Mongolia's National Inventory Report – 2017

Annex to Initial Biennial Update Report to UNFCCC

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LIST OF ABBREVIATIONS AND UNITS

ABBREVIATIONS

AAGR	Average annual growth rate
AD	Activity data
AFOLU	Agriculture, forestry and other land use
AGB	Above-ground biomass
ALAGAC	Administration of Land Affairs, Geodesy and Cartography
BAU	Business as usual
BCEF	Below-ground carbon and expansion factor
BGB	Below-ground biomass
BOD	Biochemical oxygen demand
BUR	Biennial update report
CCAC	Climate and Clean Air Coalition
CCICD	Climate Change International Cooperation Department
CCPIU	Climate Change Project Implementing Unit
CHP	Combined heat and power plant
COD	Chemical oxygen demand
COP	Conference of the parties
CRF	Common reporting format
CS	Country specific
DOC	Degradable organic carbon
EAF	Electric arc furnace
ECF	Environment and Climate Fund
EF	Emission factor
ERC	Energy Regulatory Center
ERT	Expert review team
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO statistics
FOD	First order decay
FRDC	Forest Research and Development Center
GEF	Global Environmental Facility
GHG	Greenhouse gas
GWP	Global warming potential
HFCs	Hydrofluorocarbons
HOB	Heat only boiler
HWP	Harvested wood products
iBUR	Initial Biennial update report
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
KP	Kyoto Protocol to the UNFCCC
LTO	Landing and take-off
LUC	Land use change

LULUCF	Land use, land use change and forestry
MCAA	Mongolian Civil Aviation Authority
MCF	Methane correction factor
MEGD	Ministry of Environment and Green Development
MET	Ministry of Environment and Tourism of Mongolia
MIAT	Mongolian Airlines
MMHI	Ministry of Mining and Heavy Industry of Mongolia
MOE	Ministry of Energy
MOFALI	Ministry of Food, Agriculture and Light Industry of Mongolia
MOI	Ministry of Industry
MRPAM	Mineral Resources and Petroleum Authority of Mongolia
MRTD	Ministry of Road and Transport Development
MRV	Measuring, reporting and verification system
MSW	Municipal solid waste
NAMAs	National Appropriate Mitigation Actions
NCs	National communications
NCV	Net calorific value
NFI	National forest inventory of Mongolia
NFP	National focal point to the UNFCCC
NIR	National inventory report
NOA	National Ozone Authority of Mongolia
NSO	National Statistics Office of Mongolia
ODS	Ozone depleting substances
PA	Paris Agreement
PFCs	Perfluorocarbons
QA/QC	Quality assurance and quality control
RA	Reference approach of energy sector
SA	Sectorial approach of energy sector
SAR	Second assessment report of IPCC
SNC	Second National Communication of Mongolia
SWDS	Solid waste disposal sites
TAM	Typical animal mass
TNC	Third National Communication of Mongolia
TOW	Total organically degradable material in wastewater
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Conference on Climate Change
WB	World Bank

UNITS

cap	capita
CO_2e	carbon dioxide equivalents
d.m.	dry matter
g	gram
Gg	Gigagram
ha	hectare

kg	kilogram
l	liter
m^3	cubic meter
Mt	million tons
MW	Megawatt
MWh	Megawatt hours
t	tons
thous.heads	thousand heads
TJ	Terajoules
yr	year

TABLE OF REFERENCE

AdvocatesLLP GTs Overview: Energy regulatory framework for Mongolia [Online] // www.gtsadvocates.mn. - Dec. 19, 2016. - Dec. 2, 2016. - http://gtsadvocates.mn/overview-energy-regulatory-framework-for-mongolia/.

ERC Energy Regulatory Commission of Mongolia Energy Statistics 2014 [Report]. - Ulaanbaatar : [s.n.], 2014.

ERC Energy Regulatory Commission of Mongolia Energy Statistics 2016 [Report]. - Ulaanbaatar : [s.n.], 2016.

ICAO International Civil Aviation Organization Working paper: Overview of civil aviation sector in Mongolia. - September 12, 2013.

IPCC Task Force on National Greenhouse Gas Inventories (TFI) of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol.2 Energy [Report]. - Hayama, Japan : Institute for Global Environmental Strategies (IGES), 2006.

MIAT Mongolian Airlines : History [Online] // www.miat.com. - 2017. - January 16, 2017. - http://www.miat.com/pagecontent.php?lang=en&pageId=73.

MRPAM Mineral recources and petroleum authority of Mongolia Petroleum exploitation and production [Online] // www.mrpam.gov.mn. - 2017. - June 21, 2017. - https://mrpam.gov.mn/article/49/.

Namkhainyam B. Studies in country specific GHG emission and removal factors for Mongolia [Report]. - Ulaanbaatar : Ministry of Environment and Green Development, 2014.

RCC UNFCC Regional Collaboration Centre Mongolia Grid emission factor calculation sheet (Excel file) [Report]. - Ulaanbaatar : [s.n.], 2016.

IPCC (2013) Revised Supplementary Methods and Good Practice Guidance Arising from the KyotProtocol. Hayama, Japan: Institute for Global Environmental Strategies.

Mongolian statistical website: www.1212.mn

Mongolian Statistical Yearbooks of Agriculture 1990-2014 - Ministry of food, agriculture and light industry (MOFALI)

Mongolian Report on Land Administration of Land Affairs, Geodesy and Cartography (ALAGAC)

Report of Landscaping and waste management division of the Ulaanbaatar Mayor's office, 2014

БНбП 40-01-06, Water supply, outdoor sewerage network and facilities, Order no. 27/17.03.2006 of the Minister of Construction and Urban Development, 2006.

What a waste, World Bank, 1999.

NATIONAL INVENTORY MANAGEMENT TEAM

Role	*Name*
Inventory Compiler	Tegshjargal Bumtsend
	Sanaa Enkhtaivan
	Gerelmaa Shaariibuu
Energy Sector Lead	Tegshjargal Bumtsend
Industrial Sector Lead	Tegshjargal Bumtsend
Agriculture Sector Lead	Sanaa Enkhtaivan
Land Use, Land Use Change and Forestry Sector Lead	Sanaa Enkhtaivan
Archive Manager	Tegshjargal Bumtsend
	Sanaa Enkhtaivan
	Gerelmaa Shaariibuu
QA/QC Coordinator	Batimaa Punsalmaa
Key Category Analysis Coordinator	Gerelmaa Shaariibuu
Uncertainty Analysis Coordinator	Gerelmaa Shaariibuu

CHAPTER 1: INTRODUCTION

1.1 Background information on greenhouse gas inventories

Mongolia has signed the United Nations Framework Convention on Climate Change (UNFCCC) on 12th June of 1992 and ratified on 30th September of 1993. With respect to the Kyoto Protocol (KP) of the UNFCCC Mongolia has ratified on 15th December of 1999. Mongolia is a developing country and as a non-Annex I Party not obligated to reduce its GHG emissions under regulations of KP, but under the Paris Agreement (PA) Mongolia has set its targets to reduce GHG emissions compared to business as usual (BAU) scenario until 2030.

Mongolia's National Inventory Report (NIR) has been prepared as part of its initial Biennial Update Report (iBUR). The NIR contains updated accounts of net greenhouse gas (GHG) emissions estimate for the period 1990-2014.

The GHG inventory for the NIR has been compiled using the 2006 IPCC Guidelines for National Greenhouse Gas inventories (IPCC 2006). But the NIR has been prepared according to the UNFCCC guidelines for the preparation of biennial update reporting for Parties not included in Annex I to the Convention (decision 2/CP.17, paragraph 40 and annex III of decision 2/CP.17).

Mongolia has done its GHG inventories four times, namely the first one in 1996 for the base year 1990 under the U.S. Country Studies Program (USCSP)[1]. This inventory was updated within the Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS[2], a regional project implemented by the Asian Development Bank (ADB)). As part of enabling activities of preparation of the Mongolia's initial National Communication (GEF/UNEP), the GHG inventories were updated to 1998 for the third time. In accordance with the preparation of Second National Communication (SNC) in 2010, the national GHG inventories have been compiled for the period 1990-2006. Generally the Tier 1 method of the Revised 1996 IPCC Guidelines for National GHG Inventories (revised IPCC 1996) was used and for all sectors except some subcategories of energy and agriculture (enteric fermentation). The country specific emission factors (EFs) were used for coal and livestock.

In scope of the preparation of initial BUR (iBUR) and Third National Communication (TNC), the national GHG inventories have been compiled using the IPCC 2006 and its Tier 1 and Tier 2 methods (country specific EFs for coal types). Although non-Annex I Parties are not obligated to use IPCC 2006, Mongolia decided to change the GHG inventories estimation method to the IPCC 2006.

Previous GHG inventory results have been reported as part of the National Communications (NCs). For the BUR Mongolia has prepared the NIR to present GHG inventory results. The preparation of NIR is not only meant to serve the purpose of meeting international report obligations, but it provides the basis for setting up national emissions reduction targets and MRV system for tracking them in national development policies, sustainable institutional arrangement, GHG inventory system and capacity building.

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[1] *The aim of the USCSP (no longer in existence) was to assist developing countries and countries with economies in transition in meeting their obligations under the UNFCCC. (http://unfccc.int/files/adaptation/methodologies_for/vulnerability_and_adaptation/application/pdf/us_country_studies_program__uscsp_.pdf)*

[2] *The aim of the ALGAS (executed by the ADB, 1995-1998) was to develop national, regional capacities for the preparation of GHG inventories, help to identify GHG abatement options, and prepare a portfolio of abatement projects for each country. (https://www.adb.org/publications/series/asia-least-cost-greenhouse-gas-abatement-strategy-algas)*

GREENHOUSE GASES COVERED

The inventory covers sources of GHG emissions which results from anthropogenic activities for direct GHGs, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), indirect GHGs such as nitrogen oxides (NO_x), carbon monoxide (CO), and Hydrofluorocarbons (HFCs) and their removals by sinks. Net emissions have been presented in carbon dioxide equivalents (CO_2e) using the 100-year global warming potentials (GWPs)[3] from the 1995 IPCC Second Assessment Report (SAR).

SECTORS COVERED

The GHG inventory has been conducted for key economic sectors that support Mongolia's economic development. The emissions/removals have been estimated from four sectors which defined by the IPCC 2006. The sectors are: (1) Energy, (2) Industrial processes and product use, (3) Agriculture, Forestry and Other Land Use (AFOLU) and (4) Waste.

1.2 General description of the institutional arrangement for GHG inventory preparation

1.2.1 Overview of institutional arrangement for compiling GHG inventory

The Article 24 of the Law on Air (1995; 2012) states that "the designated government authority shall estimate the emissions and removals of GHGs of Mongolia following the methodologies approved by the Conference of Parties (COP) to the UNFCCC".

The Ministry of Environment and Tourism (MET) of Mongolia is the key ministry to develop, update and implement climate related policies. Thus, the MET and its Climate Change and International Cooperation Department (CCICD) are the national entities with overall responsibility for organizing and coordinating the compilation of National Communications, Biennial updated reports, GHG inventory and submitting them to the UNFCCC Secretariat through the National focal point for the UNFCCC.

In order to facilitate smooth implementation of commitments under UNFCCC, the MET established climate change project implementing unit (CCPIU) at the Environment and Climate Fund (ECF) under the ministry. The CCPIU is also supervised by National focal point for the UNFCCC.

The inventory team of CCPIU, which consists of three sectorial experts, with the cooperation of relevant ministries, agencies and organizations, prepares national GHG inventory and compiles supplementary information.

Figure 1-1 shows the overall institutional arrangement for Mongolia's inventory preparation. More detailed information on the role and responsibility of relevant ministries, agencies and organizations in the inventory preparation process is described in the Table 1-1.

[3] *The source of GWPs used is the IPCC Second Assessment Report (SAR). The GWPs of direct GHGs are: 1=CO_2, 21=CH_4, 310=N_2O, HFC-134a=1300, HFC-152a=140, HFC-143a=3800. GWPs for indirect GHGs are not available. However they were reported but are not included in the inventory total.*

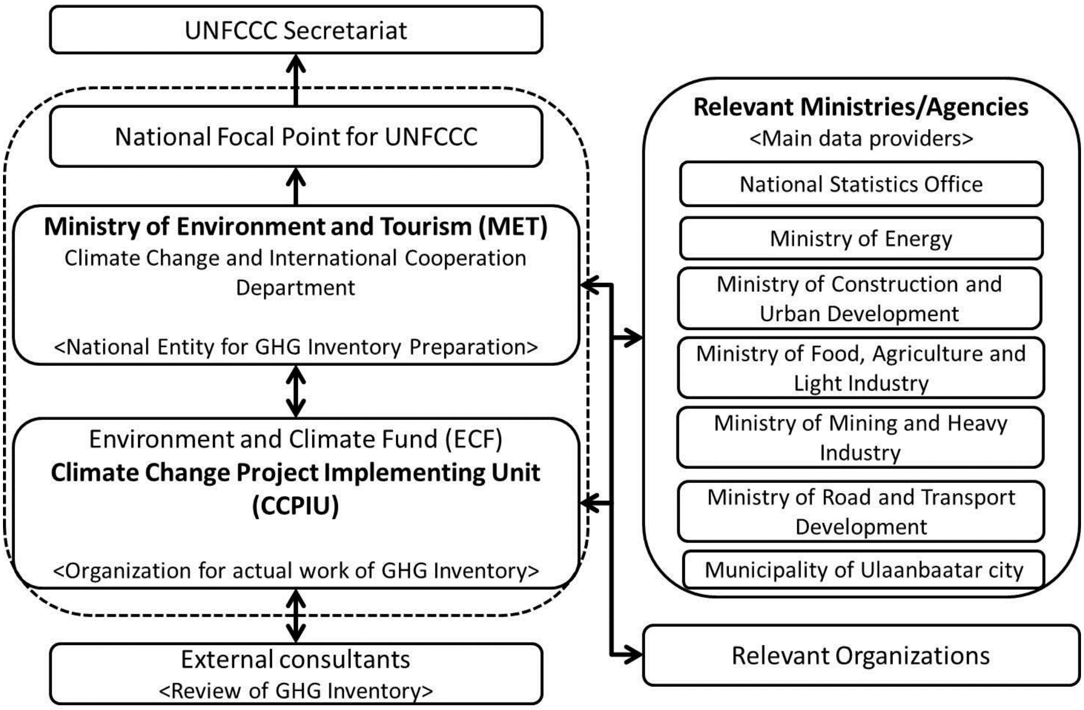

Figure 1-1: Institutional arrangement for the GHG inventory compilation of Mongolia

1.2.2 Overview of inventory preparation and management

Currently the preparation of national GHG inventory is centralized and is being compiled at CCPIU of ECF under the ministry. The main source of activity data is the National statistics office (NSO) of Mongolia and relevant institutions shown above in figure1-1. Additional statistics from international sources were used such as International Energy Agency (IEA), Food and Agriculture Organization (FAO) and World Bank (WB). Some assumptions were made for unavailable activity data in order to complete the time series.

Table 1-1 provides more detailed information about the current preparation process of national GHG inventory. The GHG inventory team consists of three specialists of CCPIU, of each responsible for energy and IPPU, AFOLU, and waste sectors.

Table 1-1: Activities and responsibilities of each entity involved in the preparation process

Phase	*Activities*	*Responsible entities*	*Description*
Measurement & Reporting	Review of previous GHG inventories	CCPIU	- Reviews previous inventory against recommendations provided by external consultants
	Gather activity data, emission factors and coefficients	CCPIU & Relevant entities	- Updates the activity and input data taking into consideration data gaps and areas needed improvement identified in previous GHG inventories - Identify the major sectors and institutions holding data and information required for GHG inventory - Discuss, agree and sign MOU with line entities for the data request from relevant ministries, agencies and organizations - Collecting information required for GHG inventory
	Prepare initial estimates and draft report	CCPIU	- Conduct sectorial and national GHG estimation - Prepare draft of the National Inventory Report (NIR) and estimation tables (CRF)
	Expert and interagency review	CCPIU & Relevant	- Organise review and validation workshops with relevant ministries, agencies and organizations - Confirm data provided for the preparation of the

		entities	inventory
	Implementation of IPCC GHG inventory guidance	CCPIU	- Implements IPCC GHG inventory guidance
Verification	Internal (QC)/External Review (QA)	CCPIU and external consultants	- Verification of the drafts of sectorial NIR and CRF - Preparation of the final draft of the NIR and CRF
Approval & Deliberation	Approval	MET	- Approval of the national GHG inventory
	Submission	MET and NFP for the UNFCCC	- Submission of NCs/BURs and NIR to UNFCCC secretariat
Publication	Archiving and publication	CCPIU	- Archiving of the relevant data and documentations - Publishing and distributing the national GHG inventory to the public

1.3 Brief general description of methodologies and data sources

Emissions of GHGs from various source and sink categories have been estimated using methodologies that are consistent with the IPCC 2006 even though non-Annex I Parties are not obliged to do so. The reason of using the IPCC 2006 is that the guidelines include updated methods and improved default values.

GHG emissions estimates have been made in accordance with the IPCC 2006 methods. In general Tier 1 IPCC method was applied. However there were selected categories such as fuel combustion, fugitive emissions from solid fuels, LULUCF for which Tier 2 method was used.

1.3.1 Methods of estimation

The methodology for Mongolia's GHG inventory has seen some improvements towards a combination of Tier 1 and Tier 2 estimation methods that a shift from the revised IPCC 1996 to the IPCC 2006 and uncertainty assessment. An overview of the methods and EFs applied for the calculations of the emissions is presented in Table 1-2.

Table 1-2: Applied methods and EFs in GHG inventory

Source and Sink Categories		*CO_2*		*CH_4*		*N_2O*		*HFCs*	
		Method	*EF*	*Method*	*EF*	*Method*	*EF*	*Method*	*EF*
1.	Energy	T1, T2	D, CS	T1	D	T1	D	-	-
1.A	Fuel Combustion	T1, T2	D, CS	T1	D	T1	D	-	-
1.A.1	Energy Industries	T1, T2	D, CS	T1	D	T1	D	-	-
1.A.2	Manufacturing Industries and Construction	T1, T2	D, CS	T1	D	T1	D	-	-
1.A.3	Transport	T1	D	T1	D	T1	D	-	-
1.A.4	Other Sectors	T1	D	T1	D	T1	D	-	-
1.A.5	Non-Specified	T1	D	T1	D	T1	D	-	-
1.B	Fugitive emissions	-	-	T1	D	-	-	-	-
1.B.1	Solid Fuels	-	-	T1, T2	D, CS	-	-	-	-
1.B.2	Oil and Natural Gas	-	-	T1	D	-	-	-	-
1.B.3	Other emissions from Energy Production	NO	NO	NO	NO	NO	NO	-	-
2.	Industrial Processes and Product Use	T1	D	-	-	-	-	-	-
2.A	Mineral Industry	T1	D	-	-	-	-	-	-
2.B	Chemical Industry	NO	NO	NO	NO	NO	NO	-	-
2.C	Metal Industry	T1	D	NO	NO	NO	NO	-	-
2.C.1	Iron and Steel Production	T1	D	-	-	-	-	-	-
2.D	Non-Energy Products from Fuels and Solvents	T1	D	-	-	-	-	-	-
2.E	Electronic Industry	NO	NO	NO	NO	NO	NO	-	-
2.F	Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	-	-	-	T1	D
2.G	Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	-	-
2.H	Other	NO	NO	NO	NO	NO	NO	-	-
3.	Agriculture	-	-	T1	D	-	-	-	-
3.A	Livestock	-	-	T1	D	-	-	-	-
3.A.1	Enteric Fermentation	-	-	T1	D	-	-	-	-
3.A.2	Manure Management	-	-	T1	D	-	-	-	-

3.B	Land			T1	D	-	-	-	-
3.B.1	Forest land	T1, T2	D, CS	-	-	-	-	-	-
3.B.2	Cropland	NE	NE	NE	NE	NE	NE	-	-
3.B.3	Grassland	NE	NE	NE	NE	NE	NE	-	-
3.B.4	Wetlands	NE	NE	NE	NE	NE	NE	-	-
3.B.5	Settlements	NE	NE	NE	NE	NE	NE	-	-
3.B.6	Other land	NE	NE	NE	NE	NE	NE	-	-
3.C	Aggregate sources and non-CO_2 emissions sources on land	-	-	-	-	T1	D	-	-
3.D.1	Harvested Wood Products	T1	D	-	-	-	-	-	-
4.	Waste	-	-	T1	D	NO	NO	-	-
4.A	Solid Waste Disposal	-	-	T1	D	NO	NO	-	-
4.B	Biological Treatment of Solid Wastes	-	-	NO	NO	NO	NO	-	-
4.C	Incineration and Open Burning of Waste	-	-	NO	NO	NO	NO	-	-
4.D	Wastewater Treatment and Discharge	-	-	T1	D	T1	D	-	-
4.E	Other	-	-	NO	NO	NO	NO	-	-

Key: EF=emission factor, CS=country specific, NE=not estimated, NO=not occurring, D=default IPCC methodology and emission factor, T1, T2=levels of tiers

1.3.2 Data sources

Mongolia's GHG inventory has been prepared using data from a combination of sources from national and international institutions. The main source of activity data are official statistics of Mongolia. According to recommendation of IPCC 2006 it's preferred to use data from national statistics. In cases where the required data was not available, the data from international sources such as IEA, FAO, WB and certain assumptions were used.

MET signed the Memorandum of understanding (MOU) with NSO, Ministry of Energy (MOE), Ministry of Construction and Urban Development (MCUD), Ministry of Food, Agriculture and Light Industry (MOFALI), Ministry of Road and Transport Development (MRTD), Ministry of Mining and Heavy Industry (MMHI) and Municipality of Ulaanbaatar City. The sectorial experts from CCPIU collect data and prepare the estimates for the national GHG inventory. The data sources for each sector are described in Table 1-3.

Table 1-3: List of important sources for GHG inventory preparation

Sectors	*Activity data sources*
1. Energy	National statistics office (NSO)-statistical yearbook, www.1212.mn, International energy agency (IEA) statistics, ministries: Ministry of road and transport development (MRTD), Ministry of mining and heavy industry (MMHI), Ministry of food, agriculture and light industry (MOFALI), institutions: Mongolian Civil Aviation Authority (MCAA), Ulaanbaatar railway joint stock company
2. Industrial processes and product use	NSO-statistical yearbook, www.1212.mn, MOFALI, MMHI
3. Agriculture	NSO-statistical yearbook, www.1212.mn, MOFALI – Statistical yearbook of agriculture
4. LULUCF	NSO-statistical yearbook, www.1212.mn, Administration of land affairs, geodesy and cartography (ALAGAC), Report on land, food and agriculture organization (FAO) – www.fao.org/faostat/en/, Forest research and development center (FRDC) – Mongolia national forest inventory (NFI), www.forest-atlas.mn
5. Waste	NSO-statistical yearbook, www.1212.mn, World Bank, Ulaanbaatar city major's office, MOFALI, Ulaanbaatar water supply and sewerage authority

1.3.3 Global warming potentials (GWPs) used

As a non-Annex I Party Mongolia used the GWPs from the IPCC second assessment report (SAR) 100-year time horizon GWPs (see Table 1-4).

Table 1-4: 100-year time horizon GWPs

Gas		*CO_2 equivalents (CO_2e)*
Direct gases	Carbon dioxide (CO_2)	1

	Methane (CH_4)	21
	Nitrous oxide (N_2O)	310
Fluorinated gases	HFC-23 (CHF_3)	11,700
	HFC-32 (CH_2F_2)	650
	HFC-125 (CHF_2CF_3)	2,800
	HFC-134a (CH_2FCF_3)	1,300
	HFC-152a (CH_3CHF_2)	140
	HFC-143a (CF_3CH_3)	3,800

1.4 Brief description of key categories

Key categories are the categories of emissions/removals, which have a significant influence on the total inventory in terms of the absolute level of emissions (1990 or 2014), the trend of emissions (change between 1990 and 2014). There are two alternative methods for identifying key categories Tier 1 and Tier 2. In this report Tier 1 method has been used. The results are presented in Table 1-5 and 1-6. Those key categories have been chosen, whose cumulative contribution is less than 95%. The identification includes all reported greenhouse gases CO_2, CH_4, N_2O, HFCs and IPCC source categories.

Table 1-5: Summary of key categories for the 2014 level assessment and trend assessment for the period 1990-2014 (including LULUCF)

IPCC Category code	*IPCC Category*	*Greenhouse gas*	*Criteria for identification*
ENERGY			
1.A.1	Energy Industries - Solid Fuels	CO_2	level, trend
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	level, trend
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	level, trend
1.A.3.b	Road Transportation	CO_2	level, trend
1.A.4	Other Sectors - Solid Fuels	CO_2	level, trend
1.A.5	Non-Specified - Solid Fuels	CO_2	level, trend
1.B.2.a	Oil	CO_2	level
AFOLU			
3.A.1	Enteric Fermentation	CH_4	level, trend
3.B.1.a	Forest land Remaining Forest land	CO_2	level, trend
3.C.4	Direct N_2O Emissions from managed soils	N_2O	level, trend
3.C.5	Indirect N_2O Emissions from managed soils	N_2O	level, trend

Table 1-6: Summary of key categories for the 2014 level assessment and trend assessment for the period 1990-2014 (excluding LULUCF)

IPCC Category code	*IPCC Category*	*Greenhouse gas*	*Criteria for identification*
ENERGY			
1.A.1	Energy Industries - Solid Fuels	CO_2	level, trend
1.A.1	Energy Industries - Liquid Fuels	CO_2	level, trend
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	level, trend
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	level, trend
1.A.3.b	Road Transportation	CO_2	level, trend
1.A.3.c	Railways	CO_2	trend

1.A.4	Other Sectors - Solid Fuels	CO_2	level, trend
1.A.4	Other Sectors - Liquid Fuels	CO_2	trend
1.A.4	Other Sectors - Liquid Fuels	CH_4	trend
1.A.5	Non-Specified - Solid Fuels	CO_2	level, trend
1.B.1	Solid Fuels	CH_4	level, trend
1.B.2.a	Oil	CH_4	level, trend
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)			
2.A.1	Cement production	CO_2	trend
2.A.2	Lime production	CO_2	trend
AGRICULTURE			
3.A.1	Enteric Fermentation	CH_4	level, trend
3.A.2	Manure Management	CH_4	trend
3.C.1	Emissions from biomass burning	CH_4	trend
3.C.1	Emissions from biomass burning	N_2O	trend
3.C.4	Direct N_2O Emissions from managed soils	N_2O	level, trend
3.C.5	Indirect N_2O Emissions from managed soils	N_2O	level, trend

According to the tables above, the most important key categories in energy sector are energy industries, road transportation, railway, and forest land remaining forest land for CO_2, in agriculture sector the enteric fermentation for CH_4, direct and indirect N_2O emissions from managed soils for N_2O. Detailed reporting tables can be found in Annex II.

1.5 Information on the QA/QC plan including verification

In accordance with IPCC 2006, volume 1, chapter 6 the quality control (QC) has been done within the inventory team. In 2013 as part of efforts to comply with the quality objectives of IPCC 2006 for inventory quality, transparency, and credibility, Mongolia has developed a quality assurance and quality control plan (QA/QC plan) which designed to check, document and improve the quality of the inventory over time.

QA/QC activities on the inventory are undertaken within the framework of this QA/QC plan. The overall aim of QA/QC plan is to maintain and improve the quality in all stages of the inventory work. The QA/QC procedures represent the main instrument for continuous improvement in subsequent inventory cycles. The QA/QC plan guides the process of ensuring inventory quality by describing data and methodology checks, developing processes governing peer review and public comments, and developing guidance on conducting an analysis of the uncertainty surrounding the emission estimates. The QA/QC procedures also include feedback loops and provide for corrective actions that are designed to improve the inventory estimates over time.

Sector specific QA/QC plan is based on the general QA/QC rules and activities in specific categories. The sector specific QC activities were performed during the GHG emissions calculation (the GHG emissions calculation has been done by the 2006 IPCC Inventory Software) such as checking several data sources and data inputs into the software, including the QC for the EFs and other parameters as well.

The main source of activity data of GHG emissions estimation is the National statistics office of Mongolia (NSO). Generally the NSO collects and consolidates data from organizations/institutions and producers by questionnaires at national level. For the QC/QA, done cross checks of activity data provided by NSO and institutions provide data to NSO. Special data sheets were prepared to collect data from relevant government and private organizations/institutions in order to compare and ensure with data from NSO.

In some cases NSO data differ from the data directly provided by questioned organizations/institutions. The IPCC 2006 recommends if there are available several sources of the activity data, it's a good practice to follow the data from national statistics. Thus NSO data was used for the inventory. Focus group meetings were organized to be agreed on assumptions made for calculations. Expert peer reviews are commissioned to provide in-depth analysis of CS EFs in energy and waste sectors. Internal reviews of the NIR, GHG inventory, CRF tables are made prior to approval.

1.6 General uncertainty evaluation

The uncertainty estimate of the 2014 inventory has been done according to the Tier 1 method presented by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006). Tier 1 method combines the uncertainty in activity rates and EFs, for each source category and GHG, and then aggregates these uncertainties for all source categories and GHGs to obtain the total uncertainty for the inventory.

In many cases uncertainty values have been assigned based on default uncertainty estimates according to IPCC guidelines or expert judgement, because there is a lack of the information. The uncertainty analysis was done for the sectors: energy, IPPU, AFOLU and waste sectors. The base year for assessment of uncertainty in trend is 1990 and the assessment has done until 2014. The results of the uncertainty analysis for all sectors have been presented in Annex III.

1.7 General assessment of the completeness

1.7.1 Sectors (sources and sinks)

All sources/removals of direct and indirect GHGs associated with activities occurring in Mongolia were covered in GHG inventory including following activities where there were data available and emissions estimated.

Table 1-7: All sources/removals covered in GHG inventory of Mongolia

	Categories	*Gases*
1.	ENERGY	CO_2, CH_4, N_2O
1.A.1.a.i	Electricity generation	CO_2, CH_4, N_2O
1.A.1.a.ii	Combined heat and power generation (CHP)	CO_2, CH_4, N_2O
1.A.2	Manufacturing industries and construction	CO_2, CH_4, N_2O
1.A.3.a.i	International aviation (international bunkers)[4]	CO_2, CH_4, N_2O
1.A.3.a.ii	Domestic aviation	CO_2, CH_4, N_2O
1.A.3.b	Road transportation	CO_2, CH_4, N_2O
1.A.3.c	Railways	CO_2, CH_4, N_2O
1.A.4.a	(Other sectors) Commercial/institutional	CO_2, CH_4, N_2O
1.A.4.b	Residential	CO_2, CH_4, N_2O
1.A.4.c	Agriculture/forestry/fishing/fish farms	CO_2, CH_4, N_2O
1.A.5.a	Non-specified (mobile)	CO_2, CH_4, N_2O
1.B.1.a.ii.1	(Surface mining) Mining	CH_4
1.B.1.a.ii.2	Post-mining seam gas emissions	CH_4
1.B.1.a.iii.2	(Oil) Production and upgrading	CO_2, CH_4
Information items [5]	CO_2 from biomass combustion for energy production	CO_2

[4] *Not included in national total, but reported as memo item.*

2.	INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	CO_2, HFCs
2.A.1	Cement production	CO_2
2.A.2	Lime production	CO_2
2.C.1	Iron and steel production	CO_2
2.D.1	Lubricant use	CO_2
2.F.1.a	Refrigeration and stationary air conditioning	HFC-32 (CHF_3), HFC-125 (CHF_2CF_3), HFC-134a (CH_2FCF_3), HFC-143a (CF_3CH_3)
2.F.1.b	Mobile air conditioning	HFC-134a (CH_2FCF_3)
2.F.2	Foam blowing agents	HFC-152a (CH_3CHF_2)
2.F.3	Fire protection	HFC-125 (CHF_2CF_3)
2.F.4	Aerosols	HFC-134a (CH_2FCF_3)
3.	AGRICULTURE, FORESTRY, AND OTHER LAND USE (AFOLU)	CO_2, CH_4, N_2O, NO_x, CO
3.A.1.a.ii	(Enteric fermentation) Other cattle	CH_4
3.A.1.c	Sheep	CH_4
3.A.1.d	Goats	CH_4
3.A.1.e	Camels	CH_4
3.A.1.f	Horses	CH_4
3.A.1.h	Swine	CH_4
3.A.2.a.ii	(Manure management) Other cattle	CH_4
3.A.2.c	Sheep	CH_4
3.A.2.d	Goats	CH_4
3.A.2.e	Camels	CH_4
3.A.2.f	Horses	CH_4
3.A.2.h	Swine	CH_4
3.A.2.j	Poultry	CH_4
3.B.1.a	(Land) Forest land remaining forest land	CO_2
3.C.1.a	Biomass burning in forest lands	CH_4, N_2O, NO_x, CO
3.C.4	Direct N_2O emissions from managed soils	N_2O
3.C.5	Indirect N_2O emissions from managed soils	N_2O
3.D.1	Harvested wood products	CO_2
4.	WASTE	CH_4, N_2O
4.A	Solid waste disposal	CH_4
4.D.1	Domestic wastewater treatment and discharge	CH_4, N_2O
4.D.2	Industrial wastewater treatment and discharge	CH_4

1.7.2 Gases

Direct gases, namely CO_2, CH_4, N_2O, HFCs and indirect gases (NO_x, CO) have been covered under this inventory. PFCs have not been considered in this inventory due to data unavailability.

1.7.3 Notation keys

NE (not estimated): The following categories have not been estimated due to activity data absence and reported as NE:

- 1.B.1.b – Uncontrolled combustion and burning of coal dumps
- 2.D.2 – Paraffin wax use
- 2.D.3 – Solvent use
- 2.G.1.b – Use of electrical equipment
- 2.G.1.c – Disposal of electrical equipment

[5] *Not included in national total.*

- 2.G.3 – N_2O from product use
- 3.B.1.b – Land converted to forest land
- 3.B.2 – Cropland
- 3.B.3 – Grassland
- 3.B.4 – Wetlands
- 3.B.5 – Settlements
- 3.B.6 – Other land
- 3.C.1.b – Biomass burning in croplands
- 3.C.1.c – Biomass burning in grasslands

NO (not occurring): The highest number of source categories marked with NO is found in IPPU sector, as most of these do not occur in the country.

1.8 Recalculations

As mentioned before the Mongolia used the methodologies consistent with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) for this submission. Thus this is new inventory with new methodology, updated activity data and EFs rather than recalculations.

CHAPTER 2: TRENDS IN GREENHOUSE GAS (GHG) EMISSIONS

2.1 Description and interpretation of emission trends for aggregated GHG emissions

The main sources of GHG emissions have been divided into the following sectors: Energy (CRF 1), Industrial processes and Product Use (IPPU, CRF 2), Agriculture (CRF 3), Land use, Land use change and Forestry (LULUCF, CRF 4) and Waste (CRF 5).

Total GHG emissions in Mongolia in 2014 were 34,482.73 Gg CO_2e (excluding LULUCF). This represents a 57.09% increase from the 1990 level of 21,950.73 Gg CO_2e and 5.49% increase from the 2013 level with 32,687.27 Gg CO_2e. Net GHG emissions in 2014 were 10,030.80 Gg CO_2e (including LULUCF). This represented a 1,034.44% increase from the 1990 level of -1,073.46 Gg CO_2e and 23.23% increase from the 2013 level with 8,139.60 Gg CO_2e (Figure 2-1 and Table 2-1).

