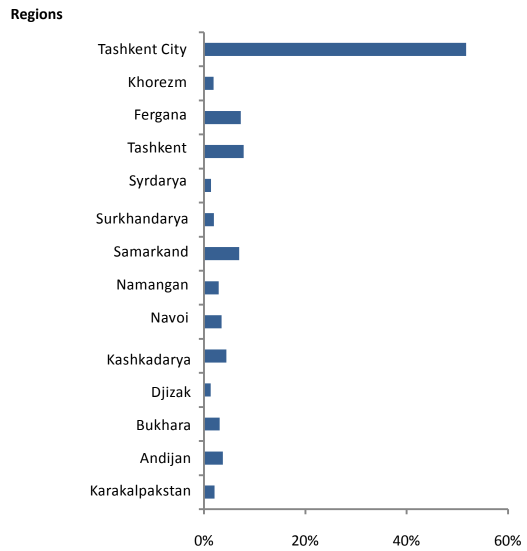


Figure 8.6 CH_4 emissions from Domestic and commercial wastewater by regions in 2010

Data analysis for 2010 shows that 59.6% of CH_4 emissions from domestic and commercial wastewater is the share of Tashkent and Tashkent region. The share of Fergana and Samarkand regions respectively is 7.3% and 6.9% of all emissions in this category.

Trends of emissions

Table 8.14 and Figure 8.7 show the dynamics of greenhouse gases emission from domestic and commercial wastewater for the period 1990-2012.

Table 8.14 GHG emissions from Domestic and commercial wastewater, Gg CO_2-eq.

GHG	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4	240.0	244.1	246.7	250.1	251.4	253.4	261.0	265.1	268.1	270.3	271.7	273.5
N_2O	478.6	488.9	500.5	512.0	522.0	531.5	541.8	508.1	516.6	479.0	485.7	491.8
Total	**718.6**	**733.0**	**747.2**	**762.1**	**773.4**	**784.9**	**802.8**	**773.2**	**784.7**	**749.3**	**757.4**	**765.3**
GHG	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**$\Delta_{(2012-1990)}$**
CH_4	273.9	274.7	277.6	281.1	292.1	294.2	294.8	309.5	314.6	321.6	322.4	**+34.3%**
N_2O	516.0	540.3	546.3	550.9	557.6	565.6	574.8	584.6	601.3	617.7	626.2	**+30.8%**
Total	**789.9**	**815.0**	**823.9**	**832.0**	**849.7**	**859.8**	**869.6**	**894.1**	**915.9**	**939.3**	**948.6**	**+32.0%**

For the period 1990-2012, increase in total emission to 32.0% was observed, in particular:

- CH_4 – 34.3 %;
- N_2O – 30.8%.

8.3.2.2 Methodology

Estimation of the CH_4 emission from domestic and commercial wastewater and N_2O emission from human waste was implemented in accordance with [3].

<u>Calculation of methane emissions was made</u>:

- for the population covered by sewerage services;
- excluding the amount of organic matter in muddy waste (due to lack of data).

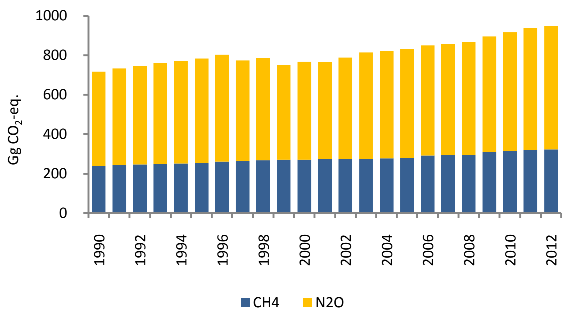


Figure 8.7 Dynamics of GHG emissions from Domestic and commercial wastewater

N_2O emission from wastewater of human activity was determined in accordance with [3].

Annual consumption of protein per capita in Uzbekistan in 1990-2012 was taken from the FAO database [37], the total number of the population – according to data of the State Committee on Statistics.

Activity data

Calculation of CH_4 emission from domestic and commercial wastewater was based on expert assessment (A.M.Rakhimov, Agency "Uzcommunkhizmat") on the number of urban and rural population having an access to central sewage system.

Data on the number of population with an access to sewage system by regions for 2010 are given in Table 8.15.

Table 8.15 Population having access to sewage system, 2010

Region	Population, thous. people
Republic of Karakalpakstan	88.92
Andijan	162.94
Bukhara	133.47
Djizak	59.25
Kashkadarya	193.80
Navoi	152.77
Namangan	126.00
Samarkand	302.4
Surkhandarya	84.60
Syrdarya	61.40
Tashkent	342.20
Fergana	317.30
Khorezm	82.20
Tashkent city	2,258.60
Total	**4,365.85**

Estimates of N_2O emission from human wastes were based on official statistics on mean annual population of Uzbekistan.

In 2010 mean annual population of Uzbekistan amounted to 28,562.4 thous. people.

BOD_5 – Biochemical oxygen demand – 18,250 kg/1000 persons/year [3], Table 6-5, p. 6.12, line "Former USSR".

Fraction of wastewater treated by certain handling system – 1.0 (data of the State Committee for Nature Protection).

Methane conversion factor – 0.75 [3], Table 6-7, p. 6.18, line "Other countries of Asia".

Maximum methane producing capacity – 0.25 kg CH_4/ kg BOD [3].

To calculate N_2O emission, the following coefficients and factors were used:

Annual per capita protein intake

To get more accurate assessments, it was decided to use FAO's rates for the period 1990-2012 (Table 8.16) [38]. Time series for this category were recalculated, as in the SNC for the whole period a global mean rate equal to **75 g protein / capita / day** was used.

Table 8.16 Protein intake per capita in the Republic of Uzbekistan (according to the FAO), [38]

Period, years	Protein consumption	
	g/capita/day	kg/capita/year
1990 - 1993	82.0	29.930
1994 - 1996	82.0	29.930
1997 - 1998	75.5	27.56
1999 - 2001	69.0	25.185
2002	71.5	26.10
2003 - 2005	74.0	27.010
2005 - 2012	74.0	27.010

For the period 1997-1998 the mean value of (82 + 69)/2 = **75.5 g protein / capita** is calculated.

For 2002: (69 + 74) / 2 = **71.5 g protein / capita.**

For 2011-2012 the value of **74 g protein /capita** is accepted due to the lack of updated data after 2010 in the statistical database of FAO.

On the basis of the newly received per capita values for protein intake of the population, the revised estimates were obtained by conversion of indirect emissions of nitrous oxide on the entire data series.

$Frac_{NPR}$ – fraction of nitrogen in protein is equal to 0.16 kg N/ kg protein [3], p. 4.41, Table 4-19.

EF_6 – emission factor is equal to 0.01 (0.002-0.12) kg N_2O-N/kg of nitrogen from wastewater [3], p. 4.37, Table 4-18.

8.3.2.3 Uncertainty and sequence of time series

Uncertainty of methane and nitrous oxide emissions in category 6B2 "Domestic wastewater" was estimated in accordance with [5].

Expert data on the number of population covered by the centralized sewerage services, the uncertainty of which amounted to ± 10%, was used as the activity data for the calculation of CH_4 emissions from domestic wastewater. Combined uncertainty of methane emission factor amounted to ± 42%.

Statistical data on the total number of population. the uncertainty of which is ± 2%, was used to calculate N_2O emissions from domestic wastewater. According to expert judgements, uncertainty of nitrous oxide emission default factor was ± 500%.

Calculations of uncertainties in all estimated Inventory categories are detailed in Annex 12.

For all years the same method and the same data set was used.

8.3.2.4 Quality Assurance/ Quality Control

The QA/QC procedures were implemented in accordance with the QA/QC principals and QA/QC plan. The check was conducted:

- of documentation of emission sources;
- of data transcription;
- whether all information sources for the input data for the Program software were referenced.

8.3.2.5 Recalculations by category

Recalculation by the category "CH_4 emission from domestic and commercial wastewater" as part of the Third National Communication was carried out across a number of data, in connection with the data specification on the number of population having access to the sewage system (Table 8.17).

Table 8.17 Recalculation of methane emission by category "CH_4 emissions from Domestic and commercial wastewater" for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	232.5	236.7	238.9	242.3	243.4	245.3	252.6	256.6
TNC	240.0	244.0	246.8	250.1	251.4	253.5	261.0	265.0
Difference, %	**3.1**	**3.0**	**3.2**	**3.1**	**3.2**	**3.2**	**3.2**	**3.2**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	264.6	266.7	265.4	267.1	267.8	268.6	272.2	275.3
TNC	268.2	270.3	271.7	273.4	273.8	274.7	277.6	281.2
Difference, %	**1.4**	**1.3**	**2.3**	**2.3**	**2.1**	**2.2**	**2.0**	**2.1**

In comparison with the results of the Second National Communication, submitted recalculation led to an increase in the value of methane emission in this category on the average to 2.6% (maximum – 3.2%, minimum – 1.3%).

Recalculation by category "N_2O emission from domestic and commercial wastewater" was conducted for the whole range of data in connection with obtaining the revised information of FAO on protein intake by the population of Uzbekistan for the period 1990-2012 (Table 8.18).

Table 8.18 Recalculation of N_2O emission by category "N_2O emission from Domestic and commercial wastewater" for the period 1990-2005, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	437.1	446.4	458.8	468.1	477.4	486.7	496.0	505.3
TNC	477.4	489.8	499.1	511.5	520.8	530.1	542.5	523.9
Difference, %	**8.4**	**8.9**	**8.1**	**8.5**	**8.3**	**8.2**	**8.6**	**3.6**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	514.6	520.8	527.0	533.2	542.5	548.7	554.9	561.1
TNC	517.7	480.5	496.0	492.9	514.6	539.4	545.6	551.8
Difference, %	**0.6**	**-8.3**	**-6.3**	**-8.2**	**-5.4**	**-1.7**	**-1.7**	**-1.7**

In comparison with the results of the Second National Communication, depending on the change of the amount of protein intake by population, recalculation of nitrous oxide emission led to the following results:

- for the period 1990-1998 – increased on the average to 7%;
- for the period 1999-2005 – decreased to 4.8%.

8.3.2.6 Planned improvement by category

In the framework of the future Fourth National Communication, it is expected to assess emission in accordance with [7].

9. RECALCULATION OF GREENHOUSE GAS EMISSIONS AND IMPROVEMENTS

The chapter provides a summary of the results according to the calculation of emissions in the GHG Inventory of the Third National Communication of the Republic of Uzbekistan (TNC) for the period 1990-2005 relative to emission estimates given in the GHG Inventory of the Second National Communication (SNC) [8].
Under the 3rd cycle of Inventory, calculations were carried out with the aim to improve the quality of Inventory in all sectors, and included:

- revision of activity data and emission factors;
- recording of new emission sources;
- use of new methodological approaches;
- correction of the identified errors and assumptions made.

The emission values obtained in the result of recalculations are less than values given in the Second National Communication for the period 1990-2005, which consequently lead to decrease in the value of the previously estimated total GHG emissions (Table 9.1), excepting 1997.

The minimum difference in the estimates for 1997 – 0.2%, the maximum – 2.0% was obtained for 2005. Differences in the estimates for different years are caused by introduction of new emission sources or termination of the existing ones, specifying activity data, using the improved values of national factors.

Table 9.1 The results of recalculations of total GHG emissions for the 1990-2005 time series (without LUCF), Gg CO_2-eq.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
SNC	181332.40	184186.89	177124.64	205572.28	185646.02	185481.19	190096.07	179004.98
TNC	180414.54	183159.37	176302.81	203060.75	183614.19	184177.08	188964.78	179421.98
Difference, Gg	917.86	1027.52	821.83	2511.53	2031.83	1304.11	1131.29	-417.00
Difference, %	**0.5**	**0.6**	**0.5**	**1.2**	**1.1**	**0.7**	**0.6**	**-0.2**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	174487.06	183305.01	200149.38	203205.87	207373.18	204731.32	201527.67	200254.63
TNC	173640.47	182189.70	197972.72	199794.44	204220.34	201709.98	198949.94	196225.33
Difference, Gg	846.59	1115.31	2176.66	3411.43	3152.84	3021.34	2577.73	4029.30
Difference, %	**0.5**	**0.6**	**1.1**	**1.7**	**1.5**	**1.5**	**1.3**	**2.0**

The results of emission calculations for each sector and notes thereto are given below.

"Energy" sector

The results of emission calculations by the "Energy" sector for the period 1990-2005 are given in Table 9.2. For all years the obtained emission values are lower than the ones given in the Second National Communication.

In the category "Fuel Combustion" recalculations were not carried out. Time series by this category were not changed.

In the category "Methane leakage" the value of methane emissions for the period 1990-2005 were decreased in the result of improving the values of national emission factors in the sub-category "Production", "Transport" and "Processing" of "Natural gas leakage" category. Detailed recalculations by categories are given in Chapter 4, Section 4.3.2.5. In general, by the category "Methane leakage" discrepancy with the SNC estimates amounted to 4-5.5% per year.

Calculation of the improved values of national emission factors is given in Annex 7.

The greatest differences in the estimates of sectoral emissions were obtained for 1993 (2.3%), the least – for 1997 (0.8%).

Table 9.2 The results of recalculations of total GHG emissions for the 1990-2005 time series included in the SNC, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	153712.20	155556.89	148478.64	177644.28	159289.59	160553.19	165440.07	154608.98
TNC	151183.78	152961.80	145912.73	173608.57	155946.73	157896.50	162717.08	153358.41
Difference, Gg	2528.42	2595.09	2565.91	4035.71	3342.86	2656.68	2722.99	1250.57
Difference, %	**1.6**	**1.7**	**1.7**	**2.3**	**2.1**	**1.7**	**1.6**	**0.8**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	149680.06	159032.01	175517.38	177747.87	181596.18	178758.32	174786.67	172338.63
TNC	147579.21	156641.35	172446.56	174494.85	178251.58	175244.60	171357.30	169231.45
Difference, Gg	2100.84	2390.66	3070.82	3253.02	3344.60	3513.72	3429.38	3107.18
Difference, %	**1.4**	**1.5**	**1.7**	**1.8**	**1.8**	**2.0**	**2.0**	**1.8**

"Industrial processes" sector

The results of emission recalculations for the "Industrial processes" sector for the period 1990-2005 are given in Table 9.3. The obtained values of emissions for all years are lower than was given in the Second National Communication, excluding 1990.

In the category "Production and use of mineral products" recalculation in the category "Clinker production" was made using the improved values of national emission factor. Recalculation has led to increase in CO_2 emission by the category to 6% per year.

In the category "Chemical Industry" recalculations were made by the categories "Ammonia production" and "Nitric acid production" associated with improving the values of national emission factors. In the category "Ammonia production" recalculation led to reduction in CO_2 emissions to 0.5% per year. In the category "Production of Nitric Acid" recalculation led to reduction in N_2O emissions to 6.9% per year.

Detailed recalculations by the categories are given in the sectors of Chapter 4 "Industrial Processes".

The greatest differences in the estimates of sectoral emissions were obtained for 1995, 1996, 1998 (1.9%), the least – for 1990 (0%).

Table 9.3 The results of recalculations of GHG emissions for the 1990-2005 time series included in the SNC within the "Industrial processes" sector, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	8059.00	8618.00	8295.00	7422.00	5949.00	5354.00	5612.00	5302.00
TNC	8059.24	8468.78	8151.06	7299.32	5856.37	5254.05	5502.63	5207.43
Difference, Gg	-0.24	149.22	143.94	122.68	92.63	99.95	109.37	94.57
Difference, %	**0.0**	**1.7**	**1.7**	**1.7**	**1.6**	**1.9**	**1.9**	**1.8**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	5270.00	4828.00	4970.00	5042.00	5118.00	5418.00	6136.00	6366.00
TNC	5170.54	4742.78	4882.77	4949.95	5033.23	5329.29	6041.89	6267.33
Difference, Gg	99.46	85.22	87.23	92.05	84.77	88.71	94.11	98.67
Difference, %	**1.9**	**1.8**	**1.8**	**1.8**	**1.7**	**1.6**	**1.5**	**1.5**

"Agriculture" sector

The results of emission calculations by the "Agriculture" sector for the period 1990-2005 are given in Table 9.4. For all years, except for 2005, similar values of emissions were obtained. The small difference in the values of sectoral emissions for the whole period is explained by differences arising from rounding the values to the separate category level.

The greatest differences in the estimates of emissions were obtained for 2005 (2.3%). The reason of differences is that the category "Field burning of agricultural residues" is excluded from calculations, which depends on obtaining during TNC preparation of an updated data on legal prohibition of burning stubble of cereal crops, beginning from 2005, and with specification of statistical data for 2005, taken into account by all categories of the sector.

Table 9.4 The results of recalculations of GHG emissions for the 1990-2005 time series included in the SNC within the "Agriculture" sector, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	17054.50	17558.00	18014.00	17881.00	17502.43	16679.00	16343.00	16337.00
TNC	17049.98	17557.78	18014.18	17879.82	17501.87	16681.42	16342.72	16439.05
Difference, Gg	4.52	0.22	-0.18	1.18	0.56	-2.42	0.28	-102.04
Difference, %	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.6**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	16423.00	16333.00	16148.00	15819.00	16333.00	16491.00	16888.00	16442.00
TNC	16422.56	16334.14	16147.68	15818.10	16334.17	16488.48	16883.27	16067.72
Difference, Gg	0.44	-1.14	0.32	0.90	-1.17	2.52	4.73	374.28
Difference, %	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.3**

"Waste" sector

The results of sectoral emission recalculations in the "Waste" sector for the period 1990-2005 are given in Table 9.5.

For the period of 1990-1998 the values of sectoral emissions are lower than in the SNC, for the period 1999-2005 – slightly higher. The maximum difference in emissions estimates were obtained for 1996 (1.3%).

The main differences accounted for recalculation by the categories "Methane emissions from domestic and commercial wastewater" and "Nitrous oxide emissions from domestic and commercial wastewater".

In the category "Methane emissions from domestic and commercial wastewater" recalculation is carried out in connection with data specification on the number of population provided with sewage services. In the result recalculation, methane emission by the category increased to 1.3-3.0% per year.

In the category "Nitrous oxide emissions from domestic and commercial wastewater" recalculation is carried out in connection with obtaining new FAO data on per capita protein intake of the population in Uzbekistan and has led to increase in N_2O emissions for the period 1990-1998 on the average to 7% per year and decrease in emissions for the period 1999-2005 on average to 4.8% per year.

The detailed recalculation by categories is given in Chapter 7 Waste, section 7.4.5.

Table 9.5 The results of recalculations of GHG emissions for the 1990-2005 time series included in the SNC within the "Waste" sector, Gg CO_2-eq.

	1990	1991	1992	1993	1994	1995	1996	1997
SNC	4072.70	4121.00	4176.00	4221.00	4257.00	4292.00	4348.00	4406.00
TNC	4121.54	4171.01	4224.84	4273.03	4309.22	4345.11	4402.35	4417.09
Difference, Gg	-48.84	-50.01	-48.84	-52.03	-52.22	-53.11	-54.35	-11.09
Difference, %	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.3**	**-0.3**
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
SNC	4463.00	4510.00	4532.00	4567.00	4622.00	4650.00	4670.00	4691.00
TNC	4468.15	4471.43	4495.71	4531.53	4601.36	4647.61	4667.48	4658.83
Difference, Gg	-5.15	38.57	36.29	35.47	20.64	2.39	2.52	32.17
Difference, %	**-0.1**	**0.9**	**0.8**	**0.8**	**0.4**	**0.1**	**0.1**	**0.7**

In "Land Use Change and Forestry" sector recalculations of emissions were not carried out.

REFERENCES

1. Reporting on Climate Change User Manual for the Guidelines on National Communications from non-Annex 1 Parties - 2004.
2. Revised 1996 IPCC Guidelines for Greenhouse Gas Inventories. Greenhouse Gas Inventory Reporting Instructions. IPCC, 1996, Volume 1.
3. Revised 1996 IPCC Guidelines for Greenhouse Gas Inventories. Workbook. IPCC, 1996, Volume 2.
4. Revised 1996 IPCC Guidelines for Greenhouse Gas Inventories. Greenhouse Gas Inventory Reference Manual. IPCC, 1996, Volume 3.
5. Good Practice and Uncertainty Management in National Greenhouse Gas Inventories IPCC, 2000.
6. Good Practice Guidance for Land-Use Change and Forestry IPCC, 2003.
7. 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
8. National Inventory Report on sources of greenhouse gas antropogenic emissions and sinks for 2000. – Tashkent: Uzhydromet, 2008. – 150 p.
9. Instruction of State Committee for Statistics of USSR № 240, 29 December 1989. On Making Up Fuel-Energy Balance for 1990. - Izhevsk: Soyuzblankizdat, 1990.
10. OECD/IEA Energy Statistics Manual (2004). OECD/IEA, Paris http:// www.iea.org
11. Statistical yearbook "The results of final accounting for sown area of agricultural crops harvest for 2006-2012 (in all lands)".
12. Instruction on Making Report on Atmospheric Air Pollution according to the form № 2-TP (2-E) (transport). Annex 1. Approved by the Resolution of the State Committee of the Republic of Uzbekistan on Forecasting and Statistics, #29, dated 20 September, 1994.
13. Statistical yearbook "Gross yield of agricultural crops in the originally-recorded weight and weight after the harvest of 2006-2012 (in all lands)".
14. Official web-site of International Energy Agency (IEA): http:// www.iea.org/IEA STATISTICS. CO_2 emissions from fuel combustion 1990-2012.
15. Recommendations for estimation of fertility damage from burning stubble of cereal crops. – Tashkent, 2002.
16. Agrochemistry / Edited by B.A. Yagodin. – 1982.
17. Atasim Al Dalfi. Mineral Fertilizers Impact on Spring Wheat Yield Depending on Soil Conditions and Sort. Author's abstract of dissertation. – Tashkent, 1984.
18. M.A. Belousov. Physiological Fundamentals of Cotton Root Nutrition. – Tashkent, 1975.
19. V.V Lapa, N.A. Ivanenko. Using Nutrients of Fertilizers and Soils by Agricultural Crops// Agrochemistry. - № 7. – Moscow, 1989.
20. E.N. Masharipov. Balance of Manure Nitrogen and Mineral Fertilizers when their Separate and Joint Application to Cotton. Author's abstract of candidate's dissertation. – Tashkent, 1984.
21. Methods of Agrochemical and Agrophysical Research in Soil. – Tashkent: SoyuzNIKI, 1978.
22. Irrigated Farming / Edited by S.N. Ryzhov. – Tashkent, 1965.
23. D.S. Satarov. Sort, Soil, Fertilizer and Yield. – Tashkent, 1988.
24. S. Siddikov. Relationship between Qualitative and Quantitative Composition of Humus in Irrigated Soils and Agrotechnique and Kinds of Plant Residues. Author's abstract of candidate's dissertation. – Tashkent, 1987.
25. Z. Umarov, Kh. N. Atabaeva. Wheat and Barley Productivity when Fall Sowing and a Possibility of Having the Second Yield // Information Leaflet. – Tashkent, 1994.
26. Manual on State Forest Inventory. – Moscow, 1982. – 96 p.
27. Peculiarities of Forest Management in Central Asia (Annex to the Manual on Forest Management in Unified State Forest Resources of USSR). – Tashkent, 1989.
28. State Forest Inventory. Form 2 "Forest Distribution by Prevailing Species and Age Groups. Sheet A", 1998.
29. State Forest Inventory. Form 2 "Forest Distribution by Prevailing Species and Age Groups. Sheet B", 1998.
30. D.M. Fuzailov. Wood Stock of Uzbekistan (Scientific-Technical Basics for Utilization). – Tashkent: "Fan", 1983. – 135 p.
31. G.M. Konobeeva. Soils of Uzbekistan, their zoning and qualitative assessment. – Tashkent: Mekhnat, 1985.
32. Handbook on Cotton Growing. -Tashkent: "Fan", 1981.
33. Pedology /Under edition of Prof. I.S. Kauricheva. – Moscow: "Kolos", 1975.
34. Geographical atlas of the Republic of Uzbekistan. – Tashkent: Uzgeodezcadastre, 2012.
35. "Sanitary rules and norms of cleaning the settlements from municipal solid waste in the conditions of the Republic of Uzbekistan" (Sanitary Rules and Norms of RUz. № 0068-96). – Tashkent, 1996. – 13 p.

36. “Increased norms of water supply and water allocation for different industrial sectors” – M.: SEV SRI VODGEO GOSSTROY USSR, 1982. – 570 p.
37. Official website of FAO: http://www.fao.org/DOCREP/005/Y3800M/y3800m07.htm
38. Official website of JSC Uzbekenergo: http://www.uzbekenergo.uz/ru
39. Statistical workbook “Almanac Uzbekistan 2013”. – Tashkent: CER, 2013. – 242 p.
40. Official web-site of the State Committee for Nature Protection of the Republic of Uzbekistan: www.uznature.uz
41. Official web-site of JSC “Uztransgas”: http://www.uztransgaz.uz
42. D. Abdusalamov. National Report on the Republic of Uzbekistan. – UNECE project “Enhancing synergistic effect of national programs of the CIS countries on energy efficiency and energy saving to improve their energy security”. – Tashkent: JSC “Uzbekenergo”, 2013. – 54 p.
43. Resolution of the President of Uzbekistan № PP-76 dated May 16, 2005 “On organizational measures for harvesting cereal crops”
44. Resolution of the President of the Republic of Uzbekistan dated May 13, 2008 “On measures for organization of land tillage. released from seeding of cereal crops”
45. Official web-site of Bekabad metallurgical plant: www.uzbeksteel.uz
46. Official web-site of PCP “Uzbekneftegaz”: http://www.ung.uz/ru
47. Official web-site of the Ministry of Economy of the Republic of Uzbekistan: http://www.mineconomy.uz
48. Statistic yearbook of the Republic of Uzbekistan for 2012. – Tashkent: Goskomstat of RUz, 2013. – 356 p.
49. Livestock production in Uzbekistan: current state, problems and prospects of development/MAWR. UNDP, MASHAV – Tashkent: “Nasaf”, 2010. – 160 p.
50. Official web-site of the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan: http://www.agro.uz
51. Land Code of the Republic of Uzbekistan // Register of Oliy Majlis of the Republic of Uzbekistan, 1998, №5-6. – p. 82 (www.kadastr.uz/ru/supplemental-information/legal-base)
52. Law of the Republic of Uzbekistan “On forest” dated 15.04.1999 as amended on 30.04.2013. ZRU №352– www.lex.uz/mobileact/86109
53. Bulletin on climate change. – Issue №2 “Main results of Greenhouse Gas emissions Inventory”. – Tashkent: Uzhydromet, SANIGMI, 1999. – 50 p.
54. Bulletin on climate change. – Issue №4 “Priority technology needs of Uzbekistan to reduce greenhouse gas emissions and mitigate the negative impacts of climate change”. – Tashkent: Uzhydromet, SANIGMI, 2002. – 90 p.
55. “Sanitary rules and norms on cleaning the settlements from municipal solid waste in the conditions of the Republic of Uzbekistan” (Sanitary Rules and Norms of RUz. № 0297-11). – Tashkent, 2011. – 13 p.
56. “The methods of calculation natural gas consumption for its own needs in natural gas production and preparation”. – Kiev: UkrNIIgaz, 1981.
57. Guide 39.2-140-95 “The methods of calculating harmful substances emissions into air for oil and gas enterprises of oil and gas industry”. – Tashkent, 1995.
58. Guide 51-100-85 “Guide for standardization of pollutants emissions into air in the transport and gas storage facilities”. – Moscow: VNIIGAZ, 1985.
59. “The methods of calculation natural gas consumption norms for its own needs and technological losses for gas processing plants”. – Tashkent: JSC “UzLITIneftegaz”, 2004.