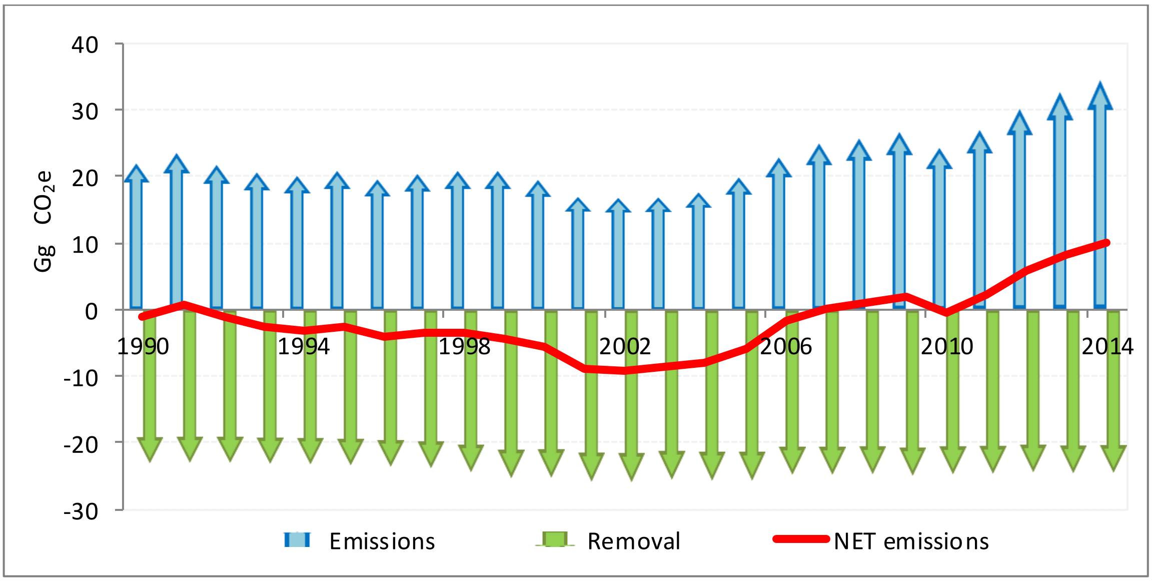

Figure 2-1: Mongolia's total and net GHG emissions and removals, 1990-2014 (Gg CO_2e)

In general, emission and removal from each sector are increased in 2014 compared to the base year and differences are shown in Table 2-1 by percentage and absolute values of each GHG inventory sectors.

Table 2-1: Mongolia's GHG emissions/removals by sectors in 1990 and 2014

Sector	Emissions, (Gg CO_2e) 1990	Emissions, (Gg CO_2e) 2014	Change from 1990 (Gg CO_2e)	Change from 1990 (%)
Energy	11,091.14	17,267.79	6,176.64	55.69
IPPU	218.66	328.06	109.39	50.03
Agriculture	10,585.30	16,726.98	6,141.68	58.02
Waste	55.62	159.91	104.29	187.49
Total (excluding LULUCF)	21,950.73	34,482.73	12,532.00	57.09
LULUCF	-23,024.18	-24,451.93	-1,427.75	6.20
Net total (including LULUCF)	-1,073.46	10,030.80	11,104.26	1,034.44

GHG emissions in 2014 from the energy sector were 17,267.79 Gg CO_2e accounting for 50.08% of total national emissions. The agriculture sector with 16,726.98 Gg CO_2e accounts for 48.51% of the national total. Emissions from IPPU and Waste sector contributed 328.1 Gg CO_2e (0.95%) and 159.91 Gg CO_2e (0.46%) respectively to the national total in 2014 (Figure 2-2).

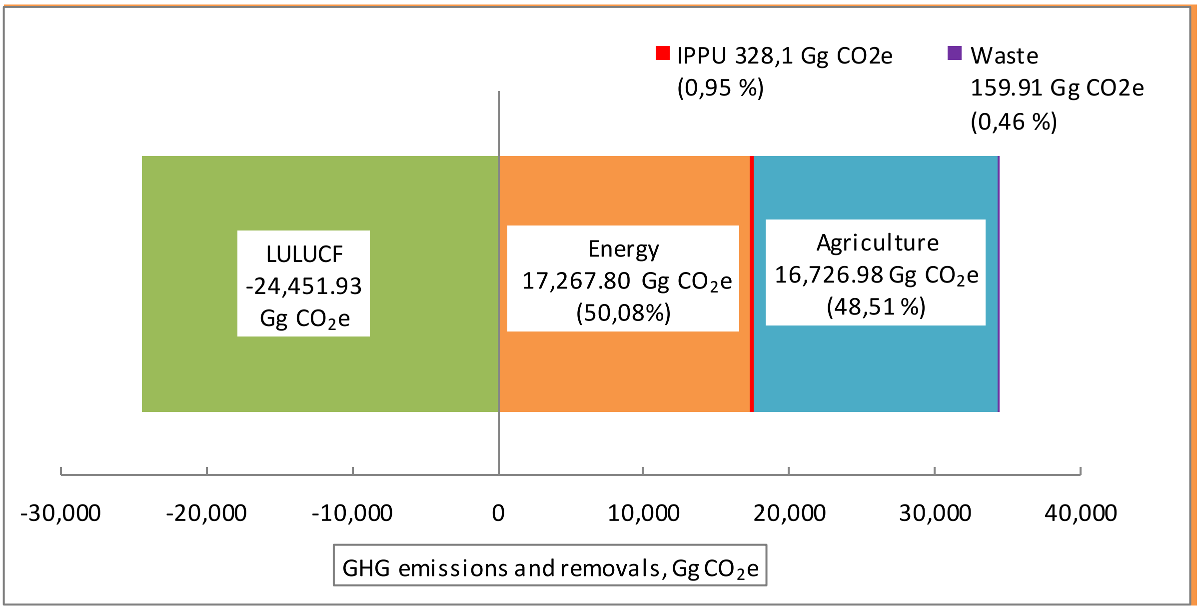

Figure 2-2: The composition of Mongolian GHG emissions by sectors in 2014

Table 2-2 shows that average annual growth rates (AAGR) of every 5 years within inventory period by sectors and by national totals. The average annual growth rates of Energy and IPPU sector were decreasing 1990-1995 and 1996-2000 subsequently, and then growth rate increase gradually in energy sector, while in IPPU sector its increased rapidly in 2001-2005.. The agriculture sector's growth rate mainly depends on livestock populations. Livestock population were dropped rapidly in 2000-2002 and 2009-2010 due to harsh winter. In the waste sector, GHG growth rate is increasing from 1996 to 2014 gradually due to increase urban population. At the national level, the GHG emissions annual growth was 2.17% per year from 1990 to 2014.

Table 2-2: Average annual growth rates, %

Sector	1990-1995	1996-2000	2001-2005	2006-2010	2011-2014	1990-2014
Energy	-3.71	-2.98	5.55	6.49	7.05	2.29
IPPU	-15.2	-4.69	24.23	14.82	9.03	5.50
Agriculture	2.18	0.38	-2.81	2.51	12.01	2.47
Waste	0.05	3.49	4.78	5.38	10.27	4.57
Total (excluding LULUCF)	-0.94	-1.21	0.77	4.39	9.26	2.17
LULUCF	0.29	1.53	0.38	-0.77	-0.22	0.26
Net total (including LULUCF)	-74.99	19.91	3.62	60.16	-98.83	-14.66

The aggregated GHG emissions and removals by sectors between 1990 and 2014 are shown in Table 2-3 including national total emissions with and without LULUCF. The trends of emission and removal from the sectors show different pattern along the time series and main factors affected to trend fluctuation in each sector are written in the later part of this section.

Comparing to the 1990, emissions increase for the energy sector was 55.69%, for the IPPU sector was 50.03%, for the agriculture sector was 58.02, for the waste sector was 187.49% and removal for the LULUCF sector was 6.2% in 2014.

In 2014 the energy sector emission decreased by 2.78%, the IPPU sector emission increased by 37.72%, the agriculture sector emission increased by 15.05%, the waste sector emission increased by 7.93% and the LULUCF sector emission decreased by -0.39% compared to 2013.

Table 2-3: The aggregated GHG emissions and removals by sectors, Gg CO_2e

Year	Energy	IPPU	Agriculture	Waste	LULUCF	Total (incl. LULUCF)	Total (excl. LULUCF)
1990	11,091.14	218.66	10,585.30	55.62	-23,024.18	-1,073.46	21,950.73
1991	12,879.99	144.23	10,407.34	56.18	-22,950.70	537.04	23,487.74
1992	11,225.37	107.57	10,348.57	54.96	-22,992.04	-1,255.57	21,736.47
1993	10,407.61	70.15	10,021.88	53.66	-23,099.45	-2,546.15	20,553.30
1994	9,093.72	83.71	10,807.34	54.00	-23,212.78	-3,174.01	20,038.77
1995	8,920.66	82.81	11,719.79	55.71	-23,364.15	-2,585.18	20,778.97
1996	7,290.90	82.26	12,067.63	56.56	-23,596.88	-4,099.54	19,497.35
1997	7,094.52	86.95	13,093.45	58.27	-23,762.22	-3,429.03	20,333.19
1998	7,204.28	84.09	13,423.70	58.58	-24,407.44	-3,636.79	20,770.65
1999	7,174.94	78.41	13,525.34	62.71	-25,328.82	-4,487.43	20,841.39
2000	7,528.89	63.95	11,790.52	66.04	-25,188.38	-5,738.98	19,449.40
2001	7,547.49	50.39	9,224.50	68.45	-25,828.96	-8,938.13	16,890.83
2002	8,068.76	92.03	8,485.01	74.16	-25,884.36	-9,164.41	16,719.95
2003	7,967.05	96.97	8,646.21	76.52	-25,547.44	-8,760.70	16,786.74
2004	8,125.47	83.47	9,265.37	79.03	-25,639.68	-8,086.33	17,553.35
2005	9,738.30	140.46	9,881.33	83.33	-25,658.09	-5,814.68	19,843.41
2006	11,503.25	139.99	11,133.62	87.74	-24,750.19	-1,885.59	22,864.60
2007	11,930.76	155.73	12,729.74	92.25	-24,757.59	150.90	24,908.49
2008	11,919.81	182.27	13,451.41	97.65	-24,716.09	935.05	25,651.14
2009	12,491.36	157.57	13,909.39	103.10	-24,950.95	1,710.48	26,661.42
2010	13,227.35	251.63	10,635.70	108.26	-24,670.87	-447.93	24,222.94
2011	14,823.77	256.05	11,723.02	122.14	-24,636.33	2,288.64	26,924.97

2012	16,357.95	300.64	13,308.67	137.79	-24,377.05	5,728.00	30,105.05
2013	17,762.11	238.21	14,538.79	148.17	-24,547.66	8,139.60	32,687.27
2014	17,267.79	328.06	16,726.98	159.91	-24,451.93	10,030.80	34,482.73

Note: Totals of columns not consistent due to rounding.

The energy and agriculture sectors are the major source for emissions for entire time series. However, percentage to national total varied depending on economic and climatic factors such as demand increase in energy sector and natural disaster occurrence in agriculture sector. Figure 2-3 shows that contribution of sectors to the Mongolia's total emissions for the period 1990-2014.

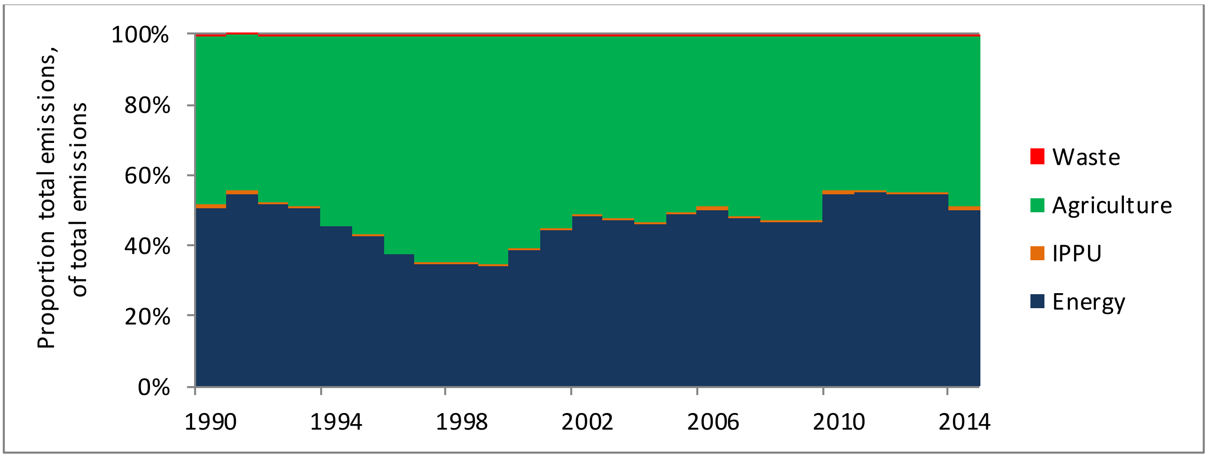

Figure 2-3: The contribution of sectors to Mongolia's total emissions for the period 1990-2014

2.2 Description and interpretation of emission trends sectors/categories

2.2.1 Energy

The energy sector is the most significant source of the GHG emissions with 50.08% share of the national total emissions in 2014. The GHG emissions fluctuate in the latest years mainly due to economic trend, the energy supply structure and climate conditions. Total emissions in energy sector in 2014 increased by 55.69% compared to the base year 1990. A large part of emissions in energy sector comes from energy industries (electricity generation, electricity and heat production in CHPs) source category (54.87%). The emissions from energy industries increased by 3.81% compared to 2013. One of the factors influencing the GHG emissions from energy industries source category is the increasing energy demand. To reduce the GHG emissions from this source category the energy efficiency of electricity and heat production should be improved (see Figure 2-4).

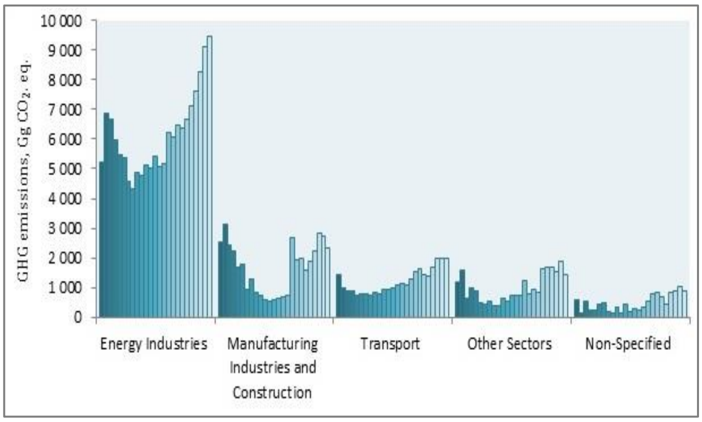

Figure 2-4: Trends in energy sector by categories, 1990-2014

2.2.2 Agriculture

In 2014, the agriculture sector accounted for 48.51% (16.726.97 Gg CO_2e) of total national direct GHG emissions (without LULUCF), being the second major source of GHG emissions after the energy sector in the country. Total emissions in agriculture sector in 2014 increased by 58.02% compared to the base year 1990; in particular, due to increasing the number of domestic livestock which increased 25.8 million in 1990 to 51.9 million in 2014 (see Figure 2-5). Emission reduction between 1999-2002 and 2009-2010 caused by livestock loss during the natural disaster.

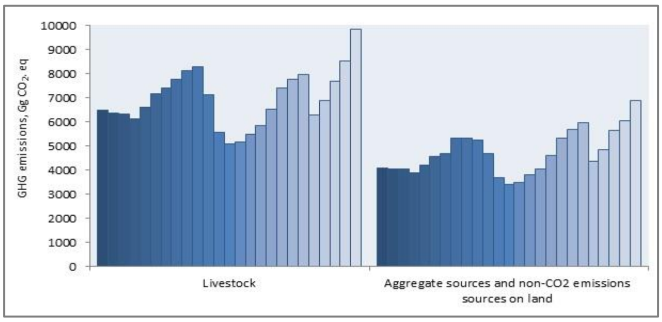

Figure 2-5: Trends in agriculture sector by categories, 1990-2014

2.2.3 Industrial Processes and Product Use (IPPU)

The Industrial Processes and Product Use (IPPU) sector contributes 0.95% of the total GHG emissions in 2014. The total GHG emissions of IPPU sector in 2014 increased by 50.03% compared to the base year 1990. The emission fluctuations in IPPU sectors are linked with the economic situation of the country. The GHG emissions increased in 2014 by 37.72% compared to 2013. The main contributor to the total emissions from IPPU sector is the mineral industry (cement and lime production) and it represents 68.86% of emissions. The cement and lime are the important ingredients for the building materials production. The building material industry is growing in parallel with the population and the economy (see Figure 2-6).

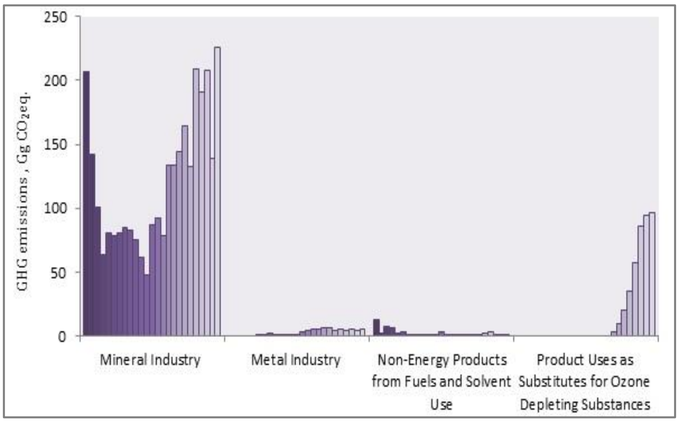

Figure 2-6: Trends in IPPU sector by categories, 1990-2014

2.2.4 Waste

The waste sector is the insignificant source of the GHG emissions contributes only 0.46% to national total. However, GHG emissions have increased continuously year after year in relation to the population growth especially in urban areas. Total aggregated emissions from the Waste sector have increased by 104.29 Gg CO_2e (187.49%) from the 1990 level of 55.62 Gg CO_2e. The total CO_2 equivalent emissions from waste sector in 2014 increased by 7.93% compared to 2013 (Figure 2-7).

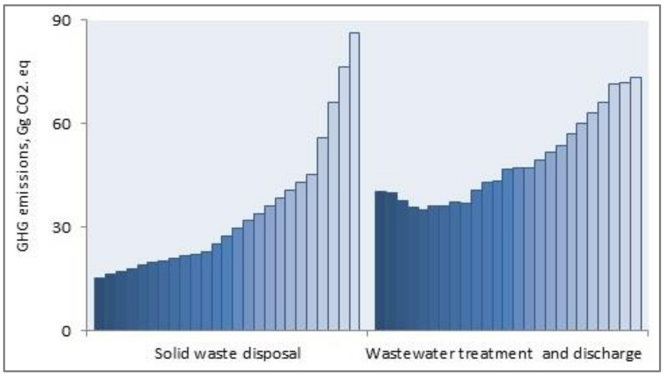

Figure 2-7: Trends in waste sector by categories, 1990-2014

2.2.5 Land use, land use change and forestry

LULUCF is a net sink in Mongolia accounted approximately 50% of net removal of the country's direct GHG emission. Total removals were -24,451.93 GgCO_2e in 2014 and -23,024.18 GgCO_2e in the base year. This increase (6.2%) in 2014 is due to forest area expansion in recent years. According to the country's land report forest area has increased from 15,660.48 thousand ha in 1990 to 16,864.77 thousand ha in 2014. Availability of data for LULUCF inventory is still lacking. It should be noted that only forest land remaining forest land category is reported under Land category for this submission (Figure 2-8).

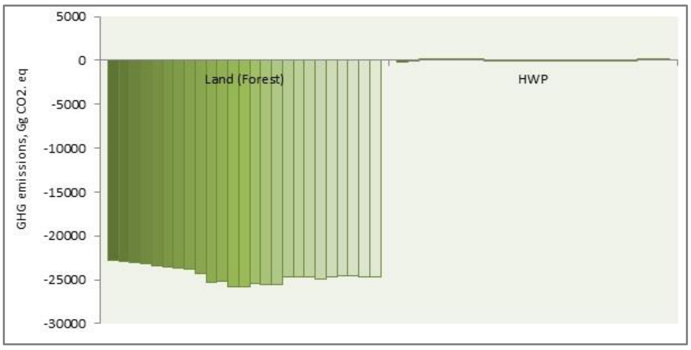

Figure 2-8: Trends in LULUCF sector by categories, 1990-2014

2.3 Description and interpretation of emission trends by gases

The most important GHG in Mongolia is carbon dioxide (CO_2) (without LULUCF) accounting 46.41% of national total in 2014. The CO_2 emissions primarily result from fuel combustion activities. Methane (CH_4), which mainly arises from enteric fermentation of livestock and solid waste disposal, contributes 32.89% to national total GHG emissions, and nitrous oxide (N_2O) from agricultural soils contributes 20.42% to national total, and HFCs from refrigeration, air conditioning, fire protection, foam blowing equipment usage contribute the remaining 0.28% in 2014. The trend of CO_2, CH_4 and N_2O emissions are presented in figure 2-9. More information about Table 2-4 can be find from chapters 2.3.1-2.3.4.

The data on HFCs which are mostly emitted from the use of these gases in refrigeration and air conditioning equipment were available from 2012. The consumption data of HFCs were taken from the "Report for HFCs inventory and identification of opportunities for introduction of low-GWP alternatives in Mongolia". More details about HFCs can be found below in Chapter 3.2 Industrial processes and product use.

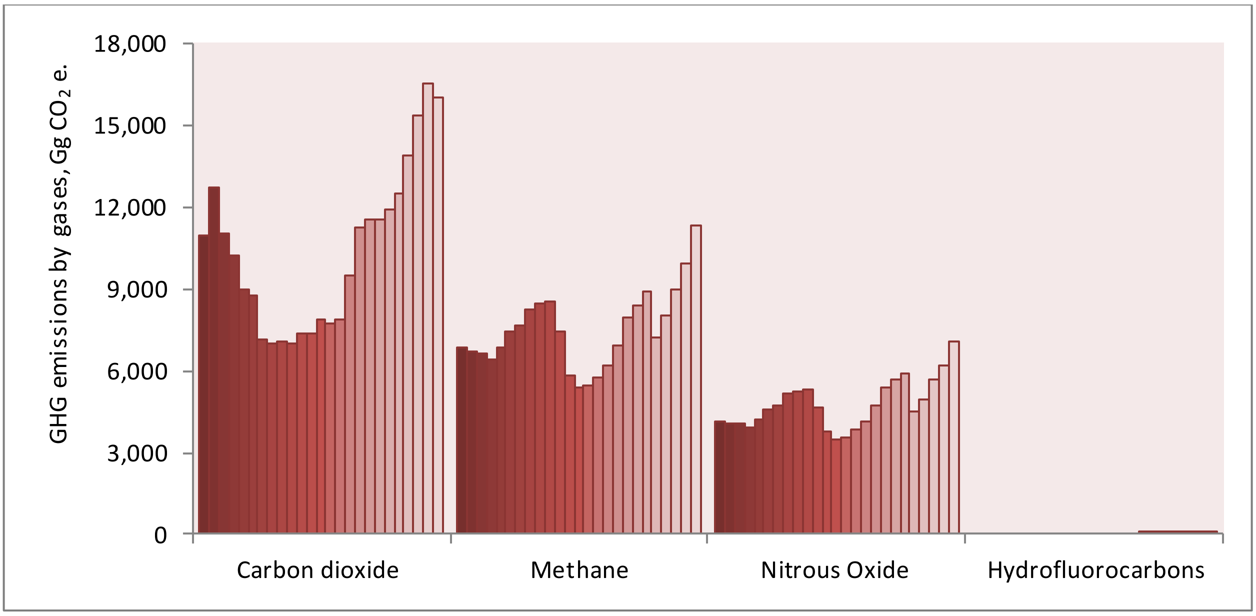

Figure 2-9: The trend of CO_2, CH_4 and N_2O emissions 1990-2014

Table 2-4: Mongolia's total GHG emissions by gases in 1990 and 2014

Direct GHGs	*Emissions, (Gg CO_2e)*		*Change from 1990 (Gg CO_2e)*	*Change from 1990 (%)*
	1990	*2014*		
CO_2	10,927.61	16,004.13	5,076.51	46.46
CH_4	6,872.62	11,341.6	4,468.98	65.03
N_2O	4,150.49	7,040.58	2,890.09	69.63
HFCs	NA	96.43	NA	NA
Total	21,950.73	34,482.73	12,532.00	57.09

Note: Total emissions exclude net removals from the LULUCF sector. The per cent change for hydro fluorocarbons is not applicable (NA) because the emissions estimation of hydrofluorocarbons was not conducted for 1990.
Source: GHG Inventory prepared by CCPIU under MET.

2.3.1 Carbon dioxide (CO_2)

The CO_2 emissions from all sectors (excl. LULUCF) increased by 46.46% from 1990 to 2014. The emissions from all (excl. LULUCF) increased from 10,927.61 in 1990 to 16,004.13 Gg CO_2e in 2014 mainly due to higher emissions from energy sector.

The main source of CO_2 emissions in Mongolia is the fossil fuel combustion. Within the fuel combustion category the energy industries is the most important sub-source with the growth of 81.92% from 5,178.13 Gg in 1990 to 9,420.14 Gg in 2014. The second contributor to CO_2 emissions is the manufacturing industries and construction source category with the decline of 8.65% from 2,519.05 Gg in 1990 to 2,301.20 Gg in 2014.

2.3.2 Methane (CH_4)

CH_4 emissions increased from 6,872.62 to 11,341.60 Gg CO_2e with a growth of 65.03% from 1990 to 2014. The main sources of CH_4 emissions in Mongolia are the enteric fermentation in agriculture sector, the fugitive emissions from coal mining and handling, and solid waste disposal on land (landfills).

2.3.3 Nitrous oxide (N_2O)

N_2O emissions increased from 4,150.49 to 7,040.58 Gg CO_2e for the period 1990-2014, which is 69.63% increase over the years. The main sources are: direct N_2O emissions from managed soils; indirect N_2O emissions from managed soils; energy industries; manufacturing industries and construction; transport and residential sectors, and domestic wastewater treatment and discharge.

2.3.4 Hydrofluorocarbons (HFCs)

The activity data for the estimation of HFCs emissions were available only from 2012 to 2014. Therefore the emissions have been estimated only for last few years. Since the HFCs emissions are directly related to the consumption of applications which include fluorinated substitutes, the emissions increasing with the growing consumption of applications. For the emissions estimation from HFCs was used Tier 1 method of IPCC 2006 which is using the default emission factors. The Tier 1 method then back-calculates the development of banks of a refrigerant from the current reporting year to the year of its introduction. The year of introduction for HFC-134a (mobile air conditioning) was 2007. Thus the emissions have been calculated for the period 2007-2014 and increased remarkably for this period from 3.17 to 96.43Gg CO_2e due to growth of imported refrigeration and air conditioning equipment.

2.4 Description and interpretation of emission trends for indirect GHGs

Emission estimates for NO_x and CO are reported in the CRF as well. This chapter summarizes the trends for these gases. The following table shows the indirect gas emissions from mainly the AFOLU sector for the years 1990 and 2014.

Table 2-5: Mongolia's total emissions by indirect gases for the years 1990 and 2014

Indirect GHG emissions	*Emissions, (Gg CO_2e)*		*Change from 1990 (Gg CO_2e)*	*Change from 1990 (%)*
	1990	*2014*		
NO_x	1.78	0.04	-1.74	-97.75
CO	63.63	1.54	-62.9	-97.58

2.4.1 Nitrogen oxides (NO_x)

The NO_x emissions caused by biomass burning in forest land decreased from 1.78 to 0.04 Gg CO_2e, during the period from 1990 to 2014. The level of NO_x emissions of 2014 were -97.75% below the level of 1990.

2.4.2 Carbon monoxide (CO)

The main source of CO emissions is burning of biomass in forest land. The CO emissions decreased from 63.63 Gg in 1990 to 1.54 Gg in 2014 which are resulted from the biomass burning in the forest land. In 2014 the CO emissions were -97.58% below the level of 1990.

CHAPTER 3: ENERGY

3.1 Overview of the sector

The energy sector of GHG inventory (GHGI) in Mongolia covers two main source categories, namely fuel combustion (CRF 1.A) and fugitive emissions (CRF 1.B). Within the fuel combustion source category were estimated emissions from energy industries (electricity generation, combined heat and power generation), manufacturing industries and construction (in aggregated manner), transport (civil aviation, road transportation, railways), other sectors (commercial/institutional, residential, agriculture/forestry), non-specified (stationary combustion) and fugitive emissions (coal mining and handling, oil production).

This sector is the main contributor to overall GHG emissions (excluding LULUCF) with its share of 62.34% and 17,267.79 Gg of CO_2 equivalents (CO_2e) in 2014. The Figure 3-1 below shows the share of each sector in the total GHG emissions excluding LULUCF from the year 2014.

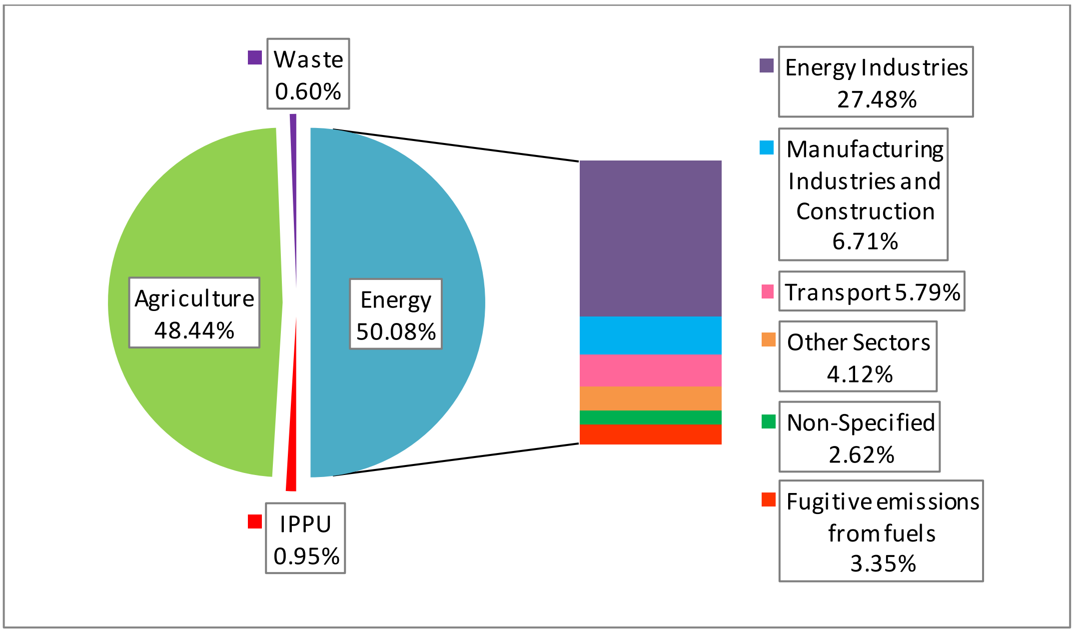

Figure 3-1: The share of each sector in total GHG emissions of Mongolia (excl. LULUCF), 2014

Within the energy sector, energy industries contribute the most percentage to the GHG emissions and next two contributors are manufacturing industries and construction, and transport sectors each with 54.87%, 13.40%, and 11.57% (see Table 3-1). The share of energy industries is relatively constant, e.g. from 46.97% in 1990 increased up to 68.09% in 2000 and slightly decreased to 54.87% in 2014. The share of manufacturing industries and construction source category is decreased from 22.86% in 1990 to 7.59% in 2000 and gradually increased up to 13.40% in 2014. This change is linked to the consequences of transition from the planned to the market economy in late 90s. In addition to fuel combustion, also pollution from small sources of residential heating systems and fugitive methane emissions from solid fuel transmission/transport/distribution contribute significantly to total GHG emissions. The emissions from energy sector have been increased by 55.69% from 11,091.1 Gg CO_2e in 1990 to 17,267.8 Gg CO_2e in 2014.

Table 3-1: GHG emissions from energy sector by source categories, Gg CO_2e

Categories	Emissions	1990	1995	2000	2005	2010	2014
Energy Industries	Gg	5,209.46	5,374.38	5,126.45	6,201.15	7,110.12	9,474.70
	%	46.97	60.25	68.09	63.68	53.75	54.87
Manufacturing Industries and Construction	Gg	2,535.38	1,792.04	571.47	716.30	1,888.93	2,313.48
	%	22.86	20.09	7.59	7.36	14.28	13.40
Transport	Gg	1,439.66	771.75	935.12	1,108.73	1,400.58	1,997.25
	%	12.98	8.65	12.42	11.38	10.59	11.57
*Other Sectors**	Gg	1,164.36	468.85	646.36	1,221.03	1,690.48	1,422.37
	%	10.50	5.25	8.58	12.54	12.78	8.24

Non-specified	Gg	611.38	421.83	148.07	333.48	456.93	903.37
	%	5.51	4.73	1.97	3.42	3.45	5.23
Fugitive emissions from fuels (coal, oil)	Gg	130.91	91.80	101.42	157.60	680.31	1,156.62
	%	1.18	1.03	1.35	1.62	5.14	6.70
Energy Total	Gg	11,091.14	8,920.66	7,528.89	9,738.30	13,227.35	17,267.79
	%	100.00	100.00	100.00	100.00	100.00	100.00

** Other sectors include Commercial/Institutional, Residential and Agriculture/Forestry/Fishing source categories.*

The inventory of emissions from fuel combustion includes direct GHG emissions such as CO_2, CH_4, N_2O and indirect such as NO_x, CO, NMVOCs, and SO_2 emissions as well, while fugitive emissions from coal and oil production are CO_2 and CH_4.

The emissions from international bunkers (CO_2, CH_4, N_2O, SO_2 and indirect gases) and CO_2 emission from biomass combustion are included in memo items and not calculated into national total. The following Figures 3-2 and 3-3 show the share of GHG emissions by source categories in percentages and the trend of GHG emissions by categories in Gg of CO_2 equivalents (CO_2e) within the energy sector.

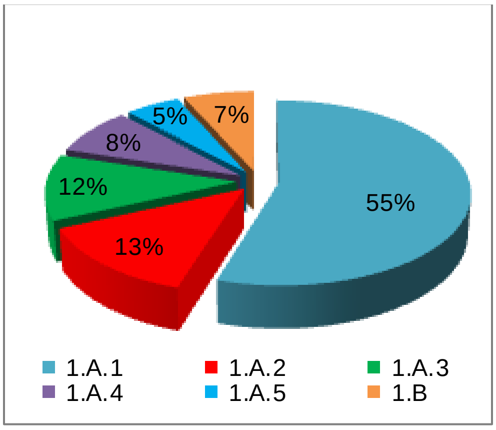

Figure 3-2: The share of aggregated GHG emissions by categories within energy sector in 2014

SECTOR 1: ENERGY – CATEGORIES, 2014	*Gg CO_2e*
1.A.1 Energy Industries	9,474.70
1.A.2 Manufacturing Industries and Construction	2,313.48
1.A.3 Transport	1,997.25
1.A.4 Other Sectors	1,422.37
1.A.5 Non-Specified	903.37
1.B Fugitive emissions from fuels	1,156.62
1. ENERGY TOTAL	17,267.79

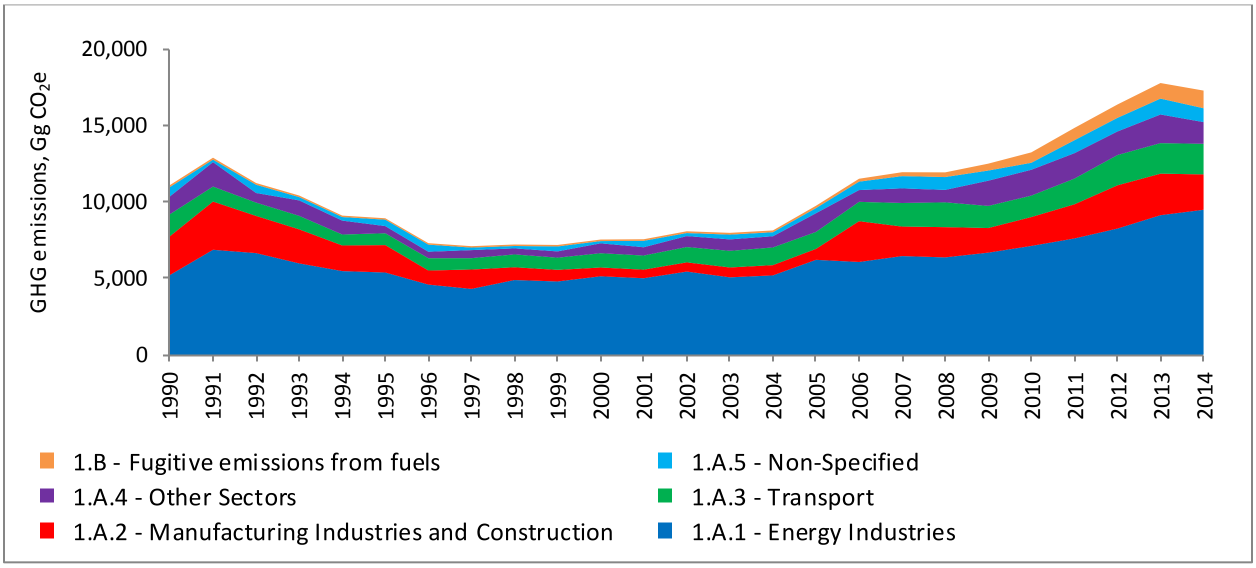

Figure 3-3: Trend in aggregated emissions by source categories within energy sector for the period 1990-2014 (in Gg CO_2e)

As in the Figure 3-3 shown, the share of energy industries (mostly electricity and heat production) in total fuel combustion source category (CRF 1.A) is the most highest, namely 54.87%, within the energy sector followed by manufacturing industries and construction with 13.40%, and other sectors where included commercial/Institutional, residential, agriculture and forestry categories with 8.24%. The residential category within the other sectors (CRF 1.A.4) has the highest share with 83.59% and followed by agriculture/forestry 14.09% and commercial/institutional 2.32% categories in the year of 2014. The road transportation represents 83.84% and it is the most important key source with one of the highest share on emissions within the transport category. The second important source is the railway with 14.12% and the civil aviation source category, from which is the domestic aviation represents 2.04% (40.72 Gg CO_2e). The international aviation bunkers will not calculated in the national total emissions, but reported as memo item with 42.62 Gg CO_2e in 2014.

Table 3-2 shows emissions of source categories within energy sector. The GHG emission (CH_4, N_2O) from all categories of energy sector was estimated by using IPCC default methodology and combined with default and country specific emission factors (CS EFs) for some types of coal.

Table 3-2: GHG emissions within energy sector in 1990-2014

Years	1.A.1 Energy Industries	1.A.2 Manufacturing industries and Construction	1.A.3 Transport		
	1.A.1.a Electricity & Heat production		1.A.3.a Civil aviation	1.A.3.b Road transportation	1.A.3.c Railways
	Gg of CO_2e				
1990	5,209.46	2,535.38	10.50	1,169.57	259.58
1991	6,859.17	3,152.22	30.54	756.85	191.94
1992	6,641.70	2,430.69	44.85	705.76	120.72
1993	5,967.53	2,227.26	50.58	624.87	206.43
1994	5,465.64	1,675.79	55.67	557.67	103.07
1995	5,374.38	1,792.04	55.67	623.51	92.57
1996	4,581.79	922.79	69.66	639.33	96.14
1997	4,300.48	1,268.19	43.90	598.55	99.92
1998	4,881.22	831.64	34.99	702.32	103.70
1999	4,788.08	758.56	27.67	649.06	121.77
2000	5,126.45	571.47	32.13	781.23	121.77
2001	4,998.02	561.63	39.44	753.03	132.69
2002	5,432.83	601.56	37.54	819.16	147.18
2003	5,058.33	645.38	51.85	872.81	161.68
2004	5,182.93	671.51	46.12	920.37	190.46
2005	6,201.15	716.30	34.35	873.20	201.17
2006	6,060.46	2,666.97	70.94	932.37	262.09
2007	6,446.99	1,929.58	71.57	1,227.44	241.08
2008	6,362.45	1,976.21	55.35	1,322.66	242.56
2009	6,671.26	1,608.01	23.86	1,206.98	215.23
2010	7,110.12	1,888.93	29.58	1,139.36	231.64
2011	7,598.97	2,231.90	47.40	1,365.64	266.29
2012	8,244.55	2,829.49	73.16	1,618.76	286.22
2013	9,120.42	2,714.87	73.16	1,639.09	285.61
2014	9,474.70	2,313.48	40.72	1,674.49	282.04

Years	1.A.4 Other Sectors			1.A.5 Non-specified	1.B Fugitive emissions from fuels	
	1.A.4.a Commercial/ Institutional	1.A.4.b Residential	1.A.4.c Agriculture/ Forestry	1.A.5.a Stationary	1.B.1.a Coal mining & handling	1.B.2.a.iii.2 Oil Production and Upgrading
	Gg of CO_2e					
1990	85.09	787.94	291.33	611.38	130.91	-
1991	610.66	795.38	191.79	162.73	128.71	-
1992	301.54	196.34	130.35	539.16	114.26	-
1993	576.72	288.71	145.77	217.01	102.74	-
1994	583.96	244.97	79.74	232.86	94.35	-

1995	171.31	233.20	64.35	421.83	91.80	-
1996	161.01	210.14	48.50	466.94	93.47	1.12
1997	229.69	252.10	45.15	165.52	90.06	0.95
1998	158.75	187.90	46.82	159.42	92.50	5.01
1999	169.38	157.58	82.04	322.79	90.80	7.22
2000	307.65	288.11	50.60	148.07	94.84	6.58
2001	182.85	305.42	52.13	419.93	94.03	8.32
2002	118.92	538.59	57.27	200.32	101.41	13.99
2003	112.24	569.15	67.61	312.48	97.11	18.40
2004	87.69	566.79	76.03	264.93	98.77	19.86
2005	38.13	1,070.70	112.21	333.48	137.48	20.13
2006	41.75	630.68	96.94	551.50	152.91	36.64
2007	30.55	813.18	111.12	803.03	172.48	83.73
2008	28.29	659.93	125.25	841.33	187.81	117.97
2009	27.04	1,488.95	133.00	664.15	264.30	188.55
2010	34.85	1,509.17	146.45	456.93	461.17	219.14
2011	34.73	1,431.51	196.00	848.09	541.36	261.88
2012	35.53	1,306.55	198.44	889.03	483.08	393.12
2013	28.85	1,620.19	221.21	1,039.72	473.70	545.29
2014	33.04	1,188.95	200.37	903.37	412.35	744.27

3.2 Description of source specific categories

3.2.1 Overview of fuel combustion activities (CRF 1.A)

The Mongolia's climate is harsh continental with sharply defined four seasons, high annual and diurnal temperature fluctuations and low rainfall. Because of the high altitude (the average altitude is 1,580m above sea level) Mongolia's climate is generally colder than other countries of the same latitude. Average annual temperatures are around +8.5°C in the Gobi region and -7.8°C in the high mountainous areas. The extreme minimum temperature is -31.1°C to -55.3°C in January and the extreme maximum temperature is +28.5°C to +44.0°C in July.

According to the Ministry of Energy, the current installed power capacity in Mongolia is approximately 1,100 MW, with an available capacity about 900 MW. Mongolia has about 8 coal-fired combined heat and power plants, 600 small diesel generators, 13 hydroelectric plants and multiple wind and solar systems. Approximately 95% of the total electricity of Mongolia is generated domestically results from coal-fired CHPs, 0.1% from diesel systems, 2.7% from wind and solar power, 1.5% from hydropower in 2016. Mongolia imports about 20% of its annual electricity demand mainly from Russia and to a lesser extent, from China. In the year of 2016 Mongolia's energy production has increased by 2.98% from previous year (ERC, 2016).

For this category the activity data was gathered mainly from National statistics office (NSO) of Mongolia, relevant ministries and agencies such as Ministry of energy, Ministry of road and transport development, Ministry of mining and heavy industry, and Mongolian civil aviation authority. International sources such as International Energy Agency (IEA) statistics were used to fill data gaps. Not all required data were available, therefore with the help of additional statistics and various assumptions some data were disaggregated and supplemented in the respective sectors of energy transformation and final consumption. The energy balance in Mongolia is not developed well, so the fuel consumption in manufacturing industries was not possible to disaggregate. The same for transport sector, the gasoline and diesel consumption for respective vehicle types was taken the imported amount of these fuels.

Total aggregated emissions from fuel combustion, including transport, based on sectorial approach represented 16,111.16 Gg of CO_2e in 2014.

The following Table 3-3 gives an overview of emission sources.

Table 3-3: Emission sources for the disaggregation of the energy balance

Balance of emission sources
Emission sources are: • public combined heat and power plants (CHPs), • hard coal mining, • brown coal mining, • heat only boilers (HOBs), • small diesel power plants, • Ulaanbaatar railways (UBTZ), • Mongolian railways, • Mongolian airlines (MIAT), • other mining and manufacturing industries, • household stoves, • vehicles,
Plant types are: • combined heat and power plants (CHPs), • steam turbine power plants, • diesel power plants, • heat only boilers (HOBs),
According to energy sources: • coal: coking coal, other bituminous coal, sub-bituminous coal, lignite, • diesel oil,

Since there is no disaggregated coal data in the national statistics, disaggregated data from International Energy Agency (IEA) statistics were used. The Ministry of Energy (MOE) and the National statistics office of Mongolia (NSO) are working currently on the development of the energy balance table of Mongolia.

Due to unavailability of the disaggregated data of fuel consumption within the manufacturing industries and construction (CRF 1.A.2) category the liquid (diesel oil) and solid fuel (coal) consumption data for different industries were taken as aggregated data.

In the transport category (CRF 1.A.3) as well the activity data like fuel consumption data of road transportation was unavailable to disaggregate by vehicle types nationwide, therefore the activity data were taken as the sum consumption of motor gasoline and diesel oil. The distinction of jet fuel consumption between international and domestic aviation was relatively complicated due to lack of activity data from the Ministry of Road and Transport Development (former Ministry of Road and Transportation, MRT) and Mongolian Civil Aviation Authority (MCAA). Therefore the jet fuel consumption of international and domestic aviation has been calculated using the flight number of domestic flights and international landing and take-off numbers from national statistics. The activity data in railways have been requested from the MRTD and disaggregated into the diesel oil consumption for locomotives and coal (mostly sub-bituminous coal) consumption for passenger wagon heating (only in heating season, which lasts almost 7 months).

Other sectors (CRF 1.A.4) include the fuel consumption in commercial and institutional, residential and agriculture/forestry/fishing subcategories. In the agriculture (CRF 1.A.4.c) subcategory the coal, diesel oil and other primary solid biomass were consumed by stationary appliances and diesel oil by off-road vehicles and other machineries.

3.2.2 Feedstock and non-energy use of fuels

For a number of applications, mainly in larger industrial processes, fossil hydrocarbons are not only used as energy sources, but also have other uses e.g. feedstock, lubricants, solvents, etc. The sectorial approaches (Tier 1, 2 and 3) are therefore based on fuel combustion statistics.

In the case of Mongolia, the lubricants use has been reported in the Industrial Processes and Product Use (IPPU) sector under non-energy products from fuels and solvent use (CRF 2.D) source category, not under fuel combustion category (CRF 1.A) in energy sector.

3.2.3 Fugitive emissions from solid fuels (CRF 1.B)

In Mongolia the fugitive emissions from fuels occur in the coal mining and handling and oil industries. Mongolia does not have yet any petroleum refining industries. The fugitive emissions from fuels were calculated from the surface mining industry, because the underground mines are not occurring in Mongolia.

The crude oil production has been started from 1996 in Mongolia and back then the amount of explored oil was around 2 thousand cubic meters and in 2014 was 1.2 million cubic meters. Approximately 5.9 million tons of oil was explored in Mongolia between 1996 and 2016. The explored crude oil is exported directly to China. There are three major oil fields in Mongolia, namely Toson-Uul XIX (field name), Tamsag XXI which are located in Dornod province of Mongolia and operated by PetroChina Daqing Tamsag LLC, and Tsagaan els which is located in Dornogobi province and operated by Dongsheng Petroleum LLC (MRPAM, 2017).

The overview of total fugitive emissions from fuels has been presented in the following figure.

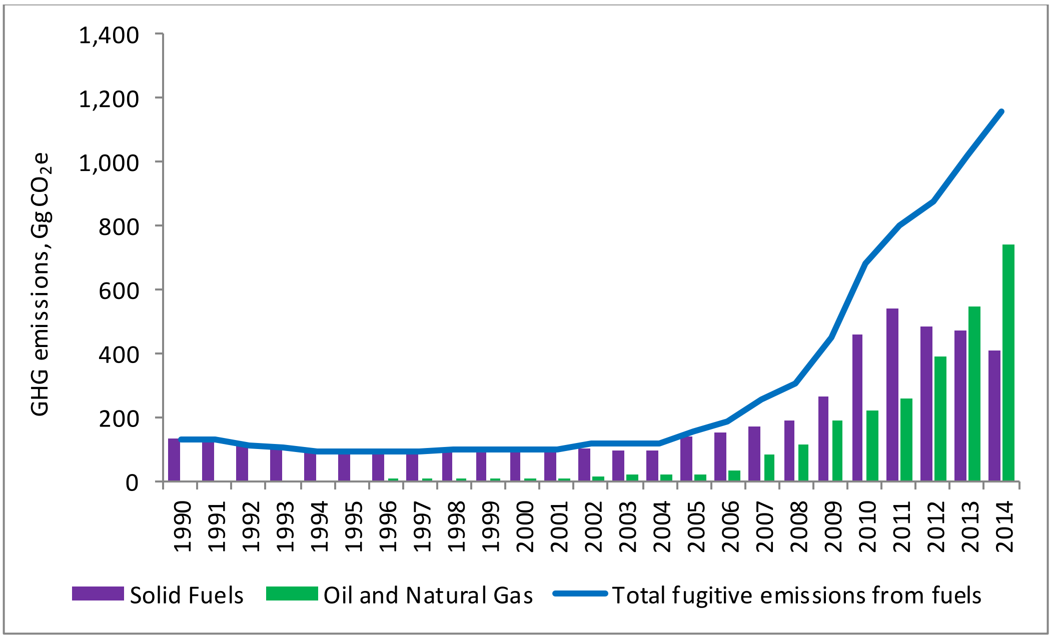

Figure 3-4: Total fugitive emissions from fuels for the period 1990-2014

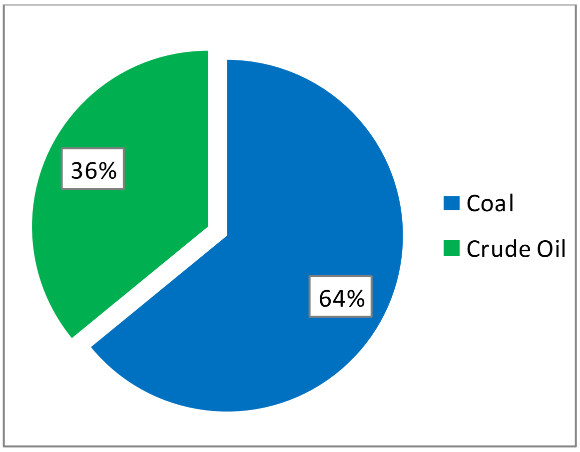

Figure 3-5: The share of coal and crude oil in the fugitive emissions from fuels over the years 1990-2014

From the figure can be seen that the fugitive emissions from coal mining and handling were relatively constant until 2011 and further have been slightly declined. On the contrary the fugitive emissions from oil production have risen steadily. Over the years the share of fugitive emissions from solid fuels represents 64% and from crude oil 36%.

3.2.4 International aviation bunkers (CRF 1.A.3.a)

This category includes emissions from the international aviation (CRF 1.A.3.a.i). These emissions are excluded from the national totals.

The history of Mongolian airlines (MIAT) is beginning from 1925 and is inseparably linked with the history of Mongolian Air Force. The first ever freighter Y-13 which was donated by the former Soviet Union, has landed on 25th of May 1925 in Mongolia. This day is considered as the foundation of Mongolian Air Force. Later 1956 was the new era in the development of Mongolian civil aviation. In early 1956, five AN-2 aircrafts were delivered from Soviet Union and with the successful completion of the training for pilots it was able to Mongolia to carry out regularly scheduled flights. From 1987 MIAT started its international operation with TU-154 aircraft to Moscow, Irkutsk of Soviet Union and to Beijing which was leased from Soviet Union (MIAT, 2017).

Mongolia remains committed to the strategic objectives of International Civil Aviation Organization (ICAO) with respect to its goal of enhancing the global aviation safety and security, improving efficiency of aviation operations, minimizing adverse environmental impacts from air transport and strengthening the laws governing civil aviation.

Mongolia's air transport industry is focusing on passenger and air cargo markets. Air passenger transport is the most important aviation activity and counts 340,024 passengers in the domestic market, and 781,000 in the international market (by 2012). While air traffic has actually declined in the domestic market since 1993 (in total 8.6% by 2012), it has been increased more than seven times in the international market in that same period.

As of 2012, there are twenty-two airports (except only one international and others are domestic) in Mongolia, three of them are private airports and nineteen airports are owned and operated by the Mongolian Civil Aviation Authority (MCAA). Sixteen airports are considered operational and six others are no longer functional for regular flights. Chinggis Khaan International Airport is the only one international airport in Mongolia, but from 2013 it has been started a Mongolian-Japanese joint project to build a New Ulaanbaatar International Airport in the Tuv province around 50 km from capital city and it will be commissioned in 2017, while the official beginning of the operation is in 2018 (ICAO, 2013).

The Mongolian Civil Aviation Authority (MCAA) has an overall responsibility for the aviation sector in Mongolia. The GHG emissions from international aviation bunkers can be seen from the Figure 3-6.

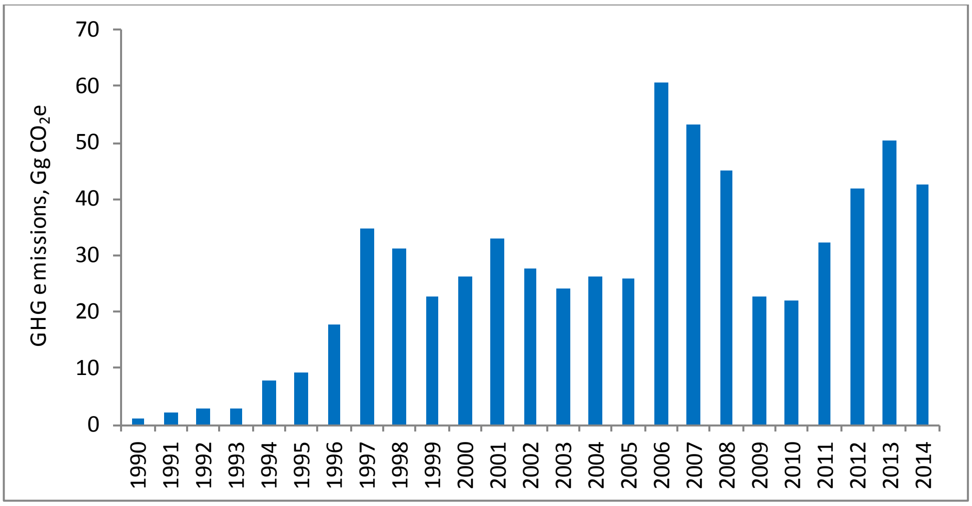

Figure 3-6: GHG emissions from international aviation bunkers for the period 1990-2014

From the trend of GHG emissions in international aviation bunkers can be seen two major rises and declines. On the one hand along the economic growth and downturn international and domestic flight numbers are changing and this has an influence to the GHG emissions in this sector. The sharp rise from 2005 to 2006 caused by:

- Eznis Airways LLC was established on January 6th 2006 with the investment of Newcom Group which is one the biggest groups in Mongolia, and imported the airplane SAAB-340B which was produced in Sweden. It has started its operation officially for the domestic flights. Thus the domestic flight number has been increased.
- In 2006 total passenger transportation increased by 16% than previous year.

The sharp decline from 2008 to 2009 caused by:

- World economic downturn,
- Growth of the U.S. dollar compared to national currency,
- Increase of fuel prices,
- Aero Mongolia LLC stopped its operation for the domestic flights due to lack of aircraft and was suspended in 2009,
- Due to these the passenger transportation decreased by 11%.

According to IPCC 2006 the Tier 1 and Tier 2 methods use fuel consumption data. Tier 1 is purely fuel based, while Tier 2 method is based on the number of landing/take-off cycles (LTOs) and fuel use. Tier 3 uses movement data for individual flights.

In the case of Mongolia, the jet fuel consumption and sold data were not available for the period of 1990-2014. Therefore the number of LTOs has been used for the GHG emissions from jet fuel consumption.

The GHG emissions estimation was performed based on the flight numbers, which were requested from the MCAA. The activity data is basically the international flight numbers of LTO cycles and domestic flight numbers. The international LTO cycles and domestic flight numbers were added together and from this the percentages have been calculated. These percentages of international LTOs and domestic flight numbers were multiplied with the numbers of imported jet fuel amount and this way the fuel consumption for international and domestic aviation has been estimated.

The one of two jet fuel trading companies the A-Jet Limited LLC was founded in 2004, with the activity operations such as crude oil (incl. jet fuel) imports and activities in agricultural and mining sectors. The activity data request from A-Jet Limited LLC on jet fuel sold was requested for the period 1990-2014, but we received data for the period 2004-2014. For the remaining years 1990-2003 there are 14 years to estimate missing years with a long term extrapolation which is not a good practice. Thus after a consultation with experts, for time series consistency it was decided to use flight numbers to estimate and calculate from it the fuel consumption for international and domestic aviation.

The overview of the jet fuel consumption and GHG emissions during 1990-2014 is presented in the Table 3-4.

Table 3-4: The jet fuel consumption and GHG emissions in international flights for the period 1990-2014

Year	*Jet kerosene*				
	Consumption (kt)	*GHG emissions*			
		CO_2 (t)	*CH_4 (t)*	*N_2O (t)*	*CO_2e (t)*
1990	0.3	945.95	0.0066	0.0265	954.29
1991	0.7	2,207.21	0.0154	0.0617	2,226.67
1992	1.0	2,837.84	0.0198	0.0794	2,862.86
1993	1.0	2,837.84	0.0198	0.0794	2,862.86
1994	2.7	7,882.88	0.0551	0.2205	7,952.39
1995	2.9	9,144.14	0.0639	0.2558	9,224.77
1996	5.6	17,657.64	0.1235	0.4939	17,813.35
1997	10.8	34,369.34	0.2403	0.9614	34,672.41
1998	9.5	30,900.87	0.2161	0.8644	31,173.36
1999	6.9	22,702.68	0.1588	0.6350	22,902.88
2000	8.3	26,171.15	0.1830	0.7321	26,401.93
2001	10.4	32,792.76	0.2293	0.9173	33,081.93
2002	8.7	27,432.41	0.1918	0.7673	27,674.31
2003	7.6	23,963.94	0.1676	0.6703	24,175.26
2004	8.3	26,171.15	0.1830	0.7321	26,401.93
2005	8.1	25,540.52	0.1786	0.7144	25,765.74
2006	19.1	60,225.17	0.4212	1.6846	60,756.24
2007	16.7	52,657.61	0.3682	1.4729	53,121.95
2008	14.2	44,774.73	0.3131	1.2524	45,169.56
2009	7.2	22,702.68	0.1588	0.6350	22,902.88
2010	6.9	21,756.74	0.1521	0.6086	21,948.59
2011	10.2	32,162.13	0.2249	0.8996	32,445.74
2012	13.2	41,621.58	0.2911	1.1642	41,988.61
2013	15.9	50,135.09	0.3506	1.4024	50,577.19
2014	13.4	42,252.21	0.2955	1.1819	42,624.80

3.3 Comparison of the Sectorial Approach (SA) with the Reference Approach (RA)

In the context of international climate protection, the reporting on fuel combustion related CO_2 emissions due to the dominant share of the total emissions are of the utmost importance.

The Reference Approach (RA) is a top-down approach, using a country's energy supply data to calculate the CO_2 emissions from mainly fossil fuels combustion. The RA is a straightforward method that can be applied on the basis of relatively easily available energy supply statistics. Excluded carbon has increased the requirements for data to some extent. However, improved comparability between the sectorial and reference approaches continues to allow a country to produce a second independent estimate of CO_2 emissions from fuel combustion with limited additional effort and data requirements (IPCC, 2006).

The RA is designed to calculate the emissions of CO_2 from fuel combustion, starting from high level energy supply data. The assumption is that carbon is conserved so that, for example, carbon in crude oil is equal to the total carbon content of all the derived products. The RA does not distinguish between different source categories within the energy sector and only total CO_2 emissions from source category fuel combustion (CRF 1.A) (IPCC, 2006).

The RA has been executed for all inventory years from 1990 until 2014. The basis for this is essentially provided by the figures for the national energy balances on primary energy consumption, but in the case of Mongolia it is provided by coal balances of national and IEA statistics.

The results of the RA are summarized and compared with SA in the Tables 3-5→ 3-7 below. The difference of energy consumption for total fuels between the RA and SA gives an average deviation of -0.35% over all years and the average difference of CO_2 emissions between RA and SA is 2.29% over all years.

Based on the IPCC methodology, RA in apparent consumption of fuels was estimated after consideration of carbon stored in iron and steel industry.

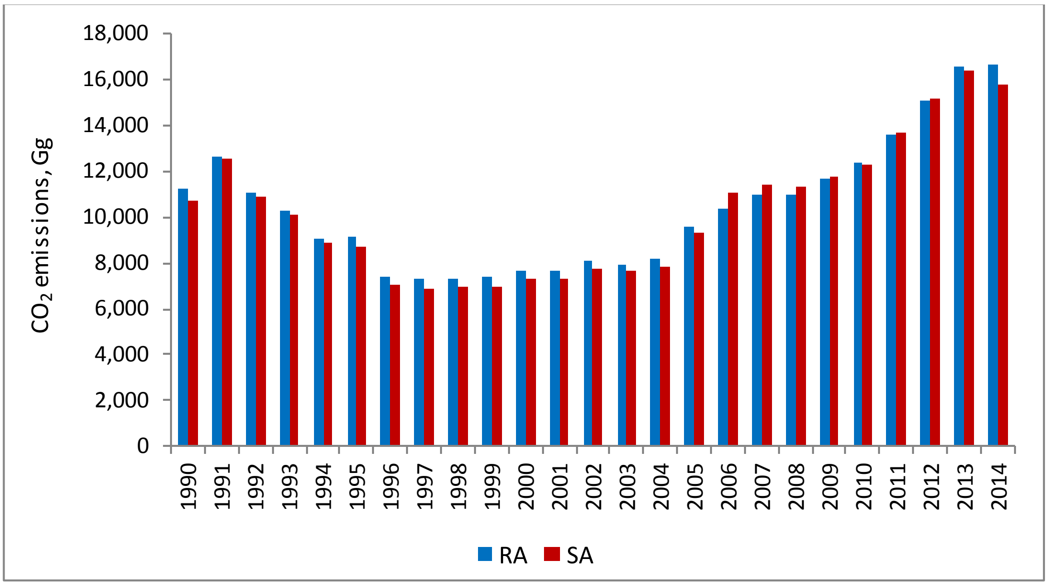

Figure 3-7: The difference of CO_2 emissions between RA and SA in 1990-2014

Table 3-5: The comparison of total fuel consumption and CO_2 emissions between RA and SA for the period 1990-2014

TOTAL FUELS						
	Apparent Energy Consumption			CO_2 emissions		
Year	RA (TJ)	SA (TJ)	Difference %	RA CO_2 (Gg)	SA CO_2 (Gg)	Difference %
1990	137,312.42	136,430.15	0.65	11,234.82	10,708.95	4.91
1991	147,957.96	150,388.18	-1.62	12,674.82	12,541.04	1.07
1992	129,027.17	130,890.31	-1.42	11,079.67	10,937.80	1.30
1993	121,033.16	122,856.91	-1.48	10,272.93	10,147.22	1.24
1994	106,627.62	107,239.71	-0.57	9,096.13	8,863.87	2.62
1995	106,608.77	105,372.69	1.17	9,106.81	8,682.22	4.89
1996	91,116.19	91,288.07	-0.19	7,400.60	7,057.21	4.87
1997	89,902.21	89,052.48	0.95	7,339.20	6,883.86	6.62

1998	89,870.64	90,592.98	-0.80	7,293.79	6,990.16	4.34
1999	91,211.79	90,005.59	1.34	7,416.73	6,948.19	6.74
2000	94,752.00	94,540.75	0.22	7,680.28	7,286.77	5.40
2001	94,297.04	94,422.40	-0.13	7,629.53	7,277.09	4.84
2002	100,371.09	100,851.84	-0.48	8,114.02	7,773.66	4.38
2003	98,275.27	99,540.71	-1.27	7,919.59	7,659.60	3.39
2004	101,319.19	101,587.35	-0.26	8,155.22	7,814.70	4.36
2005	114,909.50	115,737.16	-0.72	9,590.83	9,346.90	2.61
2006	130,004.54	134,124.80	-3.07	10,358.95	11,075.92	-6.47
2007	137,020.33	139,987.17	-2.12	11,024.58	11,404.37	-3.33
2008	137,672.49	140,092.57	-1.73	11,007.44	11,349.22	-3.01
2009	142,888.66	144,020.50	-0.79	11,711.85	11,736.51	-0.21
2010	151,668.74	151,212.86	0.30	12,342.64	12,252.67	0.73
2011	166,012.17	167,091.63	-0.65	13,620.94	13,691.49	-0.52
2012	184,084.79	185,236.55	-0.62	15,057.57	15,141.55	-0.56
2013	201,480.46	200,508.20	0.49	16,599.95	16,363.23	1.45
2014	201,537.15	193,882.93	3.95	16,644.69	15,770.14	5.55

Table 3-6: The comparison of solid fuel consumption and CO_2 emissions between RA and SA for the period 1990-2014

SOLID FUELS						
	Apparent Energy Consumption			CO_2 emissions		
Year	RA (TJ)	SA (TJ)	Difference %	RA CO_2 (Gg)	SA CO_2 (Gg)	Difference %
1990	103,863.39	102,981.12	0.86	8,821.35	8,294.87	6.35
1991	123,576.00	126,006.22	-1.93	10,906.32	10,772.06	1.25
1992	110,277.96	112,141.10	-1.66	9,730.79	9,588.63	1.48
1993	98,150.67	99,974.42	-1.82	8,609.25	8,483.06	1.49
1994	90,972.87	91,584.96	-0.67	7,967.27	7,734.75	3.01
1995	91,272.12	90,036.04	1.37	8,008.37	7,583.57	5.60
1996	75,066.90	75238.78	-0.23	6,250.59	5,906.98	5.82
1997	74445.93	73,596.20	1.15	6,229.10	5,773.53	7.89
1998	73,111.14	73,833.48	-0.98	6,094.22	5,790.36	5.25
1999	74,512.02	73,305.82	1.65	6,218.51	5,749.70	8.15
2000	76,368.39	76,157.14	0.28	6,367.22	5,973.46	6.59
2001	75,658.20	75,783.56	-0.17	6,295.45	5,942.74	5.94
2002	80,424.51	80,905.26	-0.59	6,688.16	6,347.52	5.37
2003	76,352.94	77,618.38	-1.63	6,350.82	6,090.50	4.27
2004	77,180.34	77,448.50	-0.35	6,424.53	6,083.62	5.60
2005	91,281.72	92,109.38	-0.90	7,895.21	7,650.88	3.19
2006	103,125.51	107,245.77	-3.84	8,429.23	9,145.74	-7.83
2007	103,693.08	106,659.92	-2.78	8,630.68	9,009.91	-4.21
2008	101,494.95	104,380.33	-2.76	8,406.76	8,782.05	-4.27
2009	110,159.01	111,290.85	-1.02	9,356.06	9,380.12	-0.26
2010	116,974.11	116,518.23	0.39	9,833.49	9,742.80	0.93
2011	122,853.78	123,933.24	-0.87	10,493.72	10,563.34	-0.66
2012	134,888.19	136,039.95	-0.85	11,497.96	11,580.91	-0.72
2013	150,228.96	149,256.70	0.65	12,886.37	12,648.53	1.88
2014	152,924.67	145,270.45	5.27	13,133.01	12,257.48	7.14

Table 3-7: The comparison of liquid fuel consumption and CO_2 emissions between RA and SA for the period 1990-2014

LIQUID FUELS						
	Apparent Energy Consumption			CO_2 emissions		
Year	RA (TJ)	SA (TJ)	Difference %	RA CO_2 (Gg)	SA CO_2 (Gg)	Difference %
1990	33,449.03	33,449.03	0.00	2,413.48	2,414.08	-0.03
1991	24,381.96	24,381.96	0.00	1,768.50	1,768.98	-0.03
1992	18,749.21	18,749.21	0.00	1,348.88	1,349.18	-0.02
1993	22,882.49	22,882.49	0.00	1,663.68	1,664.16	-0.03
1994	15,654.75	15,654.75	0.00	1,128.86	1,129.11	-0.02
1995	15,336.65	15,336.65	0.00	1,098.44	1,098.65	-0.02
1996	16,049.29	16,049.29	0.00	1,150.02	1,150.24	-0.02
1997	15,456.28	15,456.28	0.00	1,110.10	1,110.33	-0.02

1998	16,759.50	16,759.50	0.00	1,199.58	1,199.80	-0.02
1999	16,699.77	16,699.77	0.00	1,198.22	1,198.48	-0.02
2000	18,383.61	18,383.61	0.00	1,313.06	1,313.31	-0.02
2001	18,638.84	18,638.84	0.00	1,334.08	1,334.35	-0.02
2002	19,946.58	19,946.58	0.00	1,425.85	1,426.14	-0.02
2003	21,922.33	21,922.33	0.00	1,568.78	1,569.10	-0.02
2004	24,138.85	24,138.85	0.00	1,730.70	1,731.08	-0.02
2005	23,627.78	23,627.78	0.00	1,695.63	1,696.02	-0.02
2006	26,879.03	26,879.03	0.00	1,929.72	1,930.17	-0.02
2007	33,327.25	33,327.25	0.00	2,393.90	2,394.46	-0.02
2008	36,177.54	35,712.24	1.30	2,600.68	2,567.18	1.31
2009	32,729.65	32,729.65	0.00	2,355.79	2,356.39	-0.03
2010	34,694.63	34,694.63	0.00	2,509.15	2,509.87	-0.03
2011	43,158.39	43,158.39	0.00	3,127.22	3,128.15	-0.03
2012	49,196.60	49,196.60	0.00	3,559.62	3,560.65	-0.03
2013	51,251.50	51,251.50	0.00	3,713.58	3,714.70	-0.03
2014	48,612.48	48,612.48	0.00	3,511.67	3,512.66	-0.03

3.4 Methodological issues

3.4.1 Methods used

The current submission of Mongolia's GHG inventory was conducted using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) and software. Tier 1 and Tier 2 methods, default and country specific emission factors (EFs) and net calorific values (NCVs) were used for the GHG emissions estimation from energy sector.