ANNEXES

Annex 1 – National Inventory of anthropogenic Emissions by sources and Removals by sinks of all Greenhouse gases not controled by Montreal Protocol and Greenhouse gas precursors

Table – 1 National Inventory of anthropogenic Emissions by sources and Removals by sinks of all Greenhouse gases not controled by Montreal Protocol and Greenhouse gas precursors, 2010

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NOx	NMVOC	SO_2
	Gg							
Total National Emissions and Removals	**101762.96**	**-3064.65**	**4141.65**	**33.81**	**1043.25**	**252.98**	**253.47**	**163.09**
1. Energy	95704.21	NO	3251.17	0.28	1042.18	252.16	217.67	159.41
A. Fuel Combustion Activities (Sectoral Approach)	95704.21		8.32	0.28	1041.75	251.87	191.22	86.33
1. Energy Industries	31549.58		0.62	0.11	10.49	85.97	2.67	56.95
2. Manufacturing Industries and Construction	7520.34		0.69	0.02	4.17	21.53	0.71	2.58
3. Transport	12744.64		2.09	0.05	937.62	91.28	171.67	6.82
4. Other Sectors	43757.31		4.93	0.10	89.47	53.09	16.17	19.97
5. Other (Lubricants)	132.34		NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NE		3242.84		0.43	0.29	26.45	73.09
1. Solid Fuels			6.97		NO	NO	NO	NO
2. Oil and Natural Gas			3235.88		0.43	0.29	26.45	73.09
2. Industrial Processes	6058.75	NO	0.14	5.77	1.07	0.83	35.80	3.68
A. Mineral Products	3126.66				NE	NE	NE	2.04
B. Chemical Industry	1761.85		0.14	5.77	1.07	0.80	6.74	1.61
C. Metal Production	1170.24		NE	NE	0.00	0.03	0.02	0.03
D. Other Production	NO				NO	NO	29.04	NO
E. Production of Halocarbons and Sulfur Hexafluoride								
F. Consumption of Halocarbons and Sulfur Hexafluoride								
G. Other								
3. Solvents and Other Product Use	NE			NE			NE	
4. Agriculture			568.98	25.82	0.00	0	0	0
A. Enteric Fermentation			52856					
B. Manure Management			36.80	1.31			NA	
C. Rice Cultivation			3.62				NA	
D. Agricultural Soils			NE	24.51			NA	
E. Prescribed Burning of Savannas			NO	NO	NO	NO	NO	
F. Field Burning of Agricultural Residues			NO	NO	NO	NA	NA	
G. Other			NO	NO	NO	NO	NO	
5. Lans-Use Change and Forestry		-3064.65	NO	NO	NO	NO	NO	NO
A. Changes in Forest and Other Woody Biomass Stock		- 3588.98						
B. Forest and Grassland Conversion	NO	NO	NO	NO	NO	NO		
C. Abandonment of Manages Lands		0.00						
D. CO_2 Emissions and Removals from Soil	524.33							
E. Other								
6. Waste			321.36	1.94	NO	NO	NO	NO
A. Solid Waste Disposal on Land			303.74		NO		NO	
B. Wastewater Handling			17.62	1.94	NO	NO	NO	
C. Waste Incineration					NE	NE	NE	NE
D. Other			NO	NO	NO	NO	NO	NO
7.Other								
Memo Items								
International Bunkers	1001.31		0.01	0.03	1.42	4.24	0.71	0.66
Aviation	1001.31		0.01	0.03	1.42	4.24	0.71	0.66
Marine	NO		NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	53.71							

Table – 2 National Inventory of anthropogenic Emissions by sources and Removals by sinks of all Greenhouse gases not controled by Montreal Protocol and Greenhouse gas precursors, 2012

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NOx	NMVOC	SO_2
	Gg							
Total National Emissions and Removals	**105529.27**	**-2857.48**	**4211.56**	**36.14**	**1035.43**	**275.64**	**270.54**	**201.25**
1. Energy	99580.92	NO	3260.02	0.30	1034.37	274.81	230.33	197.46
A. Fuel Combustion Activities (Sectoral Approach)	99580.92		10.65	0.30	1033.96	274.54	205.25	107.01
1. Energy Industries	33938.34		0.66	0.12	11.16	92.70	2.85	71.18
2. Manufacturing Industries and Construction	8018.01		0.74	0.02	4.46	23.06	0.76	2.57
3. Transport	12355.26		3.13	0.05	921.39	105.24	185.16	6.86
4. Other Sectors	45079.84		6.12	0.11	96.96	53.53	16.49	26.40
5. Other (Lubricants)	189.47		NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NE		3249.37				25.08	90.45
1. Solid Fuels			5.74		NO	NO	NO	NO
2. Oil and Natural Gas			3243.63		0.41	0.27	25.08	90.45
2. Industrial Processes	5948.35	NO	0.14	5.75	1.96	0.82	40.21	3.80
A. Mineral Products	2965.05				NE	NE	NE	2.05
B. Chemical Industry	1783.33		0.14	5.74	1.06	0.79	6.65	1.72
C. Metal Production	1199.94		NE	NE	0.00	0.03	0.02	0
D. Other Production	NO				NO	NO	34	NO
E. Production of Halocarbons and Sulfur Hexafluoride								
F. Consumption of Halocarbons and Sulfur Hexafluoride								
G. Other								
3. Solvents and Other Product Use	NE			NE			NE	
4. Agriculture			616.48	28.07	0	0	0	0
A. Enteric Fermentation			573.41					
B. Manure Management			39.09	1.45			NA	
C. Rice Cultivation			3.98				NA	
D. Agricultural Soils			NE	26.62			NA	
E. Prescribed Burning of Savannas			NO	NO	NO	NO	NO	
F. Field Burning of Agricultural Residues			NA	NA	NA	NA	NA	
G. Other			NO	NO	NO	NO	NO	
5. Lans-Use Change and Forestry		-2857.48	NO	NO	NO	NO	NO	NO
A. Changes in Forest and Other Woody Biomass Stock		- 3588.98						
B. Forest and Grassland Conversion	NO	NO	NO	NO	NO	NO		
C. Abandonment of Manages Lands		0						
D. CO_2 Emissions and Removals from Soil	731.50							
E. Other								
6. Waste			334.92	2.02	NO	NO	NO	NO
A. Solid Waste Disposal on Land			316.66		NO		NO	
B. Wastewater Handling			18.26	2.02	NO	NO	NO	
C. Waste Incineration					NE	NE	NE	NE
D. Other			NO	NO	NO	NO	NO	NO
7.Other								
Memo Items								
International Bunkers	725.52		0.01	0.02	1.03	3.08	0.52	0.49
Aviation	725.52		0.01	0.02	1.03	3.08	0.52	0.49
Marine	NO		NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	53.71							

Notes: Shaded cells do not require entries.

1-The following standard indicators should be used, as appropriate, for emissions by sources and removals by sinks of GHGs:

NO (not occurring) for activities and processes that do not occur for a particular gas or source/sink category within a country;

NE (not estimated) for existing emissions and removals which have not been estimated;

NA (not applicable) for activities in a given source/sink category which do not result in emissions and removals of a specific gas;

2- Do not provide an estimate of both CO_2 emissions and CO_2 removals. “Net” emissions (emissions-removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Note that for the purposes of reporting, the signs for removals are always (-) and for emissions (+).

Annex 2 – National Inventory of antropogenic emissions of HFCs, PFCs and SF_6

Table – 1 National Inventory of antropogenic emissions of HFCs, PFCs and SF_6, 2010

GHG SOURCE AND SINK CATEGORIES	HFCs (Gg)					PFCs (Gg)		SF_6 (Gg)
	HFC-32	HFC-125	HFC-134a	HFC-143a	Others	CF_4	Others	
Total Emissions and Removals	**0.000333**	**0.001017**	**0.013153**	**0.000555**	**NE**	**NE**	**NE**	**NE**
1. Energy								
A. Fuel Combustion Activities (Sectoral Approach)								
1. Energy Industries								
2. Manufacturing Industries and Construction								
3. Transport								
4. Other Sectors								
5. Other								
B. Fugitive Emissions from Fuels								
1. Solid Fuels								
2. Oil and Natural Gas								
2. Industrial Processes	0.000333	0.001017	0.013153	0.000555	NE	NE	NE	NE
A. Mineral Products								
B. Chemical Industry								
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production								
E. Production of Halocarbons and Sulfur Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of Halocarbons and Sulfur Hexafluoride	0.000333	0.001017	0.013153	0.000555	NE	NE	NE	NE
G. Other								
3. Solvent and Other Product Use								
4. Agriculture								
A. Enteric Fermentation								
B. Manure Management								
C. Rice Cultivation								
D. Agricultural Soils								
E. Prescribed Burning of Savannas								
F. Field Burning of Agricultural Residues								
G. Other								
5. Land-Use Change and Forestry								
A. Changes in Forest and Other Woody Biomass Stock								
B. Forest and Grassland Conversion								
C. Abandonment of Manages Lands								
D. CO_2 Emissions and Removals from Soil								
E. Other								
6. Waste								
A. Solid Waste Disposal on land								
B. Wastewater Handling								
C. Waste Incineration								
D.Other								
7. Other								
Memo Items								
International Bunkers								
Aviation								
Marine								
CO_2 Emissions from Biomass								

Table – 2 National Inventory of antropogenic emissions of HFCs,PFCs and SF_6, 2012

GHG SOURCE AND SINK CATEGORIES	HFCs (Gg)					PFCs (Gg)		SF_6 (Gg)
	HFC-32	HFC-125	HFC-134a	HFC-143a	Others	CF_4	Others	
Total Emissions and Removals	**0.000181**	**0.007932**	**0.036381**	**0.006515**	**NE**	**NE**	**NE**	**NE**
1. Energy								
A. Fuel Combustion Activities (Sectoral Approach)								
1. Energy Industries								
2. Manufacturing Industries and Construction								
3. Transport								
4. Other Sectors								
5. Other								
B. Fugitive Emissions from Fuels								
1. Solid Fuels								
2. Oil and Natural Gas								
2. Industrial Processes	0.000181	0.007932	0.036381	0.006515	NE	NE	NE	NE
A. Mineral Products								
B. Chemical Industry								
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production								
E. Production of Halocarbons and Sulfur Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of Halocarbons and Sulfur Hexafluoride	0.000181	0.007932	0.036381	0.006515	NE	NE	NE	NE
G. Other								
3. Solvent and Other Product Use								
4. Agriculture								
A. Enteric Fermentation								
B. Manure Management								
C. Rice Cultivation								
D. Agricultural Soils								
E. Prescribed Burning of Savannas								
F. Field Burning of Agricultural Residues								
G. Other								
5. Land-Use Change and Forestry								
A. Changes in Forest and Other Woody Biomass Stock								
B. Forest and Grassland Conversion								
C. Abandonment of Manages Lands								
D. CO_2 Emissions and Removals from Soil								
E. Other								
6. Waste								
A. Solid Waste Disposal on Land								
B. Wastewater Handling								
C. Waste Incineration								
D.Other								
7. Other								
Memo Items								
International Bunkers								
Aviation								
Marine								
CO_2 Emissions from Biomass								

Note:
Table presents Potential HFC emissions wich are estimated using the Tier 1 approach of the IPCC Guidelines 1996 [3].

Annex 3 – Sectoral tables (IPCC Program Software, 1996)

Table – 1A1 Sector "Energy", 2010

GHG SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Energy	**95704.21**	**3251.17**	**0.28**	**252.16**	**1042.18**	**217.67**	**159.41**
A Fuel Combustion Activities (Sectoral Approach)	**95704.21**	**8.32**	**0.28**	**251.87**	**104175**	**191.22**	**86.33**
1 Fuel Processing, Energy Production and Transmission	**31549.58**	**0.62**	**0.11**	**85.97**	**10.49**	**2.67**	**56.95**
a Public Electricity and Heat Production							
b Petroleum Refining							
c Manufacture of Solid Fuels and Other Energy Industries							
2 Manufacturing Industries and Construction	**7520.34**	**0.69**	**0.02**	**21.53**	**4.17**	**0.71**	**2.58**
a Iron and Steel							
b Non-Ferrous Metals							
c Chemicals							
d Pulp, Paper and Printing							
e Food Processing, Beverages and Tobacco							
f Other (please specify)							
3 Transport	**12744.64**	**2.09**	**0.05**	**91.28**	**937.62**	**171.66**	**6.82**
a Civil Aviation	55.84	0.00	0.00	0.24	0.08	0.04	
b Road Transportation	6907.96	2.06	0.05	83.95	931.64	170.44	
c Railways	433.13	0.03	0.00	7.09	5.91	1.18	
d Navigation	0	0.00	0.00	0.00	0.00	0.00	
e Other (please specify)							
Pipeline Transport	5347.71						
4 Other Sectors	**43757.31**	**4.93**	**0.10**	**53.09**	**89.47**	**16.17**	**19.97**
a Commercial/ Institutional	10452.92	0.98	0.03	9.80	17.48	1.78	9.67
b Residential	31917.93	3.84	0.06	28.72	34.92	3.50	6.07
c Agriculture/Forestry/Fishing	1386.45	0.11	0.01	14.59	37.07	10.89	4.24
5 Other (Lubricants)	**132.34**						
B Fugitive Emissions from Fuels	**0.00**	**3242.84**	**0**	**0.29**	**0.43**	**26.45**	**73.09**
1 Solid Fuels	**0.00**	**6.97**	**0**	**0**	**0**	**0**	**0**
a Coal Mining		6.97					
b Solid Fuel Transformation							
c Other (please specify)							
2 Oil and Natural Gas	**0.00**	**3235.88**	**0**	**0.29**	**0.43**	**26.45**	**73.09**
a Oil		1.18		0.29	0.43	26.45	4.85
b Natural Gas		3228.56					68.23
c Venting and Flaring		6.14					
Memo Items (not included into national emissions)							
International Bunkers	**1001.31**	**0.01**	**0.03**	**4.24**	**1.42**	**0.71**	**0.66**
Aviation	1001.31	0.01	0.03	4.24	1.42	0.71	0.66
Marine	0	0	0	0	0	0	0
CO_2 Emissions from Biomass	**53.71**	**0**	**0**	**0**	**0**	**0**	**0**

Table – 1A2 Sector "Energy", 2012

GHG SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Energy	**99580.92**	**3260.02**	**0.30**	**274.81**	**1034.37**	**230.33**	**197.55**
A Fuel Combustion Activities (Sectoral Approach)	**95580.92**	**10.65**	**0.30**	**274.54**	**1033.96**	**205.25**	**107.11**
1 Fuel Processing, Energy Production and Transmission	**33938.34**	**0.66**	**0.12**	**92.70**	**11.16**	**2.85**	**71.28**
a Public Electricity and Heat Production							
b Petroleum Refining							
c Manufacture of Solid Fuels and Other Energy Industries							
2 Manufacturing Industries and Construction	**8018.01**	**0.74**	**0.02**	**23.06**	**4.46**	**0.76**	**2.57**
a Iron and Steel							
b Non-Ferrous Metals							
c Chemicals							
d Pulp, Paper and Printing							
e Food Processing, Beverages and Tobacco							
f Other (please specify)							
3 Transport	**12355.26**	**3.13**	**0.05**	**105.24**	**921.39**	**185.16**	**6.86**
a Civil Aviation	41.27	0.00	0.00	0.18	0.06	0.03	
b Road Transportation	7788.75	3.10	0.05	98.03	915.46	183.95	
c Railways	430.02	0.03	0.00	7.04	5.86	1.17	
d Navigation	0.00	0.00	0.00	0.00	0.00	0.00	
e Other (please specify)							
Pipeline Transport	4095.23						
4 Other Sectors	**45079.84**	**6.12**	**0.11**	**53.53**	**96.96**	**16.49**	**26.40**
a Commercial/ Institutional	19919.49	1.82	0.05	18.24	27.41	2.77	10.60
b Residential	23856.20	4.19	0.05	21.59	34.71	3.48	11.81
c Agriculture/Forestry/Fishing	1304.15	0.10	0.01	13.71	34.84	10.24	3.98
5 Other (Lubricants)	**189.47**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
B Fugitive Emissions from Fuels	**0.00**	**3249.37**	**0.00**	**0.27**	**0.41**	**25.08**	**90.45**
1 Solid Fuels	**0.00**	**5.74**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
a Coal Mining		5.74					
b Solid Fuel Transformation							
c Other (please specify)							
2 Oil and Natural Gas	**0.00**	**3243.63**	**0.00**	**00.27**	**0.41**	**25.08**	**90.45**
a Oil		1.11		0	0	25.08	4.64
b Natural Gas		3236.70					85.81
c Venting and Flaring		5.81					
Memo Items (not included into national emissions)							
International Bunkers	**725.52**	**0.01**	**0.02**	**3.08**	**1.03**	**0.51**	**0.48**
Aviation	725.52	0.01	0.02	3.08	1.03	0.51	0.48
Marine							
CO_2 Emissions from Biomass	**53.71**	0	0	0	0	0	0

Table – 2A1 Sector "Industrial Processes", 2010

GHG SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC		PFC		SF_6	
								P	A	P	A	P	A
Total Industrial Processes	**6058.74**	**0.14**	**5.77**	**0.83**	**1.07**	**35.80**	**3.68**	*****	**0**	**0**	**0**	**0**	**0**
A Mineral Products	**3126.65**	**0**	**0**	**0**	**0**	**0**	**2.04**						
1 Cement Production	2924.08						2.04						
2 Limestone Production	176.64												
3 Limestone and Dolomite Use													
4 Soda Ash Production and Use	25.93												
5 Asphalt Roofing													
6 Road Paving with Asphalt													
7 Other (please specify)													
Glass Production													
Concrete Pumice Stone													
B Chemical Industry	**1761.85**	**0.14**	**5.77**	**0.80**	**1.07**	**6.74**	**1.61**						
1 Ammonia Production	1761.85				1.07	6.74	0						
2 Nitric Acid Production			5.77	0.80									
3 Adipic Acid Production													
4 Carbide Production													
5 Other (Sulphuric Acid Production)							2						
C Metal Production	**1170.24**	**0**	**0**	**0.03**	**0.00**	**0.02**	**0.03**						
1 Iron and Steel Production	1170.24			0.03	0.00	0.02	0.03						
2 Ferroalloys Production													
3 Aluminium Production													
4 SF_6 Used in Aluminum and Magnesium Foundries													
5 Other (please specify)													
D Other Production	**0.00**	**0.14**	**0.00**	**0.00**	**0.00**	**29.04**	**0.00**						
1 Pulp and Paper													
2 Food and Drink						29.04							
E Production of Halocarbons and Sulphur Hexafluoride													
1 By-product Emissions													
2 Fugitive Emissions													
3 Other (please specify)													
F Consumption of Halocarbons and Sulphur Hexafluoride	**0**	**0**	**0**	**0**	**0**	**0**	**0**	*****					
1 Refrigeration and Air Conditioning Equipment								*					
2 Foam Blowing													
3 Fire Extinguishers													
4 Aerosols													
5 Solvents													
6 Other (please specify)													
G Other (please specify)													

P = Potential emissions based on Tier 1 Approach; A = Actual emissions based on Tier 2 Approach. This only applies in sectors where methods exist for both tiers.

* -Summary potential emissions of HFCs = 0.015058 Gg (see Annex 2).

Table – 2A2 Sector "Industrial Processes", 2012

GHG SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC		PFC		SF_6	
								P	A	P	A	P	A
Total Industrial Processes	**5948.34**	**0.15**	**5.75**	**0.82**	**1.06**	**40.21**	**3.79**	*****	**0**	**0**	**0**	**0**	**0**
A Mineral Products	**2965.05**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.05**						
1 Cement Production	2791.03						2.05						
2 Limestone Production	140.86												
3 Limestone and Dolomite Use													
4 Soda Ash Production and Use	33.16												
5 Asphalt Roofing													
6 Road Paving with Asphalt													
7 Other (please specify)													
Glass Production													
Concrete Pumice Stone													
B Chemical Industry	**1783.35**	**0.00**	**5.75**	**0.79**	**1.06**	**6.25**	**1.71**						
1 Ammonia Production	1783.35				1.06	6.25	0.02						
2 Nitric Acid Production			5.75	0.79									
3 Adipic Acid Production													
4 Carbide Production													
5 Other (Sulphuric Acid Production)							1.69						
C Metal Production	**1199.94**	**0.00**	**0.00**	**0.03**	**0.00**	**0.02**	**0.03**						
1 Iron and Steel Production	1199.94			0.03	0.00	0.02	0.03						
2 Ferroalloys Production													
3 Aluminium Production													
4 SF_6 Used in Aluminum and Magnesium Foundries													
5 Other (please specify)													
D Other Production	**0.00**	**0.15**	**0.00**	**0.00**	**0.00**	**33.94**	**0.00**						
1 Pulp and Paper													
2 Food and Drink						33.94							
E Production of Halocarbons and Sulphur Hexafluoride													
1 By-product Emissions													
2 Fugitive Emissions													
3 Other (please specify)													
F Consumption of Halocarbons and Sulphur Hexafluoride								*					
1 Refrigeration and Air Conditioning Equipment								*					
2 Foam Blowing													
3 Fire Extinguishers													
4 Aerosols													
5 Solvents													
6 Other (please specify)													
G Other (please specify)													

P = Potential emissions based on Tier 1 Approach; A = Actual emissions based on Tier 2 Approach. This only applies in sectors where methods exist for both tiers.

* -Summary potential emissions of HFCs = 0.015058 Gg (see Annex 2).

Table – 4A1 Sector "Agriculture", 2010

GHG SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	**568.98**	**25.82**	**0**	**0**	**0**
A Enteric fermentation	**528.56**				
1 Cattle	444.33				
2 Buffalo	0.00				
3 Sheep	63.78				
4 Goats	12.82				
5 Camels and Lamas	0.83				
6 Horses	3.38				
7 Mules and Asses	3.32				
8 Swine	0.10				
9 Poultry	0.00				
10 Other (please specify)					
B Manure Management	**36.80**	**1.31**			
1 Cattle	34.13				
2 Buffalo	0.00				
3 Sheep	1.35				
4 Goats	0.31				
5 Camels and Lamas	0.02				
6 Horses	0.21				
7 Mules and Asses	0.20				
8 Swine	0.10				
9 Poultry	0.47				
B Manure Management (continuation)		**0.02**			
10 Anaerobic		0.02			
11 Liquid Systems		0.97			
12 Solid Storage and Dry Lot		0.30			
13 Other (please specify)	3.62				
C Rice Cultivation	**3.62**				
1 Irrigated					
2 Rainfed					
3 Deep Water					
4 Other (please specify)		24.51			
D Agricultural Soils					
E Prescribed Burning of Savannas	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
F Field Burning of Agricultural Residues	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1 Cereals					
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

Table – 4A2 Sector "Agriculture", 2012

GHG SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	**616.48**	**28.07**	**0**	**0**	**0**
A Enteric fermentation	**573.41**				
1 Cattle	482.13				
2 Buffalo	0.00				
3 Sheep	68.92				
4 Goats	14.38				
5 Camels and Lamas	0.87				
6 Horses	3.58				
7 Mules and Asses	3.45				
8 Swine	0.10				
9 Poultry	0.00				
10 Other (please specify)					
B Manure Management	**39.09**	**1.45**			
1 Cattle	36.18				
2 Buffalo	0.00				
3 Sheep	1.46				
4 Goats	0.35				
5 Camels and Lamas	0.02				
6 Horses	0.23				
7 Mules and Asses	0.21				
8 Swine	0.10				
9 Poultry	0.56				
B Manure Management (continuation)		0.02			
10 Anaerobic		0.02			
11 Liquid Systems		1.08			
12 Solid Storage and Dry Lot		0.34			
13 Other (please specify)	**3.98**				
C Rice Cultivation	3.98				
1 Irrigated					
2 Rainfed					
3 Deep Water					
4 Other (please specify)		**26.62**			
D Agricultural Soils					
E Prescribed Burning of Savannas	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
F Field Burning of Agricultural Residues	0.00	0.00	0.00	0.00	0.00
1 Cereals					
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

Table – 5A1 Sector "Land-Use Change And Forestry", 2010

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO
Total Land-Use Change and Forestry		**-3064.65**	**0**	**0**	**0**	**0**
A Changes in Forest and Other Woody Biomass Stock		**-3588.98**				
1 Tropical Forests						
2 Temperate Forests						
3 Boreal Forests						
4 Grassland / Tundra						
5 Other (please specify)						
B Forest and Grassland Conversion	**0**	**0**	**0**	**0**	**0**	**0**
1 Tropical Forests	0					
2 Temperate Forests	0					
3 Boreal Forests	0					
4 Grassland/ Tundra	0					
5 Other (please specify)	0					
C Abandonment of Managed Land	**0.00**	**0.00**				
1 Tropical Forests		0				
2 Temperate Forests		0				
3 Boreal Forests		0				
4 Grassland/Tundra		0				
5 Other (please specify)		0				
D CO_2 Emissions and Removals from Soil	**524.33**	**0.00**				
E Other (please specify)						

Table – 5A2 Sector "Land-Use Change And Forestry" , 2012

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO
Total Land-Use Change and Forestry	**0**	**-2857.48**	**0**	**0**	**0**	**0**
A Changes in Forest and Other Woody Biomass Stock	**0**	**-3589.53**				
1 Tropical Forests						
2 Temperate Forests						
3 Boreal Forests						
4 Grassland / Tundra						
5 Other (please specify)						
B Forest and Grassland Conversion	**0**	**0**	**0**	**0**	**0**	**0**
1 Tropical Forests	0					
2 Temperate Forests	0					
3 Boreal Forests	0					
4 Grassland/ Tundra	0					
5 Other (please specify)	0					
C Abandonment of Managed Land	**0**	**0**				
1 Tropical Forests		0				
2 Temperate Forests		0				
3 Boreal Forests		0				
4 Grasslands / Tundra		0				
5 Other (please specify)		0				
D CO_2 Emissions and Removals from Soil	**731.50**	**0**				
E Other (please specify)						

Table – 6A1 Sector "Waste", 2010

GHG SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Total Waste		**321.36**	**1.94**			
A Solid Waste Disposal on Land		**303.74**				
1 Managed Waste Disposal on Land						
2 Unmanaged Waste Disposal on Land						
3 Other (please specify)						
B Wastewater Handling		**17.62**	**1.94**			
1 Industrial Wastewater		2.64				
2 Domestic and Commercial Wastewater		14.98	1.94			
3 Other (please specify)						
C Waste Incineration						
D Other (please specify)						

Table – 6A2 Sector "Waste", 2012

GHG SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Total Waste		**334.92**	**2.02**			
A Solid Waste Disposal on Land		**316.66**	**0.00**			
1 Managed Waste Disposal on Land						
2 Unmanaged Waste Disposal on Land						
3 Other (please specify)						
B Wastewater Handling		**18.26**	**2.02**			
1 Industrial Wastewater		2.91				
2 Domestic and Commercial wastewater		15.35	2.02			
3 Other (please specify)						
C Waste Incineration						
D Other (please specify)						

Table – 7A1 Summary Report for National Greenhouse Gas Inventories, 2010

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NOx	CO	NMVOC	SO_2	HFC		PFC		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**101762.96**	**-3064.65**	**4141.65**	**33.81**	**252.98**	**1043.25**	**253.47**	**163.09**	**0.02**					
1 Energy	**95704.21**		**3251.17**	**0.28**	**252.16**	**1042.18**	**217.67**	**159.41**						
A Fuel Combustion Activities (Sectoral Approach)	95704.21		8.32	0.28	251.87	1041.75	191.22	86.33						
1 Energy Industries	31549.58		0.62	0.11	85.97	10.49	2.67	56.95						
2 Manufacturing Industries and Construction	7520.34		0.69	0.02	21.53	4.17	0.71	2.60						
3 Transport	12744.64		2.09	0.05	91.28	937.62	171.66	6.82						
4 Other Sectors	43757.31		4.93	0.10	53.09	89.47	16.17	19.97						
5 Other (Lubricants)	132.34		0.00	0.00	0.00	0.00	0.00	0.00						
B Fugitive Emissions from Fuels			3242.84		0.29	0.43	26.45	73.09						
1 Solid Fuels			6.97											
2 Oil and Natural Gas			3235.88		0.29	0.43	26.45	73.09						
2 Industrial Processes	**6058.75**		**0.14**	**5.77**	**0.83**	**1.07**	**35.80**	**3.68**	**0.02**					
A Mineral Products	3126.66					0.00	0.00	2.04						
B Chemical Industry	1761.85		0.14	5.77	0.80	1.07	6.74	1.61						
C Metal Production	1170.24		0.00	0.00	0.03	0.00	0.02	0.03						
D Other Production					0.00	0.00	29.04	0.00						
E Production of Halocarbons and Sulphur Hexafluoride														
F Consumption of Halocarbons and Sulphur Hexafluoride									0.02					
G Other (please specify)														

Table – 7A1 Summary Report for National Greenhouse Gas Inventories, 2010

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NOx	CO	NMVOC	SO_2	HFC		PFC		SF_6	
									P	A	P	A	P	A
3 Solvent and Other Product Use														
4 Agriculture			**568.98**	**25.82**	**0.00**	**0.00**	**0.00**							
A Enteric Fermentation			528.56											
B Manure Management			36.80	1.31										
C Rice Cultivation			3.62											
D Agricultural Soils				24.51										
E Prescribed Burning of Savannas														
F Field Burning of Agricultural Residues														
G Other														
5 Land-Use Change and Forestry	**0.00**	**-3064.65**	**0.00**	**0.00**	**0.00**	**0.00**								
A Changes in Forest and Other Woody Biomass Stocks	0.00	-3588.98												
B Forest and Grassland Conversion	0	0												
C Abandonment of Manages Lands	0	0												
D CO_2 Emissions and Removals from Soil	524.33	0												
E Other														
6 Waste			**321.36**	**1.94**	**0.00**	**0.00**	**0.00**	**0.00**						
A Solid Waste Disposal on Land			303.74											
B Wastewater Handling			17.62	1.94										
C Waste Incineration														
D Other														
7 Other														
Memo items														
International Bunkers	**1001.31**		**0.01**	**0.03**	**4.24**	**1.42**	**0.71**	**0.66**						
Aviation	1001.31		0.01	0.03	4.24	1.42	0.71	0.66						
Marine														
CO_2 Emissions from Biomass	**5371**													

Table – 7A2 Summary Report for National Greenhouse Gas Inventories, 2012

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NOx	CO	NMVOC	SO_2	HFC		PFC		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**105529.27**	**-2857.48**	**4211.56**	**36.14**	**275.64**	**1035.43**	**270.54**	**201.25**	**0.05**					
1 Energy	**99580.92**		**3260.02**	**0.30**	**274.81**	**1034.37**	**230.33**	**197.46**						
A Fuel Combustion Activities (Sectoral Approach)	99580.92		10.65	0.30	274.54	1033.96	205.25	107.01						
1 Energy Industries	33938.34		0.66	0.12	92.70	11.16	2.85	71.18						
2 Manufacturing Industries and Construction	8018.01		0.74	0.02	23.06	4.46	0.76	2.57						
3 Transport	12355.26		3.13	0.05	105.24	921.39	185.16	6.86						
4 Other Sectors	45079.84		6.12	0.11	53.53	96.96	16.49	26.40						
5 Other (Lubricants)	189.47		0.00	0.00	0.00	0.00	0.00	0.00						
B Fugitive Emissions from Fuels			3249.37		0.27	0.41	25.08	90.45						
1 Solid Fuels			5.74											
2 Oil and Natural Gas			3243.63		0.27	0.41	25.08	90.45						
2 Industrial Processes	**5948.35**		**0.14**	**5.75**	**0.82**	**1.06**	**40.21**	**3.80**	**0.05**					
A Mineral Products	2965.05					0	0	2.05						
B Chemical Industry	1783.35		0.14	5.75	0.79	1.06	6.65	1.72						
C Metal Production	1199.94		0.00	0.03	0.00	0.00	0.02	0.034						
D Other Production	0.00				0.00	0.00	33.53	0.00						
E Production of Halocarbons and Sulphur Hexafluoride														
F Consumption of Halocarbons and Sulphur Hexafluoride									0					
G Other (please specify)														