3.4.2 Emission factors (EFs) and net calorific values (NCVs) used

The net calorific values (NCVs) for some coal types were estimated by national experts, e.g. the country specific NCVs for coking coal, sub-bituminous coal, lignite and brown coal briquettes were taken from the report "Studies on country specific GHG emission and removal factors for Mongolia", 2014. This report is the output of 2 years research project, which has been implemented for the period 2011-2013 and published in 2014, by the order of the Ministry of Environment and Green Development (MEGD) of Mongolia. This project was the first project in Mongolia which studied and estimated the country specific emission factors (EFs) for some type of coal in energy sector, EFs for some type of animals in agriculture sector and the waste generation rate, the composition of waste and the fraction of municipal solid waste (MSW) disposed to solid waste disposal sites (SWDS) in waste sector in Mongolia. These country specific EFs were taken for GHG emissions estimations of energy and waste sectors. NCVs for other liquid fuels were taken as the default values from the IPCC 2006.

Same as NCVs for some coal type the country specific emission factors for CO_2 were estimated by national experts and can be found in the above mentioned report. The emission factors of all fuels (solid and liquid) for CH_4 and N_2O were used the default values from IPCC 2006.

In the Table 3-8 below there are listed the EFs and NCVs used in GHG inventory estimation.

Table 3-8: The NCVs and CO_2 EFs which used in GHG inventory estimation

Fuel types	*Net calorific values (NCVs), TJ/Gg*		*CO_2 emission factors for combustion, kg/TJ*	
	Default (IPCC 2006)	*CS (Namkhainyam B. et al.)*	*Default (IPCC 2006)*	*CS (Namkhainyam B. et al.)*
LIQUID FOSSIL				
Crude oil	42.3	42.3	73,300	73,300
Gasoline	44.3	44.3	69,300	69,300
Jet kerosene	44.1	44.1	71,500	71,500
Gas/Diesel oil	43.0	43.0	74,100	74,100

Residual fuel oil	40.4	40.4	77,400	77,400
Lubricants	40.2	40.2	73,300	73,300
SOLID FOSSIL				
Coking coal	28.2	21.7	94,600	93,800
Other bit. coal	25.8	25.8	94,600	94,600
Sub-bit. coal	18.9	23.6	96,100	87,300
Lignite	11.9	14.4	101,000	77,900
Coke oven coke	28.2	28.2	107,000	107,000
SOLID BIOMASS				
Wood/wood waste	15.6	15.6	112,00	112,000

Note: CS=Country specific factors estimated only for solid fuels (e.g. coal types).
Source: 1. 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006); 2. Research report "Studies on country specific GHG emission and removal factors for Mongolia" Namkhainyam B. et al., 2014.

3.5 Sector specific recalculations

The previous GHG inventory estimations have been conducted in accordance with revised IPCC 1996 guidelines, but starting with the preparation of iBUR inventory team has decided to change the methodology to 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006). The aim of the change is: a) to improve quality of GHG inventory; b) comparability with other countries, c) accuracy and analysis of the activity data, d) choice of default emission factors.

In the previous GHG inventories (e.g. estimated during the submission of SNC) the consumption of lubricants was calculated under the fuel combustion category, but for this inventory it was calculated under the non-energy products from fuels and solvent use category (CRF 2.D) of IPPU sector. Thus the results from the base year 1990 over the years between two methodologies differ slightly, namely the emissions from previous inventory which calculated by using the revised IPCC 1996 are slightly higher than the emissions which calculated by using IPCC 2006. This can be explained by the difference of NCVs, EFs and activity data used. The table below shows the recalculated GHG emissions of initial Biennial update report (iBUR) compared to Second national communication (SNC).

Table 3-9: Recalculated GHG emissions from energy sector for the period 1990-2006

Category	*Total emissions from energy sector, Gg CO_2e*								
	1990	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006**
SNC	12,529	8,710	8,865	9,063	9,418	9,023	9,247	9,635	10,220
iBUR	11,091	8,921	7,529	7,547	8,069	7,967	8,125	9,738	11,503
Difference compared to SNC, %	-11.48	2.42	-15.07	-16.73	-14.32	-11.70	-12.13	1.07	12.55

*Note: SNC=Second national communication (emissions estimated using revised IPCC 1996), iBUR=Initial biennial update report (emissions estimated using IPCC 2006). *The year 2006 is the last inventory year of SNC.*

3.6 Sector specific QA/QC and verification

In accordance with IPCC 2006, volume 1, chapter 6 the quality control (QC) has been done within the inventory team. Sector specific QA/QC plan is based on the general QA/QC rules and activities in specific categories. The sector specific QC activities were performed directly during the GHG emissions calculation (the GHG emissions calculation has been done by the 2006 IPCC Inventory Software) such as checking several data sources and data inputs into the software, including the QC for the EFs and other parameters as well.

The main source of activity data of GHG emissions estimation is the National statistics office of Mongolia (NSO). Generally the NSO collects and consolidates data from organizations/institutions and producers by questionnaires in national level.

For the activity data collection of GHG emissions estimation the questionnaires, in the form of official letters, were sent to the relevant government and private organizations/institutions in order to compare and ensure with data from NSO. The data collected and published by NSO from the relevant government and private organizations/institutions, in most cases differs from the data directly provided by those organizations/institutions. The IPCC 2006 recommends if there are available several sources of the activity data, it's a good practice to follow the data from national statistics.

3.7 Sector specific planned improvements

Especially in this sector the energy balance table and the disaggregation of the fuel consumption (e.g. coal disaggregation, liquid fuel disaggregation in the transport source category and jet fuel consumption in international and domestic aviation) is very important. Mongolia does not have a proper energy balance table, but the experts of energy sector going to develop it in the near future. Mongolia has just started a project with Japan through the Japan International Cooperation Agency (JICA) on Mongolia's GHG inventory system improvement and capacity building. The duration of the project is from the end of 2017 until early 2020. With the implementation of this project it's planned to improve the Mongolia's GHG inventory system, the institutional arrangement of GHG inventory, data collection process, capacity building, and all these issues should be applied specifically in energy (the energy balance table will be in some part developed) and LULUCF sectors.

CHAPTER 4: INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)

4.1 Sector overview

The GHG emissions from IPPU sector cover emissions estimation from mineral industry (CRF 2.A), metal industry (CRF 2.C), non-energy products from fuels and solvent use (CRF 2.D), and product uses as substitutes for ozone depleting substances (CRF 2.F). The rest of the activities under IPPU sector were excluded from the inventory because they either do not occur in Mongolia or there was no sufficient data to use. For example, the chemical and electronics industries are not occurring in Mongolia. The CO_2 and HFCs were the main direct GHGs estimated and reported under IPPU sector.

4.2 Summary of the IPPU sector activities

The main contributor to the total emissions from IPPU sector is the mineral industry (cement and lime production). The share of mineral industry in the total GHG emissions of IPPU sector was around 69% in 2014. As a second contributor to the total emissions were the emissions from use of fluorinated substitutes for ozone depleting substances (CRF 2.F) and represents around 29% (see Figure 4-1).

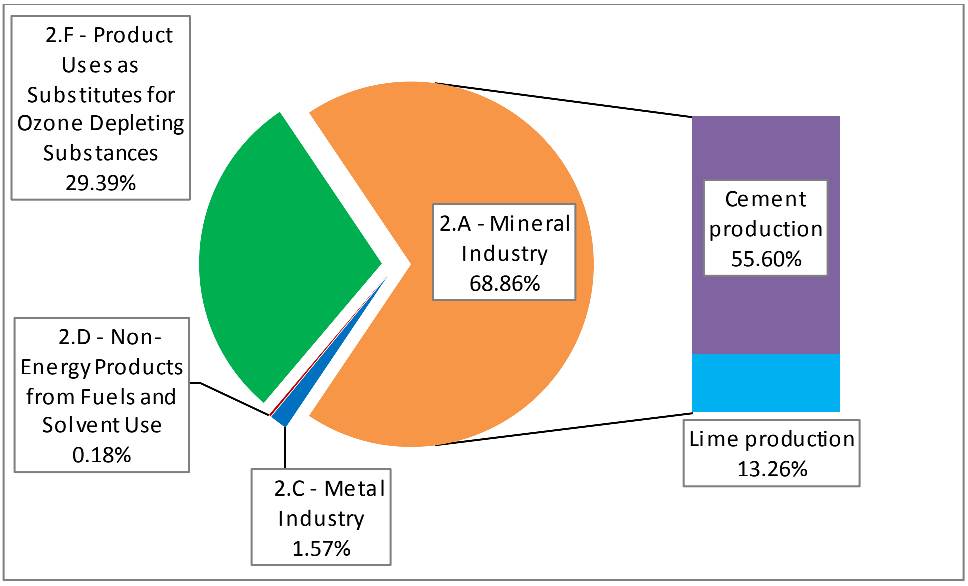

Figure 4-1: The share of each subsector in total GHG emissions of IPPU, 2014

Next table below provides the GHG emissions and percentages of IPPU categories.

Table 4-1: GHG emissions from IPPU by source categories, Gg CO_2e

Categories	Emissions	1990	1995	2000	2005	2010	2014
Mineral Industry	Gg	206.34	78.62	62.02	134.15	209.20	225.89
	%	*94.36*	*94.93*	*96.99*	*95.51*	*83.14*	*68.86*
Metal Industry	Gg	0	1.25	1.04	5.24	5.14	5.15
	%	*0*	*1.51*	*1.63*	*3.73*	*2.04*	*1.57*
Non-energy Products from Fuels and Solvent Use	Gg	12.32	2.95	0.88	1.06	1.77	0.59
	%	*5.64*	*3.56*	*1.38*	*0.76*	*0.70*	*0.18*
Product Uses as Substitutes for Ozone Depleting Substances	Gg	0	0	0	0	35.53	96.43
	%	*0*	*0*	*0*	*0*	*14.12*	*29.39*
IPPU Total	Gg	218.66	82.81	63.95	140.46	251.63	328.06
	%	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*

According to the table above, the metal industry occurs in Mongolia since 1995 and GHG emissions from this source category for the period 1990-1995 have not been estimated. Regarding the GHG emissions from product uses as substitutes for ozone depleting substances the activity data were available only from 2012, so the emissions have been back-calculated to the year introduction. According to IPCC 2006, volume 3, part 2, if there is Tier 1 method was applied for emissions estimation from HFCs then it back-calculates the development of banks of a refrigerant from the current reporting year to the year of its introduction. The year of introduction for HFC-134a (mobile air conditioning) was 2007.

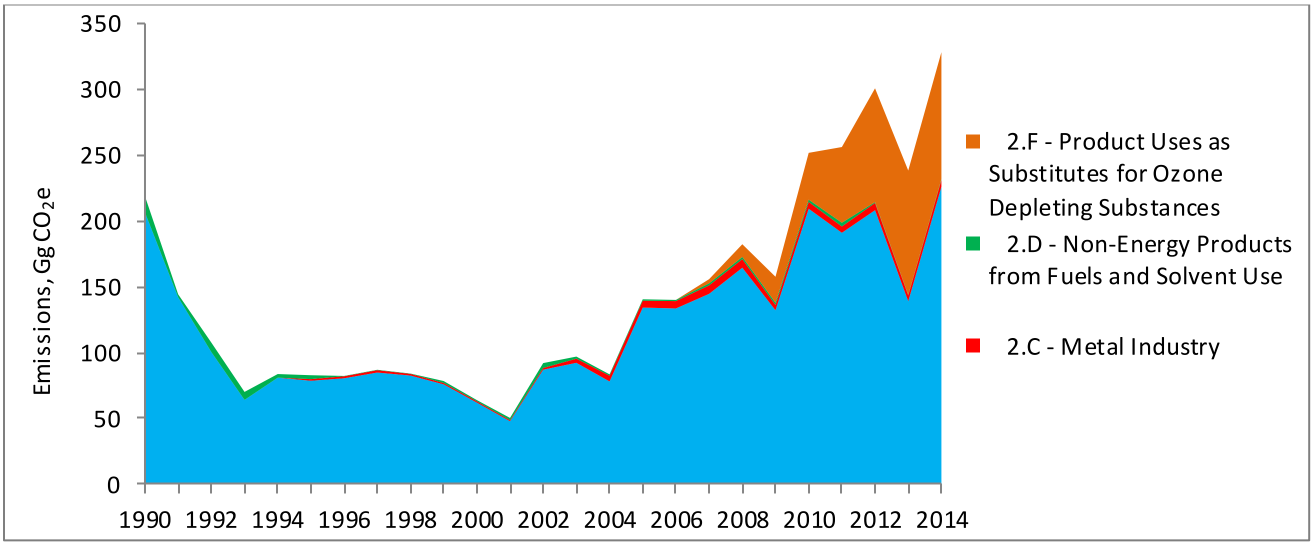

Figure 4-2: GHG emissions from IPPU sector by source categories, Gg CO_2e

From the Figure 4-3 can be seen two major rises in 2010 and in 2014. In Mongolia there were two main cement plants operating until 2013 namely Darkhan cement plant, built in 1968 and Khutul cement plant, built in 1982. Both had a wet cement processing technology. In 2014, the Khutul cement plant introduced the dry processing technology and started its operations generating capacity of 1 million tons of cement per year. From 2008-2009 there was an economic downturn in Mongolia and after this in 2010 the economy has grown back.

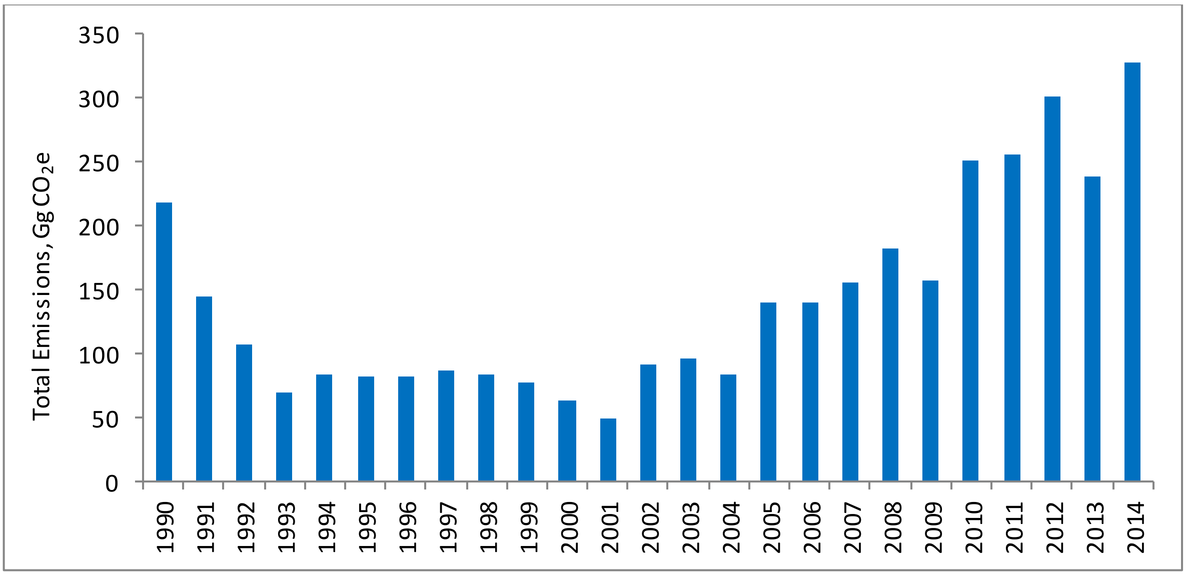

Figure 4-3: Total GHG emissions from IPPU sector over the years 1990-2014, Gg CO_2e

Table 4-2: Total GHG emissions from IPPU sector over the years 1990-2014, Gg CO_2e

Years	*Emissions, Gg CO_2e*				
	2.A-Mineral industry	*2.C-Metal industry*	*2.D-Non-energy products from fuels and solvent use*	*2.F-Product uses as substitutes for ozone depleting substances*	*Total IPPU*
1990	206.34	0	12.32	0	218.66
1991	141.99	0	2.24	0	144.23
1992	100.37	0	7.19	0	107.57
1993	64.08	0	6.07	0	70.15
1994	80.94	0	2.77	0	83.71

1995	78.62	1.25	2.95	0	82.81
1996	80.49	1.54	0.24	0	82.26
1997	84.84	1.82	0.29	0	86.95
1998	82.55	1.30	0.24	0	84.09
1999	75.88	1.05	1.47	0	78.41
2000	62.02	1.04	0.88	0	63.95
2001	47.88	0.80	1.71	0	50.39
2002	87.04	1.27	3.71	0	92.03
2003	92.24	3.14	1.59	0	96.97
2004	78.08	4.39	1.00	0	83.47
2005	134.15	5.24	1.06	0	140.46
2006	133.50	5.60	0.88	0	139.99
2007	144.60	6.43	1.53	3.17	155.73
2008	164.44	6.51	1.65	9.67	182.27
2009	132.11	4.01	1.71	19.73	157.57
2010	209.20	5.14	1.77	35.53	251.63
2011	190.95	4.80	2.83	57.47	256.05
2012	208.12	5.45	0.65	86.42	300.64
2013	138.95	4.48	0.29	94.48	238.21
2014	225.89	5.15	0.59	96.43	328.06

Source: GHG Inventory prepared by CCPIU under MET.

4.2.1 Mineral Industry (CRF 2.A)

The mineral industry of Mongolia covered cement and lime productions. As stated above the share of mineral industry in the IPPU sector was relatively high (94%) from the base year and over the years it has been slightly declined (69%) until 2014, because in this year the shares of other source categories (e.g. metal industry and the use of F-gases) has been increased. Cement and lime production share the emissions of the mineral industry respectively 56% and 13%.

Cement is manufactured from limestone through a closely controlled chemical combination of calcium, silicon, aluminium, iron and other ingredients. During the cement production process, calcium carbonate ($CaCO_3$) is heated in a cement kiln at high temperature about 1,450°C to form lime and CO_2 in a process known as calcination. As next, the lime is combined with silica-containing materials to produce clinker (an intermediate product), with the earlier by-product CO_2 being released to the atmosphere. The clinker is then allowed to cool, mixed with a small amount of gypsum and potentially other materials (e.g. slag), and used to make a Portland cement.

Until 2013 two main cement plants were operating in Mongolia, namely Darkhan cement plant which built in 1968 and Khutul cement plant built in 1982. These two plants used a wet-processing technology for cement production until 2014. From 2014 they shifted the technology from wet- to dry-processing as a result of implementation of Mongolia's Nationally Appropriate Mitigation Actions (NAMAs). Khutul cement plant capacity increased to one million tons of cement per year with the new processing technology. However Mongolia does not meet its cement demand as shown in the Figure 4-4.

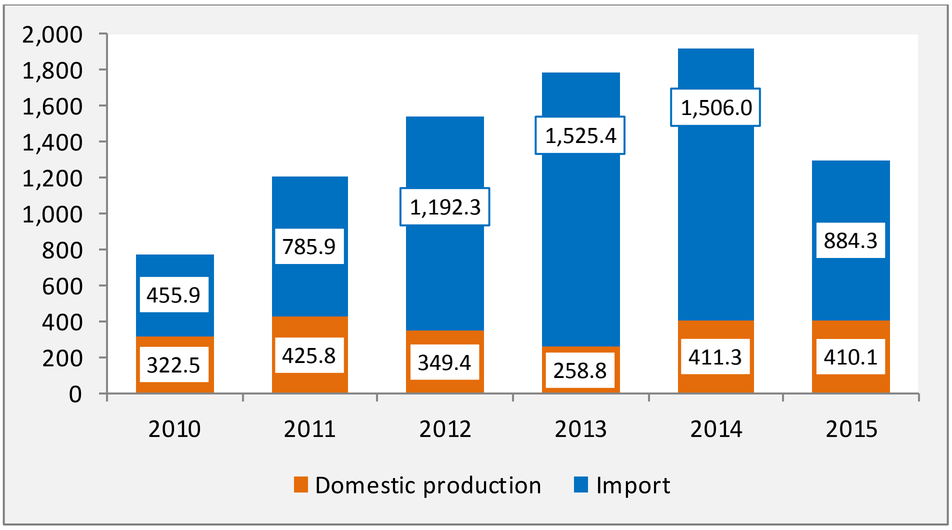

Figure 4-4: Cement consumption in thousand tons

Source: GHG Inventory prepared by CCPIU under MET.

The GHG emissions have been estimated not from directly cement production, but from clinker production. The activity data for cement production has been provided by the Ministry of Industry (MOI, former) by official letter and survey. MOI collects from producers the limestone extraction, clinker and cement production data in thousand tons. The extracted limestone is the main raw material in the clinker production. According to experts of MOI, since the limestone is the main ingredient of clinker, to get a clinker data the limestone should be decreased by 1.6 times. The CO_2 emissions from cement (clinker) and lime production can be seen from Table 4-3.

Table 4-3: GHG emissions from Mineral Industry source category of IPPU sector

Categories	*CO_2 Emissions from Mineral industry, Gg CO_2e*												
	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
Cement production	129.09	84.77	49.52	25.68	31.14	40.07	39.47	41.64	40.70	38.68	34.27	25.30	55.16
Lime production	77.25	57.23	50.85	38.40	49.80	38.55	41.03	43.20	41.85	37.20	27.75	22.58	31.88
TOTAL	206.34	141.99	100.37	64.08	80.94	78.62	80.49	84.84	82.55	75.88	62.02	47.88	87.04
Categories	*CO_2 Emissions from Mineral industry, Gg CO_2e*												
	2003	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	
Cement production	60.66	55.58	73.25	88.20	112.12	123.34	99.79	171.55	156.97	156.97	96.43	182.39	
Lime production	31.58	22.50	60.90	45.30	32.48	41.10	32.33	37.65	33.98	51.15	42.53	43.50	
TOTAL	92.24	78.08	134.15	133.50	144.60	164.44	132.11	209.20	190.95	208.12	138.95	225.89	

4.2.2 Metal Industry (CRF 2.C)

The metal industry source category has covered the iron and steel production. Other metallurgical productions are not occurring in Mongolia. Steel production occurs in Mongolia in secondary facilities, which produce steel mainly from recycled steel scrap, not from iron ore. This kind of steelmaking occurs in electric arc furnaces (EAFs). The majority of CO_2 emissions from this sector come from the utilization of metallurgical coke in the production of pig iron and from the consumption of other process by-products at the iron and steel mill. Activity data on iron and steel production (production of cast steel[6] and steel bloom[7]) were obtained from the National statistics

[6] *Cast steel = Ган цувимал*

office of Mongolia (NSO) which collects data from producers. According to experts' judgment, the data on steel bloom have been taken for the CO_2 emissions estimation from steel production in EAFs. The default EFs and Tier 1 method of IPCC 2006 were used for emissions estimations from metal industry. The iron and steel production contributes to the total emissions from IPPU sector around 2% (see Figure 4-1, Table 4-4).

Table 4-4: GHG emissions from Metal Industry source category of IPPU sector

Categories	*CO_2 Emissions from Metal industry, Gg CO_2e*												
	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
Iron & Steel production	0	0	0	0	0	1.25	1.54	1.82	1.30	1.05	1.04	0.80	1.27
TOTAL	0	0	0	0	0	1.25	1.54	1.82	1.30	1.05	1.04	0.80	1.27
Categories	*CO_2 Emissions from Mineral industry, Gg CO_2e*												
	2003	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	
Iron & Steel production	3.14	4.39	5.24	5.60	6.43	6.51	4.01	5.14	4.80	5.45	4.48	5.15	
TOTAL	3.14	4.39	5.24	5.60	6.43	6.51	4.01	5.14	4.80	5.45	4.48	5.15	

4.2.3 Non-energy products from fuels and solvent use (CRF 2.D)

In this source category have been included only GHG emissions from lubricant use in industrial and transport applications. Mongolia imports the lubricants, because there are no oil refineries. Lubricants can be used for a variety of purposes, namely motor oils and industrial oils, greases which differ in terms of physical characteristics, and commercial applications. It's complicated to determine which fraction of lubricant consumed in machinery and in vehicles is actually combusted and emitted CO_2 emissions. Therefore it has been assumed that all amount of imported lubricants consumed as motor and industrial oils. This assumption is that all amount of lubricant imported is consumed in the same year. The CO_2 emissions from this source category can be seen from Table 4-5 below.

Table 4-5: GHG emissions from Non-energy products from fuels and solvent use source category of IPPU sector

Categories	*CO_2 Emissions from Metal industry, Gg CO_2e*												
	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
Lubricant use	12.32	2.24	7.19	6.07	2.77	2.95	0.24	0.29	0.24	1.47	0.88	1.71	3.71
TOTAL	12.32	2.24	7.19	6.07	2.77	2.95	0.24	0.29	0.24	1.47	0.88	1.71	3.71
Categories	*CO_2 Emissions from Mineral industry, Gg CO_2e*												
	2003	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	
Lubricant use	1.59	1.00	1.06	0.88	1.53	1.65	1.71	1.77	2.83	0.65	0.29	0.59	
TOTAL	1.59	1.00	1.06	0.88	1.53	1.65	1.71	1.77	2.83	0.65	0.29	0.59	

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

Hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) are serving as alternatives to ozone depleting substances (ODS) being phased out under the Montreal Protocol. Current and expected application areas of HFCs and PFCs include:

- refrigeration and air conditioning;
- fire suppression and explosion protection;
- aerosols;

[7] *Steel bloom = Ган бэлдэц*

- solvent cleaning;
- foam blowing agents; and
- other applications.

In Mongolia the emissions from this source category include HFCs emissions from following application areas:

- refrigeration (stationary, mobile) and air conditioning (stationary, mobile);
- fire suppression and explosion protection; and
- foam blowing agents.

Mongolia is an importing country of above mentioned applications. The emissions from the fluorinated substitutes for ODS were estimated from following HFCs such as HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a and HFC-152a in Mongolia.

The HFCs consumption inventory was conducted in accordance with terms of reference on "Conducting HFCs Inventory and Survey of ODS Alternatives", approved by the Decree No. A/185 of State Secretary of MEGDT (former MET), dated on 26th May 2016. This inventory was done by National Ozone Authority (NOA) of the Ministry of Environment and Tourism (MET) of Mongolia in cooperation with United Nations Environmental Program (UNEP) and Climate and Clean Air Coalition-HFC Initiative (CCAC) for the period 2012-2015.

The consumption of HFCs was taken from Table 1 of the project "Report for HFC inventory and identification of opportunities for introduction of low-GWP alternatives in Mongolia". Following table provides the main applications areas for HFCs which have been counted in Mongolia.

Table 4-6: Main application areas for HFCs in Mongolia

Application areas		*Chemicals*					
		HFC-23	*HFC-32*	*HFC-125*	*HFC-134a*	*HFC-143a*	*HFC-152a*
Refrigeration	*Domestic*				x		
	Commercial			x	x	x	
	Large systems			x	x	x	
	Transport				x		
	Industrial chiller				x		
Air Conditioning	*Residential and commercial*		x	x	x		
	Other		x	x	x		
	Chillers		x	x	x		
	Mobile				x		
Aerosols	*Medical*				x		
Foam Blowing Agents	*Extruded Polystyrene*						x
Fire Protection				x			

Table 4-7: Total consumption of HFCs and low-GWP alternatives for the period 2012-2015 in Mongolia, million tons

Application areas		*Substances*	*Year*				*Total, million t*
			2012	*2013*	*2014*	*2015*	
Refrigeration	Domestic	R-600a	2.0420	3.3630	1.9720	1.0210	8.3980
		HFC-134a	4.3740	3.9640	3.7020	1.3400	13.3800
		R-602	0	0.0002	0.0004	0	0.0010
		R-600	0	0.0009	0.0042	0.0025	0.0080
		R-413A	0	0.0001	0	0	0.0001
		R-601a	0	0.0071	0	0	0.0070
	Commercial	R-600a	1.1990	1.7930	0.6930	0.3920	4.0770
		HFC-134a	0.3700	2.6060	1.2350	0.7930	5.0030
		R-744	34.4600	25.0980	727.7600	1,040.5200	1,827.8400
		R-404A	6.7100	0.3311	0.5490	0.3470	7.9370

		R-410A	0	0.0005	0	0	0.0010
		R-170	0	0.0008	0.0016	0.0037	0.0060
		R-508B	0	0.0003	0	0.0155	0.0160
		R-508A	0	0	0.0014	0	0.0010
		R-507	0.00011	0	0	0.0388	0.0390
		R-764	1.3460	0	0	1.0820	2.4290
		R-704	297.0000	397.1400	21.3800	2,226.0500	2,941.5700
	Large systems	R-404A	0.3080	0.0149	0.0033	0.0336	0.3600
		R-717	39.2920	18.8100	4.1800	42.2180	104.5000
		R-507	1.5050	0.7130	0.0160	0.1620	2.3960
	Transport refrigeration	HFC-134a	0.1400	0.1930	0.0890	0	0.4230
	Industrial chillier	HFC-134a	0	0.1370	0	0	0.1370
		R-717	0	8.5600	0	0	8.5600
Air-conditioning	Room air-conditioning	R-410A	9.6090	2.9300	4.9150	0.5500	18.0000
		R-407C	0	0	0.0010	0.0100	0.0110
	Other air-conditioning	R-410A	0.3940	0.3010	0.4920	0.1780	1.3650
		R-407C	0.0033	0	0.0101	0.0229	0.0360
		HFC-134a	0	1.9540	21.2100	0	23.1600
	Chillier	R-410A	0	0.0240	0.2040	0	0.2280
		R-407C	0	0	0	1.2240	1.2240
	MAC	HFC-134a	151.3800	91.7000	43.4400	35.1500	321.6600
Aerosol	Medical	HFC-134a	0.4600	0.5370	0	0	0.9980
Foam blowing agents	Extruded Polystyrene	HFC-152a	0	0	3.1250	0	3.1250
		R-744	21.3800	0	0	0	21.3800
		R-290	0	0	3.5000	0	3.5000
		DME	0	3.1250	0	0	3.1250
Fire protection		R-744	2.9800	5.7300	2.9700	2.5700	14.2600
		HFC-125	0	1.0500	0	0	1.0470
Total, million tons			574.9500	570.1000	841.4600	3,353.7200	5,340.2100

Source: "Report for HFC inventory and identification of opportunities for introduction of low-GWP alternatives in Mongolia", 2012-2015, National Ozone Authority (NOA) of the Ministry of Environment and Tourism of Mongolia (MET).

The activity data for the estimation of HFCs emissions were available only from 2012 to 2014. Therefore the emissions have been estimated only for last few years. For the emissions estimation from HFCs was used Tier 1 method of IPCC 2006 which is using the default emission factors. The Tier 1 method then back-calculates the development of banks of a refrigerant from the current reporting year to the year of its introduction. The year of introduction for HFC-134a (mobile air conditioning) was 2007 and for other HFCs (23, 32, 143a, 152a) was 2010. Thus the emissions have been calculated for the period 2007-2014 and increased remarkably for this period from 3.17 to 96.43Gg CO_2e due to growth of imported refrigeration and air conditioning equipment (Figure 4-6).

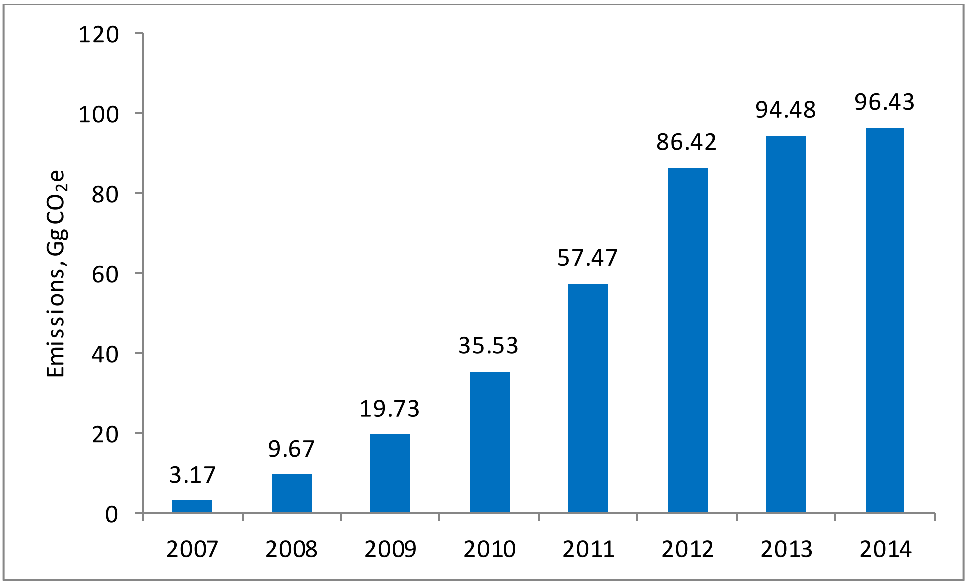

Figure 4-5: Emissions from product uses as substitutes for ozone depleting substances (HFCs), 2007-2014, Gg CO_2e

4.3 Emission factors and global warming potentials used

Emission factors (EFs) used in GHG emissions estimations of IPPU sector was taken the default values from IPCC 2006 and global warming potentials (GWPs) for HFCs were taken from 1995 IPCC Second Assessment Report (SAR). Table 4-8 provides the 100-year GWPs of HFCs.

Table 4-8: 100-year time horizon global warming potentials (GWPs) for HFCs

Gases	*CO_2 equivalents*
HFC-23 (CHF_3)	11,700
HFC-32 (CH_2F_2)	650
HFC-125 (CHF_2CF_3)	2,800
HFC-134a (CH_2FCF_3)	1,300
HFC-143a (CF_3CH_3)	3,800
HFC-152a (CH_3CHF_2)	140

4.4 Sector specific recalculations

The previous GHG inventory estimations have been conducted in accordance with revised 1996 GL, but starting with the preparation of iBUR inventory team has decided to change the methodology to 2006 IPCC GL. The advantages to use latest methodology are e.g.: a) the improvement of country's GHG inventory, b) comparability with other countries, c) accuracy and analysis of the activity data, d) choice of default emission factors.