Table – 7A2 Summary Report for National Greenhouse Gas Inventories, 2012

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NOx	CO	NMVOC	SO_2	HFC		PFC		SF_6	
									P	A	P	A	P	A
3 Solvent and Other Product Use														
4 Agriculture			**616.48**	**28.07**										
A Enteric Fermentation			573.41											
B Manure Management			39.09	1.45										
C Rice Cultivation			3.98											
D Agricultural Soils				26.62										
E Prescribed Burning of Savannas														
F Field Burning of Agricultural Residues	0.00		0.00	0	0	0	0							
G Other														
5 Land-Use Change and Forestry	**0**	**-2857.48**	**0**	**0**	**0**	**0**								
A Changes in Forest and Other Woody Biomass Stocks	**0**	-3588.98												
B Forest and Grassland Conversion	0	0												
C Abandonment of Managed Land	0	0												
D CO_2 Emissions and Removals from Soil	**731.50**	0												
E Other														
6 Waste			**334.92**	**2.02**										
A Solid Waste Disposal on Land			316.66											
B Wastewater Handling			18.26	2.02										
C Waste Incineration														
D Other														
7 Other														
Memo items														
International Bunkers	**725.52**		**0.01**	**0.02**	**3.08**	**1.03**	**0.51**	**0.48**						
Aviation	725.52		0.01	0.02	3.08	1.03	0.51	0.48						
Marine	0		0	0	0	0	0	0						
CO_2 Emissions from Biomass	**53.71**													

Table – 7B1 Short Summary Report for National Greenhouse Gas Inventories, 2010

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC		PF		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**101762.96**	**-3064.65**	**4141.65**	**33.81**	**252.98**	**1043.25**	**253.47**	**163.09**	**0.02**					
1 Energy														
Reference Approach	**85457.00**													
Sectoral Approach	**95704.21**		**3251.17**	**0.28**	**252.16**	**1042.18**	**217.67**	**159.41**						
A Fuel Combustion Activities	95704.21		8.32	0.28	251.87	1041.75	191.22	**86.33**						
B Fugitive Emissions from Fuels			3243.84		0.29	0.43	26.45	73.09						
2 Industrial Processes	**6058.75**		**0.14**	**5.77**	**0.83**	**1.07**	**35.80**	**3.68**						
3 Solvent and Other Product Use														
4 Agriculture			**568.98**	**25.82**	**0.00**	**0.00**								
5 Land-Use Change and Forestry		**-3064.65**	**0**	**0**	**0**	**0**								
6 Waste			**321.36**	**1.94**										
7 Other (please specify)														
Memo items														
International Bunkers	**1001.31**		**0.01**	**0.03**	**4.24**	**1.42**	**0.71**	**0.66**						
Aviation	1001.31		0.01	0.03	4.24	1.42	0.71	0.66						
Marine														
CO_2 Emissions from Biomass	**53.71**													

Table – 7B2 Short Summary Report for National Greenhouse Gas Inventories, 2012

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC		PF		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**105529.27**	**-2857.48**	**4211.56**	**36.14**	**275.65**	**1035.43**	**270.54**	**201.25**	**0.05**					
1 Energy														
Reference Approach	**86556.88**													
Sectoral Approach	**99580.92**		**3260.02**	**0.30**	**274.81**	**1034.37**	**230.33**	**197.46**						
A Fuel Combustion Activities	99580.92		10.65	0.30	274.54	1034.37	205.25	**107.01**						
B Fugitive Emissions from Fuels			3249.37		0.27	0.41	25.08	90.45						
2 Industrial Processes	**5948.35**		**0.14**	**5.75**	**0.82**	**1.06**	**40.21**	**3.80**						
3 Solvent and Other Product Use														
4 Agriculture			**616.48**	**28.07**										
5 Land-Use Change and Forestry	**0**	**-2857.48**	**0**	**0**	**0**	**0**								
6 Waste	**0**	**334.92**	**2.02**											
7 Other (please specify)														
Memo items														
International Bunkers	**725.52**		**0.01**	**0.02**	**3.08**	**1.03**	**0.51**	**0.48**						
Aviation	725.52		0.01	0.02	3.08	1.03	0.51	0.48						
Marine	0		0		0	0	0	0						
CO_2 Emissions from Biomass	**53.71**													

Table – 8A Overview Table for National Greenhouse Gas Inventories 2010, 2012

GHG SOURCE AND SINK CATEGORIES			CO_2		CH_4		N_2O		NO_x		CO		NMVOC		SO_2		HFC		PFC		SF_6		Documentation	Disaggre gation
			Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality		
Total National Emissions and Removals																								
1	**Energy**																							**3**
	A	Fuel Combustion Activities [(1)]																						
		Basic Approach	ALL	M																			H	1
		Sectoral Approach	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H	3
		1 Energy Industries	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H	3
		2 Manufacturing Industries and Construction	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H	3
		3 Transport	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H	3
		4 Other sectors	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H	3
		5 Other (Lubricants)	ALL	M	NA		NA		NA		NA		NA		NA								H	1
	B	Fugitive Emissions from Fuels																						
		1 Solid Fuels			ALL	M			NO		NO		NO		NO								H	3
		2 Oil and Natural Gas			ALL	H			ALL	H	ALL	H	ALL	H	ALL	H							H	3
2	**Industrial processes**																							3
	A	Mineral Products	PART	H					NE		NE		NE		PART	H							H	3
	B	Chemical Industry	PART	H	PART	H	ALL	M	PART	M	PART	H	PART	H	ALL	H							H	3
	C	Metal Production[(2)]	PART	M	NE		NE		PART	M	PART	M	PART	M	PART	M	NO		NO		NO		H	1
	D	Other Production	NO		NO		NO		NO		NO		ALL	H	NO								H	3
	E	Production of Halocarbons and Sulphur Hexafluoride															NO		NO		NO			

Notes:

(1) – in the sub-sectors "Fuel combustion activities" and "International bunkers" of the "Energy" sector, greenhouse gas emissions were estimated by index "M" as they are calculated according to expert estimates, in the connection with the lack of official data on fuel consumption. which are confidential since 2007.

(2) – in the sector "Industrial Processes" of the category C "Metal production", only greenhouse gas emissions from steel production were estimated. Data on other metal production is confidential. Greenhouse gas emissions in this category are estimated by index "M" in connection with the use of default emission factors.

Table – 8A Overview Table for National Greenhouse Gas Inventories 2010, 2012

GHG SOURCE AND SINK CATEGORIES			CO_2		CH_4		N_2O		NO_x		CO		NMVOC		SO_2		HFC		PFC		SF_6		Documentation	Disaggregation
			Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality		
	Industrial processes (continuation)																							
	F	Consumption of Halocarbons and Sulphur Hexafluoride																						
		Potential [3]															PART	L	NE		NE			M
		Actual															NO		NO		NO			
	G	Other (please specify)																						
3	**Solvent and Other Product Use**		NE				NE						NE											
4	**Agriculture**																							3
	A	Enteric Fermentation [4]			ALL	M																	H	3
	B	Manure Management [5]			ALL	M	ALL	M					NA										H	3
	C	Rice Cultivation [6]			ALL	M							NA										H	2
	D	Agricultural Soils			NE		ALL	M					NA										H	1
	E	Prescribed Burning of Savannas			NO		NO		NO		NO		NO											
	F	Field Burning of Agricultural Residues [7]			NO		NO		NA		NO		NA										H	
	G	Other (please specify)			NO		NO		NO		NO		NO											
5	**Land-Use Change and Forestry**																							
	A	Changes in Forest and Other Woody Biomass Stocks [8]	PART	M																			H	2
	B	Forest and Grassland Conversion	NO		NO		NO		NO		NO													

Notes:

(3) - in the sector "Industrial Processes" in the category F "Consumption of halocarbons and sulfphur hexafluoride" only potential emissions from HFCs consumption based on data on import of refrigerant mixtures. There is no statistical data on the consumption of PFCs and sulphur hexafluoride in the country.

(4-6) – in the sector "Agriculture" in category A "Enteric fermentation", B "Manure management" and C "Rice cultivation" index "M" is assigned to estimates of greenhouse gas emissions as default factors were used in the calculations.

(7) - in the sector "Agriculture" in the category F "Field burning of agricultural residues" there is no data on greenhouse gas emissions are missing due to the legislative prohibition of burning stubble since 2005

(8) - in the sector "LUCF" in the category A "Change in forests and other woody biomass stocks" removals of carbon dioxide only from biomass reservoirs were estimated.

Table – 8A Overview Table for National Greenhouse Gas Inventories 2010, 2012

GHG SOURCE AND SINK CATEGORIES		CO_2		CH_4		N_2O		NO_x		CO		NMVOC		SO_2		HFC		PFC		SF_6		Documentation	Disaggregation
		Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality		
5	**Land-Use Change and Forestry (continuation)**																						
	C Abandonment of Managed Land [9]																					H	2
	D CO_2 Emissions and Removals from Soil	ALL	M																			H	2
	Other (please specify)																						
6	**Waste**																						
	A Solid Waste Disposal on Land			ALL	M					NO		NO										H	2
	B Wastewater Handling			ALL	M	ALL	M	NO		NO		NO										H	2
	C Waste Incineration							NE		NE		NE		NE									
	D Other (please specify)			NO		NO		NO		NO		NO		NO									
7	**Other (please specify)**																						
Memo Items:																							
International Bunkers																							
Aviation		ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H	3
Marine		NO		NO		NO		NO		NO		NO		NO									
CO_2 Emissions from Biomass [10]		PART	L																			H	1

Notes:

(9) - in the sector "LUCF" in the category C "Abandonment of managed land" greenhouse gas emissions under conditions of Uzbekistan do not occur.

(10) - category "CO_2 emissions from biomass" includes only emissions from Fuel wood consumption.

Estimate	Quality	Documentation	Disaggregation
PART – partly estimated	H – high confidence in estimation	H – high (all background information included)	1– total emission estimated
ALL – full estimate of all possible sources	M – medium confidence in estimation	M – medium (some background information included)	2– sectoral split
NE – not estimated	L – low confidence in estimation	L – low (only emission estimates included)	3– -sub-sectoral split
NO – not occuring			
NA – not applicable			

Annex 4 – Key sources analysis

Table – 1 Level Assessment for 1990

IPCC Category code	Sector	IPCC Category	Greenhouse Gas	Estimates for 1990, Gg CO_2-eq.	% of Total	Cumulative Total, %
		Total		**180435**	**100%**	**100%**
1.B.2	Energy	Fugitive CH_4 Emissions from Oil and Gas	CH_4	43159.1	23.9%	23.9%
1.A.1	Energy	CO_2 Emissions from Fuel Gas Combustion (Natural Gas)	CO_2	37147.4	20.6%	44.5%
4.D	Agriculture	N_2O Emissions (Direct and Indirect) from Agricultural Soils	N_2O	10221.9	5.7%	50.2%
1.A.3	Energy	Mobile: CO_2 Emissions from Road Transportation	CO_2	9985.9	5.5%	55.7%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Residual Fuel Oil)	CO_2	8813.8	4.9%	60.6%
1.A.4	Energy	Residential: CO_2 Emissions from Fuel Gas	CO_2	8048.1	4.5%	65.1%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Fuel Gas	CO_2	7239.3	4.0%	69.1%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Sub-Bituminous Coal)	CO_2	7158.1	4.0%	73.0%
4.A	Agriculture	CH_4 Emissions from Livestock. Enteric Fermentation	CH_4	5832.9	3.2%	76.3%
1.A.4	Energy	Agriculture/Forestry/ Fishing: CO_2 Emissions from Liquid Fuel	CO_2	4799.2	2.7%	78.9%
1.A.3	Energy	CO_2 Emissions from Pipeline Transportation	CO_2	4575.3	2.5%	81.5%
6.A	Waste	CH_4 Emissions from Solid Waste Disposal on land	CH_4	3343.3	1.9%	83.3%
1.A.4	Energy	Residential: CO_2 Emissions from Solid Fuel	CO_2	3338.2	1.9%	85.2%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Fuel Gas	CO_2	3036.3	1.7%	86.8%
2.A	Industrial Processes	CO_2 Emissions from Cement Production	CO_2	2582.9	1.4%	88.3%
2.B	Industrial Processes	CO_2 Emissions from Ammonia Production	CO_2	2271.7	1.3%	89.5%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Liquid Fuel	CO_2	2187.3	1.2%	90.7%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Liquid Fuel	CO_2	2030.4	1.1%	91.9%
2.B	Industrial Processes	N_2O Emissions from Nitric Acid Production	N_2O	1781.9	1.0%	92.9%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Solid Fuel	CO_2	1774.3	1.0%	93.8%
1.A.3	Energy	Mobile: CO_2 Emissions from Railways	CO_2	1754.3	1.0%	94.8%
2.C	Industrial Processes	CO_2 Emissions from Iron and Steel Production	CO_2	998.4	0.6%	95.4%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Cracking Gas)	CO_2	865.5	0.5%	95.8%
1.A.4	Energy	Residential: CO_2 Emissions from Liquid Fuel	CO_2	853.2	0.5%	96.3%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Solid Fuel	CO_2	741.8	0.4%	96.7%
1.A.4	Energy	Agriculture/Forestry/ Fishing: CO_2 Emissions from Fuel Gas	CO_2	508.6	0.3%	97.0%
1.A.5	Energy	Other: (Energy)	CO_2	502.8	0.3%	97.3%
6.B	Waste	N_2O Emissions from Wastewater Handling	N_2O	478.6	0.3%	97.8%
1.B.1	Energy	Fugitive CH_4 Emissions from Coal Mining and Processing	CH_4	469.0	0.3%	97.6%
4.B	Agriculture	CH_4 Emissions from Livestock. Manure	CH_4	419.6	0.2%	98.1%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Other Bituminous Coal)	CO_2	364.1	0.2%	98.3%
1.A.4	Energy	Agriculture/Forestry/ Fishing: CO_2 Emissions from Solid Fuel	CO_2	359.0	0.2%	98.5%
2.A	Industrial Processes	CO_2 Emissions from Lime Production	CO_2	353.8	0.2%	98.6%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Crude Oil)	CO_2	313.1	0.2%	98.8%
6.B	Waste	CH_4 Emissions from Wastewater Handling	CH_4	299.7	0.2%	99.0%

IPCC Category code	Sector	IPCC Category	Greenhouse Gas	Estimates for 1990, Gg CO_2-eq.	% of Total	Cumulative Total, %
4.B	Agriculture	N_2O Emissions from Manure Management	N_2O	286.7	0.2%	99.1%
4.C	Agriculture	CH_4 Emissions from Rice Cultivation	CH_4	261.7	0.1%	99.3%
1.A.4	Energy	Other Sectors: CH_4 Emissions from Residential	CH_4	241.9	0.1%	99.4%
1.A.1	Energy	CO_2 Emissions from Gas of Underground Gasification	CO_2	191.6	0.1%	99.5%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Stove Domestic Fuel)	CO_2	168.3	0.1%	99.6%
1.A.3	Energy	CO_2 Emissions from Mobile: Aviation	CO_2	163.3	0.1%	99.7%
1.A.1	Energy	N_2O (Non-CO_2) Emissions from Fuel Combustion	N_2O	80.6	0.0%	99.8%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Diesel Fuel)	CO_2	77.9	0.0%	99.8%
2.A	Industrial Processes	CO_2 Emissions from Soda Ash Use	CO_2	70.6	0.0%	99.8%
1.A.3	Energy	CH_4 Emissions from Mobile: Road transportation	CH_4	48.2	0.0%	99.9%
1.A.4	Energy	Other Sectors: CH_4 Emissions from Agriculture/Forestry/ Fishing	CH_4	34.7	0.0%	99.9%
1.A.3	Energy	N_2O Emissions from Mobile: Road Transportation	N_2O	25.9	0.0%	99.9%
1.A.1	Energy	CH_4 (Non-CO_2) Emissions from Fuel Combustion	CH_4	24.2	0.0%	99.9%
4.F	Agriculture	CH_4 Emissions from Burning of Agricultural Residues	CH_4	23.4	0.0%	99.9%
1.A.4	Energy	Other Sectors: N_2O Emissions from Residential	N_2O	22.4	0.0%	99.9%
1.A.2	Energy	CH_4 Emissions from Manufacturing Industries and Construction	CH_4	17.6	0.0%	100.0%
1.A.4	Energy	Other Sectors: CH_4 Emissions from Commercial	CH_4	15.4	0.0%	100.0%
1.A.4	Energy	Other Sectors: N_2O Emissions from Commercial	N_2O	15.0	0.0%	100.0%
1.A.4	Energy	Other Sectors: N_2O Emissions from Agriculture/Forestry/ Fishing	N_2O	14.0	0.0%	100.0%
1.A.2	Energy	N_2O Emissions from Manufacturing Industries and Construction	N_2O	13.3	0.0%	100.0%
1.A.3	Energy	CO_2 Emissions from Mobile: Water-borne Navigation	CO_2	12.5	0.0%	100.0%
4.F	Agriculture	N_2O Emissions from Field Burning of Agricultural Residues	N_2O	8.6	0.0%	100.0%
1.A.3	Energy	N_2O Emissions from Mobile: Railways	N_2O	4.5	0.0%	100.0%
1.A.3	Energy	CH_4 Emissions from Mobile: Road transportation	CH_4	2.5	0.0%	100.0%
1.A.3	Energy	N_2O Emissions from Mobile: Aviation	N_2O	1.4	0.0%	100.0%
1.A.3	Energy	N_2O Emissions from Mobile: Water-borne Navigation	N_2O	0.0	0.0%	100.0%
1.A.3	Energy	CH_4 Emissions from Mobile: Aviation	CH_4	0.0	0.0%	100.0%
1.A.3	Energy	CH_4 Emissions from Mobile: Road Transportation	CH_4	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Coal Briquettes)	CO_2	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Gasoline)	CO_2	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Other Types of Kerosene)	CO_2	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (LFC)	CO_2	0.0	0.0%	100.0%
2.F	Industrial Processes	Consumption of Sulphur Hexafluoride and Halocarbons	HFC	0.0	0.0%	100.0%
2.B	Industrial Processes	CH_4 Emissions from Chemical Industry	CH_4	0.0	0.0%	100.0%

Table – 2 Level Assessment for 2010

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Estimation for 2010, Gg CO_2-eq.	% of Total	Combined Amount, %
		Total		**199243**	**100%**	**100%**
1.B.2	Energy	Fugitive CH_4 Emissions from Oil and Gas	CH_4	67953.4	34.1%	34.1%
1.A.4	Energy	Residential: CO_2 Emissions from Fuel Gas	CO_2	31496.1	15.8%	49.9%
1.A.1	Energy	CO_2 Emissions from Fuel Gas (Natural gas)	CO_2	26163.5	13.1%	63.0%
4.A	Agriculture	CH_4 Emissions from Livestock. Enteric Fermentation	CH_4	11099.7	5.6%	68.6%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Fuel Gas	CO_2	9302.5	4.7%	73.3%
4.D	Agriculture	N_2O Emissions (Direct and indirect) from Agricultural Soils	N_2O	7598.1	3.8%	77.1%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Fuel Gas	CO_2	6953.8	3.5%	80.6%
1.A.3	Energy	Mobile: CO_2 Emissions from Road Transportation	CO_2	6908.0	3.5%	84.1%
6.A	Waste	CH_4 Emissions from Solid Waste Disposal on land	CH_4	6378.6	3.2%	87.3%
1.A.3	Energy	CO_2 Emissions from Pipeline Transport	CO_2	5347.7	2.7%	89.9%
2.A	Industrial Processes	CO_2 Emissions from Cement Production	CO_2	2924.1	1.5%	91.4%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Sub-Bituminous Coal)	CO_2	2298.8	1.2%	92.6%
2.B	Industrial Processes	N_2O Emissions from Nitric Acid Production	N_2O	1789.5	0.9%	93.5%
2.B	Industrial Processes	CO_2 Emissions from Ammonia Production	CO_2	1761.9	0.9%	94.3%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Crude Oil)	CO_2	1556.3	0.8%	95.1%
1.A.4	Energy	Agriculture/Forestry/ Fishing: CO_2 Emissions from Liquid Fuel Combustion	CO_2	1308.6	0.7%	95.8%
2.C	Industrial Processes	CO_2 Emissions from Iron and Steel Production	CO_2	1170.2	0.6%	96.4%
4.B	Agriculture	CH_4 Emissions from Livestock. Manure	CH_4	772.8	0.4%	96.8%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Fuel Oil)	CO_2	753.4	0.4%	97.1%
1.A.4	Energy	Commercial: CO_2 Emissions from Liquid Fuel	CO_2	729.3	0.4%	97.5%
6.B	Waste	N_2O Emissions from Wastewater Handling	N_2O	601.3	0.3%	97.8%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Cracking gas)	CO_2	597.1	0.3%	98.1%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Liquid Fuel Combustion	CO_2	507.9	0.3%	98.4%
1.A.3	Energy	Mobile: CO_2 Emissions from Railways	CO_2	433.1	0.2%	98.6%
1.A.4	Energy	Commercial: CO_2 from Solid Fuel Combustion	CO_2	421.1	0.2%	98.8%
4.B	Agriculture	N_2O Emissions from Manure Use	N_2O	405.1	0.2%	99.0%
6.B	Waste	CH_4 Emissions from Wastewater Handling	CH_4	370.0	0.2%	99.2%
1.A.4	Energy	Residential: CO_2 Emissions from Solid Fuel Combustion	CO_2	314.2	0.2%	99.3%
1.B.1	Energy	Fugitive CH_4 Emissions from Coal Mining and Processing	CH_4	146.3	0.1%	99.4%
1.A.5	Energy	Other: (Energy)	CO_2	132.3	0.1%	99.5%
2.A	Industrial Processes	CO_2 Emissions from Lime Production	CO_2	176.6	0.1%	99.6%
1.A.4	Energy	Residential: CO_2 Emissions from Liquid Fuel Combustion	CO_2	107.7	0.1%	99.6%
1.A.1	Energy	CO_2 Emissions from Gas of Underground Gasification	CO_2	89.1	0.0%	99.7%
1.A.4	Energy	Other sectors: Residential CH_4 Emissions	CH_4	80.6	0.0%	99.7%
1.A.4	Energy	Agriculture/Forestry/ Fishing: CO_2 Emissions from Fuel Gas	CO_2	77.8	0.0%	99.7%
4.C	Agriculture	CH_4 Emissions from Rice Cultivation	CH_4	76.1	0.0%	99.8%

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Estimation for 2010, Gg CO_2-eq.	% of Total	Combined Amount, %
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Solid Fuel Combustion	CO_2	58.6	0.0%	99.8%
1.A.3	Energy	Mobile: CO_2 Emisions from Aviation	CO_2	55.8	0.0%	99.8%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (LFC)	CO_2	54.6	0.0%	99.9%
1.A.3	Energy	Mobile: CH_4 Emissions from Road Transportation	CH_4	43.2	0.0%	99.9%
1.A.1	Energy	N_2O (Non-CO_2) Emissions from Fuel Combustion	N_2O	32.9	0.0%	99.9%
2.A	Industrial Processes	CO_2 Emissions from Soda Use	CO_2	25.9	0.0%	99.9%
1.A.1	Energy	CO_2 from Liquid Fuel Combustion (Diesel Fuel)	CO_2	21.8	0.0%	99.9%
2.F	Industrial Processes	Consumption of Sulphur Hexafluoride and Halocarbons	HFC	22.3	0.0%	99.9%
1.A.4	Energy	Other Sectors: CH_4 Emissions from Commercial	CH_4	20.6	0.0%	99.9%
1.A.4	Energy	Other Sectors: N_2O Emissions from Residential	N_2O	19.3	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Gasoline)	CO_2	15.0	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Road Transportation	N_2O	14.9	0.0%	100.0%
1.A.2	Energy	Manufacturing Industries and Construction: CH_4 Emissions	CH_4	14.4	0.0%	100.0%
1.A.1	Energy	CH_4 (Non-CO_2) Emissions from Fuel Combustion	CH_4	13.0	0.0%	100.0%
1.A.4	Energy	Other Sectors: N_2O Emissions from Commercial	N_2O	9.0	0.0%	100.0%
1.A.2	Energy	Manufacturing Industries and Construction: N_2O Emissions	N_2O	5.6	0.0%	100.0%
1.A.4	Energy	Other Sectors: N_2O Emissions from Agriculture/Forestry/Fishing	N_2O	3.4	0.0%	100.0%
2.B	Industrial Processes	CH_4 Emissions from Chemical Industry	CH_4	3.0	0.0%	100.0%
1.A.4	Energy	Other Sectors: CH_4 Emissions from Agriculture/Forestry/Fishing	CH_4	2.0	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Railway s	N_2O	1.1	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Railways	CH_4	0.6	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Aviation	N_2O	0.5	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Aviation	CH_4	0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Other Bituminous Coal)	CO_2	0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Coal Briquettes)	CO_2	0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Other Types of Kerosene)	CO_2	0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Stove Domestic Fuel)	CO_2	0	0.0%	100.0%
1.A.3	Energy	Mobile: CO_2 Emissions from Water-borne Navigation	CO_2	0	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Water-borne Navigation	CH_4	0	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Water-borne Navigation	N_2O	0	0.0%	100.0%
1.A.4	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Solid Fuel Combustion	CO_2	0	0.0%	100.0%
4.F	Agriculture	CH_4 Emissions from Field Burning of Agricultural Residues	CH_4	0	0.0%	100.0%
4.F	Agriculture	N_2O Emissions from Field Burning of Agricultural Residues	N_2O	0	0.0%	100.0%

Table – 3 Level Assessment for 2012

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Estimation for 2012, Gg CO_2-eq.	% of Total	Combined Amount, %
		Total		**205270**	**100%**	**100%**
1.B.2	Energy	Fugitive CH_4 Emissions from Oil and Gas	CH_4	68116.2	33.2%	33.2%
1.A.1	Energy	CO_2 Emissions from Fuel Gas (Natural Gas)	CO_2	27357.2	13.3%	46.5%
1.A.4	Energy	Residential: CO_2 Emissions from Fuel Gas	CO_2	23039.9	11.2%	57.7%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Fuel Gas	CO_2	18798.6	9.2%	66.9%
4.A	Agriculture	CH_4 Emissions from Livestock. Enteric Fermentation	CH_4	12041.6	5.9%	72.8%
4.D	Agriculture	N_2O Emissions (Direct and Indirect) from Agricultural Soils	N_2O	8251.2	4.0%	76.8%
1.A.3	Energy	Mobile: CO_2 Emissions from Road Transportation	CO_2	7788.7	3.8%	80.6%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Fuel Gas	CO_2	7419.3	3.6%	84.2%
6.A	Waste	CH_4 Emissions from Solid Fuel Disposal on land	CH_4	6649.8	3.2%	87.4%
1.A.3	Energy	CO_2 from Pipeline Transport	CO_2	4095.2	2.0%	89.4%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Sub-Bituminous Coal)	CO_2	3070.7	1.5%	90.9%
2.A	Industrial Processes	CO_2 Emissions from Cement Production	CO_2	2791.0	1.4%	92.3%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Crude Oil)	CO_2	2000.1	1.0%	93.3%
2.B	Industrial Processes	CO_2 Emissions from Ammonia Production	CO_2	1783.4	0.9%	94.1%
2.B	Industrial Processes	N_2O Emissions from Nitric Acid Production	N_2O	1781.0	0.9%	95.0%
1.A.4	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Liquid Fuel Combustion	CO_2	1230.1	0.6%	95.6%
2.C	Industrial Processes	CO_2 Emissions from Iron and Steel Production	CO_2	1199.9	0.6%	96.2%
4.B	Agriculture	CH_4 Emissions from Livestock. Manure	CH_4	820.9	0.4%	96.6%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Fuel Oil)	CO_2	799.6	0.4%	97.0%
1.A.4	Energy	Residential: CO_2 Emissions from Solid Fuel Combustion	CO_2	660.2	0.3%	97.3%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Liquid Fuel Combustion	CO_2	631.6	0.3%	97.6%
6.B	Waste	N2O Emissions from Wastewater Handling	N_2O	626.8	0.3%	97.9%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Liquid Fuel Combustion	CO_2	546.7	0.3%	98.2%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Cracking Gas)	CO_2	528.6	0.3%	98.4%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Solid Fuel Combustion	CO_2	489.3	0.2%	98.7%
4.B	Agriculture	N_2O Emissions from Manure Use	N_2O	450.4	0.2%	98.9%
1.A.3	Energy	Mobile: CO_2 Emissions from Railways	CO_2	430.0	0.2%	99.1%
6.B	Waste	CH_4 Emissions from Wastewater Handling	CH_4	383.5	0.2%	99.3%
1.A.5	Energy	Other: (Energy)	CO_2	189.5	0.1%	99.4%
1.A.4	Energy	Residential: CO_2 Emissions from Liquid Fuel Combustion	CO_2	156.1	0.1%	99.4%
2.A	Industrial Processes	CO_2 Emissions from Lime Production	CO_2	140.9	0.1%	99.5%
1.B.1	Energy	Fugitive CH_4 Emissions from Coal Mining and Processing	CH_4	120.6	0.1%	99.6%
1.A.1	Energy	CO_2 Emissions from Gas of Underground Gasification	CO_2	113.7	0.1%	99.6%
2.F	Industrial Processes	Consumption of Sulphur Hexafluoride and Halocarbons	HFC	94.5	0.0%	99.7%
1.A.4	Energy	Other Sectors: Residential: CH_4 Emissions	CH_4	88.0	0.0%	99.7%

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Estimation for 2012, Gg CO_2-eq.	% of Total	Combined Amount, %
4.C	Agriculture	CH_4 Emissions from Rice Cultivation	CH_4	83.5	0.0%	99.8%
1.A.4	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Fuel Gas	CO_2	74.0	0.0%	99.8%
1.A.3	Energy	Mobile: CH_4 Emissions from Road Transportation	CH_4	65.2	0.0%	99.8%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Solid Fuel Combustion	CO_2	52.0	0.0%	99.8%
1.A.3	Energy	Mobile: CO_2 Emissions from Aviation	CO_2	41.3	0.0%	99.9%
1.A.4	Energy	Other Sectors: CH_4 Emissions from Commercial	CH_4	38.3	0.0%	99.9%
1.A.1	Energy	N_2O (Non-CO_2) Emissions from Fuel Combustion	N_2O	38.1	0.0%	99.9%
2.A	Industrial Processes	CO_2 Emissions from Soda Ash Use	CO_2	33.2	0.0%	99.9%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (LFC)	CO_2	28.7	0.0%	99.9%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Diesel Fuel)	CO_2	21.8	0.0%	99.9%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Gasoline)	CO_2	18.0	0.0%	100.0%
1.A.4	Energy	Other Sectors: N_2O Emissions from Residential	N_2O	16.3	0.0%	100.0%
1.A.2	Energy	Manufacturing Industries and Construction: CH_4 Emissions	CH_4	15.5	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Road Transportation	N_2O	14.4	0.0%	100.0%
1.A.4	Energy	Other Sectors: N_2O Emissions from Commercial	N_2O	14.3	0.0%	100.0%
1.A.1	Energy	CH_4 (Non-CO_2) Emissions from Fuel Combustion	CH_4	13.9	0.0%	100.0%
1.A.2	Energy	Manufacturing Industries and Construction: N_2O Emissions	N_2O	6.0	0.0%	100.0%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing: N_2O Emissions	N_2O	3.2	0.0%	100.0%
2.B	Industrial Processes	CH_4 Emissions from Chemical Industry	CH_4	3.0	0.0%	100.0%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing: CH_4 Emissions	CH_4	2.2	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Railways	N_2O	1.1	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Railways	CH_4	0.6	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Railways	N_2O	0.4	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Railways	CH_4	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Other Bituminous Coal)	CO_2	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Coal Briquettes)	CO_2	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Other Types of Kerosene)	CO_2	0.0	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Stove Domestic Fuel)	CO_2	0.0	0.0%	100.0%
1.A.3	Energy	Mobile: CO_2 Emissions from Water-borne Navigation	CO_2	0.0	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Water-borne Navigation	CH_4	0.0	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Water-borne Navigation	N_2O	0.0	0.0%	100.0%
1.A.4	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Solid Fuel Combustion	CO_2	0.0	0.0%	100.0%
4.F	Agriculture	CH_4 Emissions from Field Burning of Agricultural Residues	CH_4	0.0	0.0%	100.0%
4.F	Agriculture	N_2O Emissions from Field Burning of Agricultural Residues	N_2O	0.0	0.0%	100.0%

Table – 4 Trend Assessment for 1990-2010

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Base Year Emission, Gg CO_2-eq.	Current Year Emission, Gg CO_2-eq.	Relative change in the category 1990-2010, %	Trend Assessment	% Contribution to Trend	Cumulative Total, %
				1990	2010				
		Total		**180435**	**199240**	**10.42%**	**0.658**		**100%**
1.A.4	Energy	Residential: CO_2 Emissions from Fuel Gas	CO_2	8048.1	31496.1	2913%	0.125	19.4%	19.4%
1.B.2	Energy	Fugitive CH_4 Emissions from Oil and Gas	CH_4	43159.1	67953.4	57.4%	0.112	17.4%	36.7%
1.A.1	Energy	CO_2 Emissions from Fuel Gas Combustion (Natural Gas)	CO_2	37147.4	26163.5	-29.6%	0.082	12.7%	49.4%
1.A.1	Energy	CO_2 from Liquid Fuel Combustion (Fuel Oil)	CO_2	8813.8	753.4	-91.5%	0.050	7.7%	57.1%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Sub-Bituminous Coal)	CO_2	7158.1	2298.8	-67.9%	0.031	4.8%	61.9%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Fuel Gas	CO_2	3036.3	9302.5	206.4%	0.033	5.1%	67.0%
1.A.3	Energy	Mobile: CO_2 from Road Transportation	CO_2	9985.9	6908.0	-30.8%	0.023	3.5%	70.6%
4.A	Agriculture	CH_4 Emissions from Livestock. Enteric Fermentation	CH_4	5832.9	11099.7	90.3%	0.026	4.0%	74.5%
4.D	Agriculture	N_2O Emissions (Direct and Indirect) from Agricultural Soils	N_2O	10221.9	7598.1	-25.7%	0.020	3.2%	77.7%
1.A.1	Energy	Other Sectors: Agriculture/Forestry/Fishing: CO_2 Emissions from Liquid Fuel Combustion	CO_2	4799.2	1308.6	-72.7%	0.022	3.4%	81.1%
1.A.4	Energy	Residential: CO_2 Emissions from Solid Fuel Combustion	CO_2	3338.2	314.2	-90.6%	0.019	2.9%	84.0%
	Waste	CH_4 Emissions from Solid Fuel Disposal on land	CH_4	3343.3	6378.6	90.8%	0.015	2.3%	86.3%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Liquid Fuel Combustion	CO_2	2187.3	507.9	-76.8%	0.011	1.6%	87.9%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Liquid Fuel Combustion	CO_2	2030.4	729.3	-64.1%	0.008	1.3%	89.2%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Solid Fuel Combustion	CO_2	1774.3	421.1	-76.3%	0.009	1.3%	90.5%
1.A.3	Energy	Mobile: CO_2 Railways	CO_2	1754.3	433.1	-75.3%	0.008	1.3%	91.8%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Fuel Gas	CO_2	7239.3	6953.8	-3.9%	0.006	0.9%	92.7%
1.A.3	Energy	CO_2 Emissions from Liquid Fuel Combustion (Crude oil)	CO_2	313.1	1556.3	397.1%	0.007	1.0%	93.8%
2.B	Industrial Processes	CO_2 from Ammonia Production	CO_2	2271.7	1761.9	-22.4%	0.004	0.6%	94.4%
1.A.4	Energy	Residential: CO_2 Emissions from Liquid Fuel Combustion	CO_2	853.2	107.7	-87.4%	0.005	0.7%	95.1%

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Base Year Emission, Gg CO_2-eq.	Current Year Emission, Gg CO_2-eq.	Relative change in the category 1990-2010, %	Trend Assessment	% Contribution to Trend	Cumulative Total, %
1.A.1	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Solid Fuel Combustion	CO_2	741.8	58.6	-92.1%	0.004	0.7%	95.8%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing: CO_2 Emissions from Fuel Gas	CO_2	508.6	77.8	-84.7%	0.003	0.4%	96.2%
1.A.5	Energy	Other: (Energy)	CO_2	502.8	132.3	-73.7%	0.002	0.4%	96.5%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Cracking Gas)	CO_2	865.5	597.1	-31.0%	0.002	0.3%	96.8%
2.B	Industrial Processes	N_2O Emissions from Nitric Acid Production	N_2O	1781.9	1789.5	0.4%	0.001	0.2%	97.0%
1.A.4	Energy	CO_2 Emissions from Pipeline Transport	CO_2	4575.3	5347.7	16.9%	0.002	0.3%	97.3%
2.A	Industrial Processes	CO_2 Emissions from Cement Production	CO_2	2582.9	2924.1	13.2%	0.000	0.1%	97.3%
2.C	Industrial Processes	CO_2 Emissions from Iron and Steel Production	CO_2	998.4	1170.2	17.2%	0.000	0.1%	97.4%
6.B	Waste	N_2O Emissions from Wastewater Handling	N_2O	478.6	601.3	25.6%	0.000	0.1%	97.4%
1.B.1	Energy	Fugitive CH_4 Emissions from Coal Mining and Processing	CH_4	469.0	146.3	-68.8%	0.002	0.3%	97.8%
1.A.2	Agriculture	CH_4 Emissions from Livestock. Manure	CH_4	419.6	772.8	84.2%	0.002	0.3%	98.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Other Bituminous Coal)	CO_2	364.1	0.3	-99.9%	0.002	0.3%	98.4%
1.A.4	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Solid Fuel Combustion	CO_2	359.0	0.3	-99.9%	0.002	0.3%	98.7%
2.A	Industrial processes	CO_2 Emissions from Lime Production	CO_2	353.8	176.6	-50.1%	0.001	0.2%	98.9%
4.C	Agriculture	CH_4 Emissions from Rice Cultivation	CH_4	261.7	76.1	-70.9%	0.001	0.2%	99.1%
1.A.4	Energy	Other Sectors: Residential: CH_4 Emissions	CH_4	241.9	80.6	-66.7%	0.001	0.2%	99.2%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Stove Domestic Fuel)	CO_2	168.3	0.3	-99.9%	0.001	0.2%	99.4%
4.B	Agriculture	N_2O Emissions from Manure Use	N_2O	286.7	405.1	41.3%	0.000	0.1%	99.5%
1.A.1	Energy	CO_2 Emissions from Gas of Underground Gasification	CO_2	191.6	89.1	-53.5%	0.001	0.1%	99.6%
1.A.3	Energy	Mobile: CO_2 Emissions from Aviation	CO_2	163.3	55.8	-65.8%	0.001	0.1%	99.7%
4.B	Energy	N_2O (Non-CO_2) Emissions from Fuel Combustion	N_2O	80.6	32.9	-59.2%	0.000	0.0%	99.7%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Diesel Fuel)	CO_2	77.9	21.8	-72.0%	0.000	0.1%	99.8%
6.B	Waste	CH_4 Emissions from Wastewater Handling	CH_4	299.7	370.0	23.5%	0.000	0.0%	99.8%
2.A	Industrial processes	CO_2 Emissions from Soda Ash Use	CO_2	70.6	25.9	-63.2%	0.000	0.0%	99.9%
1.A.3	Energy	Mobile: CH_4 Emissions from Road Transportation	CH_4	48.2	43.2	-10.4%	0.000	0.0%	99.9%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing: CH_4 Emissions	CH_4	34.7	2.0	-94.2%	0.000	0.0%	99.9%

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Base Year Emission, Gg CO_2-eq.	Current Year Emission, Gg CO_2-eq.	Relative change in the category 1990-2010, %	Trend Assessment	% Contribution to Trend	Cumulative Total, %
1.A.3	Energy	Mobile: N_2O Emissions from Road Transportation	N_2O	25.9	14.9	-42.7%	0.000	0.0%	99.9%
1.A.1	Energy	CH_4 (Non-CO_2) Emissions from Fuel Combustion	CH_4	24.2	13.0	-46.4%	0.000	0.0%	99.9%
4.F	Agriculture	CH_4 Emissions from Field Burning of Agricultural Residues	CH_4	23.4	0.3	-98.9%	0.000	0.0%	99.9%
1.A.4	Energy	Other Sectors: N_2O Emissions from Residential	N_2O	22.4	19.3	-14.0%	0.000	0.0%	99.9%
1.A.2	Energy	Manufacturing Industries and Construction: CH_4 Emissions	CH_4	17.6	14.4	-17.9%	0.000	0.0%	99.9%
1.A.4	Energy	Other Sectors: CH_4 Emissions from Commercial/Institutional	CH_4	15.4	20.6	33.4%	0.000	0.0%	99.9%
1.A.4	Energy	Other Sectors: N_2O Emissions from Commercial/Institutional	N_2O	15.0	9.0	-39.9%	0.000	0.0%	100.0%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing: N_2O Emissions	N_2O	14.0	3.4	-75.9%	0.000	0.0%	100.0%
1.A.2	Energy	Manufacturing Industries and Construction: N_2O Emissions	N_2O	13.3	5.6	-57.8%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CO_2 Emissions from Water-borne Navigation	CO_2	12.5	0.3	-98.0%	0.000	0.0%	100.0%
4.F	Agriculture	N_2O Emissions from Field Burning of Agricultural Residues	N_2O	8.6	0.3	-97.1%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Railways	N_2O	4.5	1.1	-75.3%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Railways	CH_4	2.5	0.6	-75.3%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Aviation	N_2O	1.4	0.5	-65.8%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Road Transportation	N_2O	0	0	690.71%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Aviation	CH_4	0	0	-65.8%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Water-borne Navigation	CH_4	0	0	1300.69%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Coal Briquettes)	CO_2	0	0	150.00%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Gasoline)	CO_2	0	15.0	14879.65%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Other types of kerosene)	CO_2	0	0.3	150.00%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (CIS)	CO_2	0	54.6	54484.49%	0.000	0.0%	100.0%
2.F	Industrial processes	Consumption of Sulphur Hexafluoride and Halocarbons	HFC	0	22.3	22171.06%	0.000	0.0%	100.0%
2.B	Industrial processes	CH_4 Emissions from Chemical Industry	CH_4	0	3.0	2858.35%	0.000	0.0%	100.0%

Table – 5 Trend Assessment for 1990-2012

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Base Year Emission. Gg CO_2-eq.	Current Year Emission Gg CO_2-eq.	Relative change in the category 1990-2012, %	Trend Assessment	% Contribution to Trend	Cumulative Total,%
				1990	**2012**				
		Total		**180436**	**205270**	**13.76%**	**0.653**	**100%**	**100%**
1.B.2	Energy	Fugitive CH_4 Emissions from Oil and Gas	CH_4	43159.1	68116.2	57.8%	0.105	16.1%	16.1%
1.A.4	Energy	Commercial: CO_2 Emissions from Fuel Gas	CO_2	3036.3	18798.6	519.1%	0.085	13.0%	29.2%
1.A.1	Energy	CO_2 Emissions from Fuel Gas Combustion (Natural Gas)	CO_2	37147.4	27357.2	-26.4%	0.083	12.7%	41.8%
1.A.4	Energy	Residential: CO_2 Emissions from Fuel Gas	CO_2	8048.1	23039.9	186.3%	0.077	11.8%	53.6%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Fuel Oil)	CO_2	8813.8	799.6	-90.9%	0.051	7.8%	61.4%
4.A	Agriculture	CH_4 Emissions from Livestock. Enteric Fermentation	CH_4	5832.9	12041.6	106.4%	0.030	4.6%	66.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Sub-Bituminous Coal)	CO_2	7158.1	3070.7	-57.1%	0.028	4.3%	70.3%
1.A.1	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Liquid Fuel	CO_2	4799.2	1230.1	-74.4%	0.023	3.6%	73.9%
1.A.3	Energy	Mobile: CO_2 from Road Transportation	CO_2	9985.9	7788.7	-22.0%	0.020	3.0%	77.0%
4.D	Agriculture	N_2O emissions (Direct and indirect) from Agricultural Soils	N_2O	10221.9	8251.2	-19.3%	0.019	2.9%	79.8%
1.A.4	Energy	Residential: CO_2 Emissions from Solid Fuel Combustion	CO_2	3338.2	660.2	-80.2%	0.017	2.7%	82.5%
	Waste	CH_4 Emissions from Solid Fuel Disposal on land	CH_4	3343.3	6649.8	98.9%	0.016	2.4%	84.9%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Liquid Fuel Combustion	CO_2	2187.3	546.7	-75.0%	0.011	1.6%	86.6%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Liquid Fuel Combustion	CO_2	2030.4	631.6	-68.9%	0.009	1.4%	88.0%
1.A.3	Energy	CO_2 Emissions from Liquid Fuel Combustion (Crude Oil)	CO_2	313.1	2000.1	538.8%	0.009	1.4%	89.4%
1.A.4	Energy	Commercial/Institutional: CO_2 Emissions from Solid Fuel Combustion	CO_2	1774.3	489.3	-72.4%	0.008	1.3%	90.7%
1.A.3	Energy	Mobile: CO_2 Emissions from Railways	CO_2	1754.3	430.0	-75.5%	0.009	1.3%	92.0%
1.A.4	Energy	CO_2 Emissions from Pipeline Transport	CO_2	4575.3	4095.2	-10.5%	0.006	0.9%	92.9%
1.A.2	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Fuel Gas	CO_2	7239.3	7419.3	2.5%	0.005	0.7%	93.6%
2.B	Industrial processes	CO_2 Emissions from Ammonia Production	CO_2	2271.7	1783.4	-21.5%	0.004	0.7%	94.3%
1.A.4	Energy	Residential: CO_2 Emissions from Liquid Fuel Combustion	CO_2	853.2	156.1	-81.7%	0.005	0.7%	95.0%

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Base Year Emission. Gg CO_2-eq.	Current Year Emission Gg CO_2-eq.	Relative change in the category 1990-2012, %	Trend Assessment	% Contribution to Trend	Cumulative Total,%
1.A.1	Energy	Manufacturing Industries and Construction: CO_2 Emissions from Solid Fuel Combustion	CO_2	741.8	52.0	-93.0%	0.004	0.7%	95.7%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Cracking Gas)	CO_2	865.5	528.6	-38.9%	0.003	0.4%	96.1%
1.B.1	Energy	Fugitive CH_4 Emissions from Coal Mining and Processing	CH_4	469.0	120.6	-74.3%	0.002	0.4%	96.4%
1.A.4	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Fuel Gas	CO_2	508.6	74.0	-85.4%	0.003	0.4%	96.8%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Other Bituminous Coal)	CO_2	364.1	0.0	-100.0%	0.002	0.4%	97.2%
1.A.5	Energy	Other: (Energy)	CO_2	502.8	189.5	-62.3%	0.002	0.3%	97.5%
1.A.2	Agriculture	CH_4 Emissions from Livestock. Manure	CH_4	419.6	820.9	95.6%	0.002	0.3%	97.8%
1.A.4	Energy	Agriculture/Forestry/Fishing: CO_2 Emissions from Solid Fuel Combustion	CO_2	359.0	0.0	-100.0%	0.002	0.3%	98.2%
2.B	Industrial processes	N_2O Emissions from Nitric Acid Production	N_2O	1781.9	1781.0	-0.1%	0.001	0.2%	98.4%
2.A	Industrial processes	CO_2 Emissions from Iron and Steel Production	CO_2	353.8	140.9	-60.2%	0.001	0.2%	98.6%
4.C	Agriculture	CH_4 Emissions from Rice Cultivation	CH_4	261.7	83.5	-68.1%	0.001	0.2%	98.8%
1.A.4	Energy	Other Sectors: Residential: CH_4 Emissions	CH_4	241.9	88.0	-63.6%	0.001	0.2%	98.9%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Stove Domestic Fuel)	CO_2	168.3	0.0	-100.0%	0.001	0.2%	99.1%
2.A	Industrial processes	CO_2 Emissions from Cement Production	CO_2	2582.9	2791.0	8.1%	0.001	0.1%	99.2%
2.C	Industrial processes	CO_2 Emissions from Iron and Steel Production	CO_2	998.4	1199.9	20.2%	0.000	0.1%	99.3%
6.B	Waste	N_2O Emissions from Wastewater Handling	N_2O	478.6	626.8	31.0%	0.000	0.1%	99.3%
4.B	Agriculture	N_2O Emissions from Manure Use	N_2O	286.7	450.4	57.1%	0.001	0.1%	99.4%
1.A.1	Energy	CO_2 Emissions from Gas of Underground Gasification	CO_2	191.6	113.7	-40.6%	0.001	0.1%	99.5%
1.A.3	Energy	Mobile: CO_2 Emissions from Aviation	CO_2	163.3	41.3	-74.7%	0.001	0.1%	99.7%
6.B	Waste	CH_4 Emissions from Wastewater Handling	CH_4	299.7	383.5	28.0%	0.000	0.0%	99.7%
4.B	Energy	N_2O (Non-CO_2) Emissions from Fuel Combustion	N_2O	80.6	38.1	-52.7%	0.000	0.0%	99.7%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Diesel Fuel)	CO_2	77.9	21.8	-72.0%	0.000	0.1%	99.8%
2.A	Industrial processes	CO_2 Emissions from Soda Use	CO_2	70.6	33.2	-53.0%	0.000	0.0%	99.8%
1.A.3	Energy	Mobile: CH_4 from Road Transportation	CH_4	48.2	65.2	35.1%	0.000	0.0%	99.8%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing: CH_4 Emissions	CH_4	34.7	2.2	-93.8%	0.000	0.0%	99.9%

IPCC Category Code	Sector	IPCC Category	Greenhouse Gas	Base Year Emission. Gg CO_2-eq.	Current Year Emission Gg CO_2-eq.	Relative change in the category 1990-2012, %	Trend Assessment	% Contribution to Trend	Cumulative Total,%
1.A.3	Energy	Mobile: N_2O Emissions from Road Transportation	N_2O	25.9	14.4	-44.6%	0.000	0.0%	99.9%
1.A.1	Energy	CH_4 (Non-CO_2) Emissions from Fuel Combustion	CH_4	24.2	13.9	-42.4%	0.000	0.0%	99.9%
4.F	Agriculture	CH_4 Emissions from Field Burning of Agricultural Residues	CH_4	23.4	0.0	-100.0%	0.000	0.0%	99.9%
1.A.4	Energy	Other Sectors: Residential: N_2O Emissions	N_2O	22.4	16.3	-27.2%	0.000	0.0%	99.9%
1.A.2	Energy	Manufacturing Industries and Construction: CH_4 Emissions	CH_4	17.6	15.5	-12.0%	0.000	0.0%	99.9%
1.A.4	Energy	Other Sectors: Commercial: CH_4 Emissions	CH_4	15.4	38.3	148.5%	0.000	0.0%	100.0%
1.A.4	Energy	Other Sectors: Commercial: N_2O Emissions	N_2O	15.0	14.3	-4.3%	0.000	0.0%	100.0%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing: N_2O Emissions	N_2O	14.0	3.2	-77.4%	0.000	0.0%	100.0%
1.A.2	Energy	Manufacturing Industries and Construction: N_2O Emissions	N_2O	13.3	6.0	-55.2%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CO_2 Emissions from Water-borne Navigation	CO_2	12.5	0.0	-100.0%	0.000	0.0%	100.0%
4.F	Agriculture	N_2O Emissions from Field Burning of Agricultural Residues	N_2O	8.6	0.0	-100.0%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Railways	N_2O	4.5	1.1	-75.5%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Railways	CH_4	2.5	0.6	-75.5%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Aviation	N_2O	1.4	0.4	-74.7%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: N_2O Emissions from Water-borne Navigation	N_2O	0.0	0.0	-100.00%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Aviation	CH_4	0.0	0.0	-74.7%	0.000	0.0%	100.0%
1.A.3	Energy	Mobile: CH_4 Emissions from Road Transportation	CH_4	0.0	0.0	-100.00%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Solid Fuel Combustion (Coal Briquettes)	CO_2	0.0	0.0	-100.00%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Gasoline)	CO_2	0.0	18.0	7090.23%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (Other Types of Kerosene)	CO_2	0.0	0.0	-100.00%	0.000	0.0%	100.0%
1.A.1	Energy	CO_2 Emissions from Liquid Fuel Combustion (CIS)	CO_2	0.0	28.7	11391.47%	0.000	0.0%	100.0%
2.F	Industrial processes	Consumption of Sulphur Hexafluoride and Haloocarbons	HFC	0.0	94.5	37696.66%	0.000	0.0%	100.0%
2.B	Industrial processes	CH_4 Emissions from Chemical Industry	CH_4	0.0	3.0	1084.87%	0.000	0.0%	100.0%

Table – 6 Source Category Analysis Summary (Tier 1)

Level Assessment of 2010. Trend Assessment for 1990-2010

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Key Source Category (Yes/No)	Criteria for Identification Key Source Category	Note
1.A.1	CO_2 Emissions from Solid Fuel Combustion (Other Bituminous Coal)	CO_2	NO		
1.A.1	CO_2 Emissions from Solid Fuel Combustion (Sub-Bituminous Coal)	CO_2	YES	Level, Trend	
1.A.1	CO_2 Emissions from Solid Fuel Combustion (Coal Briquettes)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Crude Oil)	CO_2	YES	Level, Trend	
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Gasoline)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Other Types of Kerosene)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Diesel Fuel)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Fuel Oil)	CO_2	YES	Trend	
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (CIS)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Cracking Gas)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Stove Domestic Fuel)	CO_2	NO		
1.A.1	CO_2 Emissions from Fuel Gas Combustion (Natural Gas)	CO_2	YES	Level, Trend	
1.A.1	CO_2 emissions from Gas of Underground Gasification	CO_2	NO		
1.A.1	CH_4 (Non-CO_2) Emissions from Fuel Combustion	CH_4	NO		
1.A.1	N_2O (Non-CO_2) Emissions from Fuel Combustion	N_2O	NO		
1.A.2	Manufacturing Industries and Construction: CO_2 Emissions from Solid Fuel Combustion	CO_2	NO		
1.A.2	Manufacturing Industries and Construction CO_2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	
1.A.2	Manufacturing Industries and Construction: CO_2 Emissions from Fuel Gas	CO_2	YES	Level, Trend	
1.A.2	Manufacturing Industries and Construction: CH_4 Emissions	CH_4	NO		
1.A.2	Manufacturing Industries and Construction: N_2O Emissions	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Road Transportation	CO_2	YES	Level, Trend	
1.A.3	Mobile: CH_4 Emissions from Road Transportation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Road Transportation	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Water-borne Navigation	CO_2	NO		
1.A.3	Mobile: CH_4 Emissions from Water-borne Navigation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Water-borne Navigation	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Aviation	CO_2	NO		
1.A.3	Mobile: CH_4 Emissions from Aviation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Aviation	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Railway Transportation	CO_2	NO	Trend	
1.A.3	Mobile: CH_4 Emissions from Railway Transportation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Railway Transportation	N_2O	NO		
1.A.3	CO_2 Emissions from Pipeline Transport	CO_2	YES	Level, Trend	
1.A.4	Commercial/institutional: CO2 Emissions from Solid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Commercial/Institutional: CO_2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Key Source Category (Yes/No)	Criteria for Identification Key Source Category	Note
1.A.4	Commercial/Institutional: CO_2 Emissions from Fuel Gas	CO_2	YES	Level, Trend	
1.A.4	Other Sectors: Commercial/Institutional: CH_4 Emissions	CH_4	NO		
1.A.4	Other Sectors: Commercial/Institutional: N_2O Emissions	N_2O	NO		
1.A.4	Residential: CO_2 Emissions from Solid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Residential: CO_2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Residential: CO_2 Emissions from Fuel Gas	CO_2	YES	Level, Trend	
1.A.4	Other Sectors: Residential: CH_4 Emissions	CH_4	NO		
1.A.4	Other Sectors: Residential: N_2O Emissions	N_2O	NO		
1.A.4	Agriculture/Forestry/Fishing: CO_2 Emissions from Solid Fuel Combustion	CO_2	NO		
1.A.4	Agriculture/Forestry/Fishing: CO2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Agriculture/Forestry/Fishing: CO_2 Emissions from Fuel Gas	CO_2	NO		
1.A.4	Other Sectors: Agriculture/Forestry/Fishing: CH_4 Emissions	CH_4	NO		
1.A.4	Other Sectors: Agriculture/Forestry/Fishing: N_2O Emissions	N_2O	NO		
1.A.5	Other: (Energy)	CO_2	NO		
1.B.1	CH_4 Emissions from Coal Mining and Processing	CH_4	NO		
1.B.2	Fugitive CH_4 Emissions from Oil and Gas	CH_4	YES	Level, Trend	
2.A	CO_2 Emissions from Cement Production	CO_2	YES	Level	
2.A	CO_2 Emissions from Lime Production	CO_2	NO		
2.A	CO_2 Emissions from Soda Ash Use	CO_2	NO		
2.B	N_2O Emissions from Nitric Acid Production	N_2O	YES	Level	
2.B	CO_2 Emissions from Ammonia Production	CO_2	YES	Level, Trend	
2.B	CH_4 Emissions from Chemical Industry	CH_4	NO		
2.C	CO_2 Emissions from Iron and Steel Production	CO_2	NO		
2.F	Consumption of Sulphur Hexafluoride and Halocarbons	HFC	NO		
4.A	CH_4 Emissions from Livestock. Enteric Fermentation	CH_4	YES	Level, Trend	
4.B	CH_4 Emissions from Livestock. Manure	CH_4	NO		
4.B	N_2O Emissions from Manure Use	N_2O	NO		
4.F	CH_4 Emissions from Field Burning of Agricultural Residues	CH_4	NO		
4.F	N_2O Emissions from Field Burning of Agricultural Residues	N_2O	NO		
4.D	N_2O (Direct or Indirect) Emissions from Agricultural Soils	N_2O	YES	Level, Trend	
4.C	CH_4 Emissions from Rice Cultivation	CH_4	NO		
6.A	CH_4 Emissions from Solid Waste Disposal on land	CH_4	YES	Level, Trend	
6.B	CH_4 Emissions from Wastewater Handling	CH_4	NO		
6.B	N_2O Emissions from Wastewater Handling	N_2O	NO		