The changes of GHG emissions estimations from IPPU sector can be explained as follows:

1. In previous GHG inventory (during SNC) the GHG emissions have been calculated from:
   - CO_2 emissions from cement production,
   - CO_2 emissions cast steel and steel bloom production (for metal industry – iron and steel production),
   - HFCs emissions from local and mobile refrigeration and air conditioning equipment, and cars (activity data as imported numbers from national statistics),
   - NMVOCs from food and beverage production.
2. In this GHG inventory (during iBUR) the GHG emissions have been calculated from:

- CO_2 emissions from clinker production,
- CO_2 emissions from steel bloom production (for metal industry – iron and steel production),
- CO_2 emissions from lubricant use (for non-energy products from fuels and solvent use),
- HFCs consumption data from the inventory "Report for HFCs inventory and identification of opportunities for introduction of low-GWP alternatives in Mongolia"[8] (activity data for consumption of HFCs were available from 2012).

The default EFs were used for both emissions calculations. The table 4-9 shows the recalculated GHG emissions of initial Biennial update report (iBUR) compared to Second national communication (SNC) of Mongolia.

Table 4-9: Recalculated GHG emissions from IPPU sector for the period 1990-2006

Category	*Total emissions from IPPU sector, Gg CO_2e*								
	1990	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006**
SNC	326	166	276	275	451	729	972	862	892
iBUR	219	82	64	50	92	97	83	140	139
Difference compared to SNC, %	-32.82	-50.60	-76.81	-81.81	-79.60	-86.69	-91.46	-83.76	-84.42

*Note: SNC=Second national communication (emissions estimated using revised 1996 IPCC GL), iBUR=Initial biennial update report (emissions estimated using 2006 IPCC GL). *The year 2006 is the last inventory year of SNC.*

4.5 Sector specific QA/QC and verification

In accordance with IPCC 2006, volume 1, chapter 6 the quality control (QC) has been done within the inventory team. Sector specific QA/QC plan is based on the general QA/QC rules and activities in specific categories. The sector specific QC activities were performed directly during the GHG emissions calculation (the GHG emissions calculation has been done by the 2006 IPCC Inventory Software) such as checking several data sources and data inputs into the software, including the QC for the EFs and other parameters as well.

The main source of activity data of GHG emissions estimation is the National statistics office of Mongolia (NSO). Generally the NSO collects and consolidates data from organizations/institutions and producers by questionnaires in national level.

For the activity data collection of GHG emissions estimation the questionnaires, in the form of official letters, were sent to the relevant government and private organizations/institutions in order to compare and ensure with data from NSO. The data collected and published by NSO from the relevant government and private organizations/institutions, in most cases differs from the data directly provided by those organizations/institutions. The IPCC 2006 recommends if there are available several sources of the activity data, it's a good practice to follow the data from national statistics.

4.6 Sector specific planned improvements

There are needed some significant improvements in IPPU sector in the short and medium term. The improvements planned in the following areas: (i) additional activity data (AD) collection to improve the completeness; (ii) accuracy and disaggregation of the AD; (iii) AD collection system, processing

[8] *This inventory/project was conducted for the first time in Mongolia and implemented by National Ozone Authority of the Ministry of Environment and Tourism of Mongolia in cooperation with UNEP and Climate and Clean Air Coalition-HFC Initiative for the period 2012-2015. More details can be found in Chapter 4.2.4.*

and analysis; (iv) capacity building and institutional arrangement. The medium term improvements are to improve the inventory of HFCs and PFCs. For this submission the activity data on HFCs were taken from the HFCs inventory report (stated above).

CHAPTER 5: AGRICULTURE (CRF 3)

5.1 Overview of sector

The GHG inventory for the agriculture sector is conducted for three categories: enteric fermentation, manure management, and aggregated sources and non-CO_2 emissions on land. The GHG emissions from these three categories were directly dependent on the livestock population in the country. Even though, there are four discrete source categories in the Mongolian agriculture sector as follows: (i) extensive livestock, which is the traditional semi-nomadic pastoral system, where camels, horses, cattle, sheep and goats are grazed together; (ii) mechanized large-area crop production of cereals and fodder crops; (iii) intensive farming, producing potatoes and other vegetables, with both mechanized and simple production methods; and (iv) intensive livestock, with housed dairy cattle, pigs and poultry. The livestock sector dominates, contributing 84.9% of total agricultural production. Since the 1990s, the total number of animals generally increased and reached 52,159.6 thous.heads in 2014. However, there is a unique natural disaster to Mongolia named zud/dzud in which large numbers of livestock die due to severe, cold winter occasionally. In 1999-2000, 2000-2001 and 2001-2002, Mongolia was hit by three dzuds in a row, in which 3,341.4 thous.heads (10%), 4,152.2 thous.heads (14%), 2,177.6 thous.heads (8%) animals were lost respectively excluding swine and poultry population number. Second harsh winter within GHG inventory period of 1990-2014 was happened in 2009-2010, and over 11 million livestock lost and decreased by circa 26% from previous year's total. As result, methane and nitrous oxide emissions from domestic livestock are fluctuates following those long and short term impact. The livestock numbers between 1990 and 2014 are given in the Table 5-1 by animal category.

Table 5-1: Animal population data in the Mongolia within 1990-2014, thousand heads

Year	*Cattle*	*Horses*	*Camels*	*Sheep*	*Goats*	*Total livestock*	*Swine*	*Poultry* (AAP)*	*Total animal*
1990	2,848.7	2,262.0	537.5	15,083.0	5,125.7	25,856.9	134.7	53.6	26,045.2
1991	2,822.0	2,259.3	476.0	14,721.0	5,249.6	25,527.9	83.3	36.7	25,647.9
1992	2,819.2	2,200.2	415.2	14,657.0	5,602.5	25,694.1	48.6	30.2	25,772.9
1993	2,730.5	2,190.3	367.7	13,779.2	6,107.0	25,174.7	28.7	21.6	25,225.0
1994	3,005.2	2,408.9	366.1	13,786.6	7,241.3	26,808.1	23.4	12.2	26,843.7
1995	3,317.1	2,684.4	367.5	13,718.6	8,520.7	28,608.3	23.5	16.3	28,648.1
1996	3,476.3	2,770.5	355.6	13,718.6	9,134.8	29,455.8	23.5	9.5	29,488.8
1997	3,612.9	2,893.2	355.4	13,560.6	10,265.3	30,687.4	19.1	10.7	30,717.2
1998	3,725.8	3,059.1	356.5	14,165.6	11,061.9	32,368.9	20.7	10.9	32,400.5
1999	3,824.7	3,163.3	355.6	15,191.3	11,033.9	33,568.8	21.9	12.8	33,603.5
2000	3,097.6	2,660.7	322.9	13,876.4	10,269.8	30,227.4	14.7	14.7	30,256.8
2001	2,069.6	2,191.8	285.2	11,937.3	9,591.3	26,075.2	14.8	8.9	26,098.9
2002	1,884.3	1,988.9	253.0	10,636.6	9,134.8	23,897.6	13.3	10.1	23,921.0
2003	1,792.8	1,668.9	256.7	10,756.4	10,652.9	25,127.7	13.7	14.9	25,156.3
2004	1,841.6	2,005.3	256.6	11,686.4	12,238.0	28,027.9	17.2	29.2	28,074.3
2005	1,963.6	2,029.1	254.2	12,884.5	13,267.4	30,398.8	22.7	23.3	30,444.8
2006	2,167.9	2,114.8	253.5	14,815.1	15,451.7	34,803.0	32.8	34.8	34,870.6
2007	2,425.8	2,239.5	260.6	16,990.1	18,347.8	40,263.8	36.0	48.5	40,348.3
2008	2,503.4	2,186.9	266.4	18,362.3	19,969.4	43,288.4	29.3	59.2	43,376.9
2009	2,599.3	2,221.3	277.1	19,274.7	19,651.5	44,023.9	25.8	65.7	44,115.4
2010	2,176.0	1,920.3	269.6	14,480.4	13,883.2	32,729.5	24.8	70.0	32,824.3
2011	2,339.7	2,112.9	280.1	15,668.5	15,934.6	36,335.8	30.4	98.1	36,464.3
2012	2,584.6	2,330.4	305.8	18,141.4	17,558.7	40,920.9	40.4	77.2	41,038.5
2013	2,909.5	2,619.4	321.5	20,066.4	19,227.6	45,144.4	51.9	80.4	45,276.7
2014	3,413.9	2,995.8	349.3	23,214.8	22,008.9	51,982.7	46.3	130.6	52,159.6

% Change 1990/2014	19.84%	32.44%	-35.01%	53.91%	329.38%	101.04%	-65.63%	143.66%	100.27%

* annual average population of poultry is estimated according to equation 10.1 (IPCC, 2006)
Source: Statistical Yearbooks of Agriculture 1990-2014. www.1212.mn

In 2014, agriculture sector accounted for 48.44% (16.726.97 Gg CO_2e) of total national direct GHG emissions (without LULUCF), being the second major source of GHG emissions after the 'Energy' sector in the country (Figure 5-1).

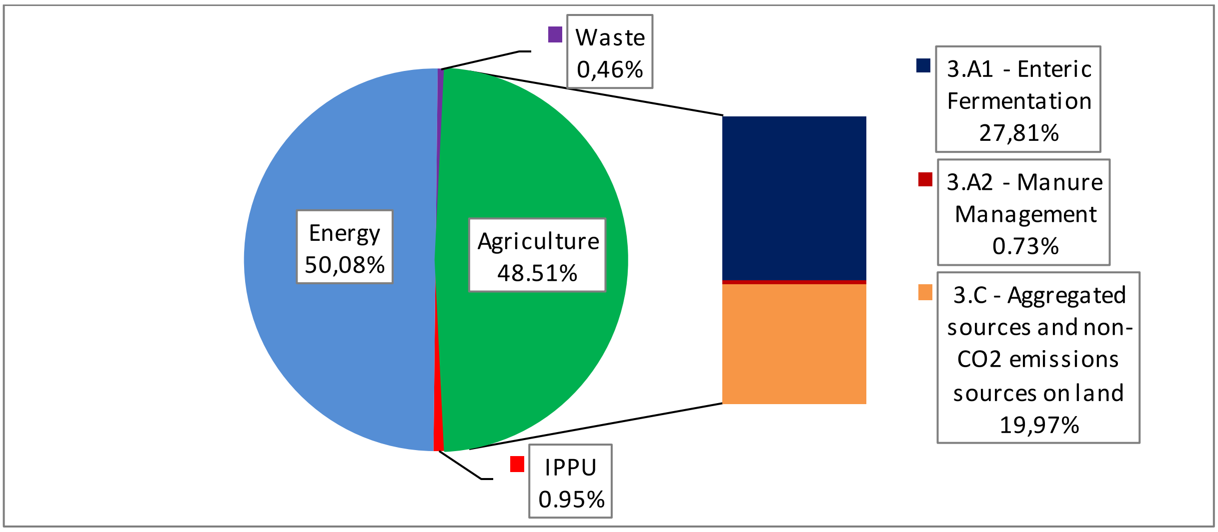

Figure 5-1: CO_2e emissions from the agriculture sector compared to the total GHG emissions (excl. LULUCF) in Mongolia in 2014

Within the agriculture sector, enteric fermentation contributes the highest to the GHG emissions with circa 57.33% followed by aggregated sources and non-CO_2 emissions sources on land (41.17%) and manure management with 1.5% (Table 5-2).

Table 5-2: GHG Emissions from agriculture by source categories, Gg CO_2e

Categories	Emissions	1990	1995	2000	2005	2010	2014
3.A1 - Enteric Fermentation	Gg	6,310.67	6,979.31	6,910.66	5,697.06	6,112.72	9,588.85
	%	59.62	59.55	58.61	57.65	57.47	57.33
3.A2 -Manure Management	Gg	175.23	190.47	188.12	153.18	160.44	251.22
	%	1.66	1.63	1.60	1.55	1.51	1.50
3.C – Aggregated sources and non-CO_2 emissions sources on land	Gg	4,099.40	4,550.01	4,691.75	4,031.10	4,362.54	6,886.94
	%	38.73	38.82	39.79	40.80	41.02	41.17
Agriculture total	Gg	10,585.30	11,719.79	11,790.52	9,881.33	10,635.70	16,726.98
	%	100.00	100.00	100.00	100.00	100.00	100.00

Between 1990 and 2014, the total GHG emissions originated from the agriculture sector tended to higher values, increasing by 58.02%, from 10,585.29 to 16.726.97 Gg CO_2e (Table 5-3), in particular, due to increasing the number of domestic livestock which increased 25,856.9 million to 51,982.7 million in 1990-2014. However animal number was fluctuated within the inventory period due to the dzud occurrence as explained above (Figure 5-2).

Table 5-3: Emissions from agriculture sector in 1990 and 2014

Sector	*Gas*	*Gg CO_2e*		*Change from 1990 (Gg CO_2e)*	*Change from 1990 (%)*
		1990	*2014*		
3.A1 - Enteric Fermentation	CH_4	6,310.67	9,588.82	3,278.15	51.95%
3.A2 - Manure Management	CH_4	175.23	251.22	75.99	43.36%

3.C - Aggregated sources and non-CO_2 emissions sources on land	CH_4, N_2O	4,099.40	6,886.94	2,787.55	68.00%
3. Total of Agriculture	CH_4, N_2O	10,585.30	16,726.98	6,141.68	58.02%

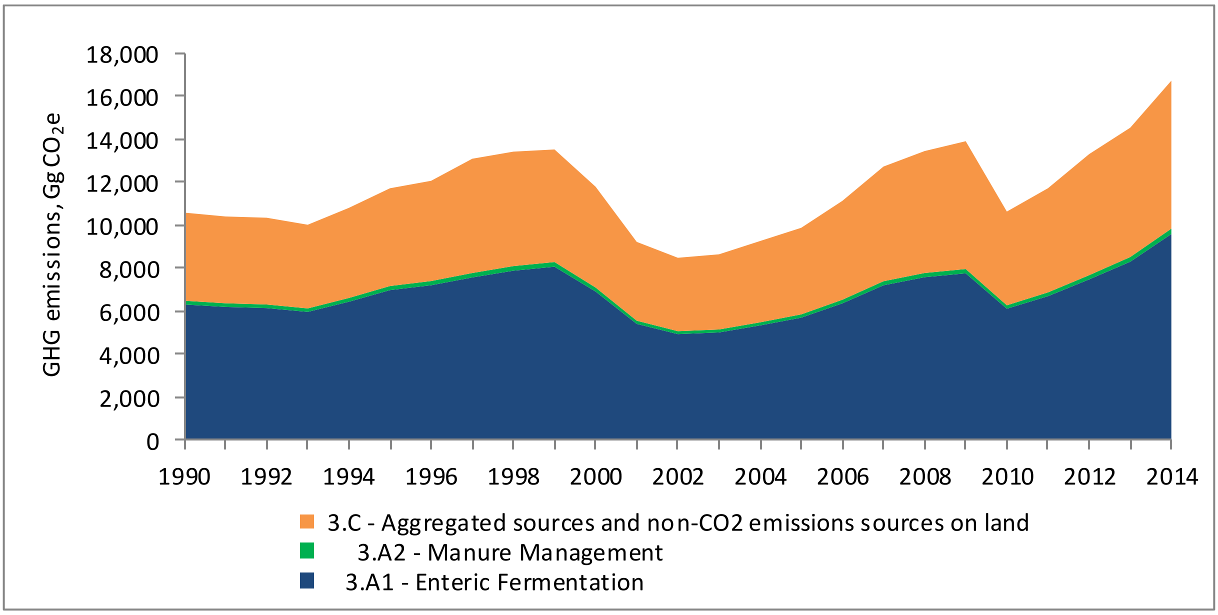

Figure 5-2: Trend in aggregated emissions by subcategories within agriculture sector for the period 1990-2014, Gg CO_2e

5.1.1 Key Categories

The results of key category analysis (including LULUCF) are shown in Table 5-4. The emission from enteric fermentation, direct N_2O emissions from managed soils were included in both level and trend assessment and indirect N_2O emissions from managed soils was included in trend assessment as key source categories.

Table 5-4: Key Categories Analysis under the agriculture sector

IPCC Category	*GHG*	*Source Category*	*Key Categories*
3.A.1	CH_4	Enteric fermentation	Yes (L,T)
3.A.2	CH_4	Manure management	No
3.C.1	CH_4	Emissions from biomass burning	No
3.C.1	N_2O	Emissions from biomass burning	No
3.C.4	N_2O	Direct N_2O Emissions from managed soils	Yes (L,T)
3.C.5	N_2O	Indirect N_2O Emissions from managed soils	Yes (T)
3.B.1.a	CO_2	Forest land Remaining Forest land	Yes (L,T)
3.D.1	CO_2	Harvested Wood Products	No

5.1.2 Methodological Issues

In the Agriculture sector of Mongolia's 2017 GHG inventory submission, the IPCC 2006 Guidelines have been used. Generally, emissions from Livestock (CRF 3.A) and Aggregated sources and non-CO_2 emissions sources on land (CRF 3.C) were estimated using the Tier 1 methodological approach and default EFs values. Obtainable country specific activity data for all the categories were used. Where country specific activity data were non-existent, data from international data source (FAOSTAT) were used.

A summary description of methods used to estimate emissions by categories is provided in Table 5-5, while a more detailed description is available in chapters 5.2-5.3 of the NIR.

Table 5-5: Summary of Methods Used to Estimate GHG Emissions for the 'Agriculture' sector

IPCC Category	*Source Category*	*CH4*		*N_2O*	
		Method	EF	Method	EF
3.A.1	Enteric Fermentation	T1	D	-	-
3.A.2	Manure Management	T1	D	-	-
3.C	Aggregated sources and non-CO_2 emissions sources on land	T1	D	T1	D

Abbreviations: T1-Tier 1 Method; T2-Tier 2 Method; CS-Country Specific; EF-Emission Factors.

5.1.3 Uncertainties Assessment and time series consistency

Uncertainties related to estimation of methane emissions from 'Livestock', in particular depend on the accuracy of the livestock characteristic, and also on the emission factors used. The uncertainty associated with livestock populations will vary widely depending on source, but should be known within +20% (IPCC 2006, section 10.2.3, page 10.23). As the emission factors for the Tier 1 method are not based on country specific data, they may not accurately represent a country's livestock characteristics, and may be highly uncertain as a result. Emission factors of enteric fermentation estimated using the Tier 1 method are unlikely to be known more accurately than +30% and may be uncertain to +50% (IPCC 2006, section 10.3.4, page 10.33). The uncertainty range for the default factors related to estimation of methane emissions from manure management is estimated to be +30% (IPCC 2006, section 10.4.4 page, 10.48). Emissions are estimated by using consistent estimation methods and data sources.

Uncertainties in estimates of direct and indirect N_2O emissions from managed soils are caused by uncertainties related to the emission factors, natural variability, partitioning fractions, activity data, lack of measurements, spatial aggregation, and lack of information on specific on-farm practices. IPCC 2006, Table 11.1 and 11.3 are used for the uncertainty analysis for the N_2O emissions from managed soils.

5.1.4 Quality Assurance and Quality Control

In the current submission all applied information and data have been double-checked as far as possible. For instance, the activity data (AD) of livestock numbers is taken from Statistical yearbooks of Agriculture cross-checked against the National Statistic Office website information. GHG emissions were estimated using AD and default factors and parameters from official sources of reference. The AD and methods used to estimate GHG emissions under this sector were documented and archived both in hard copies and electronically. For the next submission an overall quality control and quality assurance system should be in place. This system will describe transparently the involved agencies and roles, data flows and calculation methods.

5.1.5 Source specific recalculations

A recalculation in this category is not done in this submission, due to the implementation of a complete new National System for Greenhouse Gas Inventories and thus the first time application of the IPCC 2006 Guidelines and incorporation of most recent data collection methods (and first time application of their methodological approach). Thus compared to earlier versions of the Mongolian GHG Inventory the whole inventory can be considered as recalculated.

The previous GHG inventories in the first National Communication in 2001and the second National Communication in 2010 are based on the Revised 1996 IPCC Guidelines for National Greenhouse

Gas Inventories (revised IPCC 1996). That prevents the results from being easily comparable. Nevertheless Table 5-6 shows the differences over time.

Table 5-6: Recalculated GHG emissions under the agriculture sector for 1990-2006, included in the SNC and TNC and iBUR of the Mongolia, Gg CO_2e

Year	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
SNC	7,695	7,210	7,006	6,724	6,932	6,964	7,067	7,420	7,659
iBUR	10,585	10,407	10,349	10,022	10,807	11,720	12,067	13,094	13,424
Diff. %	38%	44%	48%	49%	56%	68%	71%	76%	75%
Year	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*
SNC	7,716	6,748	6,040	5,338	5,240	5,518	5,854	6,462	
iBUR	13,525	11,791	9,225	8,485	8,646	9,265	9,881	11,134	
Diff. %	75%	75%	53%	59%	65%	68%	69%	72%	

Abbreviations: SNC-Second National Communication; iBUR-initial Biennial Update Report.

5.1.6 Assessment of completeness

The current inventory covers greenhouse gas emissions from 3 categories: Enteric fermentation (CRF 3.A.1), Manure management (CRF 3.A.2) and Aggregated sources and non-CO_2 emissions sources on land (CRF 3.C) from 1990 to 2014. Table 5-7 shows the overview of the completeness status of the estimations under various source categories within the sector.

Table 5-7: Assessment of completeness of GHG emissions under the agriculture sector

IPCC Category	*Source Category*	*Status of Gas*			
		CH_4	*N_2O*	*NO_x*	*CO*
3.A.1 - Enteric Fermentation	3.A.1.a.ii –Other cattle 3.A.1.c – Sheep 3.A.1.d – Goats 3.A.1.e – Camels 3.A.1.f – Horses 3.A.1.h – Swine	E	NO	NO	NO
3.A.2 - Manure Management	3.A.2.c – Sheep 3.A.2.d – Goats 3.A.2.e – Camels 3.A.2.f – Horses 3.A.2.h – Swine 3.A.2.j – Poultry	E	NO	NO	NO
3.C - Aggregated sources and non-CO_2 emissions sources on land	3.C.1.a – Biomass burning in forest lands	E	E	E	E
	3.C.4 – Direct N_2O emissions from managed soils	NO	E	NO	NO
	3.C.5 – Indirect N_2O emissions from managed soils	NO	E	NO	NO

Abbreviations: E-source categories included in the inventory; NO-Not Occurring; NE-Not Estimated; IE-Included Elsewhere.

5.1.7 Sector specific planned improvements

Mongolian livestock is a local indigenous breed of animals with very low productivity and small size compare to other breeds of animals in the world. Mongolia's animal husbandry has been nomadic pastoralist, with livestock herding on natural pasture, even in winter time. Moreover, the climate in Mongolia influences the type of forage and the amount digested by livestock annually. The emission from enteric fermentation source category significantly contributes to national greenhouse gas inventory and it is a key category. Thus, the highest priority of planned improvements could include obtaining detailed country specific data on gross energy and methane conversion factor for livestock source categories. Additionally, Mongolia's livestock manure is almost 100 percent deposited on pastures and rangelands, thus it tends to decompose under more aerobic conditions and less CH_4 is produced and hence detailed research is needed to provide to clarify this issue.

The emission factors (EFs) of CH_4 for enteric fermentation and manure management have been developed for Mongolian specific conditions using Tier 2 method by the local experts (Namkhainyam et al., 2014). However, in this submission, those developed EFs not used due to the high uncertainty of the input parameters used. At present planning to reassess them with updated raw data of livestock survey collected in 2016-2017 by National Statistics Office (currently results are not yet finalized) and apply for the subsequent submissions of BUR and NCs.

Planned improvements within the agriculture sector are listed in below Table 5-8. The last submission did not undergo any official review, thus the improvements mentioned here became obvious during the preparation of this submission.

Table 5-8: Planned improvements in the agriculture sector

Sector	*Description*	*When*
3. Livestock	To reassess the emission factors for the enteric fermentation and manure management had been developed by local experts in order to apply Tier 2 method	next iteration
3.A.1 Enteric fermentation	To obtain and use enhanced characterization for livestock populations	next iteration
3.A.2 Manure management	To obtain and use MCF, Bo, and VS values that reflect country's specific conditions	next iteration
3. C.1 Emissions from biomass burning	To develop national estimates of the area burnt and the nature of the fires especially how they affect carbon dynamics (e.g. effects on tree mortality) to provide reliable data for the not only forest land but also for the grassland and cropland.	next iteration
3.C.4 and 3.C.5 N_2O emissions from managed soils	To obtain country specific activity data of the annual synthetic N applications	next iteration

5.2 Livestock (CRF 3.A)

Emissions from livestock are generated through enteric fermentation and manure management from domestic animals such as cattle, sheep, goats, camels, horses and swine. In 2014, the total emissions from livestock were 9,840.04 Gg CO_2e which represented 58.83% of the total Agricultural emissions. In general, the total livestock emissions showed an increasing trend from 6,485.90 Gg CO_2e in 1990 to 9,840.04 Gg CO_2e in 2014. The observed growing level of emissions was due to rising animal populations. However, there were two times sharp decrease of the livestock number in 1999-2002 and 2009-2010 due to high number of livestock loss during the harsh winter season named "dzud" explained in the overview of the Agricultural sector section. Thus livestock emissions in these years declined and gradually increased back in next following years (Figure 5-3).

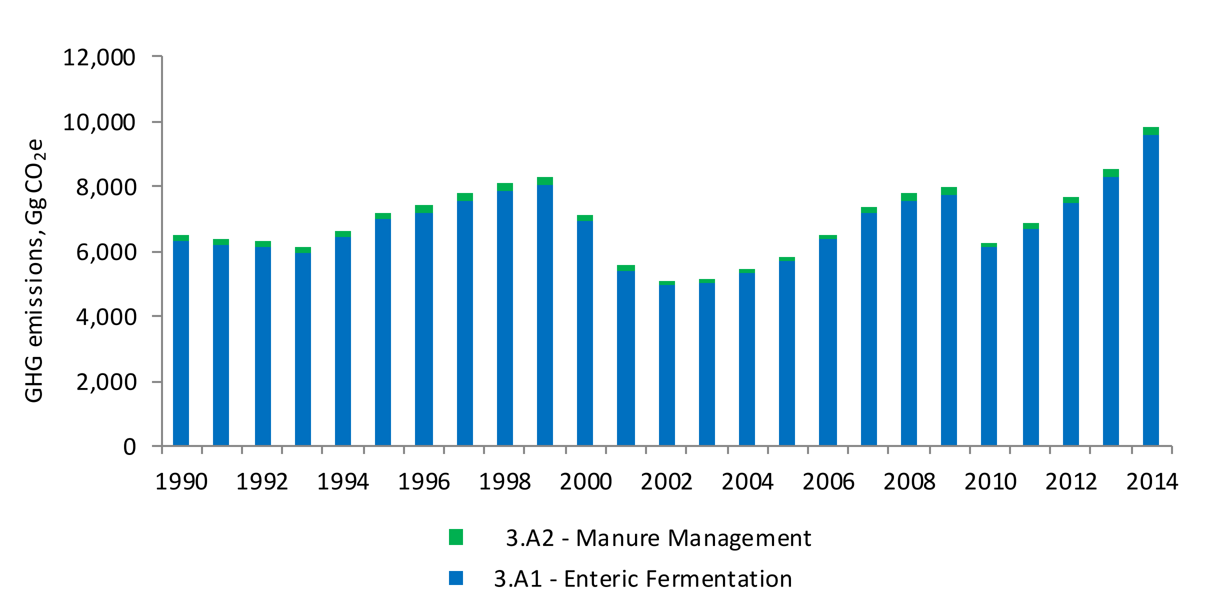

Figure 5-3: Emissions trend from livestock

The annual emission estimation and percentage of the change trend by subcategories is given in the Table 5-9. In 2014, the livestock total emission was 51.71% higher than 1990 and increased by circa 15% compared with 2013.

Table 5-9: Total CH_4 emissions from livestock category by source categories, 1990-2014, Gg CH_4 and CO_2e

Year	Gg CH_4		Livestock (Total CH_4)	Gg CO_2e		Livestock total (CO_2e)
	Enteric Fermentation	Manure Management		Enteric Fermentation	Manure Management	
1990	300.51	8.34	308.85	6,310.67	175.23	6,485.90
1991	295.13	8.11	303.24	6,197.81	170.32	6,368.13
1992	292.55	7.93	300.48	6,143.58	166.49	6,310.07
1993	284.13	7.70	291.83	5,966.79	161.61	6,128.40
1994	306.61	8.32	314.93	6,438.77	174.76	6,613.53
1995	332.35	9.07	341.42	6,979.31	190.47	7,169.77
1996	343.11	9.35	352.46	7,205.26	196.36	7,401.62
1997	360.41	9.81	370.22	7,568.56	205.98	7,774.54
1998	375.38	10.24	385.62	7,882.89	215.09	8,097.99
1999	384.21	10.39	394.60	8,068.32	218.24	8,286.56
2000	329.08	8.96	338.04	6,910.66	188.12	7,098.77
2001	257.50	7.10	264.60	5,407.51	149.14	5,556.66
2002	234.87	6.47	241.34	4,932.28	135.90	5,068.18
2003	238.57	6.54	245.11	5,009.97	137.39	5,147.37
2004	254.09	6.91	261.00	5,335.96	145.01	5,480.97
2005	271.29	7.29	278.58	5,697.06	153.18	5,850.23
2006	302.99	8.04	311.03	6,362.69	168.94	6,531.63
2007	343.04	8.99	352.03	7,203.77	188.79	7,392.56
2008	360.97	9.32	370.29	7,580.29	195.72	7,776.01
2009	369.55	9.52	379.07	7,760.63	199.85	7,960.48
2010	291.08	7.64	298.72	6,112.72	160.44	6,273.15
2011	318.93	8.38	327.31	6,697.50	176.04	6,873.54
2012	356.03	9.34	365.37	7,476.65	196.21	7,672.86
2013	395.21	10.40	405.61	8,299.34	218.45	8,517.79
2014	456.61	11.96	468.57	9,588.82	251.22	9,840.04
Diff % 1990/2014	51.95%	43.36%	51.71%	51.95%	43.36%	51.71%
Diff % 2013/2014	15.54%	15.00%	15.05%	15.54%	15.00%	15.05%

5.2.1 Enteric fermentation (CRF 3.A1)

5.2.1.1 Source category description

Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. The amount of methane that is released depends on the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed consumed. Ruminant livestock (e.g., cattle, sheep) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses). The ruminant gut (rumen, reticulum, omasum, and abomasum) structure fosters extensive enteric fermentation of their diet (IPCC 2006, page 10.24).

5.2.1.2 Summary of emission trends

The total emissions attributed to enteric fermentation was 9,588.82 Gg CO_2e making up 97% of the total livestock emissions in 2014. This was 51.95% and 15.54% above 1990 and 2013 levels respectively (Table 5-9). Main driver of the emission fluctuation of the enteric fermentation between 1990 and 2014 is loss of livestock population during the natural disaster (see in overview of the agricultural sector). The Figure 5-4 shows that total methane emissions from enteric fermentation by livestock type.

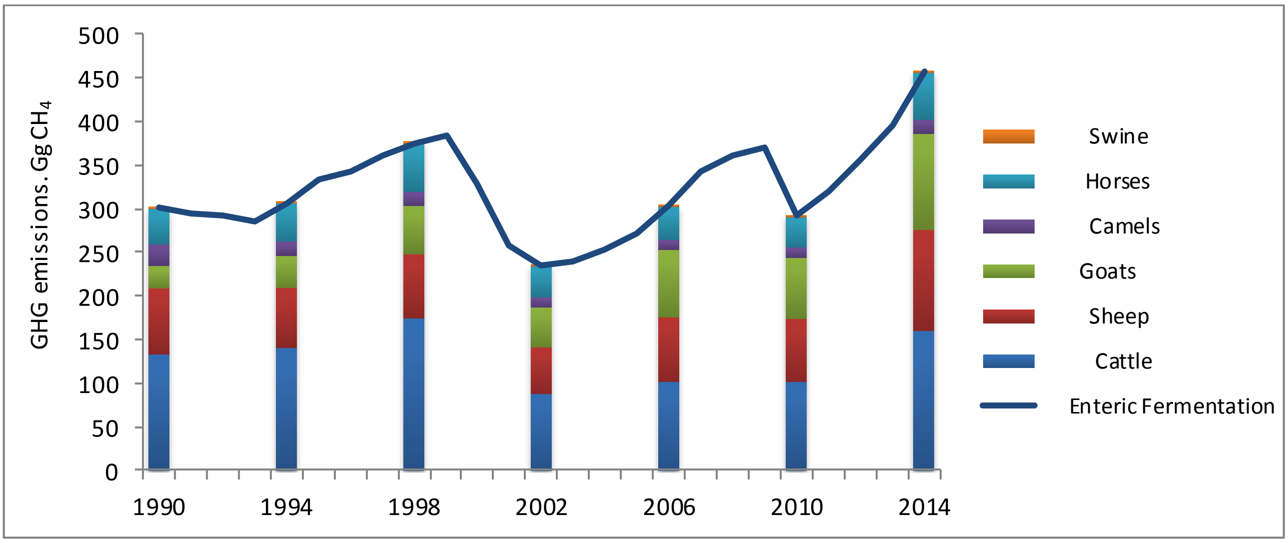

Figure 5-4: Total emission trend from enteric fermentation of livestock

In 1990, cattle contributed 45% of the total emissions from enteric fermentation (Figure 5-5). The rest were as follows: sheep (25%), horses (14%), camels (8%), goats (8%) and swine (0.04%). By 2014, percentage share of the each livestock contribution to the enteric fermentation is changed as follows: cattle (35%), sheep (25%), horses (12%), camels (4%), goats (24%) and swine (0.01%).

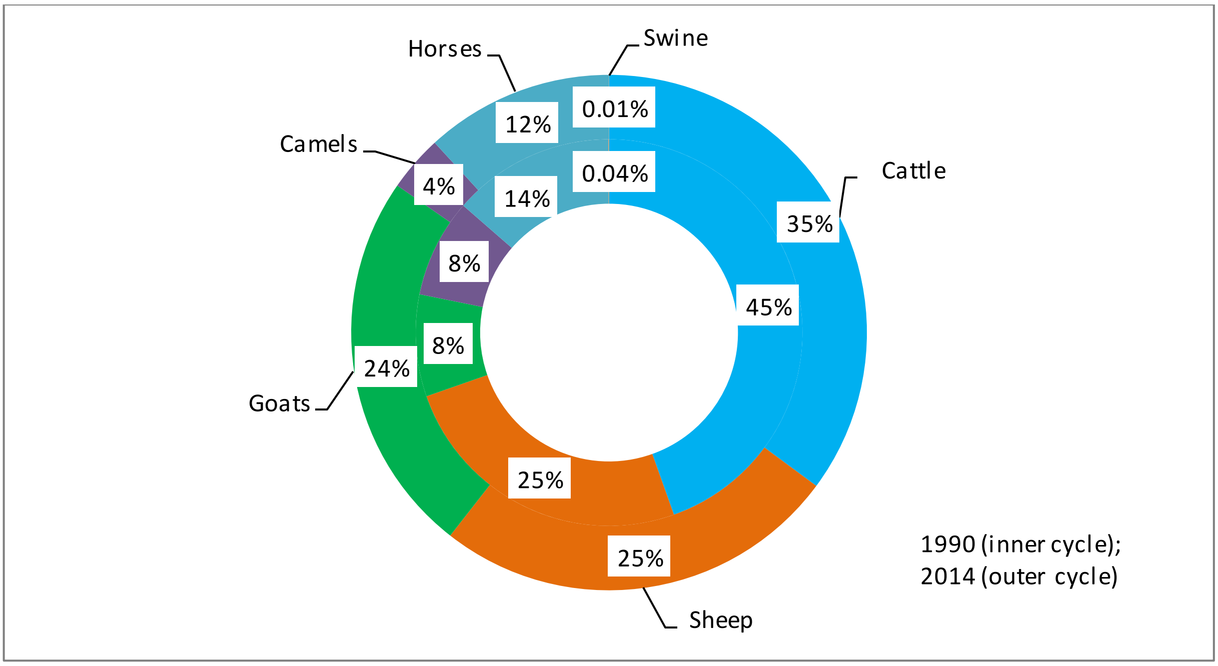

Figure 5-5: Each livestock contribution to the enteric fermentation emission in 1990 and 2014

Over the period under review, emission trend from each livestock category showed different pattern of change comparing with the base year. By 2014, the percentage of such categories as camel and swine decreased compared to 1990 year level, while the percentage of other categories such as cattle, sheep, goats and horses increased (Table 5-10).