Table – 7 Source Category Analysis Summary (Tier 1)

Level Assessment for 2012. Trend Assessment for 1990-2012

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Key Source Category (Yes/No)	Criteria for Identification Key Source Category	Note
1.A.1	CO_2 Emissions from Solid Fuel Combustion (Other Bituminous Coal)	CO_2	NO		
1.A.1	CO_2 Emissions from Solid Fuel Combustion (Sub-Bituminous Coal)	CO_2	YES	Level, Trend	
1.A.1	CO_2 Emissions from Solid Fuel Combustion (Coal Briquettes)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Crude Oil)	CO_2	YES	Level, Trend	
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Gasoline)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Other Types of Kerosene)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Diesel Fuel)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Fuel Oil)	CO_2	YES	Trend	
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (CIS)	CO_2	NO		
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Cracking Gas)	CO_2	NO	Trend	
1.A.1	CO_2 Emissions from Liquid Fuel Combustion (Stove Domestic Fuel)	CO_2	NO		
1.A.1	CO_2 Emissions from Fuel Gas Combustion (Natural Gas)	CO_2	YES	Level, Trend	
1.A.1	CO_2 emissions from Gas of Underground Gasification	CO_2	NO		
1.A.1	CH_4 (Non-CO_2) Emissions from Fuel Combustion	CH_4	NO		
1.A.1	N_2O (Non-CO_2) Emissions from Fuel Combustion	N_2O	NO		
1.A.2	Manufacturing Industries and Construction: CO_2 Emissions from Solid Fuel Combustion	CO_2	NO		
1.A.2	Manufacturing Industries and Construction CO_2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	
1.A.2	Manufacturing Industries and Construction: CO_2 Emissions from Fuel Gas	CO_2	YES	Level, Trend	
1.A.2	Manufacturing Industries and Construction: CH_4 Emissions	CH_4	NO		
1.A.2	Manufacturing Industries and Construction: N_2O Emissions	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Road Transportation	CO_2	YES	Level, Trend	
1.A.3	Mobile: CH_4 Emissions from Road Transportation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Road Transportation	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Water-borne Navigation	CO_2	NO		
1.A.3	Mobile: CH_4 Emissions from Water-borne Navigation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Water-borne Navigation	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Aviation	CO_2	NO		
1.A.3	Mobile: CH_4 Emissions from Aviation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Aviation	N_2O	NO		
1.A.3	Mobile: CO_2 Emissions from Railway Transportation	CO_2	YES	Trend	
1.A.3	Mobile: CH_4 Emissions from Railway Transportation	CH_4	NO		
1.A.3	Mobile: N_2O Emissions from Railway Transportation	N_2O	NO		
1.A.3	CO_2 Emissions from Pipeline Transport	CO_2	YES	Level, Trend	
1.A.4	Commercial/institutional: CO_2 Emissions from Solid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Commercial/Institutional: CO_2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	

IPCC Category Code	IPCC Source Categories	Greenhouse Gas	Key Source Category (Yes/No)	Criteria for Identification Key Source Category	Note
1.A.4	Commercial/Institutional: CO_2 Emissions from Fuel Gas	CO_2	YES	Level, Trend	
1.A.4	Other Sectors: Commercial/Institutional: CH_4 Emissions	CH_4	NO		
1.A.4	Other Sectors: Commercial/Institutional: N_2O Emissions	N_2O	NO		
1.A.4	Residential: CO_2 Emissions from Solid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Residential: CO_2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Residential: CO_2 Emissions from Fuel Gas	CO_2	YES	Level, Trend	
1.A.4	Other Sectors: Residential: CH_4 Emissions	CH_4	NO		
1.A.4	Other Sectors: Residential: N_2O Emissions	N_2O	NO		
1.A.4	Agriculture/Forestry/Fishing: CO_2 Emissions from Solid Fuel Combustion	CO_2	NO		
1.A.4	Agriculture/Forestry/Fishing: CO_2 Emissions from Liquid Fuel Combustion	CO_2	YES	Trend	
1.A.4	Agriculture/Forestry/Fishing: CO_2 Emissions from Fuel Gas	CO_2	NO		
1.A.4	Other Sectors: Agriculture/Forestry/Fishing: CH_4 Emissions	CH_4	NO		
1.A.4	Other Sectors: Agriculture/Forestry/Fishing: N_2O Emissions	N_2O	NO		
1.A.5	Other: (Energy)	CO_2	NO		
1.B.1	CH_4 Emissions from Coal Mining and Processing	CH_4	NO		
1.B.2	Fugitive CH_4 Emissions from Oil and Gas	CH_4	YES	Level, Trend	
2.A	CO_2 Emissions from Cement Production	CO_2	YES	Level	
2.A	CO_2 Emissions from Lime Production	CO_2	NO		
2.A	CO_2 Emissions from Soda Ash Use	CO_2	NO		
2.B	N_2O Emissions from Nitric Acid Production	N_2O	YES	Level	
2.B	CO_2 Emissions from Ammonia Production	CO_2	YES	Level, Trend	
2.B	CH_4 Emissions from Chemical Industry	CH_4	NO		
2.C	CO_2 Emissions from Iron and Steel Production	CO_2	NO		
2.F	Consumption of Sulphur Hexafluoride and Halocarbons	HFC	NO		
4.A	CH_4 Emissions from Livestock. Enteric Fermentation	CH_4	YES	Level, Trend	
4.B	CH_4 Emissions from Livestock. Manure	CH_4	NO		
4.B	N_2O Emissions from Manure Use	N_2O	NO		
4.F	CH_4 Emissions from Field Burning of Agricultural Residues	CH_4	NO		
4.F	N_2O Emissions from Field Burning of Agricultural Residues	N_2O	NO		
4.D	N_2O (Direct or Indirect) Emissions from Agricultural Soils	N_2O	YES	Level, Trend	
4.C	CH_4 Emissions from Rice Cultivation	CH_4	NO		
6.A	CH_4 Emissions from Solid Waste Disposal on land	CH_4	YES	Level, Trend	
6.B	CH_4 Emissions from Wastewater Handling	CH_4	NO		
6.B	N_2O Emissions from Wastewater Handling	N_2O	NO		

Annex 5 – The Calorific Value Of Sub-Bituminous Coal

In 2006, within the framework of the Second National Communication, in preparation of Greenhouse Gases National Inventory, the national fuel conversion factor was recalculated from natural values into energy ones for Uzbek sub-bituminous coal for the period 1999-2005. In the Third National Communication the factor was revised.

In the SNC, calculated for each year weighted average factors for coal were used for calculation of emissions for the period 1990-1997 (Table – 5A2), as in this period not only Uzbek coal but also coal imported from other countries (Russia, Kazakhstan), was used. The calculations took into account the fact that imported coal has a higher calorific value than the Uzbek one [8].

For 1998 it was decided to use the average value – 13.158 GJ / t between the previous year – 1997 (13.901 GJ / t) and the following year – 1999 (12.414 GJ/t), as there is no data on the calorific value of imported coal (Table – 5A2).

When calculating the calorific value of sub-bituminous coal in the framework of TNC, it was taken into account that only Uzbek coal has been used in the country in the period 2006-2012.

To clarify value of the national factor, data on net calorific value of sub-bituminous coal provided by JSC "O`zbekko`mir" for the period 2006-2012 was used. Data for 2010 is given in Table – 5A1 as an example.

Table – 5A1 Data of JSC "O`zbekko`mir" on the sorts of sub-bituminous coal used and the average annual lowest calorific value in 2010

Sort of Coal	Lowest Calorific Value	Measurement Unit	Normative Document
BPK	3723	kcal / kg	GOST 8302-87
BR	3381	kcal / kg	GOST 8297-87
BR-Б1	3074	kcal / kg	TSh12-18:2007
BR-Б2	1847	kcal / kg	TSh12-17:2007
BM	3349	kcal / kg	GOST 8298-89
BM-B1	2983	kcal / kg	TSh12-18:2007
BM-B2	2443	kcal / kg	TSh12-17:2007

The data sample on sorts used as fuel and the lowest calorific value of sub-bituminous coal for the period 2006-2012 was treated with standard statistical methods. The following characteristics were obtained for this sample:

Average calorific value of the sample = 2965.0 kcal / kg (or **12.414** GJ / t).

Standard square deviation σ = ± 272.5 kkal / kg.

Relative maximum deviation = ± 9.19%.

Thus, for the period 1999-2012 it was decided to use the average calorific value of coal sorts, equal to **2965.0** kcal / kg (or **12.414** GJ/t) used in Uzbekistan on the basis of information provided by the JSC "Uzbekko`mir" on the quality of coal, corresponding to GOST, for CO_2 emission calculations from fuel combustion. This value is the same as previously used in the Second National Communication.

Table – 5A2 Weighted average factors for coals by years

Year	Coal	Year	Coal
1990	15.413	**1998**	13.158
1991	15.252	**1999**	12.414
1992	14.489	**2000**	12.414
1993	14.242	**2001**	12.414
1994	14.124	**2002**	12.414
1995	13.830	**2003**	12.414
1996	13.622	**2004**	12.414
1997	13.901	**2005**	12.414
		2006-2012	12.414

Annex 6 – Calculation of National Indirect GHG Emission Factors for "Transport" in the "Energy" Sector in Uzbekistan

In 2007, within the framework of the Second National Communication, national emission factors were calculated during preparation of Greenhouse Gas Inventory:

- CO from fuel combustion for transport;
- NOx from fuel combustion for transport;
- CxHy from fuel combustion for transport.

All factors were calculated using the same way based on the "Instruction on Making Report on Air Protection" according to [12], approved by the State Committee for Forecasting and Statistics of the Republic of Uzbekistan dated 20.09.94 #29 (Table – 6A1).

In the framework of preparation the Third National Communication, in addition to the existing national factors, the national factors from burning compressed natural gas were calculated.

Table – 6A1 shows polluting substances emissions when burning one tone of fuel.

Table – 6A1 Polluting substances emissions from combustion of 1 tone of fuel, t/t [11]

Polluting sustance	Polluting substances emissions		
	Gasoline engine	Diesel engine	Engine working on Gas
Carbon monixide	0.6	0.1	0.17
Hydrocarbons	0.1	0.03	0.06
Nitrogen oxides (converted into nitrogen dioxide)	0.04	0.04	0.04
Sulfurous gas	0.002	0.02	
Soot		0.016	
Aldehydes	0.04	0.0025	
Benzopyrene	0.23*10-6	0.31*10-6	
Lead compounds	0.0003		

As the emission factor should be measured in kg / TJ, fuel is expressed in energy units.

Table – 6A2 presents national calorific values of the main fuels used by Road Transportation.

Таблица – 6A2 Calorific value of Fuel

Fuel	Gasoline	Diesel Fuel	Liquefied Natural Gas	Compressed Natural Gas
Calorific value	0.043668 TJ/t	0.042496 TJ/t	0.046013 TJ/t	0.033997 J/1000 m^3

Calculation of emission in kg gas / TJ was made in proportion:

– Specific emission n kg of gas – 1 tone of fuel expressed in energy units (TJ);
– Specific emission X kg of gas – 1 TJ;
– Hence X = n kg of gas * 1 TJ / 1 tone of fuel expressed in energy units (TJ).

Since the volume of compressed gas is given in statistical reports in thousand cubic meters, specific emission kg CO / 1000 m^3 of compressed gas is calculated separately.

Accepted assumptions to calculate the emission factor for the combustion of compressed natural gas:

– Natural gas is 99.9% of methane;
– Weight 1 mole of CH_4 = 16.04 g;
– The volume of 1 mole of (any) gas = 22.4 liters under normal conditions.

Consequently, the weight of 1 l of CH_4 = (16.04 * 1 l) / 22.4 l = 0.716 g.

It follows from this that the weight 1 m^3 = 0.716 kg. and the weight 1.000 m^3 of natural gas = 716 kg.

Taking into account the characteristics of fuel used for Transport, which is produced and used domestically, it is preferable to use national factors to calculate emissions rather than the IPCC default factors.

The following are calculations for each of the calculated national factors.

6.1. National CO Emission Factor from Fuel Combustion in "Transport"

In SNC, national CO emission factors from Road Transportation were calculated, in TNC the value of national CO emission factors for compressed gas was calculated [8].

Specific CO emissions for compressed gas were calculated in proportion:

- 170 kg CO – 1000 kg gas;
- X CO kg – 716 kg gas (1000 m^3);
- X = 170 kg CO * 716 kg gas / 1000 kg gas = 121.7 kg CO.

Table – 6A3 shows the values of specific CO emissions from fuel combustion in transport of the Republic of Uzbekistan. The table is compiled on the basis of Tables – 6A1 and 6A2, as well as the results of the specific CO emission calculations for the compressed gas.

Table – 6A3 Specific CO emissions from Road Transportation

Fuel	Gasoline	Diesel Fuel	Liquefied Natural Gas	Compressed Natural Gas
1 t of fuel in energy units (1000 m^3 for the compressed gas), TJ	0.043668	0.042496	0.046013	0.033997
Specific CO emission, kg	600	100	170	122

Calculation of national factors of CO emissions from Road Transportation, kg CO /TJ:

- Gasoline X = 600 * 1 / 0.043668 = 13,740.0 kg/TJ;
- Diesel fuel X = 100 * 1 / 0.042496 = 2,353.2 kg/TJ;
- Liquefied gas X = 170 * 1 / 0.046013 = 3,694.6 kg/TJ;
- Compressed gas X = 121.7 * 1 / 0.033997 = 3,580.7 kg/TJ.

Table – 6A4 shows the values obtained for national CO emission factors from road transportation used in the calculations of the Second and Third National Communications.

Table – 6A4 National CO emission factors from Road Transportation, kg/TJ

Gasoline	Diesel Fuel	Liquefied Natural Gas	Compressed Natural Gas
13,740.0	2,353.2	3,694.6	3,580.7
IPCC default factors (given for comparison), [3]			
8000	1000	-	400

6.2. NOx emission factor from fuel combustion for "Transport"

In SNC national NOx emission factors from road transportation were calculated, in TNC value of national CO emission factor for the compressed gas was calculated [8].
Specific NOx emissions for compressed gas were calculated in proportion:

- 40 kg NOx – 1000 kg gas;
- X of NOx kg – 716 kg gas (1000 m^3);
- X = 40 kg * 716 kg NOx gas / 1000 kg gas = 28.6 kg NOx.

Table – 6A5 shows the values of specific NOx emissions from fuel combustion in transport of the Republic of Uzbekistan. The table is compiled on the basis of Tables – 6A1 and 6A2, as well as the results of the specific NOx emission calculations for the compressed gas.

Table – 6A5 Specific NOx emissions from Road Transportation

Fuel	Gasoline	Diesel Fuel	Liquefied Natural Gas	Compressed Natural Gas
1 t of fuel in energy units	0.043668	0.042496	0.046013	0.033997
Specific NOx emission, kg	40	40	40	28.6

Calculation of national factors of NOx emissions from road transportation, kg NOx /TJ:

- Gasoline X = 40 * 1 / 0.043668 = 916.0 kg/TJ;
- Diesel fuel X = 40 * 1 / 0.042496 = 941.3 kg/TJ;
- Liquefied gas X = 40 * 1 / 0.046013 = 869.3 kg/TJ;
- Compressed gas X = 28.6 * 1 / 0.033997 = 842.5 kg/TJ.

Table – 6A4 shows the obtained values of national NOx emission factors from road transportation used in the calculations of the Second and Third National Communications.

Table 6A6 National NOx emission factors from Road Transportation, kg/TJ

Gasoline	Diesel fuel	Liquefied Natural Gas	Compressed Natural Gas
916.0	941.3	869.3	842.5
IPCC default factors (given for comparison), [3]			
600	800	-	600

6.3. CxHy emission factor from fuel combustion in "Transport"

In accordance with the "Instructions on the procedure of drawing up a report on air quality" [12], gas emissions per ton of fuel expressed in energy units of fuel are listed below.

Specific CxHy emissions for compressed gas were calculated from the proportion:

- 60 kg CxHy – 1000 kg gas;
- X kg CxHy – 716 kg gas (1000 m^3);
- X = 60 kg CxHy *716 kg gas/1000 kg gas = 43.0 kg CxHy.

Table – 6A7 shows the values of specific CxHy emissions from fuel combustion in transport of the Republic of Uzbekistan. The table is compiled on the basis of Tables – 6A1 and 6A2, as well as the results of the specific CxHy emission calculations for the compressed gas.

Table – 6A7 Specific CxHy emissions

Fuel	Gasoline	Diesel Fuel	Liquefied Natural Gas	Compressed Natural Gas
1 t of fuel in energy units, TJ	0.043668	0.042496	0.046013	0.033997
Specific CxHy emission, kg	100	30	60	43

Calculation of national CxHy emission factors from road transportation, kg CxHy /TJ:

- Gasoline X = 100 * 1 / 0.043668 = 2,290.0 kg/TJ;
- Diesel fuel X = 30 * 1 / 0.042496 = 705.9 kg/TJ;
- Liquefied gas X = 60 * 1 / 0.046013 = 1,304.0 kg/TJ;
- Compressed gas X = 43 * 1 / 0.033997 = 1,263.8 kg/TJ.

Table – 6A8 shows the values obtained for national CxHy emission factors from road transportation used in the calculations of the Second and Third National Communications.

Table – 6A8 National CxHy emission factors, kg/TJ

Gasoline	Diesel fuel	Liquefied Natural Gas	Compressed Natural Gas
2,290.0	705.9	1,304.0	1,263.8
IPCC default factors (given for comparison), [3]			
1,500	200	-	-

Annex 7 – Calculation of National Factors for Fugitive Methane Emissions from Natural Gas Production/ Processing / Transmission in the "Energy" Sector

Within preparation of the Third National Comuuunication of 2012-2015, using new data on the activities, the following national factors for fugitive methane emissions were clarified:

- from natural gas production and preparation;
- from gas-main pipeline transport;
- from gas processing (gas treatment from from sulfurous compounds).

Calculation was made based on the data of the National Holding Company "Uzbekneftegaz".

All factors have been calculated by the same method.

Calculation for each of the factors developed is given below.

7.1. Calculation of national methane emission factors for natural gas production and preparation

The national factor 56,798 kg / PJ was used in the Second National Communication. It was calculated on the basis of small sample of data (1999 - 2004). In connection with the expansion of a number of data in the Third National Communication, the value of the national factor for the period 1999 – 2012 was clarified. Uncertainty of a new factor decreased in comparison to that used in the Second National Communication.

The general scheme of emission factor calculation is as follows:

$$K = V_{SRandN} / V_{AD} * 1000 \qquad (1)$$

where:

К – emission factor, kg / thous. m^3;

V_{SRandN} – volume of gas used for own needs and gas losses, t;

V_{AD} – activity data (volume of gas production and preparation), thous. m^3.

Calculation of methane volume:

$$V_{SRandN} = V * C * \rho_i / 1000 \qquad (2)$$

where:

V – volume of natural gas, m^3;

C – fraction of methane in natural gas;

ρ – density of methane equal to 0.668 kg/m^2 – under 20°C and 760 mm of mercury column;

1000 – conversion factor that converts kg to tons.

Calculation of emission factor, kg / PJ:

$$K\, kg/PJ = K\, kg/thous.m^3 * 8{,}100{,}000\, cal/m^3 * 4.1868\, J/cal / 10^{15} \qquad (3)$$

Annual emission factors were calculated for the period 1999 – 2012

Volumes of own needs and losses were calculated, using the same way as in the preparation of the Second National Communication, on the basis of consumption.

Activity data (Table – 7A1) were provided by the National Holding Company "Uzbekneftegaz". As data on natural gas production are confidential since 2006, data for 1999-2005 used in the Second National Communication are given in the table as an example.

Table – 7A1 Data on Natural Gas production and losses from Natural Gas Production and Preparation on the example of 1999-2005

	1999	2000	2001	2002	2003	2004	2005
Total gas production and preparation, thous. m^3	55,581,000	56,400,000	57,414,000	58,430,000	58,060,000	60,428,000	60,324,000
Natural gas losses into air, thous. m^3	180,439	153,085	224,747	188,729	175,234	143,846	150,356

Methane fraction in natural gas is taken equal to 0.935 in volume units (averaged data of regular analysis of gas produced).

Calculation of methane emissions:

According to formula (2):
CH_4 = 143846 thous. m^3 * 0.935 * 0.668*1000/1000 = 89843 t .
(Example of calculation for 2004)

Calculation of annual aggregated methane emission factor:

Specific CH_4 emission = 89843 t / 60428000 thous. m^3 * 1000 = 1.49 kg / thous. m^3;
Specific CH_4 emission = 89843 t / (60428000 thous. m^3 * 1000 * 8100000 cal / m^3 * 4.1868 J / cal / 1015) = 43841 kg / PJ.
(Example of calculation for 2004)

Within preparation of the Third National Communication, taking into account newly obtained activity data, recalculation of national factor of methane emission into air (1999-2012) was carried out, as the factor used in the Second National Communication – 56,798 kg / PJ was calculated for a very small sample. Table – 7A2 shows the annual emission factors, kg CH_4 / PJ for all available data series.

Table – 7A2 Annual factors of methane emission from Natural Gas Production, kg / PJ

1999	2000	2001	2002	2003	2004	2005
59,789	49,989	72,094	59,487	55,586	43,841	45,904
2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
48,689	51,897	52,787	50,801	48,971	47,806	42,717

Calculation of average factor and its uncertainty:

To estimate the uncertainty, statistical regularities included in Microsoft Office Excel table processor were applied.

Based on the above mentioned aggregated factors of methane emission from natural gas production and preparation for the period 1999 – 2004, the average factor **52,168.5 kg/PJ** was calculated.

Standard square deviation σ = ± 7679.16 kg CH_4/PJ;

Maximum relative deviation (coefficient of variation) = ± 14.72%.

Table – 7A3 summarizes the changes in CH_4 emission when using factor 52,168.5 kg/PJ in comparison with CH_4 emission in the category "Methane leakages" when using the factor 56,798 kg / PJ on the example of 2010.

Table – 7A3 Change in CH_4 emission, Gg CO_2-eq. (on the example of 2010) when using different Emission factors

Category	When used in calculations of:		Change in CH_4 emission, %
	EF of the SNC	EF of the TNC	
Natural gas production and preparation	2424.45	2226.84	-8.9
"Natural gas" category	67970.49	67799.76	-0.3
"Methane leakage" category	68297.33	68099.72	-0.3
"Energy" sector	68471.04	68273.43	-0.3
CH_4 national emission	86775.99	86973.60	-0.2
GHG national emission	**198877.79**	**198680.18**	**-0.1**

7.2. Calculation of national CH_4 emission factor from gas-main transmission

National factor 70,615 kg / PJ was used in the Second National Communication. It was calculated on the basis of a small sample of data (1999 - 2003). In connection with the expansion of a range of data in the Third National Communication, the value of national factor for the period 1999 – 2012 was clarified. Uncertainty of a new factor decreased in comparison to that used in the Second National Communication.

General scheme of emission factors calculation is as follows:

$$K = V_{SRandN} / V_{AD} * 1000 \quad (1)$$

where:

К – emission factor, kg/thous. m^3;

V_{SNandR} – volume of gas for own needs and losses, t;

V_{AD} – activeity data (volume of gas transmitted), thous. m^3.

Calculation of methane volume:

$$V_{SRandN} = V * C * \rho_i / 1000 \quad (2)$$

where:

V – volume of gas, m^3;

C – methane fraction in natural gas;

ρ – density of methane, equal to 0.668 kg/m^2 – under 20°C and 760 mm of mercury column;

1000 – conversion factor that converts kg to ton.

Calculation of emission factor, kg / PJ:

$$K\, kg / PJ = K\, kg / thous.m^3 * 8{,}100{,}000\, cal / m^3 * 4.1868\, J / cal / 10^{15} \quad (3)$$

Annual factors are calculated for the period 1999 – 2012

The volumes of own needs and losses were calculated based on methods [56,58].

Activity data provided by the National Holding Company "Uzbekneftegaz" (Table – 7A4). In connection with the confidentiality of activity data for the period 2006-2012, data for the period 1999-2005 which were used for calculations in the Second National Communication are given in the table as an example.

Table – 7A4 Data on volumes of Natural Gas transmissed and lost at gas-main Transmission

	1999	2000	2001	2002	2003	2004	2005
Total gas intake in the pipelines of JSC "Uztransgaz", (including transit of Turkmen gas), thous. m^3	57,381,533	79,092,548	82,164,489	83,321,929	87,277,265	88,890,900	89,100,000
Total gas losses into air, thous. m^3	2,195,345	2,303,959	2,912,861	3,674,561	3,943,376	3,125,895	2,983,854

Methane fraction in natural gas is taken equal to 0.927 in volume units (averaged data of regular analyses of gas produced).

Calculation of methane emission:

According to the formula (2):
CH_4 = 2.195.345 thous. m^3 * 0.927 * 0.668 * 1000/1000 = 1359437 t .
(Example of calculation for 1999).

Calculation of annual aggregated methane emission factor:

Specific CH_4 emission = 1359437 t / 57381533 thous. m^3 * 1000 = 23.69 kg / thous. m^3.
Specific CH_4 emission = 1359437 t / (57381533 thous. m^3 * 1000 * 8100000 cal / m^3 * 4.1868 J / cal / 1015) = 698 586 kg / PJ.
(Example of calculation for 1999).

For all years, taken for calculation of methane emission factor (1999 – 2012), the following annual emission factors, kg/PJ (Table – 7A5) were obtained:

Table 7A5 Annual methane emission factors from Natural Gas Transmission, kg/PJ

1999	2000	2001	2002	2003	2004	2005
698,586	531,898	647,328	805,258	825,004	642,105	611,489
2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
553,688	574,221	632,241	818,760	817,114	574,722	565,217

Calculation of the average factor and its uncertainty:

To estimate the uncertainty, statistical regularities included in Microsoft Office Excel table processor were applied.

Based on the above mentioned aggregated factors of methane emission from natural gas transmission for 1999 – 2012, the average factor **664116 kg / PJ** was calculated.

Standard square deviation σ = ± 108981 kg CH_4 / PJ;

Maximum relative deviation (coefficient of variation) = ± 16.4%.

CH_4 emission when using factor 664116 kg / PJ in comparison with CH_4 emissions in the category "Methane leakages" using the coefficient 56,798 kg / PJ (used in the second National Communication) for 2010 changed as follows (Table – 7A6):

Table – 7A6 Change in CH_4 emission when used in calculation of different values of national factors, Gg CO_2-eq. (on the example of 2010)

Category	When used in calculation of:		Change in CH_4 emission, %
	EF of the SNC	EF of the TNC	
Natural gas transmission	31084.62	29423.31	-5.3
"Natural gas" category	69461.07	67799.76	-2.4
"Methane leakages" category	69761.03	68099.72	-2.4
"Energy" sector	69934.74	68273.43	-2.4
CH_4 national emission	88634.91	86973.6	-1.9
GHG national emission	**200341.49**	**198680.18**	**-0.8**

7.3. Calculation of national factors of methane emission from Natural Gas Processing (refinement from sulfurous compounds)

The Inventory includes a new source of fugitive methane emissions – Shurtan Gas Chemical Complex which came into operation in 2006. National emission factor for this source was calculated for the first time. For two other sources of emissions – Mubarek Gas Processing Plant and GPE "Shurtanneftegaz" national factors were recalculated in connection with the extension of data series. In the Second National Communication emission factor 1,001,098 kg/PJ was used for Mubarek Gas Processing Plant, 71,733 kg / PJ – for GPE "Shurtanneftegaz". Emission factors recalculated in the Third National Communication have less uncertainty than previously used ones.

General scheme of emission factors calculation is as follows:

$$K = V_{SRandN} / V_{AD} * 1000 \qquad (1)$$

where:

К – emission factor, kg/thous. m^3;

V_{SNandR} – volume of gas used for own needs and losses, t;

V_{AD} – activity data (volume of gas processed), thous. m^3.

Calculation of methane amount:

$$V_{SRandN} = V * C * \rho_i / 1000 \qquad (2)$$

where:

V – volume of gas. m^3 ;

C – methane fraction in natural gas;

ρ – density of methane, equal to 0.668 kg/m^2 – under 20°C and 760 mm of mercury column;

1000 – conversion factor, that converts kg to tons.

Calculation of emission factor, kg/PJ:

$$K\ kg / PJ = K\ kg / thous.m^3 * 8{,}100{,}000\ cal / m^3 * 4.1868\ J / cal / 10^{15} \qquad (3)$$

Annual factors were calculated for the following periods:

- 1999 - 20 12 (Mubarek GPP);
- 1995 - 2012 (GPE "Shurtanneftegaz");
- 2007 - 2012 (GCC "Shurtan").

The volumes of own needs and losses were calculated based on the methods of gas discharge calculation for own needs and technological losses for gas processing plants [57, 59].

Activity data: provided by the National Holding Company "Uzbekneftegaz" (Tables – 7A7,7A8). Since activity data for 2006-2012 was considered confidential, data for Mubarek Gas Processing Plant and GPE "Shurtanneftegaz" are given in tables as an example for the period 1999-2005, which were used in the Second National Communication. Activity data are not given for Shurtan Gas Chemical Complex which came into operation in 2006.