Table 5-10: Breakdown of the CH_4 emissions from enteric fermentation by livestock category for the period 1990-2014, Gg

Year	*Other Cattle*	*Sheep*	*Goats*	*Camels*	*Horses*	*Swine*	*Poultry* (AAP)*	*Total animal*
1990	133.89	75.42	25.63	24.73	40.72	0.13	-	300.51
1991	132.63	73.61	26.25	21.90	40.67	0.08	-	295.13
1992	132.50	73.29	28.01	19.10	39.60	0.05	-	292.55
1993	128.33	68.90	30.54	16.91	39.43	0.03	-	284.13
1994	141.24	68.93	36.21	16.84	43.36	0.02	-	306.61
1995	155.90	68.59	42.60	16.91	48.32	0.02	-	332.35
1996	163.39	67.80	45.67	16.36	49.87	0.02	-	343.11
1997	169.81	70.83	51.33	16.35	52.08	0.02	-	360.41
1998	175.11	73.47	55.31	16.40	55.06	0.02	-	375.38
1999	179.76	75.96	55.17	16.36	56.94	0.02	-	384.21
2000	145.59	69.38	51.35	14.85	47.89	0.01	-	329.08
2001	97.27	59.69	47.96	13.12	39.45	0.01	-	257.50
2002	88.56	53.18	45.67	11.64	35.80	0.01	-	234.87
2003	84.26	53.78	53.26	11.81	35.44	0.01	-	238.57
2004	86.56	58.43	61.19	11.80	36.10	0.02	-	254.09
2005	92.29	64.42	66.34	11.69	36.52	0.02	-	271.29
2006	101.89	74.08	77.26	11.66	38.07	0.03	-	302.99
2007	114.01	84.95	91.74	11.99	40.31	0.04	-	343.04
2008	117.66	91.81	99.85	12.25	39.36	0.03	-	360.97
2009	122.17	96.37	98.26	12.75	39.98	0.03	-	369.55
2010	102.27	72.40	69.42	12.40	34.57	0.02	-	291.08
2011	109.97	78.34	79.67	12.88	38.03	0.03	-	318.93
2012	121.48	90.71	87.79	14.07	41.95	0.04	-	356.03
2013	136.75	100.33	96.14	14.79	47.15	0.05	-	395.21
2014	160.45	116.07	110.04	16.07	53.92	0.05	-	456.61
Diff% 1990/2014	19.84%	53.91%	329.38%	-35.01%	32.44%	-65.62%	-	51.95%
Diff% 2013/2014	17.34%	15.69%	14.47%	8.65%	14.37%	-10.72%	-	15.54%

5.2.1.3 Activity data, methodological issues and emission factors

Emissions from enteric fermentation were calculated at Tier 1, following IPCC 2006 Vol. 4, Ch. 10 methodology according to the formula:

$$Emission = A * EF$$

Where:

Emission = GHG emissions, in kg CH_4 yr^{-1};

A = Activity data, representing the number of livestock in heads (1);

EF = Tier 1, default IPCC emission factors, expressed in units of kg CH_4 $head^{-1}$ yr^{-1} (2).

(1) Activity data cover the following animal categories: cattle, horses, camels, sheep, goats, swine and poultry. For the period between 1990 and 2014, the activity data are taken from Statistical yearbooks of agriculture 1990-2014. For dairy cattle, in Mongolia, specialized dairy breeds are still rare (<1%), and females are more appropriately categorized as 'other cattle'. Therefore all cattle of Mongolia are taken as other cattle. Broiler chickens are typically grown approximately 60 days before slaughter. In order to avoid overestimation, annual average population of poultry is estimated according to equation 10.1 (IPCC 2006) and estimated numbers are entered in the Table 5-1.

(2) The EF values are specified by livestock category and regional grouping in the IPCC 2006, Vol. 4, Ch. 10, Tables 10.10 and 10.11. The EF listed under Asia region are chosen for the Mongolia (Table 5-11).

The dimensionless conversion factors used are:

- 10^{-6}, to convert the emissions from kg CH_4 to Gg CH_4; and
- GWP-CH_4 = 21 (100-year time horizon global warming potential provided by the IPCC in its Second Assessment Report), to convert Gg CH_4 to Gg CO_2e (17/CP.8, Annex, paragraph 20).

Table 5-11: Default EFs for Asia used to estimate CH_4 emissions from enteric fermentation source category

Livestock category	*EF, kg CH_4/head/year*	*Comments*	*Typical animal mass, kg*
Other cattle	47	Includes multi-purpose cows, bulls and young	319
Sheep	5	Average live weight – 45 kg	28
Goats	5	Average live weight – 40 kg	30
Horses	18	Average live weight – 550 kg	238
Camels	46	Average live weight – 570 kg	217
Swine	1.0		28
Source	IPCC Guidelines, 2006, Vol. 4, Ch. 10, Tables 10.10 and 10.11		IPCC, 2006 software Ver 2.18

5.2.2 Manure management (CRF 3.A.2)

5.2.2.1 Source category description

The GHG emissions from manure management consist of methane (CH_4) and nitrous oxide (N_2O) gases from aerobic and anaerobic manure decomposition processes. The term 'manure' is used here collectively include both dung and urine produced by livestock. The emissions level depends on the amount of manure treated and handled within manure management systems and type of manure management systems.

The main manure management systems covered by this inventory were: pasture/range/paddock for the cattle, sheep, goats, horses and camels, and daily spread system for the swine and poultry. For in this case, N_2O emissions during storage and treatment of these two systems are assumed to be zero and N_2O emissions from land application of Mongolian livestock are covered under the Aggregated sources and non-CO_2 emissions sources on land (CRF 3.C) source category. Only CH_4 is reported under the source category manure management (CRF 3.A.2).

5.2.2.2 Summary of emission trends

The total emissions attributed to manure management was 251.22 Gg CO_2e making up 3% of the total livestock emissions in 2014. This was 43.36% and 15.00% above 1990 and 2013 levels respectively (Table 5-13). Main driver of the emission fluctuation of the manure management between 1990 and 2014 is loss of livestock population during the natural disaster (See in overview of the Agricultural sector). The Figure 5-6 shows that total methane emissions from manure management by livestock type.

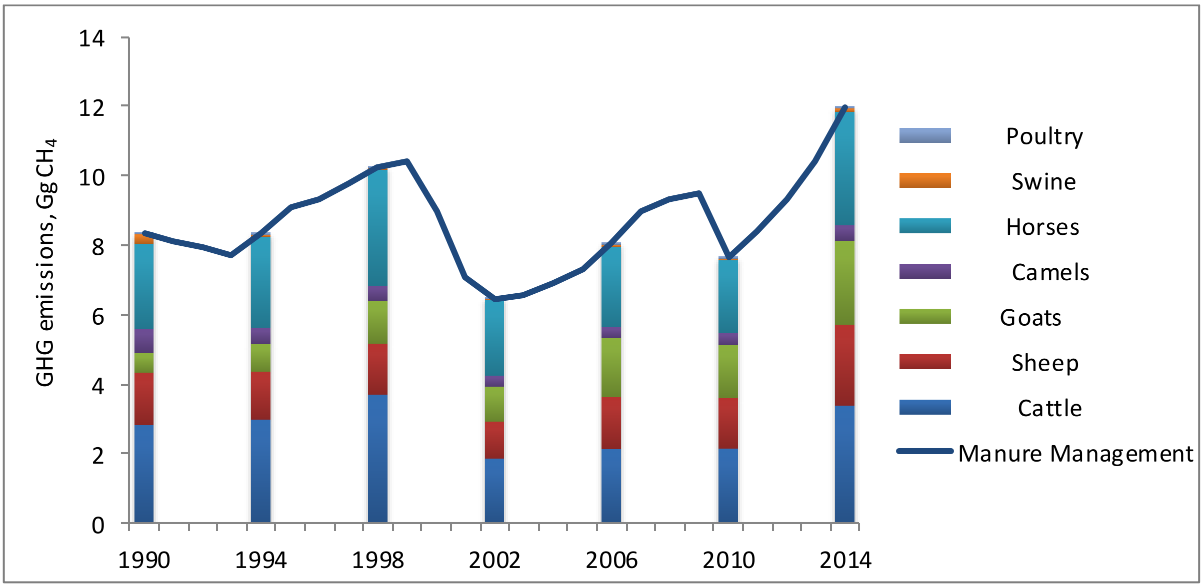

Figure 5-6: Total emission trend from manure management of livestock

In 1990, cattle contributed 34% of the total emissions from manure management (Figure 5-7). The rest were as follows: sheep (18%), horses (30%), camels (8%), goats (7%), swine (3%) and poultry (0.006%). By 2014, percentage share of the each livestock contribution to the manure management is changed as follows: cattle (29%), sheep (19%), horses (27%), camels (4%), goats (20%) swine (1%) and poultry (0.011%).

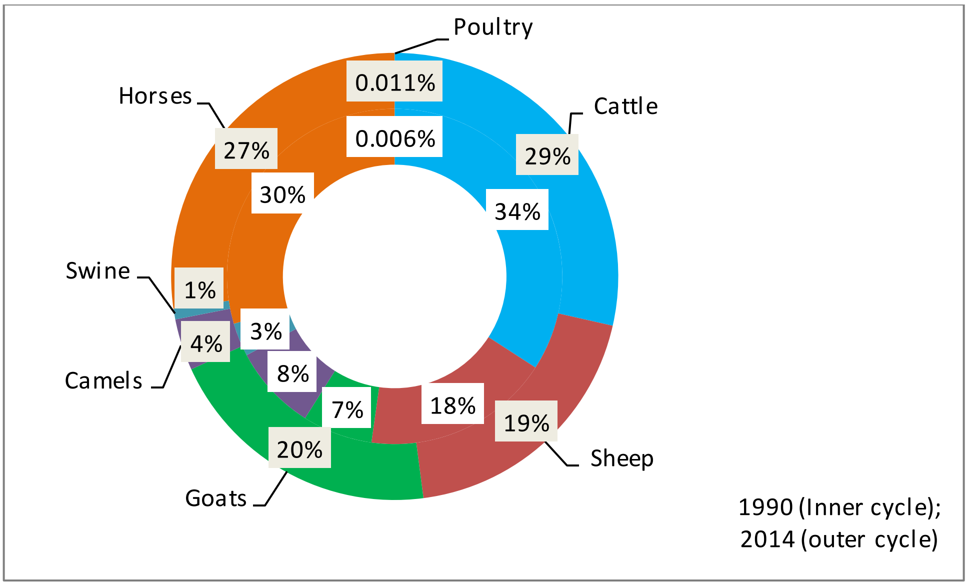

Figure 5-7: Each livestock contribution to the manure management emission in 1990 and 2014

Over the period under review, emission trend from each livestock category showed different pattern of change comparing with the base year. By 2014, the percentage of such categories as camel and swine decreased compared to 1990 year level, while the percentage of other categories such as cattle, sheep, goats, horses and poultry increased (Table 5-12).

Table 5-12: Breakdown of the CH_4 emissions from manure management by livestock category for the period 1990-2014, Gg

Year	*Other Cattle*	*Sheep*	*Goats*	*Camels*	*Horses*	*Swine*	*Poultry* (AAP)*	*Total animal*
1990	2.85	1.51	0.56	0.69	2.47	0.27	0.0005	8.34
1991	2.82	1.47	0.58	0.61	2.46	0.17	0.0004	8.11
1992	2.82	1.47	0.62	0.53	2.40	0.10	0.0003	7.93
1993	2.73	1.38	0.67	0.47	2.39	0.06	0.0002	7.70
1994	3.01	1.38	0.80	0.47	2.63	0.05	0.0001	8.32
1995	3.32	1.37	0.94	0.47	2.93	0.05	0.0002	9.07
1996	3.48	1.36	1.00	0.46	3.02	0.04	0.0001	9.35
1997	3.61	1.42	1.13	0.45	3.15	0.04	0.0001	9.81
1998	3.73	1.47	1.22	0.46	3.33	0.04	0.0001	10.24
1999	3.82	1.52	1.21	0.46	3.33	0.04	0.0001	10.39
2000	3.10	1.39	1.13	0.41	2.90	0.03	0.0001	8.96
2001	2.07	1.19	1.06	0.37	2.39	0.03	0.0001	7.10
2002	1.88	1.06	1.00	0.32	2.17	0.03	0.0001	6.47
2003	1.79	1.08	1.17	0.33	2.15	0.03	0.0001	6.54
2004	1.84	1.17	1.35	0.33	2.19	0.03	0.0003	6.91
2005	1.96	1.29	1.46	0.33	2.21	0.05	0.0002	7.29
2006	2.17	1.48	1.70	0.32	2.31	0.07	0.0003	8.04
2007	2.43	1.70	2.02	0.33	2.44	0.07	0.0005	8.99
2008	2.50	1.84	2.20	0.34	2.38	0.06	0.0006	9.32
2009	2.60	1.93	2.16	0.35	2.42	0.05	0.0007	9.52
2010	2.18	1.45	1.53	0.35	2.09	0.05	0.0007	7.64
2011	2.34	1.57	1.75	0.36	2.30	0.06	0.0010	8.38
2012	2.58	1.81	1.93	0.39	2.54	0.08	0.0008	9.34
2013	2.91	2.01	2.12	0.41	2.86	0.10	0.0008	10.40
2014	3.41	2.32	2.42	0.45	3.27	0.09	0.0013	11.96
Diff% 1990/2014	19.84%	53.91%	329.38%	-35.01%	32.44%	-665.62%	143.58%	43.36%
Diff% 2013/2014	17.34%	15.69%	14.47%	8.65%	14.37%	-10.72%	62.39%	15.00%

5.2.2.3 Activity Data, Methodological Issues and Emission Factors

Emissions from manure management were calculated at Tier 1, following IPCC 2006 Vol. 4, Ch. 10 methodology according to the formula:

$$Emission = A * EF$$

Where:

Emission = GHG emissions, in kg CH_4 yr^{-1};

A = Activity data, representing the number of livestock in heads (1);

EF = Tier 1, default IPCC emission factors, expressed in units of kg CH_4 $head^{-1}$ yr^{-1} (2).

(1) Activity data cover the following animal categories: cattle, horses, camels, sheep, goats, swine and poultry. For the period between 1990 and 2014, the activity data are taken from Statistical yearbooks of agriculture 1990-2014. For dairy cattle, in Mongolia, specialized dairy breeds are still rare (<1%), and females are more appropriately categorized as 'other cattle'. Therefore all cattle of Mongolia are taken as other cattle. Broiler chickens are typically grown approximately 60 days before slaughter. In order to avoid overestimation, annual average population of poultry is estimated according to equation 10.1 (IPCC 2006) and estimated numbers are entered in the Table 5-1.

(2) The EF values are specified by livestock category and regional grouping in the IPCC 2006, Vol. 4, Ch. 10, Tables 10A-5 and 10A-9. The EF listed under Asia region and average annual temperature ($\leq$10) are chosen for the Mongolia (Table 5-13). The share of the individual animal manure management systems common in Mongolia were estimated by expert judgment and categorized by animal type.

The dimensionless conversion factors used are:

- 10^{-6}, to convert the emissions from kg CH_4 to Gg CH_4; and
- GWP-CH_4 = 21 (100-year time horizon global warming potential provided by the IPCC in its Second Assessment Report), to convert Gg CH_4 to Gg CO_2e (17/CP.8, Annex, paragraph 20).

Table 5-13: Default EFs for Asia used to estimate CH_4 emissions from manure management source category

Livestock category	*Typical animal mass(kg)*	*Excretion Rate per mass per day [kg N/(animal yr)]*	*MMS*	*Fraction of MMS*	*MMS EF*	*Source*
Cattle	Asia-319	Asia-0.34	Pasture/Range/Paddock	1	Asia-1	IPCC, 2006. Table 10A-5
Sheep	Asia-developing-28	Asia-1.17		1	Developing-0.1	IPCC, 2006. Table 10A-9
Goats	Asia-developing-30	Asia-1.37		1	Developing-0.11	IPCC, 2006. Table 10A-9
Horses	Asia-developing-238	Asia-0.46		1	Developing-1.09	IPCC, 2006. Table 10A-9
Camels	Asia-developing-217	Asia-0.46		1	Developing-1.28	IPCC, 2006. Table 10A-9
Swine	Asia-breeding swine-28	Asia-breeding-0.24	Daily spread	1	Asia-2	IPCC, 2006. Table 10A-8
Poultry AAP	Asia-not developed	Asia-0.82		1	Developing-0.01	IPCC, 2006. Table 10A-9

5.3 Aggregated sources and non-CO_2 emission sources from land (CRF 3.C)

Emissions under this category, CH_4 and N_2O from biomass burning, direct and indirect N_2O from managed soils, are reported in this inventory. In 2014, the total GHG emissions from this source category were 6,886.94 Gg CO_2e representing 41.17% of the total emissions of agriculture sector.

In general, the total 3C sector emissions showed an increasing trend from 4,099.40 Gg CO_2e in 1990 to 6,886.94 Gg CO_2e in 2014. The observed growing level of emissions was mainly due to rising animal populations which directly increase the amount of manure deposited on the pasture. However, there were two times sharp decrease of the livestock number in 1999-2002 and 2009-2010 due to high number of livestock loss during the cold disaster event during the winter season named dzud explained in the overview of the agricultural sector section. Thus N_2O emissions from managed soils in these years declined and gradually increased back in next following years (see Figure 5-2 and Table 5-14). The percentage of the trend change of the aggregated sources and non-CO_2 emission sources category emissions by source categories is given in the Table 5-14.

Table 5-14: Breakdown of the Mongolia's aggregated sources and non-CO_2 emissions sources on land category CH_4 and N_2O emissions by source category, 1990-2014, Gg

Year	CH_4	Total CH_4 Emissions from biomass burning (CO2e)	N_2O			Total Emissions (N_2O)	Total N_2O Emissions (CO_2e)	3.C - Aggregate sources and non-CO_2 emissions sources on land (CO_2e)
	3.C.1. Emissions from biomass burning		3.C.1. Emissions from biomass burning	3.C.4 - Direct N_2O Emissions from managed soils	3.C.5 - Indirect N_2O Emissions from managed soils			
1990	2.80	58.70	0.155	9.60	3.28	13.03	4,040.70	4,099.40
1991	2.80	58.70	0.155	9.45	3.24	12.84	3,980.52	4,039.22
1992	2.80	58.70	0.155	9.45	3.24	12.84	3,979.80	4,038.50
1993	2.80	58.70	0.155	9.09	3.13	12.37	3,834.79	3,893.48
1994	2.80	58.70	0.155	9.82	3.37	13.34	4,135.12	4,193.81
1995	2.80	58.70	0.155	10.68	3.65	14.49	4,491.32	4,550.01
1996	2.07	43.40	0.114	11.04	3.76	14.91	4,622.61	4,666.00
1997	11.67	245.12	0.646	11.71	4.01	16.37	5,073.79	5,318.91
1998	6.12	128.52	0.339	12.23	4.20	16.77	5,197.20	5,325.72
1999	1.89	39.79	0.105	12.41	4.25	16.77	5,198.99	5,238.78
2000	4.48	94.12	0.248	10.82	3.77	14.83	4,597.64	4,691.75
2001	0.002	0.05	0.0001	8.69	3.14	11.83	3,667.79	3,667.84
2002	1.27	26.58	0.070	7.98	2.88	10.94	3,390.25	3,416.83
2003	0.28	5.95	0.016	8.24	3.01	11.27	3,492.89	3,498.84
2004	0.27	5.60	0.015	8.90	3.28	12.19	3,778.80	3,784.40
2005	0.12	2.56	0.007	9.49	3.50	13.00	4,028.54	4,031.10
2006	1.23	25.81	0.068	10.72	3.97	14.76	4,576.18	4,601.99
2007	3.86	81.00	0.213	12.21	4.53	16.96	5,256.18	5,337.18
2008	4.40	92.36	0.243	12.94	4.82	18.01	5,583.04	5,675.40
2009	8.59	180.46	0.475	13.22	4.91	18.61	5,768.45	5,948.91
2010	0.08	1.67	0.004	10.29	3.77	14.07	4,360.88	4,362.55
2011	0.55	11.46	0.030	11.39	4.19	15.61	4,838.02	4,849.48
2012	6.14	128.94	0.340	12.74	4.69	17.76	5,506.86	5,635.80
2013	0.02	0.42	0.001	14.20	5.22	19.42	6,020.58	6,021.00
2014	0.07	1.42	0.004	16.25	5.96	22.21	6,885.52	6,886.94
Diff % 1990/ 2014	-97.58%	-97.58%	-97.58%	69.34%	81.44%	70.40%	70.40%	68.00%
Diff % 2013/ 2014	236.91%	236.91%	236.91%	14.40%	14.23%	1.37%	14.37%	14.38%

Figure 5-8 shows that percentage comparison between each source category of aggregated sources and non-CO_2 emission sources on land between 1990 and 2014. Direct N_2O emissions from managed soils are the dominant source within the category.

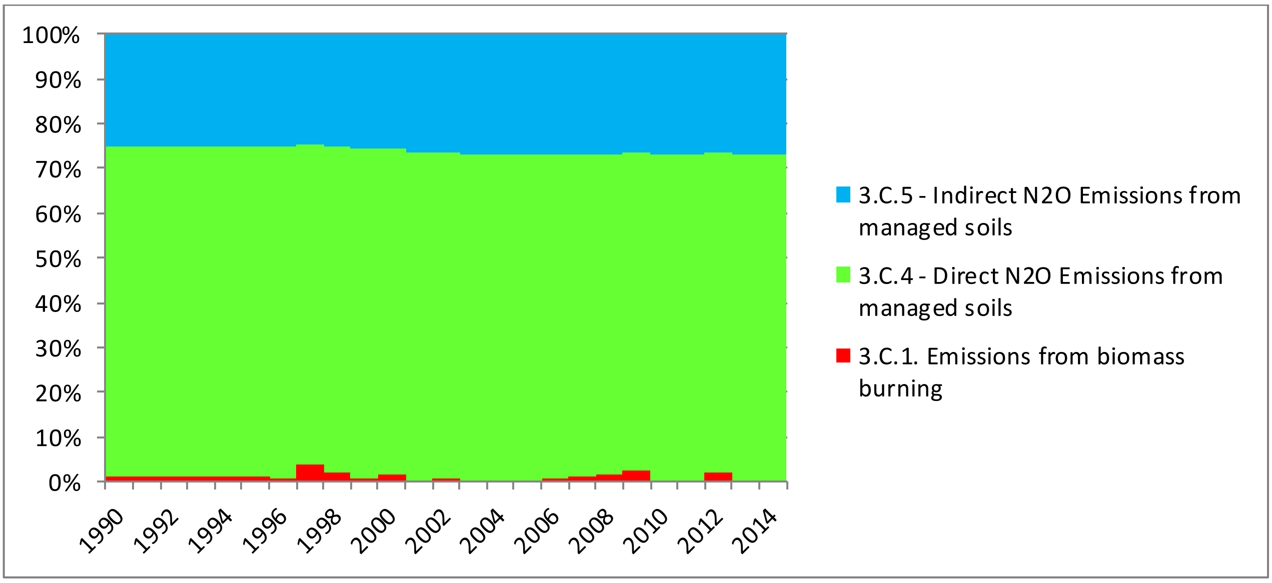

Figure 5-8: Each subcategory contribution to the 'aggregated sources and non-CO_2 emission sources on land' category

5.3.1 Biomass burning (CRF 3.C.1)

5.3.1.1 Source category description

Both uncontrolled (wildfires) and managed (prescribed) fires can have a major impact on the non-CO_2 emission from forests. Under this category, burning of biomass consists of CH_4, N_2O, NO_x and CO from biomass combustion of forest land is estimated.

5.3.1.2 Summary of emission trends

The total emissions attributed to biomass burning was 2.58 Gg CO_2e making up 0.02 % of the total aggregated sources and non-CO_2 emission sources on land emissions in 2014. This was -97.58% below and 236.91% above 1990 and 2013 levels respectively (Table 5-15). Main driver of the emission fluctuation is forest fire occurrence of the certain years (Figure 5-9).

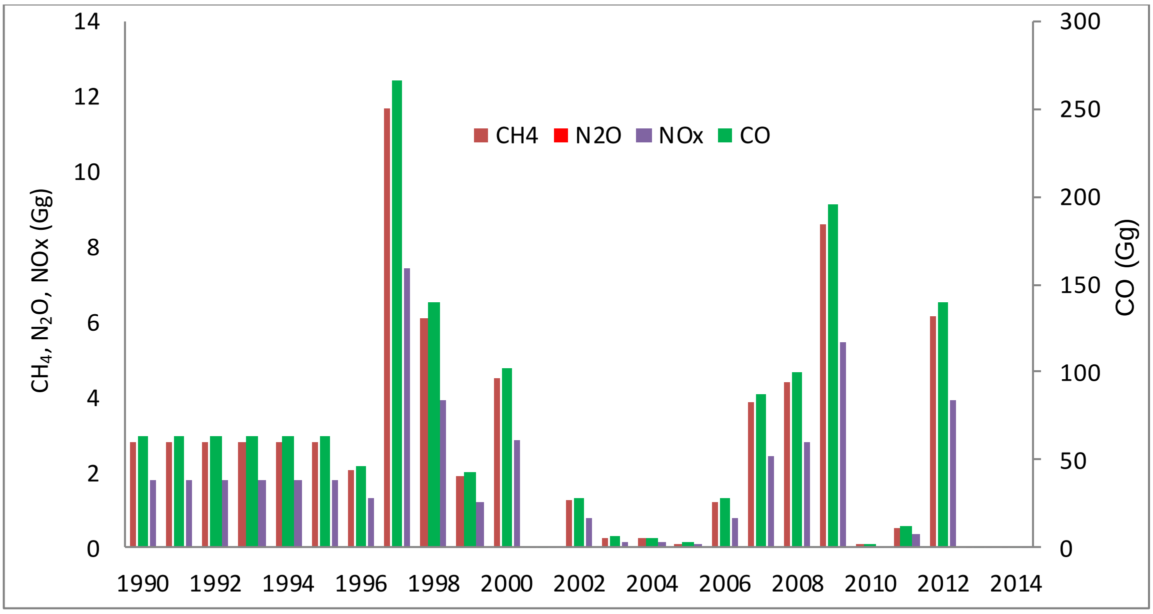

Figure 5-9: GHG emission of biomass burning, Gg

Table 5-15: Total GHG Emissions from biomass burning within 1990-2014 periods

Year	*3.C.1 - Emissions from biomass burning*					*3.C.1 - Emissions from biomass burning (CO_2e)*		
	CH_4	*N_2O*	*NO_x*	*CO*	*NMVOCs*	*CH_4 (CO_2e)*	*N_2O (CO_2e)*	*Total (CO_2e)*
1990	2.795	0.155	1.784	63.633	0.000	58.70	47.93	106.63
1991	2.795	0.155	1.784	63.633	0.000	58.70	47.93	106.63
1992	2.795	0.155	1.784	63.633	0.000	58.70	47.93	106.63
1993	2.795	0.155	1.784	63.633	0.000	58.70	47.93	106.63
1994	2.795	0.155	1.784	63.633	0.000	58.70	47.93	106.63
1995	2.795	0.155	1.784	63.633	0.000	58.70	47.93	106.63
1996	2.067	0.114	1.319	47.047	0.000	43.40	35.44	78.84
1997	11.672	0.646	7.450	265.734	0.000	245.12	200.17	445.29
1998	6.120	0.339	3.906	139.329	0.000	128.52	104.95	233.47
1999	1.895	0.105	1.209	43.132	0.000	39.79	32.49	72.28
2000	4.482	0.248	2.861	102.031	0.000	94.12	76.86	170.97
2001	0.002	0.000	0.002	0.055	0.000	0.05	0.04	0.09
2002	1.266	0.070	0.808	28.815	0.000	26.58	21.71	48.29
2003	0.283	0.016	0.181	6.453	0.000	5.95	4.86	10.81
2004	0.267	0.015	0.170	6.074	0.000	5.60	4.58	10.18
2005	0.122	0.007	0.078	2.777	0.000	2.56	2.09	4.65
2006	1.229	0.068	0.784	27.980	0.000	25.81	21.08	46.89
2007	3.857	0.213	2.462	87.809	0.000	81.00	66.14	147.14
2008	4.398	0.243	2.807	100.129	0.000	92.36	75.42	167.79
2009	8.593	0.475	5.485	195.639	0.000	180.46	147.37	327.83
2010	0.080	0.004	0.051	1.810	0.000	1.67	1.36	3.03
2011	0.546	0.030	0.348	12.426	0.000	11.46	9.36	20.82
2012	6.140	0.340	3.919	139.788	0.000	128.94	105.30	234.24
2013	0.020	0.001	0.013	0.457	0.000	0.42	0.34	0.77
2014	0.068	0.004	0.043	1.538	0.000	1.42	1.16	2.58
Diff % 1990/2014	-97.58%	-97.58%	-97.58%	-97.58%	-	-97.58%	-97.58%	-97.58%
Diff % 2013/2014	236.91%	236.91%	236.91%	236.91%	-	236.91%	236.91%	236.91%

5.3.1.3 Activity data, methodological issues and emission factors

The emissions from burning of biomass combustion of forest land were estimated using the Tier 1 method of IPCC 2006 according to the following formula:

$$Emission = A * MB * Cf * EF$$

Where:

- *Emission* = GHG emissions in Gg CH_4, Gg N_2O, Gg NOx and Gg CO.
- *A* = Activity data, representing the total mass of fuel burned, in kg of dry matter. AD (area burnt) is taken from FAOSTAT Emissions database, in the Emissions-Land Use/Burning-Biomass domain from 1990 to 2014. Obtained data from FAOSTAT were based on official data between 1996 and 2014 and calculated data between 1990 and 1995.
- MB = the mass of fuel (MB) available for combustion, in tons/ha, which includes biomass, litter and dead wood.
- Cf = combustion factor
- *EF* = Tier 1 IPCC emission factor, expressed in g CH_4, g N_2O or g CO_2, per kg of burned dry matter (IPCC 2006, Vol. 4, Ch. 2, Table 2.4-2.6).

5.3.2 Direct N_2O emissions from managed soils (CRF 3.C.4)

5.3.2.1 Source category description

In most soils, an increase in available N enhances nitrification and denitrification rates which then increase the production of N_2O. Increases in available N can occur through human-induced N additions or change of land-use and/or management practices that mineralize soil organic N.

The following N sources included for estimating direct N_2O emissions from managed soils in this report are: synthetic N fertilizers (F_{SN}); organic N applied as fertilizer (animal manure) (F_{ON}); urine and dung N deposited on pasture, range and paddock by grazing animals (F_{PRP}); and N in crop residues (F_{CR}).

5.3.2.2 Summary of emission trends

The total emissions attributed to direct N_2O emissions from managed soils was 5,037.18 Gg CO_2e making up 73.16% of the total aggregated sources and non-CO_2 emission sources on land emissions in 2014. This was 69.34% and 14.40% above 1990 and 2013 levels respectively (Table 5-16). Main driver of the emission fluctuation of the direct N_2O emissions from managed soils between 1990 and 2014 is number of livestock population (See in overview of the Agricultural sector).

Table 5-16: Breakdown of the N_2O emissions from Direct N_2O emissions from managed soils category by source categories for the period 1990-2014, Gg

Year	N_2O				3.C.4 - Direct N_2O Emissions from managed soils	Direct N_2O Emissions from managed soils (CO_2e)
	Inorganic N fertilizer application	Organic N applied as fertilizer (manure)	Urine and dung N deposited on pasture, range and paddock by grazing animals	N in crop residues		
1990	0.14	0.0052	9.31	0.13	9.60	2,974.67
1991	0.16	0.0032	9.21	0.08	9.45	2,929.01
1992	0.17	0.0019	9.20	0.07	9.45	2,928.12
1993	0.01	0.0011	9.01	0.07	9.09	2,817.63
1994	0.01	0.0009	9.76	0.05	9.82	3,043.38
1995	0.03	0.0009	10.61	0.04	10.68	3,311.37
1996	0.03	0.0007	10.97	0.03	11.04	3,421.17
1997	0.08	0.0008	11.60	0.04	11.71	3,631.21
1998	0.07	0.0008	12.13	0.03	12.23	3,790.61
1999	0.04	0.0008	12.34	0.03	12.41	3,847.78
2000	0.05	0.0006	10.74	0.02	10.82	3,352.83
2001	0.05	0.0006	8.62	0.02	8.69	2,695.04
2002	0.07	0.0005	7.89	0.02	7.98	2,474.76

2003	0.06	0.0005	8.15	0.03	8.24	2,553.40
2004	0.09	0.0007	8.78	0.02	8.90	2,757.55
2005	0.06	0.0009	9.41	0.02	9.49	2,940.44
2006	0.10	0.0013	10.60	0.02	10.72	3,324.52
2007	0.09	0.0014	12.09	0.02	12.21	3,784.65
2008	0.11	0.0011	12.80	0.04	12.94	4,012.94
2009	0.12	0.0010	13.04	0.06	13.22	4,099.43
2010	0.17	0.0010	10.06	0.06	10.29	3,190.72
2011	0.22	0.0012	11.10	0.07	11.39	3,530.97
2012	0.26	0.0016	12.40	0.08	12.74	3,948.11
2013	0.39	0.0020	13.75	0.06	14.20	4,403.19
2014	0.29	0.0018	15.88	0.08	16.25	5,037.18
Diff % 1990/2014	103.24%	-65.62%	70.47%	-41.64%	69.34%	69.34%
Diff % 2013/2014	-25.13%	-10.72%	15.47%	25.60%	14.40%	14.40%

In 1990, urine and dung N deposited on pasture, range and paddock by grazing animals contributed 97.07% of the total emissions from direct N_2O. The rest were as follows: inorganic N fertilizer application (1.49%), organic N applied as fertilizer (0.05%) and N in crop residues (1.38%). By 2014, percentage share of the each source contribution to the direct N_2O emissions from managed soils is changed as follows: urine and dung N deposited on pasture, range and paddock by grazing animals (97.72%), inorganic N fertilizer application (1.79%), organic N applied as fertilizer (0.01%), and N in crop residues (0.48%). The results are shown in the Figure 5-10 and Figure 5-11.