Table – 7A7 Data on costs for own needs and losses from Natural Gas Processing at Mubarek Gas Processing Plant

	1999	2000	2001	2002	2003	2004	2005
Intake for processing, thous. m^3	24,678,410	25,825,880	27,298,000	27,323,451	27,521,672	27,801,264	28,122,150
Total losses of natural gas, thous. m^3	1,506,400	1,544,817	1,467,033	1,444,064	1,394,659	1,334,942	1,377,654

Table – 7A8 Data on costs for own needs and losses from Natural Gas Processing at GPE "Shurtanneftegaz"

	1995	1996	1997	1998	1999	2000
Intake for processing, thous. m^3	12,668,530	13,340,360	13,380,740	13,262,590	13,456,560	13,586,258
Losses of natural gas, thous. m^3	132,208	75,701	60,374	36,433	65,854	86,985
	2001	**2002**	**2003**	**2004**	**2005**	
Intake for processing, thous. m^3	13,256,862	12,986,986	12,896,356	12,568,989	1,205,6125	
Losses of natural gas, thous. m^3	95,875	102,589	115,658	143,253	135,425	

Methane fraction in natural gas is taken equal to 0.935 in volume units (averaged data of regular analyses for gas processed).

Calculation of methane emission:

According to the formula (2):
CH_4 = 1334942 thous. m^3 * 93.5/100 * 0.668*1000/1000 = 833778 t .
(Example of calculation for 2004, Mubarek GPP).

Calculation of annual aggregated methane emission factor:

Specific CH_4 emission = 833778 t / 27801264 thous. m^3 * 1000 = 29.99 kg / thous. m^3;
Specific CH_4 emission = 833778 t / (27801264 thous. m^3 * 1000*8 100 000 cal / m^3 * 4.1868 J / cal / 10^{15}) = 884339 kg / PJ.
(Example of calculation for 2004, Mubarek GPP).

To calculate methane emission factors at Mubarek Gas Processing Plant for the period 1999 – 2012, the following annual emission factors were obtained, kg / PJ (Table – 7A9):

Table – 7A9 Annual factors of methane emission from Processing at Mubarek Gas Processing Plant, kg/PJ

1999	2000	2001	2002	2003	2004	2005
1,124,201	1,101,648	989,760	973,356	933,285	884,339	902,220
2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
912,912	916,685	703,456	658,165	968,706	947,996	857,084

In connection with the expansion of a number of data to obtain revised estimates of methane emissions, it is proposed to use the average emission factor – **919,558 kg / PJ** calculated in the framework of the Third National Communication for the whole period 1999 – 2012.

Due to increased number of available data at GPP "Shurtanneftegaz", the average factor of methane emissions for the whole period 1995-2012 was recalculated, and the following annual emission factors, kg / PJ were obtained (Table – 7A10):

Table – 7A10 Annual factors of methane emission from Processing at GPE "Shurtanneftegaz", kg/PJ

1995	1996	1997	1998	1999	2000
1,992,200	104,509	83098	50,593	90,145	117,934
2001	**2002**	**2003**	**2004**	**2005**	**2006**
133,217	145,508	165,197	209,941	206,911	207,900
2007	**2008**	**2009**	**2010**	**2011**	**2012**
208,165	172,982	149,067	164,991	177,724	182,610

In calculation of methane emission from gas processing at GPE "Shurtanneftegas", in the framework of the Third National Communication, it was decided to use the average emission factor for the whole data series of 1995 - 2012 – **153,483 kg/PJ**.

For the new source of methane emissions – Shurtan Gas Chemical Complex which put into operation in 2006, annual factors for the series of 2007-2012 are given in Table – 7A11.

Table – 7A11 Annual factors of methane emission from Processing at GCC "Shurtan", kg/PJ

2006	2007	2008	2009	2010	2011	2012
294,542	2,195,089	2,799,688	2,489,763	2,324,581	2,461,896	2,464,675

2006 is the year of putting the plant into operation. The obtained values of methane emissions of the plant is considerably less than in all subsequent years. In calculation of methane emission from gas processing at GCC "Shurtan" in the framework of the Third National Communication, it was decided to use the period 2007-2012 to derive the average factor of methane emission. The average factor is equal to **2,455,949 kg/PJ**.

Calculation of average factor:

Based on the above mentioned aggregated factors of methane emission from gas processing, the following average factors were calculated:

1) **For Mubarek Gas Processing Plant** – **919,558 kg/PJ** is a clarified national factor from natural gas processing;

2) **For GPE "Shurtanneftegaz"** – **153,483 kg/PJ** is a clarified national factor of methane emission from natural gas processing;

3) **For Shurtan Gas Chemical Complex** – **2,455,949 kg/PJ** is a new national factor of methane emission from natural gas processing.

A great difference in factors for three companies is caused by difference in the technology of gas processing: Mubarek GPP uses amine gas treating sets; GPE "Shurtanneftegaz" – amine and zeolite sets for gas treating; Shurtan Gas Chemical Complex – hydrotreating and cryogenic processing.

Uncertainty estimation:

To estimate the uncertainty, statistical regularities included in Microsoft Office Excel table processor were applied.

Mubarek Gas Processing Plant:

Standard square deviation σ = ± 126123.7 kg CH_4 / PJ;

Maximum relative deviation (coefficient of variation) = ± 13.7%.

GPE Shurtanneftegaz:

Standard square deviation σ = ± 48982.2 kg CH_4 / PJ;

Maximum relative deviation (coefficient of variation) = ± 31.9%.

Shurtan GCC:

Standard square deviation σ = ± 202344.6 кг CH_4/PJ;

Maximum relative deviation (coefficient of variation) = ± 8.2%.

CH_4 emissions using new factors for three sources of methane emissions in the category "Natural gas processing" as compared to CH_4 emissions using the factors calculated in the Second National Communication for 2010 were changed as follows (Table – 8A6):

Table – 8A6 Change in CH_4 emissions when used in calculation of different values of national factors

Category	When used in calculation of:		Change in CH_4 emission, %
	EF of the SNC	EF of the TNC	
Natural gas processing	28142.31	27236.37	-3.2
"Natural gas" category	68705.49	67799.76	-1.3
"Methane leakages" category	69005.66	68099.72	-1.3
"Energy" sector	69179.37	68273.43	-1.3
CH_4 national emission	87879.54	86973.6	-1.0
GHG national emission	**199586.12**	**198680.18**	**-0.5**

Annex 8 – Calculation of National SO_2 Emission Factor from Natural Gas Processing (Gas Treatment from Sulfurous Compounds)

In the Third National Communication the value of national SO_2 emission factor from natural gas treatment from sulfurous compounds was clarified based on expansion of activity data provided by the National Holding Company "Uzbekneftegaz". This allowed to reduce uncertainty in the value of emission factor.

In the Second National Communication, for calculation of sulfur dioxide emissions from gas processing, a national factor of 0.279 t SO_2/t of sulfur calculated for the period 1998-2000 has been used.

In Uzbekistan about 70% of the produced natural gas contains up to 5% (by volume) of sulfurous compounds. Gas treatment from sulfurous compounds is made at enterprises of the National Holding Company "Uzbekneftegaz". Gaseous sulfur is produced in the result of gas treatment from sulfurous compounds. The main enterprise for gaseous sulfur production is Mubarek Gas Processing Plant.

General scheme of emission factor calculation is as follows:

$$K = V_{SO_2} / V_{AD} \quad (1)$$

where:
K – emission factor, t SO_2 / t of sulfur produced;
V_{SO2} – SO_2 emissions, t;
V_{AD} – activity data (volume of sulfur produced), t.

Annual factors were calculated for the period 1998-2012.

SO_2 emissions were calculated using "The method of calculation of polluting substances emissions for oil and gas production and processing enterprises of oil and gas industry" [57]. Activity data on the example of the period 1998-2005 are given in Table – 8A1.

Table – 8A1 Data on sulfur production and sulfur dioxide (SO_2) emissions from Gas treatment

Year	Sulfur production, t	SO_2 emitted into air, t
1998	280000	91737
1999	273600	73507
2000	260000	62564
2001	251500	55631
2002	217500	45981
2003	187400	41901
2004	169900	36614
2005	153100	37112

Calculation of annual aggregated SO_2 emissions factor:
SO_2 emission factor = 37112 t / 153100 t = 0.242 SO_2 / t of sulfur .
(Example of calculation for 2005).
For the period 1998 – 2012 taken for the calculation SO_2 emission factors. annual emission factors, t SO_2/t of sulfur obtained, are given in Table – 8A2:

Table – 8A2 Annual factors of SO_2 emission from sulfur production, t SO_2 /t of sulfur

1998	1999	2000	2001	2002	2003	2004	2005
0.328	0.269	0.241	0.221	0.211	0.224	0.216	0.242
2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	
0.178	0.212	0.225	0.272	0.236	0.211	0.221	

Calculation of average factor:

Based on aggregated factors of SO_2 emissions from gas treatment from sulfurous compounds at Mubarek Gas Processing Plant for 1998 – 2012, the average factor 0.234 t SO_2/t of sulfur was used to calculate SO_2 emissions from gas systems in preparation of Inventory in the framework of the Third National Communication to all available data series (instead of data series used in preparation of the Second National Communication – 0.279 t SO_2/t).

Uncertainty estimation:

To estimate the uncertainty, statistical regularities included in Microsoft Office Excel table processor were applied. Estimation of available data deviations was made.

Standard square deviation σ = ± 0.035 т SO_2/ t sulfur;

Maximum relative deviation (coefficient of variation) = ± 14.96 %.

Annex 9 – Calculation of national emission factors in the "Industrial processes" sector in Uzbekistan

In preparation of Greenhouse Gas Inventory within the framework of the Third National Communication, national emission factors were clarified:

- CO_2 emission factor from ammonia production;
- N_2O emission factor from nitric acid production;
- NOx emission factor from nitric acid production;
- SO_2 emission factor from sulfuric acid production;
- CO_2 emission factor from clinker production.

Clarification of national factors was made in connection with the extension of time series and appeared updated information on technological processes.

All factors were calculated using one way. It was based upon data on production data and annual amount of relevant emissions. Annual emissions were calculated on the industrial enterprises according to sectoral methods of calculation of polluting substances emissions, technological regulations or based on direct measurements of waste gases.

Based on these data, the annual emission factors were calculated for each enterprise. In its turn, the average national emission factor for each gas was calculated for the whole territory of the Republic of Uzbekistan using the annual emission factors.

Uncertainty of each factor (coefficient of variation) was calculated by the method of mathematical statistics.

Coefficient of variation (variability) C_v was calculated using the following formula:

$$Cv = \frac{\sigma}{\overline{X}_i} \cdot 100\%$$

where:

σ – standard deviation;

$\overline{X}_i$ – average value for given series of data.

Standard deviation σ is calculated according to formula:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \overline{X}_i)^2}{(n-1)}}$$

where:
X_i – i variable (value of emission factor);
$\overline{X}_i$ – average value for the given series;
n – number of terms in the series.

Data and calculations for each of the developed factors are given belowfurther.

"CHEMICAL INDUSTRY" CATEGORY

9.1. National CO_2 emission factor from Ammonia production

Ammonia is produced at the following enterprises of the Joint-Stock Company (JSC) "Uzkimyosanoat": JSC "Maxam-Chirchik" (former "Elektrokimyosanoat"), JSC "Navoiazot", JSC "Ferganaazot".

Data on ammonia production (thous. tons) from 1990 to 2012, as well as the annual CO_2 emissions from ammonia production for each enterprise were provided by JSC "Uzkimyosanoat". Table – 9A1 gives examples of data on ammonia production in three enterprises of the republic.

Table – 9A1 Data for calculation of national factor, 2010

Year	Ammonia production, thous.t	CO_2 emissions, thous.t	Ammonia production, thous.t	CO_2 emissions, thous.t	Ammonia production, thous.t	CO_2 emissions, thous.t
	JSC "Maxam-Chirchik"		JSC "Navoiazot"		JSC "Ferganaazot"	
2010	515.1	667.1	457.4	340.3	371.4	461.1

Based on these data, the emission factors were calculated for each year for each enterprise and average national CO_2 emission factor from ammonia production (Table – 9A2).

Table – 9A2 CO_2 (t/t) Emission factor for Ammonia production

Enterprise		JSC "Maxam-Chirchik"	JSC "Navoiazot"	JSC "Ferganaazot"
1990		1.324	1.337	1.408
1991		1.327	1.336	1.408
1992		1.331	1.330	1.527
1993		1.346	1.336	1.527
1994		1.306	1.350	1.241
1995		1.322	1.330	1.241
1996		1.314	1.338	1.241
1997		1.322	1.342	1.241
1998		1.304	1.341	1.241
1999		1.319	1.339	1.241
2000		1.304	1.342	1.241
2001		1.312	1.345	1.241
2002		1.293	1.345	1.241
2003		1.278	1.343	1.241
2004		1.294	1.344	1.241
2005		1.300	1.345	1.241
2006		1.307	1.343	1.241
2007		1.307	1.34	1.241
2008		1.304	1.338	1.241
2009		1.294	1.336	1.241
2010		1.295	1.34	1.241
2011		1.309	1.445	1.241
2012		1.290	1.338	1.241
Average value		**1.309**	**1.344**	**1.281**
(Cv), %		**1.2**	**1.7**	**7.1**
σ, ±		**0.015**	**0.022**	**0.091**
Total	**Average value**	**1.311**		
	(Cv), %	**4.6**		
	σ, ±	**0.060**		

In calculation of emission factors for each of enterprises, the values of natural gas consumption in the production of 1 ton of ammonia set in the Second National Communication was used.

National average factor of CO_2 emission from ammonia production for the period 1990-2012 – 1.311 t CO_2 / t **ammonia,** its uncertainty is **4.6%.** The factor calculated in the Second National Communication was **1.317 t CO_2/t** of ammonia, its uncertainty is **4.8%.**

CO_2 emissions using the factor 1.311 compared to CO_2 emissions in the category "Ammonia production" using the factor 1.317 for 2010 are amended as follows (Table – 9A3):

Table – 9A3 Change in CO_2 emission when used in the calculation of different values of national factors

Category	When used in calculation of:		Change in CO_2 emission, %
	EF of the SNC	EF of the TNC	
Ammonia production	1769.92	1761.85	-0.5
"Industrial processes" sector	6066.81	6058.74	-0.13
CO_2 national emission	101215	101207	-0.01
GHG national emission	**198669**	**198661**	**0**

9.2. N_2O emission factors from weak nitric acid production

Strong nitric acid is produced at JSC "Maxam-Chirchik". Its production is not accompanied by nitrous oxide emission.

Weak nitric acid is produced at the following enterprises of JSC "Uzkimyosanoat": JSC "Maxam-Chirchik", JSC "Navoiazot", JSC "Ferganaazot". The way of production is combined, each enterprise is equipped with the units working under both increased pressure and atmospheric pressure.

Data for weak nitric acid production (thous. tons) from 1990 to 2012, as well as the annual N_2O emissions from weak nitric acid production for each enterprise were provided by JSC "Uzkimyosanoat". Data on weak nitric acid production at three enterprises of the republic in 2010 are given as an example in Table – 9A4. Activity data are not given as they are confidential.

N_2O emissions were calculated based on instrumental measurements in waste gases released from weak nitric acid production units. Such measurements were not conducted at the enterprise of JSC "Ferganaazot" until 2007, therefore data of this company are available only since 2007.

Based on these data, the emission factors were calculated for each year, each enterprise and average national N_2O emission factor from weak nitric acid production given in Table – 9A5.

Table – 9A4 N_2O Emission factors (kg/t) from Weak nitric acid production

Enterprise		JSC "Maxam-Chirchik"	JSC "Navoiazot"	JSC "Ferganaazot"
1990		4.125	4.890	-
1991		4.479	4.792	-
1992		4.087	4.834	-
1993		3.212	4.785	-
1994		2.217	4.801	-
1995		4.413	4.730	-
1996		1.697	4.698	-
1997		3.012	4.626	-
1998		3.846	4.595	-
1999		1.151	4.661	-
2000		4.175	4.642	-
2001		2.761	4.596	-
2002		3.637	4.704	-
2003		6.630	4.664	-
2004		3.803	4.755	-
2005		5.326	4.730	-
2006		-	4.518	
2007		9.800	4.549	5.101
2008		8.141	4.283	4.137
2009		0.466	2.624	5.833
2010		0.659	2.527	2.667
2011		0.696	2.628	1.752
2012		1.044	2.553	1.928
Average value		**3.613**	**4.312**	**3.570**
(C_v), %		**66.1**	**19.0**	**47.9**
σ, ±		**2.387**	**0.821**	**1.709**
Total	**Average value**	**3.923**		
	(C_v), %	**3.872**		
	σ, ±	**6.217**		

Thus, the national N_2O emission factor from nitric acid production for time series of 1990-2012 is equal to **3.923 kg N_2O / t nitric acid,** its uncertainty is **44.9%.** In the Second National Communication [8], the calculated factor was used only for two enterprises – "Maxam-Chirchik" and "Navoiazot" – 4.193 kg N_2O / t nitric acid, its uncertainty is 25.7% [8].

In calculation of the amount of N_2O emissions for the category "Weak nitric acid production" using the revised factor 3.923 in comparison with the previously calculated ones in the SNC – 4.193 for 2010, the values obtained are changed as follows (Table – 9A5):

Table – 9A5 Change in N_2O emission, Gg (on the example of 2010)

Category	When used in calculation of:		Change in N_2O emission, %
	EF of the SNC	EF of the TNC	
Weak nitric acid production	6.17	5.77	-6.49
"Industrial processes" sector	6.17	5.77	-6.49
N_2O national emission	34.21	33.81	-1.17
GHG national emission (Gg CO_2-eq.)	**198,785**	**198,661**	**-0.06**

9.3. NO_x emission factor from Weak nitric acid production

Weak nitric acid is produced at the following enterprises of JSC "Uzkimyosanoat": JSC "Maxam-Chirchik", JSC "Navoiazot", JSC "Ferganaazot".

Data on nitric acid production (thous. tons) from 1990 to 2012 were provided by JSC "Uzkimyosanoat", as well as annual NOx emissions from nitric acid production for each enterprise. Data for 2010 are given as an example in Table – 9A7.

Concentrated nitric acid production is carried out by JSC "Maxam-Chirchik" since 1997. The process is in dehydration of weak nitric acid (58%) with a solution of magnesium nitrate with subsequent regeneration. Wherein, NOx emissions are almost absent.

NOx emissions were calculated using the departmental methods for definition of polluting substances emissions.

Based on these data. emission factors were calculated for each year, each enterprise and average national NO_X emission factor for weak nitric acid production given in Table – 9A8.

Table – 9A6 Change in N_2O emission, Gg (on the example of 2010)

Year		JSC "Maxam-Chirchik"	JSC "Navoiazot"	JSC "Ferganaazot"
1990		0.328	0.618	
1991		0.373	0.601	0.610
1992		0.928	0.618	0.610
1993		0.594	0.596	0.610
1994		0.096	0.687	0.680
1995		0.442	0.667	0.700
1996		0.513	0.634	0.680
1997		0.363	0.562	0.750
1998		0.401	0.613	0.800
1999		0.511	0.649	0.845
2000		0.505	0.669	-
2001		0.441	0.676	-
2002		0.548	0.751	-
2003		0.287	0.860	0.439
2004		0.592	0.995	0.943
2005		0.915	0.777	0.803
2006		0.039	0.813	0.167
2007		0.035	0.709	1.015
2008		0.033	0.859	0.217
2009		0.046	0.844	0.167
2010		0.028	0.891	0.102
2011		0.036	0.852	0.150
2012		0.035	0.776	0.133
Average value		**0.352**	**0.727**	**0.549**
(C_v), %		**78.3**	**16.0**	**55.1**
σ, ±		**0.275**	**0.117**	**0.302**
Total	**Average value**	**0.542**		
	(C_v), %	**52.7**		
	σ, ±	**0.286**		

Thus, national NOx emission factor from nitric acid production calculated within the TNC is equal to **0.542 kg NOx / t nitric acid,** instead of **0.620,** used in SNC, its uncertainty amounts to 52.7%. The high level of uncertainty is associated with a significant reduction of nitrogen oxides emissions at the enterprises JSC "Maxam-Chirchik" and JSC "Ferganaazot" for the period 2006-2012 due to reconstruction of production at these enterprises. In contrast, some increase in nitrogen oxides emissions is continued at JSC "Navoiazot".

Changes in NOx emissions using emission factors applied in the Second (0.620 kg NOx / t nitric acid) and the Third (0.542 kg NOx / t nitric acid) National Communications on the example of 2010 are given in Table – 9A7:

Table – 9A7 Change in NOx emission, Gg using different Emission factors (on the example of 2010)

Category	When used in calculation of:		Change in NOx emission, %
	EF of the SNC	EF of the TNC	
Weak nitric acid production	0.91	0.80	-12.09
"Industrial processes" sector	0.94	0.83	-11.70
NOx national emission	**252.60**	**252.49**	**-0.04**

9.4. SO_2 emission factor from Sulphuric acid production

Sulfuric acid is produced at the following enterprises of JSC "Uzkimyosanoat" – JSC "Ammofos-Maxam" and JSC "Maxam-Chirchik" (since 2006). In Samarkand chemical plant sulphuric acid was produced up to 2002, at "Caprolactam" plant – until 2006.

Data on sulphuric acid production (thous. tons) from 1990 to 2012 were provided by JSC "Uzkimyosanoat", as well as SO_2 annual emissions from sulphuric acid production for each enterprise. Not all enterprises on production of sulphuric acid belong to JSC "Uzkimyosanoat". Enterprises that do not belong to the JSC "Uzkimyosanoat" were not taken into account in calculation of the national emission factor due to lack of necessary data on annual sulfuric gas emissions. The production conditions at these plants are assumed to be the same as at the JSC "Uzkimyosanoat". The developed factor was employed for the calculation of national emissions to the whole production of sulphuric acid in Uzbekistan.

Data on sulphuric acid production in 2010 at two enterprises of the Republic are given in Table – 9A8.

Table – 9A8 Data for national emission factor calculation

Year	Sulphuric acid production, thous. t	SO_2 emissions, t	Sulphuric acid production, thous. t	SO_2 emissions, t	Sulphuric acid production, thous. t	SO_2 emissions, t	Sulphuric acid production, thous. t	SO_2 emissions, t
	JSC "Ammofos-Maxam"		Samarkand Chemical Plant		"Caprolactam" plant		JSC "Maxam-Chirchik"	
2010	268.7	205.0	**	**	**	**	147.1	74.8

** – production was stopped

Based on these data, the emission factors were calculated for each year and for each enterprise as well as average national SO_2 emission factor from sulphuric acid production.

Table – 9A9 SO_2 Emission factors (kg/t) from Sulphuric acid production

Enterprise	JSC "Ammofos-Maxam"	Samarkand Chemical Plant	"Caprolactam" plant	JSC "Maxam-Chirchik"
1990			0.764	
1991		0.791	0.616	
1992		1.095	0.703	
1993		0.301	0.608	
1994	0.942		0.633	
1995	1.748		0.528	
1996	1.571	0.450	0.304	
1997	2.417	2.457	0.349	
1998	2.234	3.410	0.588	
1999	2.579	4.267	0.298	
2000	2.155	4.425	0.485	
2001	1.937	6.768	0.735	
2002	2.727		0.651	

Enterprise		JSC "Ammofos-Maxam"	Samarkand Chemical Plant	"Caprolactam" plant	JSC "Maxam-Chirchik"
2003		2.639		0.890	
2004		1.282		0.744	
2005		3.415		0.768	
2006		1.395		0.276	0.332
2007		0.372			0.119
2008		0.195			0.276
2009		0.400			0.367
2010		0.763			0.509
2011		1.108			0.466
2012		2.340			0.685
Average value		**1.696**	**2.663**	**0.585**	**0.393**
(C_v), %		**53.7**	**83.5**	**31.8**	**46.1**
σ, ±		**0.911**	**2.224**	**0.186**	**0.181**
Total	**Average value**	**1.325**			
	(C_v), %	**99.9**			
	σ, ±	**1.324**			

Thus, national SO_2 emission factor from sulphuric acid production calculated in the TNC is equal to **1.325 kg SO_2/t of sulphuric acid**, its uncertainty is **99.9%.**

The factor calculated in the Second National Communication was 1.567 kg SO_2/t of sulphuric acid.

SO_2 emissions by the category "Sulphuric acid production" when using the factor 1.325 in comparison with the emissions when using the factor 1.567 for 2010 have been changed as follows (Table – 9A10):

Table – 9A10 Change in SO_2 emission, Gg using different Emission factors (on the example of 2010)

Category	When used in calculation of:		Change in SO_2 emission, %
	EF of the SNC	EF of the TNC	
Sulfuric acid production	1.87	1.58	-15.51
"Industrial processes" sector	3.97	3.68	-7.31
SO_2 national emission	**163.37**	**163.08**	**-0.18**

"MINERAL PRODUCTS" CATEGORY

9.5. CO_2 emission factor from clinker production

Clinker is produced in the Republic of Uzbekistan from local raw materials at the following enterprises: JSC "Kyzylkumcement", JSC "Akhangarancement", JSC "Kuvasaycement", JSC "Bekabadcement".

Volumes of clinker production in the category "Industrial processes" for 2006 - 2012 are provided by the JSC "O`zqurilishmateriallari".

Clinker consists of clinker materials and basic oxides. The share of calcium oxide and magnesium oxide in clinker at two of six cement production enterprises of Uzbekistan are given in Table – 9A11.

Table – 9A11 Share of calcium oxide and magnesium oxide in clinker at various enterprises

Enterprise	Share of components in clinker, %	
	CaO	MgO
"Akhangarancement"	65.22	2.74
"Kyzylkumcement"	62.00	3.15
Average value	**63.61**	**2.95**

Table – 9A11 shows that uncertainty of calcium oxide in clinker produced at two cement plants of Uzbekistan does not exceed 6%.

The value of national CO_2 emission factor in cement clinker production depends on calcium carbonate content in the original mineral raw materials. For the calculation, average national data on the content of calcium and magnesium oxides in the composition of clinker were used (Table – 9A11).

Assumptions:

1. The content of CaO in clinker composition is strictly limited. and MgO content is very low.
2. The plants can control CaO content widely in the utilization of raw materials and clinker.
3. The content of CaO in clinker released at a particular plant is virtually unchanged over the years.
4. The main source of CaO is $CaCO_3$.
5. 100% calcination of the original carbonate material is reached in clinker production. including material loss as cement dust, not recycled in the process.

Calculation of national CO_2 emission factor from cement clinker production was carried out in accordance with Equation 2.4, p.2.12, Chapter 2.1.2. T.2-1 of the IPCC Guidelines for National Greenhouse Gas Inventories, 2006 [7].

Based on the fact that the average CaO content of clinker produced in Uzbekistan is 63.61%.

1 tone of clinker contains 0.6361 tons of CaO from $CaCO_3$. $CaCO_3$ consists of 56.03% (wt.) CaO and 43.97% CO_2 (based on molecular weight).

The amount of $CaCO_3$ needed to produce 0.6361 tons of CaO (X) X = 0.6361 / 0.5603 = 1.1353 tons of $CaCO_3$.

The amount of CO_2 emitted during calcination of $CaCO_3$ = 1.1353*0.4397 = 0.4992 tons of CO_2. Accepting an amendment in the form of additional two percent to form cement dust (0.01 tons of CO_2), we obtain the value of the national emission factor for clinker production in Uzbekistan EF_{clc}.

EF_{clc} = 0.4992*1.00 (amendment for cement dust) = 0.5092 ~ 0.51

Table – 9A12 shows the change in CO_2 emission in the category “Clinker production” using national CO_2 emission factor **0.5092** t CO_2 / t clinker calculated in the Third National Communication, and default factor 0.5071 t CO_2 / t clinker used in the Second National Communication.

Table – 9A12 Change in CO_2 emissions, Gg using different Emission factors (on the example of 2010)

Category	When used in calculation of:		Change in CO_2 emission, %
	default factor (SNC)	national factor (TNC)	
Clinker production	2,912.02	3,086.02	+6.0
“Industrial processes” sector	6,232.74	6,058.74	+2.79
CO_2 national emission	**198,835**	**198,661**	**+0.09**

Annex 10 – Calculation of Potential HFCs Emissions

Due to incomplete data available on HFCs import in the Republic of Uzbekistan to estimate potential HFC emissions, calculation was made of the amount of HFCS imported for the period from 2000 to 2012 based on the following data and assumptions.

To calculate the potential HFCs emissions according to Tier 1, data of the State Committee for Nature Protection of the Republic of Uzbekistan on import in the country of the following compounds of hydrofluorocarbons as refrigerants: R-407c, R-404a and R-134a (Table – 10A1).

Table – 10A1 Import of fluorocarbons in the country for the period 2000-2012, t

Year	R-407c	R-404a	R-134a
2000	0.199	0.490	3.442
2001	0.199	0.490	3.442
2002	0.053	0.130	0.916
2003	0.285	0.700	4.915
2004	1.203	2.954	20.743
2005	0.382	0.937	6.581
2006	3.645	3.474	14.837
2007	1.018	0.992	4.482
2008	2.407	0.533	20.725
2009	2.239	1.536	8.378
2010	1.447	1.261	12.350
2011	4.907	7.326	33.568
2012	0.786	14.875	35.377
Total	**18.77**	**35.698**	**169.756**

Assumptions:

1. Composition of HFC compounds for each year is the same;
2. Composition of the compound is proportional to total amount of each HFC;
3. Amount of HFCs is equal for 2000 and 2001;
4. All amount of HFCs imported in a given year was consumed.

The calculation of HFCs amount for each year is given below.