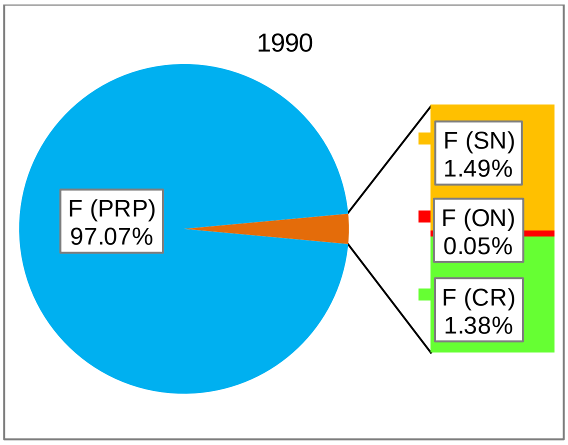

Figure 5-10: Direct N_2O emissions by source category in 1990

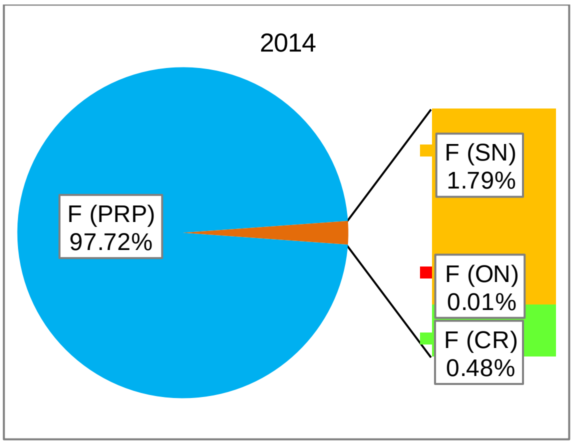

Figure 5-11: Direct N_2O emissions by source category in 2014

5.3.2.3 Activity data, methodological Issues and emission factors

Emissions from direct N_2O emissions from managed soils were calculated at Tier 1, following IPCC 2006 Vol. 4, Ch. 10 and 11 methodologies according to the formula:

$$N_2O\ direct = N_2O_{(SN)} + N_2O_{(ON)} + N_2O_{(PRP)} + N_2O_{(CR)}$$

Where:

- $N_2O_{(SN)}$ – annual N_2O emissions from the amount of synthetic fertilizer N applied to soils; Gg/yr;
- $N_2O_{(ON)}$ – annual N_2O emissions from the amount of animal manure, compost, sewage sludge and other organic N additions applied to soils, Gg/yr;
- $N_2O_{(PRP)}$ – annual N_2O emissions from urine and dung inputs to grazed soils, Gg/yr;

- N_2O (CR) – annual N_2O emissions from the amount of N in crop residues (above-ground and below-ground), including N-fixing crops and from forages during pasture renewal, returned to soils, Gg/yr;

Summary of activity data and emission factor used to obtain the $N_2O_{(SN)}$; $N_2O_{(ON)}$; $N_2O_{(PRP)}$; $N_2O_{(CR)}$ is included in Table 5-17.

Table 5-17: Summary of AD and EF used for Direct N_2O emissions from managed soils category

Source	*AD; EF*	*Description*
N_2O (SN)	Activity data	The amount of annual synthetic N applications in kg N yr-1
		N consumption data are taken from the FAOSTAT Fertilizers Archive Dataset (1990-2001) (Inputs/ Fertilizers Archive sub domain/) and the Fertilizers Dataset (2002 to present) (Inputs/Fertilizers sub domain). These are derived as an annual balance of N production and net trade (http://www.fao.org/faostat/en/#data). In the latter dataset, the element "Nitrogen Fertilizers (N total nutrients)" corresponds to the old "Nitrogenous Fertilizers"; "Consumption in nutrients (tons of nutrients)" corresponds to the old "Consumption".
	Emission factor	Tier 1, default IPCC EFs, expressed in kg N_2O-N / kg N
		Global default EF values are taken from IPCC 2006, Vol. 4, Ch.11, Table 11.1.
N_2O (ON)	Activity data	The total amount of N in manure applied to soils in kg N yr-1
		The amount of N excreted by swine, treated in "daily spread" manure management systems (100%) is used for this inventory. Following IPCC 2006, Vol. 4, Ch. 10, Equation 10.30, the total amount of N excreted by swine category is calculated by multiplying the number of swine heads by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (Nex). Both parameters listed under Asia region are chosen for the Mongolia. TAM value is obtained from IPCC 2006, Vol. 4, Ch. 10, 10A-8; Nex value is derived from IPCC 2006, Vol. 4, Ch. 10, Table 10.19.
	Emission factor	Tier 1, default IPCC EFs in kg N_2O-N/kg N yr-1
		Global IPCC default EF values are taken from IPCC 2006: Vol. 4, Ch. 11, Table 11.1.
N_2O (PRP)	Activity data	The total amount of manure N left on pasture in kg N yr-1
		The amount of N excreted by cattle, sheep, goats, horses, and camels, treated in Pasture/Range/Paddock manure management systems (100%) used for this inventory. Following IPCC 2006, Vol. 4, Ch. 10, Equation 10.30, the total amount of N excreted by livestock category (cattle, sheep, goats, horses, and camels) is calculated by multiplying the number of livestock heads by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (Nex). Both parameters listed under Asia region are chosen for the Mongolia. TAM value is obtained from IPCC 2006, Vol. 4, Ch. 10, 10A-5 and 10A-9; N_{ex} values are derived from IPCC 2006, Vol. 4, Ch. 10, Table 10.19.
	Emission factor	Tier 1, default IPCC EFs, expressed in kg N_2O-N/kg N yr-1
		Global default EF values taken from IPCC 2006, Vol. 4, Ch. 11, Table 11.1.
N_2O (CR)	Activity data	The total amount of N in crop residues in Kg N yr-1
		Activity data are calculated from crop yield and harvested area, and cover for wheat and potatoes as these are the most common and dominant crops in Mongolia. For the period between 1990 and 2014, the crop yield and harvested area data are taken from Statistical Office website www.1212.mn Crop yield and harvested area data are used to estimate the amount of biomass N in above and below-ground residues, by crop using Equation 11.6 in IPCC 2006, Vol. 4, Ch. 11, and the default crop values available in Table 11.2.
	Emission factor	Tier 1, default IPCC EFs, expressed in Kg N_2O-N/Kg N yr-1
		Global default EF values taken from IPCC 2006, Vol. 4, Ch. 11, Table 11.1.

5.3.3 Indirect N_2O emissions from managed soils (CRF 3.C.5)

5.3.3.1 Source category description

In addition to the direct emissions of N_2O from managed soils that occur through a direct pathway (i.e., directly from the soils to which N is applied), emissions of N_2O also take place through two indirect pathways. The first of these pathways is the volatilization of N as NH_3 and oxides of N (NO_x), and the deposition of these gases and their products NH^{4+} and NO^{3-} onto soils and the surface of lakes and other waters. The second pathway is the leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residues, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals.

The following N sources included for estimating indirect N_2O emissions from managed soils in this report are: synthetic N fertilizers $_{(FSN)}$; organic N applied as fertilizer (animal manure) $_{(FON)}$; urine and dung N deposited on pasture, range and paddock by grazing animals $_{(FPRP)}$; and N in crop residues $_{(FCR)}$ and results are summarized as volatilization and leaching/runoff pathways in the Table 5-18.

5.3.3.2 Summary of emission trends

The total emissions attributed to indirect N_2O emissions from managed soils was 1,847.19 Gg CO_2e making up 26.83% of the total aggregated sources and non-CO_2 emission sources on land emissions in 2014. This was 81.44% and 14.23% above 1990 and 2013 levels respectively (Table 5-20). In 1990 and 2014, percentage share between volatilization and leaching/runoff pathways are 46-47% and 54-53% respectively.

Table 5-18: Breakdown of the N_2O emissions from Indirect N_2O emissions from managed soils category by emission pathway for the period 1990-2014, Gg

Year	*N_2O*			*3.C.5 - Indirect N_2O Emissions from managed soils*	*3.C.5 - Indirect N_2O Emissions from managed soils (CO_2e)*
	Volatilization pathway	*Leaching/runoff pathway*	*3.C.6 - Indirect N_2O Emissions from manure management*		
1990	1.52	1.76	0.00	3.28	1,018.10
1991	1.51	1.73	0.00	3.24	1,003.57
1992	1.51	1.73	0.00	3.24	1,003.75
1993	1.46	1.66	0.00	3.13	969.23
1994	1.58	1.79	0.00	3.37	1,043.80
1995	1.71	1.94	0.00	3.65	1,132.01
1996	1.76	2.00	0.00	3.76	1,166.00
1997	1.88	2.13	0.00	4.01	1,242.41
1998	1.97	2.23	0.00	4.20	1,301.64
1999	2.00	2.26	0.00	4.25	1,318.73
2000	1.77	2.00	0.00	3.77	1,167.95
2001	1.47	1.67	0.00	3.14	972.71
2002	1.35	1.53	0.00	2.88	893.78
2003	1.41	1.60	0.00	3.01	934.62
2004	1.54	1.74	0.00	3.28	1,016.67
2005	1.64	1.86	0.00	3.50	1,086.01
2006	1.86	2.11	0.00	3.97	1,230.58
2007	2.13	2.41	0.00	4.53	1,405.39
2008	2.26	2.56	0.00	4.82	1,494.67
2009	2.30	2.61	0.00	4.91	1,521.65
2010	1.76	2.01	0.00	3.77	1,168.79
2011	1.95	2.24	0.00	4.19	1,297.69
2012	2.18	2.50	0.00	4.69	1,453.45
2013	2.43	2.79	0.00	5.22	1,617.04
2014	2.78	3.18	0.00	5.96	1,847.19
Diff % 1990/2014	82.46%	80.55%	0.00	81.44%	81.44%
Diff % 2013/2014	14.54%	13.97%	0.00	14.23%	14.23%

5.3.3.3 Activity data, methodological issues and emission factors

Emissions from indirect N_2O emissions from managed soils were calculated using Tier 1 method of IPCC 2006, Vol. 4, Ch. 10 and 11 methodologies according to the formula:

$$N_2O_{\ indirect} = N_2O_{\ (ATD)} + N_2O_{\ (L)}$$

Where:

- N_2O $_{(ATD)}$ – indirect N_2O emissions, produced from atmospheric deposition of nitrogen as ammonia (NH_3), oxides of N (NO_x), and their products NH^{4+} and NH^{3-} onto soils and the surface of lakes and other waters; deposition of agriculturally derived NH_3 and NO_x, following the application of synthetic and organic N fertilizers and/or urine and dung deposition from grazing animals;
- N_2O $_{(L)}$ – from leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residues returned to soils, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices and urine and dung deposition from grazing animals.

Summary of activity data and emission factor used to obtain the $N_2O_{(SN)}$; $N_2O_{(ON)}$; $N_2O_{(PRP)}$; N_2O $_{(CR)}$ to include above formula is included in Table 5-19.

Table 5-19: Summary of AD and EF used for Indirect N_2O emissions from managed soils category

Source	AD; EF	Description
N_2O (SN)	Activity data	The amount of annual synthetic N applications that volatilizes as NH_3 and NO_x and is lost through runoff and leaching in kg N yr-1
		Obtained through the volatilization and leaching factors in IPCC 2006, Vol. 4, Ch.11, Table 11.3.
	Emission factor	Tier 1, default IPCC EFs, expressed in kg N_2O-N / kg N yr-1
		Global default EF values from IPCC 2006, Vol. 4, Ch. 11, Table 11.3.
N_2O (ON)	Activity data	The fraction of manure N applications that volatilizes as NH_3 and NO_x, and is lost through runoff and leaching in kg N yr-1
		Obtained through the volatilization and leaching factors in IPCC 2006, Vol. 4, Ch.11, Table 11.3.
	Emission factor	Tier 1, default IPCC EFs in kg N_2O-N/kg N yr-1
		Global IPCC default EF values, from IPCC 2006, Vol. 4, Ch. 11, Table 11.3.
N_2O (PRP)	Activity data	the fraction of manure N left on pastures that volatilizes as NH_3 and NO_x and is lost through runoff and leaching in kg N yr-1
		Obtained through the volatilization and leaching factors in IPCC 2006, Vol. 4, Ch. 11, Table 11.3.
	Emission factor	Tier 1, default IPCC EFs, expressed in kg N_2O-N/kg N yr-1
		Global IPCC default EF values from IPCC 2006, Vol. 4, Ch. 11, Tab. 11.3
N_2O (CR)	Activity data	The fraction of N in crop residues forage/pasture renewal that is lost through runoff and leaching in kg N yr-1
		Obtained through the leaching factor in IPCC 2006, Vol. 4, Ch. 11, Table 11.3
	Emission factor	Tier 1, default IPCC EFs, expressed in kg N_2O-N / kg N yr-1
		Global IPCC default EF values from IPCC 2006, Vol. 4, Ch. 11, Table 11.3

CHAPTER 6: FORESTRY AND OTHER LAND USE/LULUCF (CRF 4)

6.1 Overview of the sector

In the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006), the AFOLU (Agriculture, Forestry and Land Use) category combines two previously distinct sectors LULUCF (Land Use, Land Use Change and Forestry) and agriculture defined in the 1996 Revised IPCC Guidelines for National Greenhouse Gas Inventories (revised IPCC 1996). The structure of 6 land use categories under LULUCF was retained. Although, only Forest land remaining forest land (CRF 3.B.1) of Land category and Harvested wood products (CRF 3.D.1) of Other (CRF 3.D) category are covered under the LULUCF sector for this submission (Table 6-1). The emissions and removals from the HWP were less than one per cent for all years of the inventory. The changes of trend in percentage between 1990/2014 and 2013/2014 are given below of the following table.

Table 6-1: GHG emissions from LULUCF by source categories, Gg CO_2e

Year	3.B.1 – Forest land	3.D.1 - Harvested Wood Products	Total Forestry, and Other Land Use (LULUCF)
1990	-22,795.13	-229.05	-23,024.18

1991	-22,930.61	-20.09	-22,950.70
1992	-23,094.90	102.86	-22,992.04
1993	-23,233.74	134.29	-23,099.45
1994	-23,372.71	159.93	-23,212.78
1995	-23,511.80	147.65	-23,364.15
1996	-23,651.01	54.13	-23,596.88
1997	-23,790.35	28.13	-23,762.22
1998	-24,351.87	-55.57	-24,407.44
1999	-25,274.34	-54.48	-25,328.82
2000	-25,134.97	-53.41	-25,188.38
2001	-25,776.59	-52.36	-25,828.96
2002	-25,833.03	-51.33	-25,884.36
2003	-25,497.11	-50.33	-25,547.44
2004	-25,590.34	-49.34	-25,639.68
2005	-25,609.71	-48.37	-25,658.09
2006	-24,702.76	-47.43	-24,750.19
2007	-24,711.09	-46.50	-24,757.59
2008	-24,670.51	-45.58	-24,716.09
2009	-24,906.26	-44.69	-24,950.95
2010	-24,627.06	-43.81	-24,670.87
2011	-24,593.38	-42.95	-24,636.33
2012	-24,560.00	182.95	-24,377.05
2013	-24,733.68	186.02	-24,547.66
2014	-24,634.30	182.37	-24,451.93
Diff % 1990/2014	8.07%	-179.62%	6.20%
Diff % 2013/2014	-0.40%	-1.96%	-0.39%

6.1.1 Key Categories

The results of key category analysis (including LULUCF) are shown in Table 6-2. The removal from Forest land Remaining Forest land was included in both level and trend assessment as key source categories.

Table 6-2: Key categories analysis under the LULUCF sector

IPCC Category	*GHG*	*Source Category*	*Key Categories*
3.A.1	CH_4	Enteric fermentation	Yes (L,T)
3.A.2	CH_4	Manure management	No
3.C.1	CH_4	Emissions from biomass burning	No
3.C.1	N_2O	Emissions from biomass burning	No
3.C.4	N_2O	Direct N2O Emissions from managed soils	Yes (L,T)
3.C.5	N_2O	Indirect N2O Emissions from managed soils	Yes (T)
3.B.1.a	CO_2	Forest land Remaining Forest land	Yes (L,T)
3.D.1	CO_2	Harvested Wood Products	No

Abbreviations: L-Level Assessment; T-Trend Assessment.

6.1.2 Methodological Issues

In the LULUCF sector of Mongolia's 2017 GHG inventory submission, the IPCC 2006 guidelines have been used. Additionally for the calculation of the harvested wood products (HWP) emissions and removals the Kyoto Protocol (KP) Supplement was used. The emissions and removals from Land (CRF 3.B) and Harvested wood products (CRF 3.D.1) were estimated using the mixture of Tier 1 and Tier 2 methods, and country specific and default emission factors (EFs) values. Obtainable country specific activity data for all the categories were used. Where country specific activity data were non-existent, data from international data source (FAOSTAT) were used.

A summary description of methods used to estimate emissions by categories is provided in Table 6-3, while a more detailed description is available in chapters 6.2-6.3 of the National inventory report (NIR).

Table 6-3: Summary of methods used to estimate GHG emissions for the LULUCF sector

IPCC Category	*Source Category*	*CO_2*	
		Method	*EF*
3.B.1	*Forest land remaining Forest land*	T1/T2	CS/D
3.D.1	*Harvested Wood Products*	T1	CS

Abbreviations: T1-Tier 1 Method; T2-Tier 2 Method; CS-Country Specific; EF-Emission Factors.

6.1.3 Uncertainties assessment and time series consistency

There is an uncertainty attached to the estimation of area information for forest land from the Administration of Land Affairs, Geodesy and Cartography (ALAGAC). The uncertainties for the emission factors (EFs) are noted by the IPCC, whereas the data applied to estimate the gains and losses definitely have inherent uncertainties: wood harvest information (and the uncertainties attached to the linear extrapolation of the information from 1999 to 1990), areas of different forest types to weight the emission factor calculations. The disturbance numbers are based on international sources, extrapolation and expert knowledge.

Based on IPCC 2013 KP Supplement the uncertainties in FAOSTAT data is given with -25 / +5 % for the HWP. The uncertainties for applied emission factors are not given in IPCC Table 2.8.2. Thus no overall calculation of uncertainties for HWP estimations is possible.

6.1.4 Quality Assurance and Quality Control

In the current submission all applied information and data have been double-checked as far as possible. The application of methods has been proof-read and follows the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006). The activity data (AD) and methods used to estimate GHG emissions under this sector were documented and archived both in hard copies and electronically. For the next submission an overall quality control and quality assurance system should be in place. This system will describe transparently the involved agencies and roles, data flows and calculation methods.

6.1.5 Source specific recalculations

A recalculation in this category is not done in this submission, due to the implementation of a complete new National System for Greenhouse Gas Inventories and thus the first time application of the IPCC 2006 Guidelines and incorporation of most recent data collection methods (and first time application of their methodological approach). Thus compared to earlier versions of the Mongolian GHG inventory the whole inventory can be considered as recalculated.

6.1.6 Assessment of completeness

The current LULUCF inventory covers CO_2 emissions and removals from 2 source categories: Land (CRF 3.B) and Other (CRF 3.D) from 1990 to 2014. The Land category estimation based only Forest land remaining forest land (CRF 3.B.1.a) source category whilst Other (CRF 3.D) category consist Harvested wood products (CRF 3.D.1).

6.1.7 Source specific planned improvements

In the initial BUR of Mongolia (iBUR), it was decided to estimate only biomass gain and losses on the forest land remaining forest land category, including HWP for the LULUCF sector without land use change (LUC) calculation (Table 6-1). Thus the removals are may overestimated or underestimated and further improvement will be needed and to be addressed in further national inventory. There is on-going project to improve the land use assessment using Collect Earth tool at the Climate Change Project Implementing Unit (CCPIU, main compiler unit of GHGI) with support of the UNREDD Mongolia National Program. Current assessment plots are cover all over the Mongolia territory with circa 120,000 grid-plots and aiming to evaluate land use, land use change from 1990 to 2015/2016. The six main land categories of the Collect Earth assessment is align with IPCC categories.

Planned improvements within the LULUCF sector are listed in below Table 6-4. The last submission did not undergo any official review, thus the improvements mentioned here became obvious during the preparation of this submission.

Table 6-4: Planned improvements in the LULUCF sector

Sector	*Description*	*When*
General	Uncertainty discussion of the applied data sources	next iteration
3.B Land	To include all six land category, land use changes between land categories based on better data sources such as Collect Earth tool.	next iteration
3.B Land	To include all carbon pools in the correspondent land use category	next iteration
3.B Land	To include better information on management practice of forest land, cropland and grassland	next iteration
3.B Land	To include more reliable information on disturbances (fire) in Mongolia	next iteration
3.B Forest land	To include better and more domestic information on Saxaul forest.	next iteration

6.2 Land (CRF 3.B)

GHG emissions from the Land use, Land use change and Forestry sector consist largely of carbon dioxide gas, generated mainly through cropland, grassland and forest management activities, including carbon gain and losses linked to anthropogenic land use changes. According to the IPCC methodology, estimation on this sector should consider all six land categories: forest land, cropland, grassland, wetland, settlement and other land. Due to the some limitations regarding activity data generation and time series consistency, only forest land remaining forest land category is reported for this submission. The Figure 6-1 shows that 24 years' trend of CO_2 removal in Mongolia.

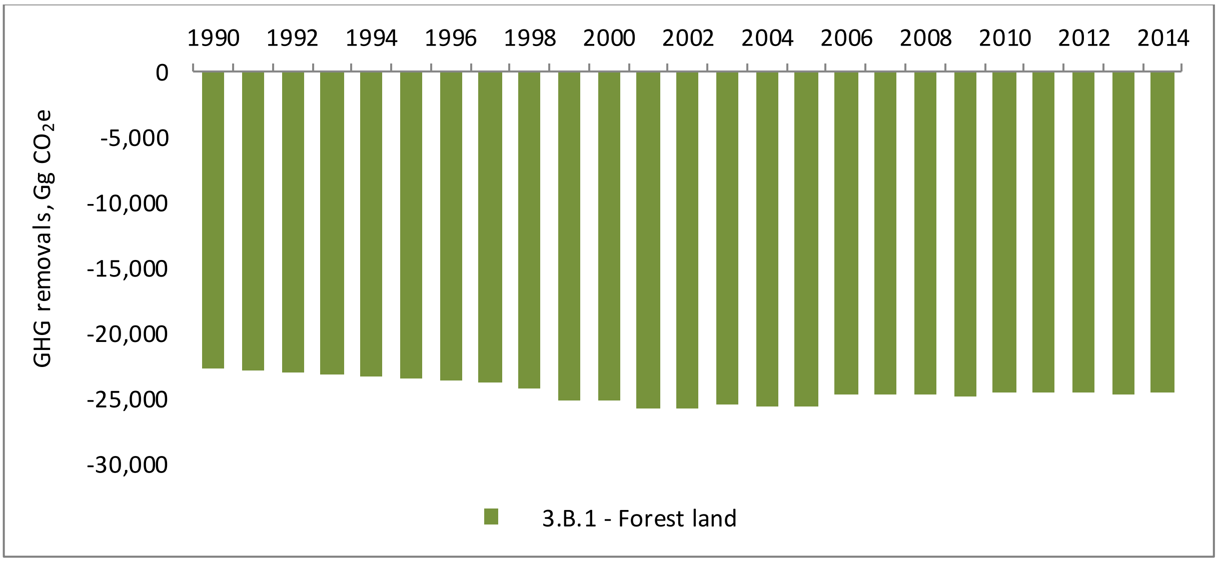

Figure 6-1: GHG removal trend in Land source category for the period 1990-2014, Gg CO_2e

The forest resources which cover about 10% of the country are split in Mongolia: in the north the more boreal type of forest is found whilst in the southern regions the predominant forest type is

Saxaul. The question of definition of forest is controversial in Mongolia and thus under constant debate. The different agencies and institutions rely on different attributes of their forest definitions for several purposes. Nevertheless there is a vital discussion on-going in Mongolia about the necessity of one or more definitions of forest land and woody biomass ecosystems in general. This might influence also the reporting in the successional submissions of the NIR. In the GHG inventory sense, the IPCC definition of Forest land was applied: *This category includes all land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but in situ could potentially reach the threshold values used by a country to define the Forest Land category.*

For the consistent representation of lands, their utilization throughout the time series, available data from the Administration of Land Affairs, Geodesy and Cartography (ALAGAC) have been applied. The national land use classification consists of a 3 level hierarchical stratification, starting from the country total (level 0) to broad land use classes (level 1: Agricultural Land; Settlements; Road, Line and Network; Land with Forest Resource; Land with Water Resources; Land for Special Utilization) and even more detailed land use sub-classes (level 2). Particular is the class "Land for Special Utilization" since its level 2 strata can be further divided in the level 1 classes of the land use classes other than "Land for Special Utilization". Thus it represents a subset of the respective land use class, but with another function, defined by ALAGAC. This spilt is important for domestic reporting but not for the areas' potential in sequestering and emit GHGs, therefore we re-allocated the areas under "special utilization" to the relevant land-use classes without the restriction of special use.

The aggregation of the ALAGAC land use classification into the applied seven sub-classes is based on the definitions available from ALAGAC plus expert knowledge (Table 6-5).

Table 6-5: Land conversion key from ALAGAC definition to IPCC land use class

	ALAGAC Level 1 class	*ALAGAC Level 2 class*	*IPCC Land Use Class*
1	*Agricultural land*	Pastureland	Grassland
		Hayfields	Grassland
		Cropland	Cropland
		Fallow land	Grassland
		Lands under agricultural constructions	Settlement
		Lands not suitable for agricultural use	Other land
2	*Land of cities, villages and other urban settlements*	Lands under construction and buildings	Settlement
		Lands for public use	Settlement
		Industrial land	Settlement
		Mining area	Settlement
		Residential areas	Settlement
3	*Road and line network*	Railway	Settlement
		Transport	Settlement
		Air transport	Settlement
		Water transport	Settlement
		Cable, network, lines etc.	Settlement
4	*Land with forest resources*	Land covered forest including Saxaul forest	Forest land
		Logged areas	Forest land
		Tree nursery	Forest land
		Lands reserved for forest expansion	Woody Grassland
		Other land of forest	Forest land
5	*Land with water resources*	River, stream	Wetlands
		Lake, pond, marsh	Wetlands
		Spring	Wetlands
		Glaciers and lands covered with perpetual snows and ice-river	Other land

Especially when it comes to forest area further clarification, consolidation and country-wide harmonization has to be done: The forest in Mongolia consists of two mayor types of forest:

1. Boreal conifer forests in the north and
2. Saxaul forest in the south of the country.

The forest area for the boreal forests, their coverage and characteristics are assessed in a national forest inventory (NFI) whilst more detailed information on Saxaul forests remain sparse. For that reason in this submission the definitions for forest is applied following the ALAGAC land classification. Nevertheless it is planned to incorporate new area information on both forest types (and thus the remaining land-use classes) as soon as they are available.

The area aggregation of the ALAGAC land use data into the applied IPCC six land classes is shown in the Table 6-6.

Table 6-6: National land use totals, thousand hectares

Year	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land
	Thousand ha					
1989	15,581.88	1,305.65	134,431.54	1,747.19	661.36	2,683.92
1990	15,660.48	1,283.45	134,407.39	1,759.15	679.88	2,621.20
1991	15,726.66	1,261.34	134,395.15	1,771.28	698.47	2,558.66
1992	15,817.86	1,239.00	134,359.03	1,783.10	716.95	2,495.61
1993	15,896.64	1,216.74	134,334.83	1,795.09	735.51	2,432.75
1994	15,975.48	1,194.47	134,310.60	1,807.08	754.08	2,369.84
1995	16,054.38	1,172.19	134,286.36	1,819.09	772.66	2,306.88
1996	16,133.34	1,149.88	134,262.10	1,831.10	791.26	2,243.88
1997	16,212.35	1,127.56	134,237.82	1,843.12	809.87	2,180.82
1998	16,497.59	954.34	133,979.16	1,656.80	737.67	2,586.00
1999	16,937.59	904.14	133,764.86	1,657.00	806.37	2,341.60
2000	16,937.63	808.21	134,047.81	1,659.16	824.95	2,133.80
2001	17,277.94	753.45	133,761.49	1,659.91	833.37	2,125.41
2002	17,278.33	757.46	133,760.99	1,659.89	830.08	2,124.80
2003	17,119.61	719.51	134,159.51	2,272.54	859.60	1,280.78
2004	17,135.54	719.60	134,116.67	2,295.89	867.69	1,276.15
2005	17,193.85	710.93	134,038.05	2,295.89	896.71	1,276.13
2006	16,730.47	711.68	134,769.30	1,994.20	929.42	1,276.49
2007	16,738.27	717.84	134,726.73	1,994.20	958.04	1,276.47
2008	16,739.07	849.08	134,563.20	1,994.12	989.61	1,276.47
2009	16,827.81	919.38	134,379.56	1,994.12	1,014.22	1,276.47
2010	16,767.12	946.28	134,293.83	2,011.37	1,116.44	1,276.51
2011	16,758.12	978.30	134,184.82	2,015.42	1,198.38	1,276.51
2012	16,789.29	1,044.96	134,043.77	2,015.42	1,241.59	1,276.52
2013	16,839.32	1,000.69	134,039.24	2,015.31	1,242.38	1,274.62
2014	16,864.77	1,026.62	133,951.98	2,015.05	1,278.10	1,275.04
Diff % 1990/2014	7.69%	-20.01%	-0.34%	14.55%	87.99%	-51.36%
Diff % 2013/2014	0.15%	2.59%	-0.07%	-0.01%	2.87%	0.03%

Since ALAGAC area data only gives a broad forest class with no separation in the two forest types, a general split of 75% boreal to 25% Saxaul forest was applied based on recent report (Report on Forest, 2014 approved by Ministry of Environment and Tourism) and expert knowledge. Figure 6-2 shows that total forest area of Mongolia based on National Land Agency (ALAGAC) data.

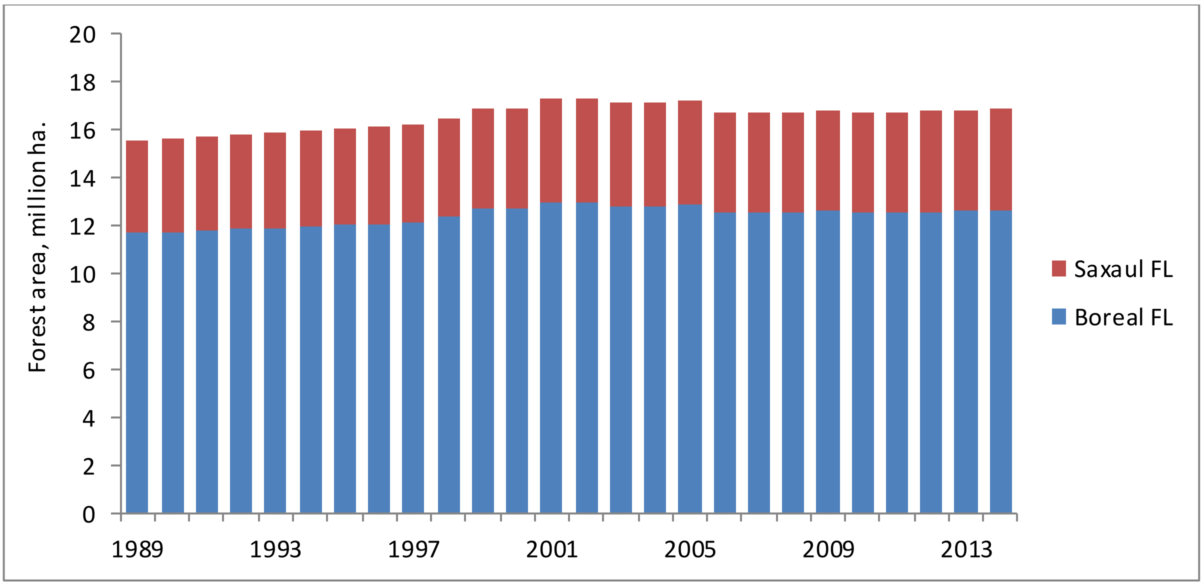

Figure 6-2: Total forest area by two sub-categories

The IPCC 2006 methodology was followed to estimate the gains and losses. The emission factors like below-ground carbon and expansion factors (BECFs), carbon fractions, above-ground biomass and below-ground biomass ratio (AGB-BGB-ratios) are taken from the IPCC tables (IPCC 2006, Table 4.4) and national information like on growth and stocks (The Multipurpose National Forest Inventory of Mongolia, 2016). The main factors used for the forest land GHG estimation are showed in the Table 6-7.

Table 6-7: Emission factors applied in Forest Land emission and removal estimation

Emission factor	*Unit*	*Boreal forest*	*Saxaul forest*	*Source*
Above-ground biomass growth	[t d.m./ha/yr]	1	0.4	IPCC 2006, Vol. 4, Ch. 4, Table 4.12 (4.9/4.10)
Below-ground to above-ground biomass ratio	[t BGB d.m./ (t AGB d.m.)]	0.30	0.30	NFI 2016, p101
Carbon fraction	[t C/(t d.m.)]	0.51	0.47	IPCC 2006, Vol. 4, Ch. 4, Table 4.3
Biomass carbon and expansion factor	[-]	0.55	0.75	IPCC 2006, Vol. 4, Ch. 4, Table 4.5
Default litter stocks	[t C/ha]	15.9	7.95	NFI 2016, Saxaul is assumed to have half the litter biomass than boreal forest
Above-ground biomass stocks	[t d.m./ha]	60.2	25	NFI 2016, p103-104; IPCC 2006, Vol. 4, Ch. 4, Table 4.8
Split between Boreal and Saxaul forest	[%]	75	25	Report on Forest, 2014, Ministry of Environment and Tourism

The activity data of wood harvest collected from the National Statistical Information Database (http://1212.mn). Information on harvested wood is available from 1999 to date. Despite the fact, that data is available on provincial-disaggregation level, the nation-wide data was used. It is assumed that fuel wood is only collected in whole tree form, thus the same methodology is applied as for the harvest removals. Further it is assumed that wood harvest and fuel wood collection only happens on Forest Land Remaining Forest Land.

The information of disturbance consolidated the NFI which found 18.60% of the forested area (11.3 million ha) was burned. That results in 2,101,800 ha. Further it assumed that the forest effect can be detected in the NFI for about 10 years. Thus the assumption taken was 2,101,800 ha divided by 10 years equals 210,180 ha / year. Based on this assumption, disturbed area is taken as 200,000 ha in every year in the Forest land estimation.

6.3 Other (CRF 3.D) - Harvested Wood Products (CRF 3.D.1)

Much of the wood that is harvested from Forest Land, Cropland and other types of land use remain in products for differing lengths of time. Harvested Wood Product (HWP) constitutes a carbon reservoir. The time carbon is held in products will vary depending on the product and its uses (IPCC 2006, Vol. 4, p12.5).

For the HWP UN FAO's FAOSTAT database have been applied. The category is a bit different from the land use categories since the data source is rather clear and well described by for example FAOSTAT. The emission and removal trend from the HWP category is given in the Table 6-1 and Figure 6-3.

Figure 6-3: Emission trend of Harvested Wood Products

6.4 Activity data, methodological issues and emission factors

The estimation of harvested wood products' (HWP) contribution to the LULUCF part of the GHG inventory in Mongolia is based on IPCC 2006 and IPCC 2013 KP Supplement as far as methodological choices and emission factor selection are concerned. Activity data stem from UN FAO's FAOSTAT database. What becomes obvious in the data source is a possible linear interpolation introduced by FAOSTAT between 1995 and 2010.