It should be noted that the above given HFCs have a complex composition (Table – 10A2).

Table – 10A2 HFCs composition

HFCs	Composition	Fraction of component
R-407c	HFC-32	0.23
	HFC-125	0.25
	HFC-134a	0.52
R-404a	HFC-143a	0.44
	HFC-125	0.52
	HFC-134a	0.04
R-134a	HFC-134a	1.00

Information on the composition of each multi-component HFC were taken from the web-site of the manufacturing company AlChem, Ukraine: www.alchemi.com.

As a result of calculations and summation, the following amount of the separate HFCs were obtained for each year in tons, which are given in Table – 10A3:

Table – 10A3 Annual amount of separate HFCs, tons

Year	HFC-32	HFC-125	HFC-134a	HFC-143a	Total
2000	0.0459	0.3048	3.5650	0.2157	**4.13**
2001	0.0459	0.3048	3.5650	0.2157	**4.13**
2002	0.0122	0.0811	0.9492	0.0574	**1.10**
2003	0.0656	0.4352	5.0912	0.3080	**5.90**
2004	0.2767	1.8369	21.4866	1.2998	**24.90**
2005	0.0878	0.5828	6.8170	0.4124	**7.90**
2006	0.838	2.718	16.871	1.529	**21.956**
2007	0.234	0.770	5.051	0.436	**6.492**
2008	0.554	0.879	21.998	0.235	**23.665**
2009	0.515	1.358	9.604	0.676	**12.153**
2010	0.333	1.017	13.153	0.555	**15.058**
2011	1.129	5.036	36.413	3.223	**45.801**
2012	0.181	7.932	36.381	6.545	**51.038**

Recalculation of annual amount (tons) of the separate HFCs in CO_2-eq.:

For recalculations the following values of global warming potentials were used (FCCC / SBSTA / 1999 / L.5, p.18, Table 1), which are given in Table – 10A4:

Table – 10A4 Global Warming Potentials

HFC-32	HFC-125	HFC-134a	HFC-143a
650	2800	1300	3800

Using the global warming potentials from Table – 10A4, the following estimates of HFCs potential emissions in tonnes of CO_2-eq. have been obtained (Table – 10A5):

Table – 10A5 HFCs emissions, t CO_2-eq.

Year	HFC-32	HFC-125	HFC-134a	HFC-143a	Total
2000	29.85	853.36	4634.48	819.48	**6337.17**
2001	29.85	853.36	4634.48	819.48	**6337.17**
2002	7.95	227.22	1233.97	218.19	**1687.32**
2003	42.62	1218.70	6618.56	1170.31	**9050.19**
2004	179.89	5143.32	27932.56	4939.11	**38194.88**
2005	57.07	1631.82	8862.14	1567.03	**12118.05**
2006	544.93	7609.64	21932.77	5808.53	**35895.87**
2007	152.19	2156.95	6566.35	1658.62	**10534.12**
2008	359.85	2460.95	28597.35	891.176	**32309.32**
2009	334.73	3803.72	12484.84	2568.19	**19191.47**
2010	216.33	2848.92	17098.74	2108.39	**22272.38**
2011	733.60	14101.56	47336.48	12249.07	**74420.71**
2012	117.51	22208.2	47294.94	24871.0	**94491.64**

Annex 11 – Calculation of carbon removals by forest biomass in the category "Changes in forest and other woody biomass stocks"

(copy of worksheets of the 1996 IPCC software)

		MODULE	LAND USE CHANGE AND FORESTRY								
		SUB-MODULE	CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS								
		WORKSHEETS	5-1								
		SHEET	1 OF 4								
		COUNTRY	UZBEKISTAN								
		YEAR	2012								
STEP 1											
			A	A1	A2	A3	A4	B	C	D	E
			Area of forests or other woody biomass stocks	Average gain in damp wood	Volume shrinkage	Average gain in dry wood	Density of dry wood matter	Annual gain rate	Annual biomass gain	Fraction of carbon in dry biomass	Total carbon sequestration
			(thous.ha)	(m^3/ha)	%	(m^3/ha)	(kg/m^3)	(t d.m./ha)	(thous. t. d.m.)		(thous.t C)
						A3=A1x(100-A2)/100		B=A3xA4/1000	C=(A x B)		E=(C x D)
Temperate forests	Other										
	Mountain forests	Juniper arboreal	196.155	0.157	9.9	0.14	440	0.06	12.21	0.5	6.10
		Other arboreal species growing in mountains	44.169	1.027	13.2	0.89	545	0.49	21.46	0.5	10.73
	Valley and floodplain forests	Poplar (Asiatic poplar)	62.617	3.081	10.2	2.77	395	1.09	68.43	0.5	34.22
		Other arboreal species growing mainly in valleys and floodplains	39.895	1.587	17.1	1.32	710	0.93	37.27	0.5	18.63
	Desert forests	Saxaul	1141.476	0.814	16.2	0.68	867	0.59	675.08	0.5	337.54
	Shrubs		1343.224	2.019	14.7	1.72	510	0.88	1 179.79	0.5	589.89
Total			**2827.536**								**997.12**

MODULE	**LAND USE CHANGE AND FORESTRY**									
SUB-MODULE	**CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS**									
WORKSHEETS	**5-1**									
SHEET	**2 OF 4**									
COUNTRY	**UZBEKISTAN**									
YEAR	**2012**									
STEP 2										
Categories of harvesting	**F** Amount of wood produced (thous. m^3)	**G1** Volume shrinkage %	**G2** Amount of Absolute dry wood density (thous. m^3 d.m.)	**G3** Density of dry wood matter (t/1000 m^3)	**H** Total biomass removed from forest for commercial purposes (thous. m^3 d.m.)	**H1** Amount of wood produced (1000 m^3)	**H2** Volume shrinkage %	**H3** Total wood fuel consumption (1000 m^3 d.m.)	**H4** Density of dry wood matter (t / 1000 m^3)	**I** Total amount of the traditionally used wood (thous. m^3 d.m.)
			G2=Fx(100-G1)/100		H = (G2 x G3)			H3=H1x(100-H2)/100		I=H3xH4/ 1000
Total for										
all types of cuttings:										
Poplar	3.35	10.2	3.01	395	1.19	4.56	10.20	4.09	395.00	1.62
Saxaul		16.2		867	0.00	46.11	16.20	38.64	867.00	33.50
					0.00					
					0.00					
Total	**3.35**				**1.19**					**35.12**

MODULE	LAND USE CHANGE AND FORESTRY							
SUB-MODULE	CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS							
WORKSHEETS	5-1							
SHEET	3 OF 4							
COUNTRY	UZBEKISTAN							
YEAR	2012							
STEP 2								
Categories of harvesting	I1 Other use of wood (1000 m^3)	I2 Volume shrinkage %	I3 Other use of wood (1000 m^3 d.m.)	I4 Density of dry wood matter (t / 1000 m^3)	J Other use of wood (thous. t. d.m.)	K Total biomass consumption (thous. t. d.m.)	L Wood removed from the forest in forest clearing (thous. t. d.m.)	M Total use of biomass from the available reserves (thous. t. d.m.)
			I3=I1x(100-I2)/100		J=I3xI4/ 1000	K = (H + I + J)	(From the column M of Worksheet 5-2)	M = K - L
Total for								
all types of cuttings:								
Poplar	0.1	10.2	0.09	395	0.04	2.84		
Saxaul	0.36	16.2	0.30	867	0.26	33.76		
						0.00		
						0.00		
Total					**0.30**	**36.60**	**0.00**	**36.60**

MODULE	**LAND USE CHANGE AND FORESTRY**
SUB-MODULE	**CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS**
WORKSHEETS	**5-1**
SHEET	**4 OF 4**
COUNTRY	**UZBEKISTAN**
YEAR	**2012**

STEP 3		**STEP 4**	
N	**O**	**P**	**Q**
Share of carbon	Carbon loss per year (thous. t C)	Net carbon removal (+) or loss (-) per year (thous. t C)	Conversion to CO_2 annual emission (-) or sink (+) (Gg CO_2)
	O = (M x N)	P = (E - O)	Q = (P x [44/12])
0.5	**18.30**	**978.81**	**3 588.98**

Annex 12 – Quantitative Estimate of Uncertainties by Separate Gases and Sectors (Level 1)

Overall Inventory Uncertainty (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into total national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CO_2	55099.70	31549.60	10.00	5.00	11.18	1.77	-0.16	0.18	-0.82	249	2.62
1A1	Energy Industries	CH_4	24.20	13.00	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy Industries	N_2O	80.60	32.90	10.00	30.00	31.62	0.01	0.00	0.00	-0.01	0.00	0.01
1A2	Manufacturing Industries and Construction	CO_2	10168.00	7520.30	15.00	5.00	15.81	0.60	-0.02	0.04	-0.11	0.89	0.90
1A2	Manufacturing Industries and Construction	CH_4	17.60	14.40	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Manufacturing Industries and Construction	N_2O	13.30	5.60	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A3	Transport	CH_4	50.80	43.80	10.00	40.00	41.23	0.01	0.00	0.00	0.00	0.00	0.00
1A3	Transport	N_2O	31.90	16.40	10.00	50.00	50.99	0.00	0.00	0.00	-0.01	0.00	0.01
1A3a ii	Aviation (domestic)	CO_2	163.32	55.84	40.00	5.00	40.31	0.01	0.00	0.00	0.00	0.02	0.02
1A3b	Road transportation	CO_2	9985.86	6908.00	5.00	5.00	7.07	0.25	-0.02	0.04	-0.12	0.27	0.30
1A3c	Railways	CO_2	1754.34	433.13	5.00	5.00	7.07	0.02	-0.01	0.00	-0.04	0.02	0.05
1A3e i	Pipeline transport	CO_2	4575.34	5347.70	5.00	5.00	7.07	0.19	0.00	0.03	0.01	0.21	0.21
1A4a	Residential (combustion)	CO_2	12239.50	31917.90	15.00	5.00	15.81	2.54	0.10	0.18	0.51	3.78	3.81
1A4a	Commercial/Institutional (combustion)	CH_4	15.40	20.60	15.00	50.00	52.20	0.01	0.00	0.00	0.00	0.00	0.00
1A4a	Commercial/Institutional (combustion)	N_2O	14.90	9.00	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Commercial/Institutional (combustion)	CO_2	6840.90	10452.92	15.00	5.00	15.81	0.83	0.02	0.06	0.08	1.24	1.24
1A4b	Residential (combustion)	CH_4	241.90	80.60	15.00	50.00	52.20	0.02	0.00	0.00	-0.05	0.01	0.05
1A4b	Residential (combustion)	N_2O	22.30	19.20	10.00	40.00	41.23	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Agriculture (Combustion)	CO_2	5666.80	1386.45	15.00	5.00	15.81	0.11	-0.03	0.01	-0.14	0.16	0.21
1B1a i	Underground coal mining	CH_4	45.80	45.78	10.00	33.00	34.48	0.01	0.00	0.00	0.00	0.00	0.00
1B1a ii	Surface coal mining	CH_4	100.40	100.38	10.00	300.00	300.17	0.15	0.00	0.00	-0.02	0.01	0.02

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into total national emission trends
			Gg CO_2-eq.		%								
1B2b i	Methane emissions from natural gas production	CH_4	1511.16	2226.84	1.00	14.73	14.76	0.17	0.00	0.01	0.05	0.02	0.05
1B2b i	Methane emissions from natural gas processing at Mubarek GPP	CH_4	14461.86	18398.10	1.00	13.70	13.74	1.27	0.01	0.10	0.18	0.15	0.23
1B2b i	Methane emissions from natural gas processing at GPE Shurtanneftegaz	CH_4	0.00	1362.27	1.00	31.90	31.92	022	0.01	0.01	0.24	0.01	0.24
1B2b i	Methane emissions from natural gas processing at GCC Shurtan	CH_4	0.00	7476.00	1.00	8.20	8.26	0.31	0.04	0.04	0.34	0.06	0.35
1B2b ii	1.в.2 Methane emissions from natural gas transmission	CH_4	19422.27	29423.31	10.00	5.00	11.18	1.65	0.04	0.16	0.22	2.32	2.33
1B2b ii	Methane emissions from the distribution networks for low pressure in Non-residential sector	CH_4	7157.85	6643.77	1.00	50.00	50.01	1.67	-0.01	0.04	-0.36	0.05	0.37
1B2bii	Methane emissions from the distribution networks for low pressure in Residential sector	CH_4	579.81	2269.47	1.00	50.00	50.01	0.57	0.01	0.01	0.45	0.02	0.45
1B2bii	Fugitive emissions from oil (production)	CH_4	12.00	18.00	1.00	94.00	94.01	0.01	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (processing)	CH_4	10.00	6.00	1.00	94.00	94.01	0.00	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (storage)	CH_4	2.00	1.00	1.00	92.00	92.01	0.00	0.00	0.00	0.00	0.00	0.00
2A1	Clinker production	CO_2	2582.87	2924.08	1.00	6.00	6.08	0.09	0.00	0.02	0.00	0.02	0.02
2A2	Lime production	CO_2	353.80	176.64	2.00	2.00	2.83	0.00	0.00	0.00	0.00	0.00	0.00
2A4	Soda ash use	CO_2	70.55	25.93	10.00	100.00	100.50	0.01	0.00	0.00	-0.03	0.00	0.03
2B1	Ammonia production	CO_2	2271.70	1761.85	2.00	4.60	5.02	0.04	0.00	0.01	-0.02	0.03	0.03
2B2	Nitric acid production	N_2O	1667.80	1788.70	1.00	44.90	44.91	0.40	0.00	0.01	-0.02	0.01	0.02
2C1	Iron and steel production	CO_2	998.40	1170.24	10.00	25.00	26.93	0.16	0.00	0.01	0.01	0.09	0.09
4A	Enteric fermentation	CH_4	5830.40	11099.70	5.00	50.00	50.25	2.80	0.03	0.06	1.29	0.44	1.36
4B	Manure management	CH_4	417.40	772.80	5.00	50.00	50.25	0.20	0.00	0.00	0.09	0.03	0.09
4D1	Agricultural soils (Direct emissions from mineral fertilizers)	N_2O	3047.30	25.81	5.00	200.00	200.06	0.03	-0.02	0.00	-3.75	0.00	3.75

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into total national emission trends
			Gg CO_2-eq.		%								
4D1	Agricultural soils (Direct emissions from manure – organic fertilizers)	N_2O	1261.70	2060.54	5.00	200.00	200.06	2.07	0.00	0.01	0.74	0.08	0.74
4D1	Agricultural soils (Direct emissions from – nitrogen-fixing plants)	N_2O	1.86	10.76	5.00	200.00	200.06	0.01	0.00	0.00	0.01	0.00	0.01
4D1	Agricultural soils (Direct emissions from crop residues)	N_2O	842.53	939.93	5.00	200.00	200.06	0.95	0.00	0.01	0.01	0.04	0.04
4D2	Manure from pasture and grazing	N_2O	1536.00	2533.00	5.00	300.00	300.04	3.82	0.00	0.01	1.39	0.10	1.39
4D3	Agricultural soils (Indirect emissions – associated with atmospheric deposition)	N_2O	530.72	423.70	5.00	200.00	200.06	0.43	0.00	0.00	-0.18	0.02	0.19
4D3	Agricultural soils (Indirect emissions – associated with leaching)	N_2O	3000.80	1602.26	5.00	480.00	480.03	3.87	-0.01	0.01	-4.63	0.06	4.63
4F	Field burning of agricultural residues	N_2O	8.68	0.00	5.00	20.00	20.62	0.00	0.00	0.00	0.00	0.00	0.00
4B	Manure management	N_2O	286.70	405.10	50.00	100.00	111.80	0.23	0.00	0.00	0.05	0.16	0.17
6A	Solid waste disposal on land	CH_4	3343.30	6378.60	2.00	50.00	50.04	1.60	0.01	0.04	0.74	0.10	0.75
6B1	Industrial wastewater	CH_4	59.60	55.40	5.00	105.00	105.12	0.03	0.00	0.00	-0.01	0.00	0.01
6B2	Domestic watewater	CH_4	240.00	314.60	10.00	42.00	43.17	0.07	0.00	0.00	0.01	0.02	0.03
6B2	Domestic wastewater	N_2O	478.60	601.30	2.00	500.00	500.00	1.51	0.00	0.00	0.20	0.01	0.20
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			179140.52	198869.20				**8.1**					**8.4**

Summary of Direct Greenhouse Gas Uncertainties

Carbon Dioxide Uncertainties (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into total national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CO_2	55099.70	31549.60	10.00	5.00	11.18	3.47	-0.16	0.28	-0.80	3.96	4.04
1A2	Manufacturing Industries and Construction	CO_2	10168.00	7520.30	15.00	5.00	15.81	1.17	-0.01	0.07	-0.07	1.41	1.42
1A3a ii	Aviation (domestic)	CO_2	163.32	55.84	40.00	5.00	40.31	0.02	0.00	0.00	0.00	0.03	0.03
1A3b	Road transportation	CO_2	9985.86	6908.00	5.00	5.00	7.07	0.48	-0.02	0.06	-0.09	0.43	0.44
1A3c	Railways	CO_2	1754.34	433.13	5.00	5.00	7.07	0.03	-0.01	0.00	-0.05	0.03	0.06
1A3e i	Pipeline transport	CO_2	4575.34	5347.70	5.00	5.00	7.07	0.37	0.01	0.05	0.05	0.34	0.34
1A4a	Residential (combustion)	CO_2	12239.50	31917.90	15.00	5.00	15.81	4.97	0.19	0.28	0.93	6.00	6.07
1A4b	Commercial/Institutional (combustion)	CO_2	6840.90	10452.92	15.00	5.00	15.81	1.63	0.04	0.09	0.19	1.97	1.98
1A4c	Agriculture (combustion)	CO_2	5666.80	1386.45	15.00	5.00	15.81	0.22	-0.03	0.01	-0.16	0.26	0.31
2A1	Clinker production	CO_2	2582.87	2924.08	1.00	6.00	6.08	0.18	0.01	0.03	0.03	0.04	0.05
2A2	Lime production	CO_2	353.80	176.64	2.00	2.00	2.83	0.00	0.00	0.00	0.00	0.00	0.01
2A4	Soda ash use	CO_2	70.55	25.93	10.00	100.00	100.50	0.03	0.00	0.00	-0.03	0.00	0.03
2B1	Ammonia production	CO_2	2271.70	1761.85	2.00	4.60	5.02	0.09	0.00	0.02	-0.01	0.04	0.05
2C1	Iron and steel production	CO_2	998.40	1170.24	10.00	25.00	26.93	0.31	0.00	0.01	0.06	0.15	0.16
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			112771.08	101630.58				**6.4**					**7.7**

Methane Uncertainties (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced byactivity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CH_4	24..20	13.00	10.00	30.00	31.62	0.00	0.00	0.00	-0.01	0.00	0.02
1A2	Manufacturing Industries and Construction	CH_4	17.60	14.40	15.00	30.00	33.54	0.01	0.00	0.00	-0.01	0.01	0.01
1A3	Transport	CH_4	50.80	43.80	10.00	40.00	41.23	0.02	0.00	0.00	-0.03	0.01	0.03
1A4a	Commercial/Institutional (combustion)	CH_4	15.40	20.60	15.00	50.00	52.20	0.01	0.00	0.00	0.00	0.01	0.01
1A4b	Residential sector (combustion)	CH_4	241.90	80.60	15.00	50.00	52.20	0.05	-0.01	0.00	-0.29	0.03	0.29
1B1a i	Underground coal mining	CH_4	45.80	45.78	10.00	33.00	34.48	0.02	0.00	0.00	-0.02	0.01	0.02
1B1a ii	Surface coal mining	CH_4	100.40	100.38	10.00	300.00	300.17	0.35	0.00	0.00	-0.35	0.03	0.35
1B2b i	Methane emissions from natural gas production	CH_4	1511.16	2226.84	1.00	14.73	14.76	0.38	0.00	0.04	-0.06	0.06	0.08
1B2b i	Methane emissions from natural gas processing at Mubarek GPP	CH_4	14461.86	18398.10	1.00	13.70	13.74	2.91	-0.09	0.34	-1.29	0.49	1.37
1B2b i	Methane emissions from natural gas processing at GPE Shurtanneftegaz	CH_4	0.00	1362.27	1.00	31.90	31.92	0.50	0.03	0.03	0.81	0.04	0.81
1B2b i	Methane emissions from natural gas processing at GCC Shurtan	CH_4	0.00	7476.00	1.00	8.20	8.26	0.71	0.14	0.14	1.14	0.20	1.16
1B2b ii	1.в.2 Methane emissions from natural gas transmission	CH_4	19422.27	29423.31	10.00	5.00	11.18	3.79	-0.04	0.55	-0.19	7.77	7.77
1B2b ii	Methane emissions from the distribution networks for low pressure in Non-residential sector	CH_4	7157.85	6643.77	1.00	50.00	50.01	3.83	-0.09	0.12	-4.62	0.18	4.62
1B2bii	Methane emissions from the distribution networks for low pressure in Residential sector	CH_4	579.81	2269.47	1.00	50.00	50.01	1.31	0.02	0.04	1.24	0.06	1.24
1B2bii	Fugitive emissions from oil (production)	CH_4	12.00	18.00	1.00	94.00	94.01	0.02	0.00	0.00	0.00	0.00	0.00

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced byactivity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1B2bii	Fugitive emissions from oil (processing)	CH_4	10.00	6.00	1.00	94.00	94.01	0.01	0.00	0.00	-0.02	0.00	0.02
1B2bii	Fugitive emissions from oil (storage)	CH_4	2.00	1.00	1.00	92.00	92.01	0.00	0.00	0.00	0.00	0.00	0.00
4A	Enteric fermentation	CH_4	5830.40	11099.70	5.00	50.00	50.25	6.43	0.03	0.21	1.54	1.47	2.13
4B	Manure management	CH_4	417.40	772.80	5.00	50.00	50.25	0.45	0.00	0.01	0.09	0.10	0.14
6A	Solid waste disposal on land	CH_4	3343.30	6378.60	2.00	50.00	50.04	3.68	0.02	0.12	0.90	0.34	0.96
6B1	Industrial wastewater	CH_4	59.60	55.40	5.00	105.00	105.12	0.07	0.00	0.00	-0.08	0.01	0.08
6B2	Domestic watewater	CH_4	240.00	314.60	10.00	42.00	43.17	0.16	0.00	0.01	-0.06	0.08	0.10
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			53543.75	86764.42				**9.8**					**9.6**

Nitrous Oxide Uncertainties (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	N_2O	80.60	32.90	10.00	30.00	31.62	0.10	0.00	0.00	-0.08	0.04	0.09
1A2	Manufacturing Industries and Construction	N_2O	13.30	5.60	15.00	30.00	33.54	0.02	0.00	0.00	-0.01	0.01	0.02
1A3	Transport	N_2O	31.90	16.40	10.00	50.00	50.99	0.08	0.00	0.00	-0.04	0.02	0.04
1A4a	Commercial/Institutional (combustion)	N_2O	14.90	9.00	10.00	30.00	31.62	0.03	0.00	0.00	-0.01	0.01	0.01
1A4b	Residential sector (combustion)	N_2O	22.30	19.20	10.00	40.00	41.23	0.08	0.00	0.00	0.00	0.02	0.02
2B2	Nitric acid production	N_2O	1667.80	1788.70	1.00	44.90	44.91	7.67	0.03	0.14	1.49	0.20	1.50
4D1	Agricultural soils (Direct emissions from mineral fertilizers)	N_2O	3047.30	25.81	5.00	200.00	200.06	0.49	-0.19	0.00	-38.31	0.01	38.31
4D1	Agricultural soils (Direct emissions from manure – organic fertilizers)	N_2O	1261.70	2060.54	5.00	200.00	200.06	39.36	0.08	0.16	16.05	1.14	16.09
4D1	Agricultural soils (Direct emissions from – nitrogen-fixing plants)	N_2O	1.86	10.76	5.00	200.00	200.06	0.21	0.00	0.00	0.14	0.01	0.14
4D1	Agricultural soils (Direct emissions from crop residues)	N_2O	842.53	939.93	5.00	200.00	200.06	17.95	0.02	0.07	3.93	0.52	3.96
4D2	Manure from pasture and grazing	N_2O	1536.00	2533.00	5.00	300.00	300.04	72.56	0.10	0.20	29.87	1.40	29.90
4D3	Agricultural soils (Indirect emissions – associated with atmospheric deposition)	N_2O	530.72	423.70	5.00	200.00	200.06	8.09	0.00	0.03	-0.15	0.23	0.28
4D3	Agricultural soils (Indirect emissions – associated with leaching)	N_2O	3000.80	1602.26	5.00	480.00	480.03	7343	-0.07	0.12	-31.68	0.88	31.69
4F	Field burning of agricultural residues	N_2O	8.68	0.00	5.00	20.00	20.62	0.00	0.00	0.00	-0.01	0.00	0.01
4B	Manure management	N_2O	286.70	405.10	50.00	100.00	111.80	4.32	0.01	0.03	1.33	2.23	2.60
6B2	Domestic wastewater	N_2O	478.60	601.30	2.00	500.00	500.00	28.70	0.02	0.05	8.20	0.13	8.20
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			12825.69	10474.20				**116.2**					**61.0**

SUMMARY OF SECTORS UNCERTAINTIES (2010)

Energy Sector (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CO_2	55099.70	31549.60	10.00	5.00	11.18	2.15	-0.19	0.21	-094	2.97	3.12
1A1	Energy Industries	CH_4	24.20	13.00	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy Industries	N_2O	80.60	32.90	10.00	30.00	31.62	0.01	0.00	0.00	-0.01	0.00	0.01
1A2	Manufacturing Industries and Construction	CO_2	10168.00	7520.30	15.00	5.00	15.81	0.73	-0.02	0.05	-0.12	1.06	1.07
1A2	Manufacturing Industries and Construction	CH_4	17.60	14.40	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Manufacturing Industries and Construction	N_2O	13.30	5.60	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A3	Transport	CH_4	50.80	43.80	10.00	40.00	41.23	0.01	0.00	0.00	0.00	0.00	0.01
1A3	Transport	N_2O	31.90	16.40	10.00	50.00	50.99	0.01	0.00	0.00	-0.01	0.00	0.01
1A3a ii	Aviation (domestic)	CO_2	163.32	55.84	40.00	5.00	40.31	0.01	0.00	0.00	0.00	0.02	0.02
1A3b	Road transportation	CO_2	9985.86	6908.00	5.00	5.00	7.07	0.30	-0.03	0.05	-0.13	0.32	0.35
1A3c	Railways	CO_2	1754.34	433.13	5.00	5.00	7.07	0.02	-0.01	0.00	-0.05	0.02	0.05
1A3e i	Pipeline transport	CO_2	4575.34	5347.70	5.00	5.00	7.07	0.23	0.00	0.04	0.01	0.25	0.25
1A4a	Residential (combustion)	CO_2	12239.50	31917.90	15.00	5.00	15.81	3.08	0.12	0.21	0.62	4.50	4.55
1A4a	Commercial/Institutional (combustion)	CH_4	15.40	20.60	15.00	50.00	52.20	0.01	0.00	0.00	0.00	0.00	0.00
1A4a	Commercial/Institutional (combustion)	N_2O	14.90	9.00	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Commercial/Institutional (combustion)	CO_2	6840.90	10452.92	15.00	5.00	15.81	1.01	0.02	0.07	0.10	1.48	1.48
1A4b	Residential (combustion)	CH_4	241.90	80.60	15.00	50.00	52.20	0.03	0.00	0.00	-0.06	0.01	0.06
1A4b	Residential (combustion)	N_2O	22.30	19.20	10.00	40.00	41.23	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Agriculture (Combustion)	CO_2	5666.80	1386.45	15.00	5.00	15.81	0.13	-0.03	0.01	-0.16	0.20	0.25
1B1a i	Underground coal mining	CH_4	45.80	45.78	10.00	33.00	34.48	0.01	0.00	0.00	0.00	0.00	0.00

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1B1a ii	Surface coal mining	CH_4	100.40	100.38	10.00	300.00	300.17	0.18	0.00	0.00	-0.02	0.01	0.02
1B2b i	Methane emissions from natural gas production	CH_4	1511.16	2226.84	1.00	14.73	14.76	0.20	0.00	0.01	0.06	0.02	0.06
1B2b i	Methane emissions from natural gas processing at Mubarek GPP	CH_4	14461.86	18398.10	1.00	13.70	13.74	1.54	0.02	0.12	0.24	0.17	0.30
1B2b i	Methane emissions from natural gas processing at GPE Shurtanneftegaz	CH_4	0.00	1362.27	1.00	31.90	31.92	0.27	0.01	0.01	0.29	0.01	0.29
1B2b i	Methane emissions from natural gas processing at GCC Shurtan	CH_4	0.00	7476.00	1.00	8.20	8.26	0.38	0.05	0.05	0.41	0.07	0.41
1B2b ii	1.в.2 Methane emissions from natural gas transmission	CH_4	19422.27	29423.31	10.00	5.00	11.18	2.01	0.05	0.20	0.27	2.77	2.78
1B2b ii	Methane emissions from the distribution networks for low pressure in Non-residential sector	CH_4	7157.85	6643.77	1.00	50.00	50.01	2.03	-0.01	0.04	-0.38	0.06	0.39
1B2bii	Methane emissions from the distribution networks for low pressure in Residential sector	CH_4	579.81	2269.47	1.00	50.00	50.01	0.69	0.01	0.02	0.54	0.02	0.55
1B2bii	Fugitive emissions from oil (production)	CH_4	12.00	18.00	1.00	94.00	94.01	0.01	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (processing)	CH_4	10.00	6.00	1.00	94.00	94.01	0.00	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (storage)	CH_4	2.00	1.00	1.00	92.00	92.01	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			150309.81	163798.26				**5.2**					**6.5**

Industrial Process Sector (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
2A1	Clinker production	CO_2	2582.87	2924.08	1.00	6.00	6.08	2.27	0.05	0.37	0.28	0.52	0.59
2A2	Lime production	CO_2	353.80	176.64	2.00	2.00	2.83	0.06	-0.02	0.02	-0.04	0.06	0.08
2A4	Soda ash use	CO_2	70.55	25.93	10.00	100.00	100.50	0.33	-0.01	0.00	-0.55	0.05	0.55
2B1	Ammonia production	CO_2	2271.70	1761.85	2.00	4.60	5.02	1.13	-0.06	0.22	-0.28	0.63	0.69
2B2	Nitric acid production	N_2O	1667.80	1788.70	1.00	44.90	44.91	10.24	0.02	0.23	0.80	0.32	0.86
2C1	Iron and steel production	CO_2	998.40	1170.24	10.00	25.00	26.93	4.02	0.02	0.15	0.58	2.08	2.16
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			7945.12	7847.44				**11.3**					**2.6**

Agriculture Sector (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
4A	Enteric fermentation	CH_4	5830.40	11099.70	5.00	50.00	50.25	28.07	0.25	0.66	12.45	4.68	13.30
4B	Manure management	CH_4	417.40	772.80	5.00	50.00	50.25	1.95	0.02	0.05	0.83	0.33	0.89
4D1	Agricultural soils (Direct emissions from mineral fertilizers)	N_2O	3047.30	25.81	5.00	200.00	200.06	0.26	-0.21	0.00	-42.71	0.01	42.71
4D1	Agricultural soils (Direct emissions from manure – organic fertilizers)	N_2O	1261.70	2060.54	5.00	200.00	200.06	20.74	0.03	0.12	6.73	0.87	6.79
4D1	Agricultural soils (Direct emissions from – nitrogen-fixing plants)	N_2O	1.86	10.76	5.00	200.00	200.06	0.11	0.00	0.00	0.10	0.00	0.10
4D1	Agricultural soils (Direct emissions from crop residues)	N_2O	842.53	939.93	5.00	200.00	200.06	9.46	0.00	0.06	-0.70	0.40	0.81
4D2	Manure from pasture and grazing	N_2O	1536.00	2533.00	5.00	300.00	300.04	38.24	0.04	0.15	12.73	1.07	12.78
4D3	Agricultural soils (Indirect emissions – associated with atmospheric deposition)	N_2O	530.72	423.70	5.00	200.00	200.06	4.27	-0.01	0.03	-2.45	0.18	2.46
4D3	Agricultural soils (Indirect emissions – associated with leaching)	N_2O	3000.80	1602.26	5.00	480.00	480.03	38.70	-0.12	0.10	-55.88	0.68	55.89
4F	Field burning of agricultural residues	N_2O	8.68	0.00	5.00	20.00	20.62	0.00	0.00	0.00	-0.01	0.00	0.01
4B	Manure management	N_2O	286.70	405.10	50.00	100.00	111.80	2.28	0.00	0.02	0.39	1.71	1.75
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			16764.09	19873.60				**65.5**					**73.1**

Waste Sector (2010)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2010)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2010)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq		%								
6A	Solid waste disposal on land	CH_4	3343.30	6378.60	2.00	50.00	50.04	43.43	0.10	1.55	5.01	4.38	6.65
6B1	Industrial wastewater	CH_4	59.60	55.40	5.00	105.00	105.12	0.79	-0.01	0.01	-1.30	0.10	1.30
6B2	Domestic watewater	CH_4	240.00	314.60	10.00	42.00	43.17	1.85	-0.03	0.08	-1.15	1.08	1.58
6B2	Domestic wastewater	N_2O	478.60	601.30	2.00	500.00	500.00	40.91	-0.06	0.15	-30.56	0.41	30.56
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			4121.50	7349.90				**59.7**					**31.3**

Overall Inventory Uncertainty (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CO_2	55099.70	33938.00	10.00	5.00	11.18	1.85	-0.16	0.19	-0.81	2.68	2.80
1A1	Energy Industries	CH_4	24.20	13.90	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy Industries	N_2O	80.60	38.13	10.00	30.00	31.62	0.01	0.00	0.00	-0.01	0.00	0.01
1A2	Manufacturing Industries and Construction	CO_2	10168.00	8018.00	15.00	5.00	15.81	0.62	-0.02	0.04	-0.10	0.95	0.95
1A2	Manufacturing Industries and Construction	CH_4	17.60	15.50	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Manufacturing Industries and Construction	N_2O	13.30	5.90	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A3	Transport	CH_4	50.80	65.80	10.00	40.00	41.23	0.01	0.00	0.00	0.00	0.01	0.01
1A3	Transport	N_2O	24.80	24.80	0.00	50.00	50.00	0.01	0.00	0.00	0.00	0.00	0.00
1A3a ii	Aviation (domestic)	CO_2	163.32	41.30	40.00	5.00	40.31	0.01	0.00	0.00	0.00	0.01	0.01
1A3b	Road transportation	CO_2	9985.86	7789.75	15.00	5.00	15.81	0.60	-0.02	0.04	-0.10	0.92	0.93
1A3c	Railways	CO_2	1754.34	430.02	10.00	5.00	11.18	0.02	-0.01	0.00	-0.04	0.03	0.06
1A3e i	Pipeline transport	CO_2	4575.34	4095.23	1.00	5.00	5.10	0.10	-0.01	0.02	-0.03	0.03	0.05
1A4a	Residential (combustion)	CO_2	12239.50	23856.198	15.00	5.00	15.81	1.84	0.06	0.13	0.28	2.83	2.84
1A4a	Commercial/Institutional (combustion)	CH_4	15.40	38.30	10.00	30.00	31.62	0.01	0.00	0.00	0.00	0.00	0.00
1A4a	Commercial/Institutional (combustion)	N_2O	14.90	14.26	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Commercial/Institutional (combustion)	CO_2	6840.90	19919.48	15.00	5.00	15.81	1.54	0.07	0.11	0.34	2.36	2.38
1A4b	Residential (combustion)	CH_4	241.90	88.00	10.00	30.00	31.62	0.01	0.00	0.00	-0.03	0.01	0.03
1A4b	Residential (combustion)	N_2O	22.30	16.43	10.00	40.00	41.23	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Agriculture (Combustion)	CO_2	5666.80	1304.15	15.00	5.00	15.81	0.10	-0.03	0.01	-0.14	0.15	0.21
1B1a i	Underground coal mining	CH_4	45.80	10.92	10.00	33.00	34.48	0.00	0.00	0.00	-0.01	0.00	0.01
1B1a ii	Surface coal mining	CH_4	100.40	109.62	10.00	300.00	300.17	0.16	0.00	0.00	-0.01	0.01	0.01

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1B2b i	Methane emissions from natural gas production	CH_4	1511.16	2284.59	1.00	14.73	14.76	0.16	0.00	0.01	0.05	0.02	0.05
1B2b i	Methane emissions from natural gas processing at Mubarek GPP	CH_4	14461.86	18687.27	1.00	13.70	13.74	1.25	0.01	0.10	0.16	0.15	0.22
1B2b i	Methane emissions from natural gas processing at GPE Shurtanneftegaz	CH_4	0.00	1208.34	1.00	31.90	31.92	0.19	0.01	0.01	0.22	0.01	0.22
1B2b i	Methane emissions from natural gas processing at GCC Shurtan	CH_4	0.00	7337.19	1.00	8.20	8.26	0.30	0.04	0.04	0.34	0.06	0.34
1B2b ii	1.в.2 Methane emissions from natural gas transmission	CH_4	19422.27	29040.06	10.00	5.00	11.18	1.59	0.04	0.16	0.19	2.29	2.30
1B2b ii	Methane emissions from the distribution networks for low pressure in Non-residential sector	CH_4	7157.85	7307.58	1.00	50.00	50.01	1.78	0.00	0.04	-0.24	0.06	0.25
1B2bii	Methane emissions from the distribution networks for low pressure in Residential sector	CH_4	579.81	2105.67	1.00	50.00	50.01	0.51	0.01	0.01	0.40	0.02	0.40
1B2bii	Fugitive emissions from oil (production)	CH_4	12.00	16.80	1.00	94.00	94.01	0.01	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (processing)	CH_4	10.00	5.67	1.00	94.00	94.01	0.00	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (storage)	CH_4	2.00	1.05	1.00	92.00	92.01	0.00	0.00	0.00	0.00	0.00	0.00
2A1	Clinker production	CO_2	2582.87	2791.03	1.00	6.00	6.08	0.08	0.00	0.02	-0.01	0.02	0.02
2A2	Lime production	CO_2	353.80	140.86	2.00	2.00	2.83	0.00	0.00	0.00	0.00	0.00	0.00
2A4	Soda ash use	CO_2	70.55	33.16	10.00	100.00	100.50	0.02	0.00	0.00	-0.03	0.00	0.03
2B1	Ammonia production	CO_2	2271.70	1783.35	2.00	4.60	5.02	0.04	0.00	0.01	-0.02	0.03	0.04
2B2	Nitric acid production	N_2O	1667.80	1782.50	1.00	44.90	44.91	0.39	0.00	0.01	-0.03	0.01	0.03
2C1	Iron and steel production	CO_2	998.40	1199.94	10.00	25.00	26.93	0.16	0.00	0.01	0.01	0.09	0.10
4A	Enteric fermentation	CH_4	5830.40	12041.63	5.00	50.00	50.25	2.95	0.03	0.07	1.50	0.48	1.57
4B	Manure management	CH_4	417.40	820.93	5.00	50.00	50.25	0.20	0.00	0.00	0.10	0.03	0.10
4B	Agricultural soils (Direct emissions from mineral fertilizers)	N_2O	286.70	450.40	50.00	100.00	111.80	0.25	0.00	0.00	0.07	0.18	0.19

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
4D1	Agricultural soils (Direct emissions from manure – organic fertilizers)	N_2O	3047.30	37.20	5.00	200.00	200.06	0.04	-0.02	0.00	-3.85	0.00	3.85
4D1	Agricultural soils (Direct emissions from – nitrogen-fixing plants)	N_2O	1261.70	2241.30	5.00	200.00	200.06	2.19	0.00	0.01	0.89	0.09	0.90
4D1	Agricultural soils (Direct emissions from crop residues)	N_2O	1.86	12.40	5.00	200.00	200.06	0.01	0.00	0.00	0.01	0.00	0.01
4D1	Manure from pasture and grazing	N_2O	842.53	995.10	5.00	200.00	200.06	0.97	0.00	0.01	0.04	0.04	0.05
4D2	Agricultural soils (Indirect emissions – associated with atmospheric deposition)	N_2O	1536.00	2752.00	5.00	300.00	300.04	4.03	0.01	0.02	1.67	0.11	1.67
4D3	Agricultural soils (Indirect emissions – associated with leaching)	N_2O	530.72	461.90	5.00	200.00	200.06	0.45	0.00	0.00	-0.16	0.02	0.16
4D3	Field burning of agricultural residues	N_2O	3000.80	1748.40	5.00	480.00	480.03	4.10	-0.01	0.01	-4.51	0.07	4.51
4F	Energy Industries	N_2O	8.68	0.00	5.00	20.00	20.62	0.00	0.00	0.00	0.00	0.00	0.00
6A	Solid waste disposal on land	CH_4	3343.30	6649.80	2.00	50.00	50.04	1.62	0.02	0.04	0.79	0.10	0.80
6B1	Industrial wastewater	CH_4	59.60	61.10	5.00	105.00	105.12	0.03	0.00	0.00	0.00	0.00	0.00
6B2	Domestic watewater	CH_4	240.00	322.40	10.00	42.00	43.17	0.07	0.00	0.00	0.01	0.03	0.03
6B2	Domestic wastewater	N_2O	478.60	626.20	2.00	500.00	50000	1.53	0.00	0.00	0.22	0.01	0.22
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			179133.42	204779.51				**8.4**					**8.4**

Summary of Direct Greenhouse Gas Uncertainties

Carbon Dioxide Uncertainties (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CO_2	55099.70	33938.00	10.00	5.00	11.18	3.60	-0.15	0.30	-0.77	4.26	4.33
1A2	Manufacturing Industries and Construction	CO_2	10168.00	8018.00	15.00	5.00	15.81	1.20	-0.01	0.07	-0.07	1.51	1.51
1A3a ii	Aviation (domestic)	CO_2	163.32	41.30	40.00	5.00	40.31	0.02	0.00	0.00	0.00	0.02	0.02
1A3b	Road transportation	CO_2	9985.86	7789.75	15.00	5.00	15.81	1.17	-0.01	0.07	-0.07	1.47	1.47
1A3c	Railways	CO_2	1754.34	430.02	10.00	5.00	11.18	0.05	-0.01	0.00	-0.05	0.05	0.08
1A3e i	Pipeline transport	CO_2	4575.34	4095.23	1.00	5.00	5.10	020	0.00	0.04	-0.01	0.05	0.05
1A4a	Residential sector (combustion)	CO_2	12239.50	23856.198	15.00	5.00	15.81	3.58	0.11	0.21	0.55	4.49	4.52
1A4b	Commercial/Industrial sector (combustion)	CO_2	6840.90	19919.48	15.00	5.00	15.81	2.99	0.12	0.18	0.60	3.75	3.79
1A4c	Agriculture (combustion)	CO_2	5666.80	1304.15	15.00	5.00	15.81	0.20	-0.04	0.01	-0.18	0.25	0.30
2A1	Clinker production	CO_2	2582.87	2791.03	1.00	6.00	6.08	0.16	0.00	0.02	0.02	0.04	0.04
2A2	Lime production	CO_2	353.80	140.86	2.00	2.00	2.83	0.00	0.00	0.00	0.00	0.00	0.00
2A4	Soda ash use	CO_2	70.55	33.16	10.00	100.00	100.50	0.03	0.00	0.00	-0.03	0.00	0.03
2B1	Ammonia production	CO_2	2271.70	1783.35	2.00	4.60	5.02	0.08	0.00	0.02	-0.01	0.04	0.05
2C1	Iron and steel production	CO_2	998.40	1199.94	10.00	25.00	26.93	0.31	0.00	0.01	0.06	0.15	0.16
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			112771.08	105340.47				**6.1**					**7.6**

Methane Uncertainties (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CH_4	24.20	13.90	10.00	30.00	31.62	0.00	0.00	0.00	-0.01	0.00	0.02
1A2	Manufacturing Industries and Construction	CH_4	17.60	15.50	15.00	30.00	33.54	0.01	0.00	0.00	-0.01	0.01	0.01
1A3	Transport	CH_4	50.80	65.80	10.00	40.00	41.23	0.03	0.00	0.00	-0.01	0.02	0.02
1A4a	Commercial/Institutional (combustion)	CH_4	15.40	38.30	10.00	30.00	31.62	0.01	0.00	0.00	0.01	0.01	0.01
1A4b	Residential sector (combustion)	CH_4	241.90	88.00	10.00	30.00	31.62	0.03	-0.01	0.00	-0.17	0.02	0.18
1B1a i	Underground coal mining	CH_4	45.80	10.92	10.00	33.00	34.48	0.00	0.00	0.00	-0.04	0.00	0.04
1B1a ii	Surface coal mining	CH_4	100.40	109.62	10.00	300.00	300.17	0.37	0.00	0.00	-0.31	0.03	0.31
1B2b i	Methane emissions from natural gas production	CH_4	1511.16	2284.59	1.00	14.73	14.76	0.38	0.00	0.04	-0.06	0.06	0.08
1B2b i	Methane emissions from natural gas processing at Mubarek GPP	CH_4	14461.86	18687.27	1.00	13.70	13.74	2.91	-0.10	0.35	-1.31	0.49	1.40
1B2b i	Methane emissions from natural gas processing at GPE Shurtanneftegaz	CH_4	0.00	1208.34	1.00	31.90	31.92	0.44	0.02	0.02	0.72	0.03	0.72
1B2b i	Methane emissions from natural gas processing at GCC Shurtan	CH_4	0.00	7337.19	1.00	8.20	8.26	0.69	0.14	0.14	1.12	0.19	1.14
1B2b ii	1.в.2 Methane emissions from natural gas transmission	CH_4	19422.27	29040.06	10.00	5.00	11.18	3.68	-0.06	0.54	-0.28	7.67	7.68
1B2b ii	Methane emissions from the distribution networks for low pressure in Non-residential sector	CH_4	7157.85	7307.58	1.00	50.00	50.01	4.14	-0.08	0.14	-4.18	0.19	4.19
1B2bii	Methane emissions from the distribution networks for low pressure in Residential sector	CH_4	579.81	2105.67	1.00	50.00	50.01	1.19	0.02	0.04	1.07	0.06	1.08
1B2bii	Fugitive emissions from oil (production)	CH_4	12.00	16.80	1.00	94.00	94.01	0.02	0.00	0.00	-0.01	0.00	0.01
1B2bii	Fugitive emissions from oil (processing)	CH_4	10.00	5.67	1.00	94.00	94.01	0.01	0.00	0.00	-0.02	0.00	0.02
1B2bii	Fugitive emissions from oil (storage)	CH_4	2.00	1.05	1.00	92.00	92.01	0.00	0.00	0.00	0.00	0.00	0.00

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
4A	Enteric fermentation	CH_4	5830.40	12041.63	5.00	50.00	50.25	6.86	0.05	0.22	2.27	1.59	2.77
4B	Manure management	CH_4	417.40	820.93	5.00	50.00	50.25	0.47	0.00	0.02	0.12	0.11	0.16
6A	Solid waste disposal on land	CH_4	3343.30	6649.80	2.00	50.00	50.04	3.77	0.02	0.12	1.06	0.35	1.12
6B1	Industrial wastewater	CH_4	59.60	61.10	5.00	105.00	105.12	0.07	0.00	0.00	-0.07	0.01	0.07
6B2	Domestic watewater	CH_4	240.00	322.40	10.00	42.00	43.17	0.16	0.00	0.01	-0.06	0.09	0.10
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			53543.75	88232.12				**10.2**					**9.5**

Nitrous Oxide Uncertainties (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	N_2O	80.60	38.13	10.00	30.00	31.62	0.11	0.00	0.00	-0.08	0.04	0.09
1A2	Manufacturing Industries and Construction	N_2O	13.30	5.90	15.00	30.00	33.54	0.02	0.00	0.00	-0.01	0.01	0.02
1A3	Transport	N_2O	24.80	15.80	0.00	50.00	50.00	0.07	0.00	0.00	-0.02	0.00	0.02
1A4a	Commercial/Institutional (combustion)	N_2O	14.90	14.26	10.00	30.00	31.62	0.04	0.00	0.00	0.00	0.02	0.02
1A4b	Residential sector (combustion)	N_2O	22.30	16.43	10.00	40.00	41.23	0.06	0.00	0.00	-0.01	0.02	0.02
2B2	Nitric acid production	N_2O	1667.80	1782.50	1.00	44.90	44.91	7.15	0.03	0.14	1.14	0.20	1.16
4B	Manure management	N_2O	286.70	450.40	50.00	100.00	111.80	4.50	0.02	0.04	1.56	2.48	2.93
4D1	Agricultural soils (Direct emissions from mineral fertilizers)	N_2O	3047.30	37.20	5.00	200.00	200.06	0.66	-0.20	0.00	-40.86	0.02	40.86
4D1	Agricultural soils (Direct emissions from manure – organic fertilizers)	N_2O	1261.70	2241.30	5.00	200.00	200.06	40.04	0.09	0.17	17.76	1.24	17.80
4D1	Agricultural soils (Direct emissions from – nitrogen-fixing plants)	N_2O	1.86	12.40	5.00	200.00	200.06	0.22	0.00	0.00	0.17	0.01	0.17
4D1	Agricultural soils (Direct emissions from crop residues)	N_2O	842.53	995.10	5.00	200.00	200.06	17.78	0.02	0.08	4.04	0.55	4.08
4D2	Manure from pasture and grazing	N_2O	1536.00	2752.00	5.00	300.00	300.04	73.74	0.11	0.21	32.96	1.52	33.00
4D3	Agricultural soils (Indirect emissions – associated with atmospheric deposition)	N_2O	530.72	461.90	5.00	200.00	200.06	8.25	0.00	0.04	-0.03	0.25	0.26
4D3	Agricultural soils (Indirect emissions – associated with leaching)	N_2O	3000.80	1748.40	5.00	480.00	480.03	74.95	-0.07	0.14	-32.61	0.96	32.63
4F	Field burning of agricultural residues	N_2O	8.68	0.00	5.00	20.00	20.62	0.00	0.00	0.00	-0.01	0.00	0.01
6B2	Domestic wastewater	N_2O	478.60	626.20	2.00	500.00	500.00	27.96	0.02	0.05	8.11	0.14	8.12
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			12818.59	11197.92				**117.9**					**65.1**

Summary of Sectors Uncertainties (2012)

Energy Sector (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1A1	Energy Industries	CO_2	55099.70	33938.00	10.00	5.00	11.18	2.26	-0.18	0.23	-0.91	3.19	3.32
1A1	Energy Industries	CH_4	24.20	13.90	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy Industries	N_2O	80.60	38.13	10.00	30.00	31.62	0.01	0.00	0.00	-0.01	0.00	0.01
1A2	Manufacturing Industries and Construction	CO_2	10168.00	8018.00	15.00	5.00	15.81	0.76	-0.02	0.05	-0.11	1.13	1.14
1A2	Manufacturing Industries and Construction	CH_4	17.60	15.50	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Manufacturing Industries and Construction	N_2O	13.30	5.90	15.00	30.00	33.54	0.00	0.00	0.00	0.00	0.00	0.00
1A3	Transport	CH_4	50.80	65.80	10.00	40.00	41.23	0.02	0.00	0.00	0.00	0.01	0.01
1A3	Transport	N_2O	24.80	15.80	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3a ii	Aviation (domestic)	CO_2	163.32	41.30	40.00	5.00	40.31	0.01	0.00	0.00	0.00	0.02	0.02
1A3b	Road transportation	CO_2	9985.86	7789.75	15.00	5.00	15.81	0.73	-0.02	0.05	-0.11	1.10	1.11
1A3c	Railways	CO_2	1754.34	430.02	10.00	5.00	11.18	0.03	-0.01	0.00	-0.05	0.04	0.06
1A3e i	Pipeline transport	CO_2	4575.34	4095.23	1.00	5.00	5.10	0.12	-0.01	0.03	-0.03	0.04	0.05
1A4a	Residential (combustion)	CO_2	12239.50	23856.198	15.00	5.00	15.81	2.25	0.07	0.16	0.34	3.37	3.38
1A4a	Commercial/Institutional (combustion)	CH_4	15.40	38.30	10.00	30.00	31.62	0.01	0.00	0.00	0.00	0.00	0.01
1A4a	Commercial/Institutional (combustion)	N2O	14.90	14.26	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Commercial/Institutional (combustion)	CO_2	6840.90	19919.48	15.00	5.00	15.81	1.88	0.08	0.13	0.41	2.81	2.84
1A4b	Residential (combustion)	CH_4	241.90	88.00	10.00	30.00	31.62	0.02	0.00	0.00	-0.04	0.01	0.04
1A4b	Residential (combustion)	N_2O	22.30	16.43	10.00	40.00	41.23	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Agriculture (Combustion)	CO_2	5666.80	1304.15	15.00	5.00	15.81	0.12	-0.03	0.01	-0.17	0.18	0.25
1B1a i	Underground coal mining	CH_4	45.80	10.92	10.00	33.00	34.48	0.00	0.00	0.00	-0.01	0.00	0.01

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
1B1a ii	Surface coal mining	CH_4	100.40	109.62	10.00	300.00	300.17	0.20	0.00	0.00	0.00	0.01	0.01
1B2b i	Methane emissions from natural gas production	CH_4	1511.16	2284.59	1.00	14.73	14.76	0.20	0.00	0.02	0.06	0.02	0.06
1B2b i	Methane emissions from natural gas processing at Mubarek GPP	CH_4	14461.86	18687.27	1.00	13.70	13.74	1.53	0.02	0.12	0.23	0.18	0.29
1B2b i	Methane emissions from natural gas processing at GPE Shurtanneftegaz	CH_4	0.00	1208.34	1.00	31.90	31.92	0.23	0.01	0.01	0.26	0.01	0.26
1B2b i	Methane emissions from natural gas processing at GCC Shurtan	CH_4	0.00	7337.19	1.00	8.20	8.26	0.36	0.05	0.05	0.40	0.07	0.41
1B2b ii	1.в.2 Methane emissions from natural gas transmission	CH_4	19422.27	29040.06	10.00	5.00	11.18	1.93	0.05	0.19	0.24	2.73	2.74
1B2b ii	Methane emissions from the distribution networks for low pressure in Non-residential sector	CH_4	7157.85	7307.58	1.00	50.00	50.01	2.18	0.00	0.05	-0.23	0.07	0.24
1B2bii	Methane emissions from the distribution networks for low pressure in Residential sector	CH_4	579.81	2105.67	1.00	50.00	50.01	0.63	0.01	0.01	0.49	0.02	0.49
1B2bii	Fugitive emissions from oil (production)	CH_4	12.00	16.80	1.00	94.00	94.01	0.01	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (processing)	CH_4	10.00	5.67	1.00	94.00	94.01	0.00	0.00	0.00	0.00	0.00	0.00
1B2bii	Fugitive emissions from oil (storage)	CH_4	2.00	1.05	1.00	92.00	92.01	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			150302.71	167818.91				**5.1**					**6.4**

Industrial Process Sector (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
2A1	Clinker production	CO_2	2582.87	2791.03	1.00	6.00	6.08	2.20	0.03	0.35	0.21	0.50	0.54
2A2	Lime production	CO_2	353.80	140.86	2.00	2.00	2.83	0.05	-0.03	0.02	-0.05	0.05	0.07
2A4	Soda ash use	CO_2	70.55	33.16	10.00	100.00	100.50	0.43	0.00	0.00	-0.45	0.06	0.45
2B1	Ammonia production	CO_2	2271.70	1783.35	2.00	4.60	5.02	1.16	-0.05	0.22	-0.25	0.63	0.68
2B2	Nitric acid production	N_2O	1667.80	1782.50	1.00	44.90	44.91	10.36	0.02	0.22	0.90	0.32	0.95
2C1	Iron and steel production	CO_2	998.40	1199.94	10.00	25.00	26.93	4.18	0.03	0.15	0.72	2.14	2.25
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			7945.12	7730.84				**11.4**					**2.6**

Agriculture Sector (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
4A	Enteric fermentation	CH_4	5830.40	12041.63	5.00	50.00	50.25	28.06	0.27	0.72	13.50	5.08	14.42
4B	Manure management	CH_4	417.40	820.93	5.00	5000	50.25	1.91	0.02	0.05	0.85	0.35	0.91
4B	Manure management	N_2O	286.70	450.40	50.00	100.00	111.80	2.34	0.00	0.03	0.49	1.90	1.96
4D1	Agricultural soils (Direct emissions from mineral fertilizers)	N_2O	3047.30	37.20	5.00	200.00	200.06	0.35	-0.23	0.00	-46.28	0.02	46.28
4D1	Agricultural soils (Direct emissions from manure – organic fertilizers)	N_2O	1261.70	2241.30	5.00	200.00	200.06	20.80	0.04	0.13	7.37	0.95	7.43
4D1	Agricultural soils (Direct emissions from – nitrogen-fixing plants)	N_2O	1.86	12.40	5.00	200.00	200.06	0.12	0.00	0.00	0.12	0.01	0.12
4D1	Agricultural soils (Direct emissions from crop residues)	N_2O	842.53	995.10	5.00	200.00	200.06	9.23	-0.01	0.06	-1.06	0.42	1.14
4D2	Manure from pasture and grazing	N_2O	1536.00	2752.00	5.00	300.00	300.04	38.30	0.05	0.16	13.87	1.16	13.92
4D3	Agricultural soils (Indirect emissions – associated with atmospheric deposition)	N_2O	530.72	461.90	5.00	200.00	200.06	4.29	-0.01	0.03	-2.64	0.19	2.64
4D3	Agricultural soils (Indirect emissions – associated with leaching)	N_2O	3000.80	1748.40	5.00	480.00	480.03	38.93	-0.13	0.10	-60.43	0.74	60.43
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			16755.41	21561.26				**65.7**					**79.1**

Waste Sector (2012)

Category code	IPCC Source Category	Gas	Base year emissions	Year t emissions (2012)	Activity data uncertainty	Emission factors uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t (2012)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in national emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced in trend in national emission trends
			Gg CO_2-eq.		%								
6A	Solid waste disposal on land	CH_4	3343.30	6649.80	2.00	50.00	50.04	43.44	0.11	1.61	5.25	4.56	6.96
6B1	Industrial wastewater	CH_4	59.60	61.10	5.00	105.00	105.12	0.84	-0.01	0.01	-1.27	0.10	1.27
6B2	Domestic watewater	CH_4	240.00	322.40	10.00	42.00	43.17	1.82	-0.03	0.08	-1.26	1.11	1.68
6B2	Domestic wastewater	N_2O	478.60	626.20	2.00	500.00	500.00	40.88	-0.06	0.15	-31.90	0.43	31.90
	TOTAL:		$\sum C$	$\sum D$				$\sqrt{\sum H^2}$					$\sqrt{\sum M^2}$
			4121.50	7659.50				**59.7**					**32.7**