The activity data applied consists of the 1961-2014 time series information that is available for the imports, exports and domestic production quantities for paper and paperboard, sawnwood, and wood-based panels (as defined in http://www.fao.org/forestry/statistics/80572/en/)[9] . To prevent

[9] *Selection made on FAOstat → "Download data" → „Forestry" → „Forestry Production and Trade": Countries:* „Mongolia"; Elements: „Production Quantity", „Import Quantity", and „Export Quantity"; Items Aggregated: „Paper and Paperboard + (Total)", „Sawnwood + (Total)", and „Wood-Based Panels + (Totals)"; Years: „Select all", *downloaded as PIVOT with area and year in rows and item and element in columns.*

double-counting the following statement is considered:

HWP in SWDS and wood harvested for energy are thus implicitly treated on the basis of instantaneous oxidation (i.e. reporting no net - emissions from HWP). Estimates that are based on the three default commodities [annotation: as mentioned above] *are by definition not derived from wood harvested for energy purposes* (p. 2.119 IPCC 2013 KP Supplement).

For this submission the starting year of accumulation is set to i = 1961, since activity data are available since this year. An extrapolation until the recommended starting year of i = 1900 is mentioned as a possible improvement.

Since aggregated values of the three default commodities (mentioned above) have been obtained from the FAOSTAT database also conversion factors are used in an aggregated way. For this submission no country specific values for the disaggregation of sub-commodities, nor conversion factors, or half-live times have been applied[10]. Table 6-8 shows that summary of parameters used for the estimation.

Table 6-8: Parameters used for HWP estimation

Parameter	*Value*	
1961	Starting year	
Simple decay approach	Approach	
Solid wood products	Half Lives	35
	Average lifetime	50.494
	Decay rate (ks)	0.02
Paper products	Half Lives	2
	Average lifetime	2.885
	Decay rate (ks)	0.347
Sawnwood, other industrial roundwood	Conversion factors	0.229
Wood-based panels	Conversion factors	0.269
Paper products	Conversion factors	0.386
Estimated growth rate of HWP consumption prior to starting year	Growth rate	0.0217 (Asia)

CHAPTER 7: WASTE SECTOR

7.1 Overview of the sector

This Chapter includes information on the GHG emissions from the waste sector. The categories and activities for estimation methane (CH_4) and nitrous oxide (N_2O) emissions are described in detail. The GHG inventory of the waste sector is based on estimating of methane from solid waste disposal sites, methane emissions from wastewater treatment and discharge and nitrous oxide from human sewage.

The approaches and emission factors employed in estimations of GHG emissions from source categories of the waste sector are presented in Table 7-1. The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) default values are applied in calculations. The selection of methods followed the decision trees in IPCC 2006.

[10] *Table 2.8.1 and 2.8.2, p. 2.122, IPCC 2013 KP Supplement*

Table 7-1: Methods and emission factors used in estimations of emissions from waste sector

Source and Sink Categories	*CO_2*	*CH_4*	*N_2O*
	Method applied/EF		
4. - WASTE	NO	T1/D	NO
4.A - Solid Waste Disposal	NO	T1/D	NO
4.B - Biological Treatment of Solid Waste	NO	NO	NO
4.C - Incineration and Open Burning of Waste	NO	NO	NO
4.D - Wastewater Treatment and Discharge	NO	T1/D	T1/D

T1 = Tier 1 method, D = IPCC 2006 default value, NO=Not Occurring

CO_2 equivalent emissions from waste sector in 2014 were 159.91 Gg and accounts for 0.46% of the national totals (Figure 7-1).

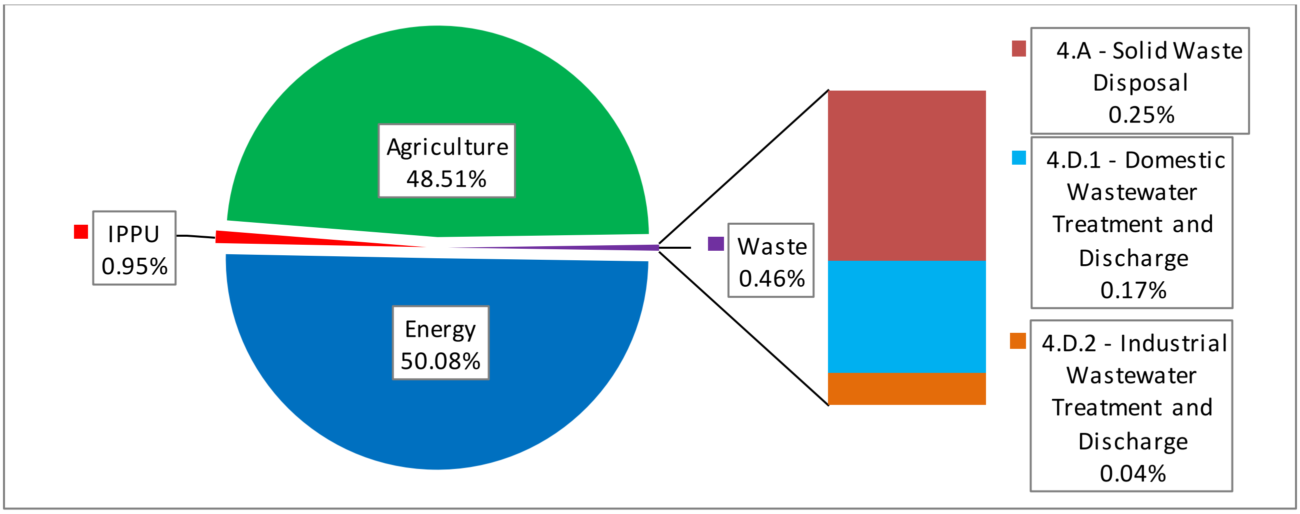

Figure 7-1: CO_2 equivalent emissions from the waste sector compared to the total GHG emissions (excl. LULUCF) in Mongolia in 2014

Total aggregated emissions from the Waste sector have increased by 104.29 Gg CO_2e (187.49%) from the 1990 level of 55.62 Gg CO_2e. The total CO_2e emission from waste sector in 2014 increased 7.93% compared to 2013.

Table 7-2: Emissions from waste sector in 1990 and 2014

Sector	*Gas*	*Gg CO_2e*		*Change from 1990 (Gg CO_2- eq)*	*Change from 1990 (%)*
		1990	*2014*		
4.A - Solid Waste Disposal	CH_4	15.33	86.39	71.06	463.35%
4.D.1 - Domestic Wastewater Treatment and Discharge	CH_4	19.45	36.48	17.03	87.56%
4.D.1 - Domestic Wastewater Treatment and Discharge	N_2O	12.39	21.02	8.63	69.71%
4.D.2 - Industrial Wastewater Treatment and Discharge	CH_4	8.46	16.02	7.56	89.48%
4. Total Waste	*CO_2e*	55.62	159.91	104.29	187.49%

In 2014, the methane emission from solid waste disposal (SWD) increased 463.35% and the methane emission from industrial wastewater treatment and discharge has increased 89.48%, methane and nitrous oxide emissions from domestic wastewater treatment and discharge have increased 87.56% and 69.71% separately, compared to the base year.

The GHG emissions trends in this sector are presented in Table 7-2 and Figure 7-2.

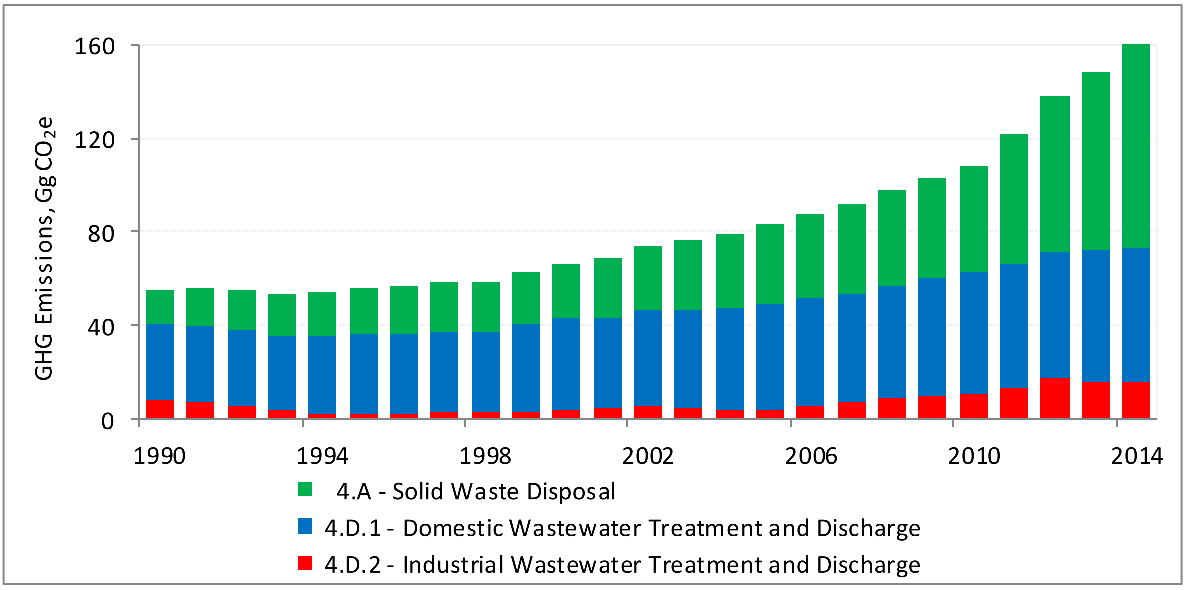

Figure 7-2: Trend of GHG emissions in the waste sector by source categories in 1990-2014, Gg CO_2e

The emissions from solid waste disposal sites (SWDS) contribute 54.02%, domestic wastewater treatment and discharge 35.96% and industrial wastewater treatment and discharge 10.02% to waste sector's total emissions in 2014 (detailed in Table 7-3).

Table 7-3: GHG emissions from waste sector by source categories, Gg CO_2e

Categories	Emissions	1990	1995	2000	2005	2010	2014
4.A Solid Waste Disposal Sites	(Gg)	15.33	19.60	22.92	34.00	45.27	86.39
	%	27.56	35.18	34.71	40.80	41.82	54.02
4.D.1 Domestic Wastewater	(Gg)	31.83	33.49	39.25	45.03	52.14	57.50
	%	57.23	60.11	59.43	54.04	48.17	35.96
4.D.2 Industrial Wastewater	(Gg)	8.46	2.62	3.87	4.29	10.85	16.02
	%	15.21	4.70	5.86	5.15	10.02	10.02
4 Waste Total	Gg	55.62	55.71	66.04	83.33	108.26	159.91
	%	100.00	100.00	100.00	100.00	100.00	100.00

As seen from the Figure 7-2 and Table 7-2 CH_4 and N_2O emissions from SWDS and domestic wastewater treatment and discharge have increased continuously year after year in relation to the population increase especially in urban areas. CH_4 emission has rapidly increased for last five years due to waste disposed to well-managed landfills which are covered with soil since 2010, in Ulaanbaatar. Meanwhile, the emission trend of methane from industrial wastewater treatment and discharge was fluctuating due to the certain year's economic condition.

7.1.1 Key categories

There is no key category in the waste sector in the national level key category analysis (KCA). The total emissions from this sector are the insignificant contributing only 0.46% to national total. The SWDS and domestic wastewater treatment and discharge are the major sources for emissions in 2014 under the waste sector.

7.1.2 Uncertainties and time series consistency

The uncertainty estimate of the 2014 inventory has been done according to the Tier 1 method proposed by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006).

All calculated uncertainties of emission factors and activity data used are in accordance with methodology used in emission estimations, derived from IPCC 2006 and detailed uncertainty values used in uncertainty assessment are presented under source categories descriptions below.

The estimated uncertainties for total greenhouse gas emissions in 2014 in waste sector presented in the Table 7-4.

Table 7-4: The inventory uncertainties for level and trend (percentage change from 1990) under the Waste sector

IPCC 2006 Categories	*Gas*	*Activity Data Uncertainty (%)*	*Emission Factor Uncertainty (%)*	*Combined Uncertainty (%)*	*Contribution to Variance by Category in 2014*	*Introduced into the trend in total waste sector's emissions (%)*
4.A - Solid Waste Disposal	CH_4	51.96	78.15	0.938	0.257	1.654
4.D.1 - Domestic Wastewater Treatment and Discharge	CH_4	63.64	64.44	0.906	0.043	0.399
4.D.1 - Domestic Wastewater Treatment and Discharge	N_2O	49.73	99.80	1.115	0.021	0.139
4.D.2 - Industrial Wastewater Treatment and Discharge	CH_4	50.25	42.43	0.658	0.004	0.046
Total					0.6%	1.5%

According to the tables above, the total uncertainties in waste sector's inventory were 0.6%. The trend uncertainty was 1.5% in total emissions from waste sector. The uncertainty is high due to assessment of insufficient data and applied default emission factors. Investigation will be performed with a view to collect more accurate data. All categories comprised in uncertainty estimates this can be seen in Annex III. The time series was checked for the consistency.

7.1.3 Source specific QA/QC and verification

General quality control (QC) procedures were applied in the waste sector according to the IPCC 2006 (Vol 1, Chapter 6, Table 6.1):

- Documentation on activity data and emission factors have been cross-checked with the corresponding data in the calculation model.
- Units and conversion factors were checked.
- The GHG emissions were estimated using the 2006 IPCC software and compared to the emissions calculated on the excel sheets as well. As a result of this quality control typing errors were identified and corrected.
- Completeness and consistency of emission estimates and on the proper use of notation keys in the common reporting format (CRF) tables were checked.
- Every annual inventory were archived both in hard copies and electronically.

7.1.4 Source specific recalculations

The previous GHG inventory estimations have been conducted in accordance with revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (revised IPCC 1996). Recalculations were made according to applied IPCC 2006 all emission sources have been recalculated accordingly.

Table 7-5: Recalculated CH_4 emissions under the Waste sector for 1990-2006, included in the SNC and iBUR of the Mongolia under the UNFCCC, Gg

Total waste sector		*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*
SNC	*CH_4*	4.57	4.48	4.86	5.00	4.90	5.19	5.19	5.14
iBUR	*(Gg)*	2.06	2.08	2.01	1.98	1.97	2.01	2.04	2.10
Difference	*%*	-54.96%	-53.55%	-58.67%	-60.39%	-59.93%	-61.21%	-60.69%	-59.09%

Total waste sector		*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
SNC	*CH_4*	5.19	5.29	5.71	5.90	5.90	6.05	6.19	6.38	6.57
iBUR	*(Gg)*	2.16	2.28	2.39	2.58	2.74	2.86	3.00	3.16	3.37
Difference	*%*	-58.31%	-56.81%	-58.21%	-56.31%	-53.60%	-52.76%	-51.54%	-50.48%	-48.67%

Abbreviations: SNC – Second National Communication; iBUR – First Biennial Update Report

As seen from Table 7-5, in comparison with the performed recalculation quantities of emitted methane from waste sector in the BUR are lower than the results included into the Mongolia's Second National Communication (SNC) under the UNFCCC, due to updating activity data and emission factors according to new methodology.

7.1.5 Source specific planned improvements

All activity data and parameters of waste sector for the emissions estimations will be kept under investigation and updated when data will be available, and will consider using them in the calculation of the emissions.

7.2 Solid waste disposal

7.2.1 Source specific description

The CH_4 emissions from solid waste disposal sites (SWDS) cover managed and un-managed waste disposal sites. Emissions from both disposal sites are estimated by using the first order decay (FOD) method from the year 1970.

Total emissions from the SWDS have increased by 71.06 Gg CO_2e (463.35%) from the 1990 level of 15.33 Gg CO_2e. CH_4 emissions from SWDS are presented in Figure 7-3.

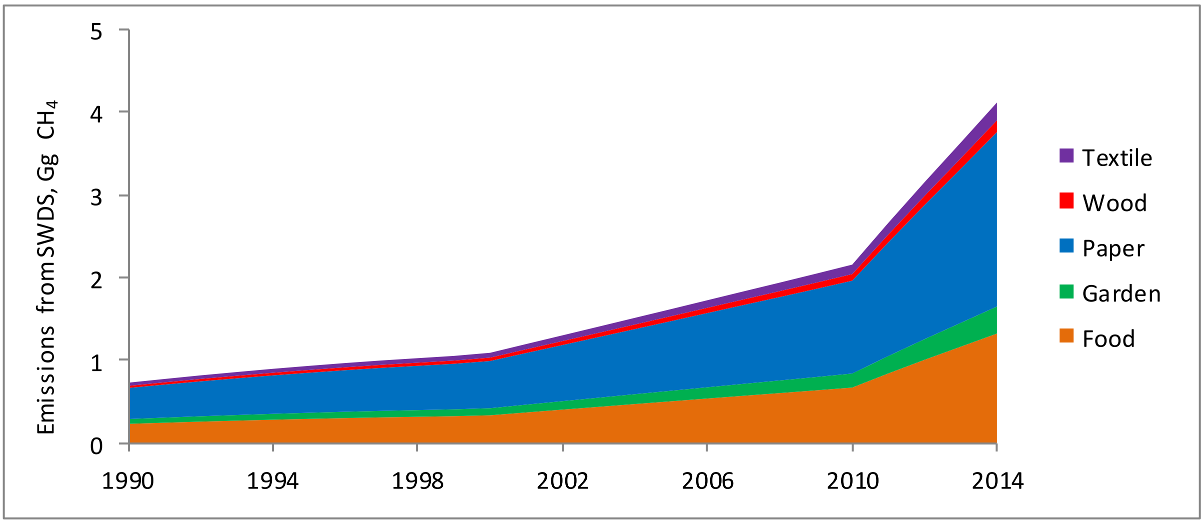

Figure 7-3: Quantities of CH_4 emission from biodegradable solid waste disposed in landfills 1990–2014, Gg

As seen from the Figure 7-3, the quantities of emitted methane from solid waste disposal (SWD) is in increasing trend, and it depends on the population growth especially in urban areas. The methane emissions have rapidly increased for last five years, due to waste disposed to well-managed landfills which are covered with soil since 2010, in Ulaanbaatar. Another main factor which affected to the increase of emission estimation is application of the FOD method for the SWD source category in first time.

7.2.2 Methodological issues

7.2.2.1 CH_4 emissions

The method used to calculate CH_4 emissions according to 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) by using the FOD method. Emissions from MSW disposal consist of domestic and commercial sources. The emissions were estimated taking into account population, per capita waste generation, and quantity collected and deposited of waste disposal sites.

The quantity of CH_4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste.

7.2.2.2 Activity data and methane correction factor

Incomplete data for municipal solid waste (MSW) in Mongolia makes it difficult to accurately determine GHG emissions from the waste sector. The amount of generation waste is available only from Ulaanbaatar city. The exact amounts of MSW generated from other urban and rural areas of Mongolia are not available. Therefore, the amounts of MSW from the urban areas were calculated by multiplying the per capita waste generation rates with the number of urban population. Data on urban population obtained from the dataset of the NSO.

The generation rates were assumed as the follows and it can be divided into three periods:

- 1970-1999: 0.334 kg/cap/day[11],
- 2000-2009: 0.6 kg/cap/day[12],
- 2010-2014: 0.84 kg/cap/day[13]

The fraction of the MSW disposed to SWDS assumed as 65% by local experts (Namkhainyam B. et al. "Studies on country specific GHG emission and removal factors for Mongolia, 2014"). The assumption was used for whole inventory period. Additionally, the amount of waste generation from Ulaanbaatar city is used for verification of the estimated MSW balance.

The amount of waste disposed at SWDS derived from the dataset of the Ulaanbaatar City Mayor's Office. In 2006, was developed Project "The Study on Solid Waste Management Plan for Ulaanbaatar City in Mongolia by Japan International Cooperation Agency (JICA).

Based on this study, MSW waste includes waste from household and streets and public spaces that account approximately 55% of the solid waste disposal sites.

The Figure 7-4 shows the comparison of MSW disposed to SWDS.

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[11] *Report WMO, Cal Recovery, 2003*
[12] *What a waste, World bank*
[13] *Namkhainyam B.et al. (2014), Studies on country specific GHG emission and removal factors for Mongolia, technical report*

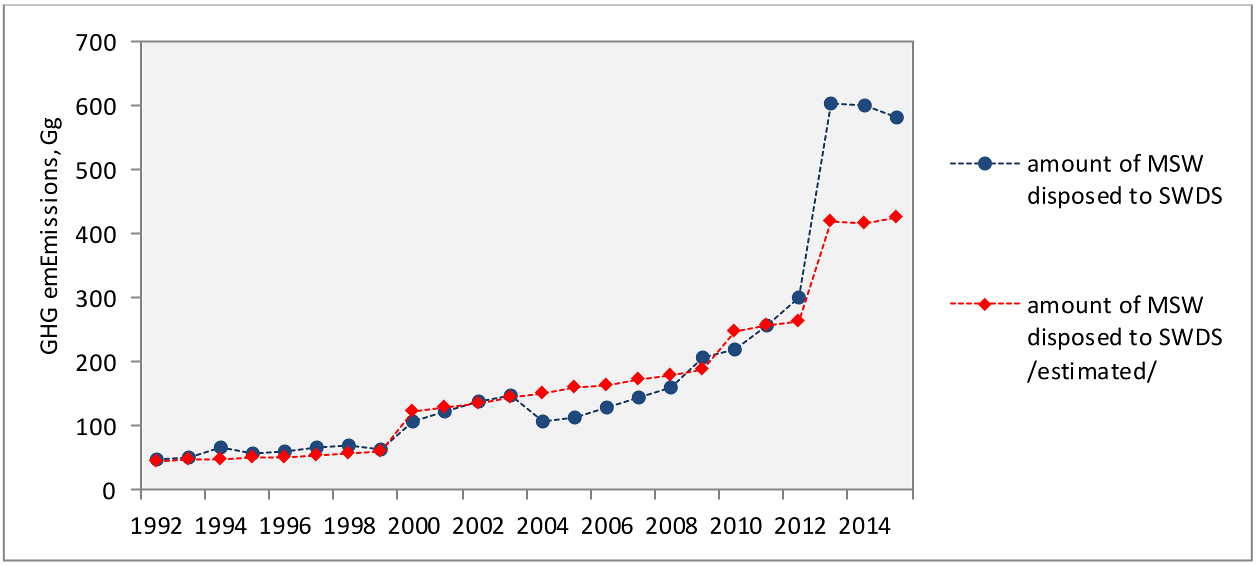

Figure 7-4: Amount of MSW disposed to SWDS in Ulaanbaatar city

As seen from the Figure 7-4, the observed MSW in last 5 years bigger than estimated amount due to illegal disposed wastes were collected in Ulaanbaatar city. The waste composition is probably the most important factor affecting landfill gas generation rates and quantities. The amount of landfill gas produced is dependent on the amount of organic matter landfilled.

The country specific data of waste composition were taken from the research report from Namkhainyam B. et al. "Studies on country specific GHG emission and removal factors for Mongolia, 2014". The composition of waste is presented in the Figure 7-5, which was used for entire period of 1990 – 2014.

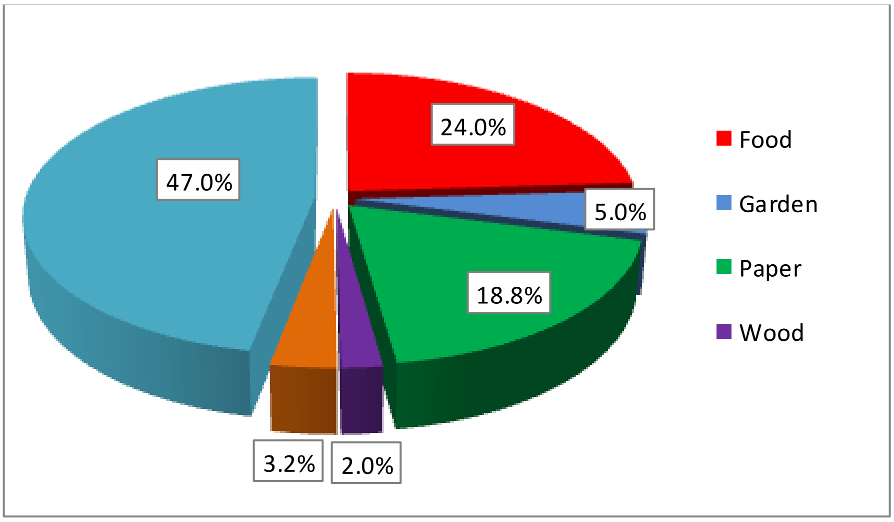

Figure 7-5: Composition of waste

In 2014, Mongolia's total urban population was 1,990,320 and 2/3 of the total urban population lives in Ulaanbaatar city. Therefore it was assumed that approximately 2/3 of the total waste is generating only from Ulaanbaatar city. There are 3 operational controlled landfill sites in Ulaanbaatar city. In Mongolia's case, the first regulated municipal solid waste disposal site, namely Moringiin davaa which started its operation in 1970. Thus, to estimate the CH_4 emissions from SWDS by using the

FOD method, the time series for disposed waste amounts were developed from the 1970 (detailed in Table 7-6).

Table 7-6: Urban population and estimated MSW in urban areas of Mongolia

Indicators	*Units*	*1970*	*1980*	*1985*	*1990*	*1995*	*2000*	*2005*	*2010*	*2014*
Population	thous.person	541.6	839.0	964.2	1226.53	1202.3	1361.27	1579.39	1910.75	1990.32
Generated Waste	Gg	66.03	102.28	117.55	149.53	146.57	298.12	345.89	586.22	610.63
Deposited MSW	Gg	42.92	66.48	76.4	97.19	95.27	193.78	224.83	381.04	396.91
Biodegradable waste	Gg	22.75	35.24	40.49	51.51	50.49	102.7	119.16	201.95	210.36

All solid waste disposal sites in Mongolia, in particular in the Ulaanbaatar city, were un-managed before 2009 using mainly up to 5 meters soil cover. Landfill technology was started to use at the operational SWDSs of Ulaanbaatar city from the end of 2009 and 8-10 ha areas are processing annually on these sites. Thus, calculations made under solid waste disposal comprise of managed as well as un-managed disposal sites. The solid waste disposal sites in Mongolia fall into the un-managed shallow type according to IPCC guidelines before 2009 and then divided un-managed and managed type from the 2010. Based on this national circumstance, the methane correction factor (MCF) was chosen differently for the inventory period. MCF of 0.4 is taken as default value for emission estimation between 1970 and 2009. Then in the later period of inventory (2010-2014), MCF of 1.0 is applied for the managed landfill sites and 0.4 (default value) for un-managed sites for the emission estimation. The MCFs were used for calculation are presented in the Table 7-7.

Table 7-7: MCF distribution in solid waste disposal

Year	SWDS classification		Weighted MCF
	Unmanaged –shallow, %	Managed – anaerobic, %	
1970-2009	100	0	0.400
2010	35	65	0.790
2011	32	68	0.808
2012	32	68	0.808
2013	31	69	0.814
2014	32	68	0.808

The quantity of CH_4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste. The values that have been applied for calculations are reported in Table 7-8.

Table 7-8: Variables used in the calculations of methane from landfills

Variables	*Type of waste*				
	Food	*Garden*	*Paper*	*Wood*	*Textile*
DOC	0.15	0.20	0.40	0.43	0.24
DOCf	0.5	0.5	0.5	0.5	0.5
CH_4 generation rate constant, k	0.06	0.05	0.04	0.02	0.04
Half-life time ($t_{1/2}$, years), h	11.60	13.90	17.33	34.70	17.30
Process start in deposition year. Month, M	13	13	6	13	13
Fraction to CH_4	0.5	0.5	0.5	0.5	0.5

7.2.3 Source specific uncertainties and time-series consistency

The IPCC recommended default values were used as source of uncertainty values. However, expert judgment was performed to choose values applicable for GHG emission calculations from SWD are presented in Table 7-9. The time series was checked for the consistency.

Table 7-9: Uncertainties in MSW disposal

Input	Uncertainties
CH_4 emissions from Solid waste disposal	
Total of MSW	±30%
Fraction of MSW sent to SWDS	±30%
Total uncertainty of waste composition	±30%
Emission factor	
Degradable organic carbon	±10%
Fraction of Degradable organic carbon (DOCf)	±15%
MCF:	
=1.0	-10%, +0%
=0.4	±30%
Fraction of CH_4 in generated Landfill gas (F)	±5%
Total uncertainty of the Half-life ($t_{1/2}$)	
Paper textile	17 (14-23)
Wood	35 (23-69)
Garden	14 (12-17)
Food	12 (9-14)
Combined uncertainties	*94%*

7.2.4 Source specific QA/QC and verification

General quality control (QC) procedures were applied in the waste sector according to the IPCC 2006 (Vol 1, Chapter 6, Table 6.1):

- Documentation on activity data and emission factors have been cross-checked with the corresponding data in the calculation model.
- Units and conversion factors were checked.
- The GHG emissions were estimated using the 2006 IPCC software and compared to the emissions calculated on the excel sheets as well. Results of this comparison typing errors were identified and corrected. Additionally, the amount of waste generation from Ulaanbaatar city was used for verification of the estimated MSW balance.
- Completeness and consistency of emission estimates and on the proper use of notation keys in the CRF tables were checked.
- Every annual inventory were archived both in hard copies and electronically.

7.2.5 Source specific recalculations

Recalculations performed for entire time series due to use of IPCC 2006 particularly use of the FOD method.

Table 7-10: Recalculated CH_4 emissions under the Solid waste disposal for 1990-2006

Total Solid waste disposal		*1990*	*1995*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
SNC	*CH_4*	1.86	1.90	2.14	2.14	2.19	2.24	2.29	2.38	2.43
iBUR	*(Gg)*	0.73	0.93	1.09	1.20	1.30	1.41	1.51	1.62	1.73
Difference	*%*	-60.68%	-50.99%	-49.07%	-44.13%	-40.55%	-37.12%	-33.80%	-32.01%	-28.94%

Abbreviations: SNC – Second National Communication; iBUR – First Biennial Update Report

Differences of waste sector GHG emissions for SNC and iBUR (Table 7-10), estimates can be explained by the following updates:

- total MSW generation due to revision of waste generation rates per capita
- composition of waste
- fraction of MSW sent to SWDS

- methods of disposals and their various percentages.

7.2.6 Source specific planned improvements

As reported above there is still lack of activity data. Thus for the improvement of emissions estimates are:

- update the historical data on waste generation per capita
- refine the distribution of waste by waste management type.

7.3 Wastewater Treatment and Discharge

7.3.1 Source specific description

This sector covers emissions generated during municipal and industrial wastewater treatment. When the wastewater is treated anaerobically, methane is produced. Wastewater handling can also be a source of N_2O. Therefore N_2O emissions from human sewage are also part of the inventory.

The GHG emissions trends from the Wastewater treatment and discharge are presented in Table 7-11 and Figure 7-6.

Table 7-11: CH_4 and N_2O emissions from wastewater treatment and discharge

Year	*Domestic wastewater*	*Domestic wastewater*	*Industrial wastewater*	*Wastewater treatment and discharge*
	CH_4 Emissions (Gg)	*N_2O Emissions (Gg)*	*CH_4 Emissions (Gg)*	*Total emissions (Gg CO_2e)*
1990	0.93	0.04	0.40	40.29
1991	0.94	0.04	0.37	39.91
1992	0.92	0.04	0.27	37.77
1993	0.94	0.04	0.19	35.63
1994	0.94	0.04	0.13	35.15
1995	0.95	0.04	0.12	36.11
1996	0.96	0.04	0.12	36.24
1997	0.97	0.05	0.14	37.30
1998	0.99	0.04	0.15	37.02
1999	1.08	0.05	0.15	40.58
2000	1.11	0.05	0.18	43.12
2001	1.15	0.05	0.23	43.31
2002	1.19	0.05	0.25	46.81
2003	1.24	0.05	0.21	46.96
2004	1.28	0.05	0.21	47.26
2005	1.34	0.05	0.20	49.33
2006	1.38	0.05	0.27	51.50
2007	1.42	0.05	0.34	53.77
2008	1.47	0.06	0.43	56.95
2009	1.53	0.06	0.46	60.13
2010	1.61	0.06	0.52	62.99
2011	1.63	0.06	0.63	66.26
2012	1.67	0.06	0.82	71.61
2013	1.72	0.06	0.78	71.93
2014	1.74	0.07	0.76	73.52

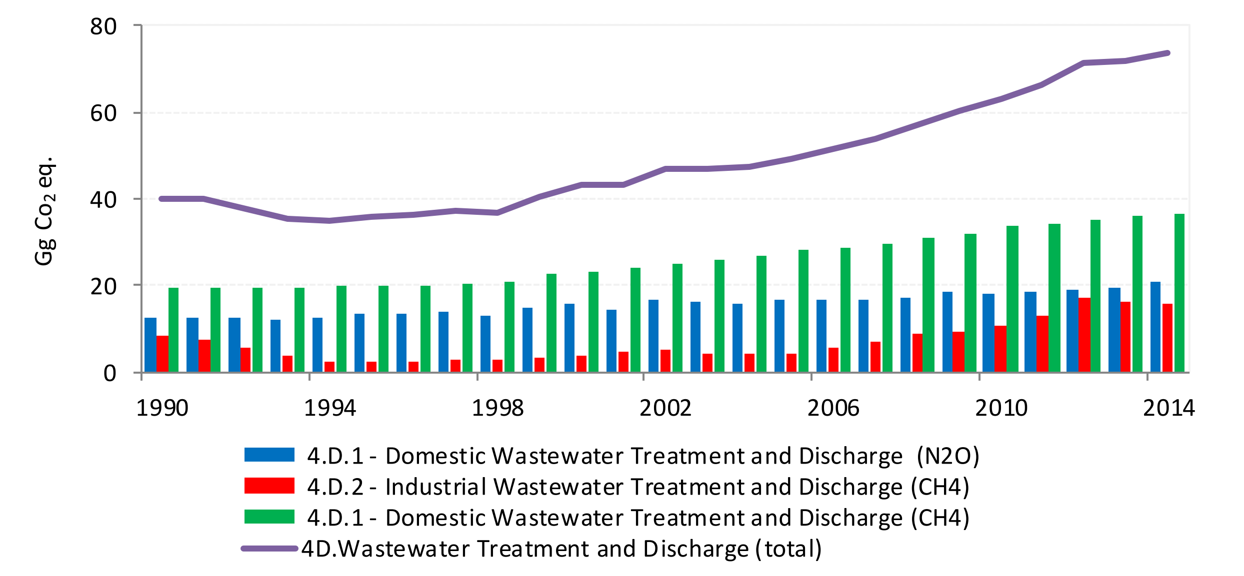

Figure 7-6: Emissions of methane and nitrous oxide from wastewater treatment by source categories

7.3.2 Domestic Wastewater Treatment and Discharge

7.3.2.1 Description

GHG emissions from the Domestic wastewater treatment and discharge sector have increased by 25.66 Gg CO_2e (80.6%) from the 1990 level of 31.84 Gg CO_2e. The total CO_2e emission from waste sector in 2014 increased by 3.4% compared to 2013.

The CH_4 emissions trends domestic wastewater treatment and discharge are presented in Figure 7-7.

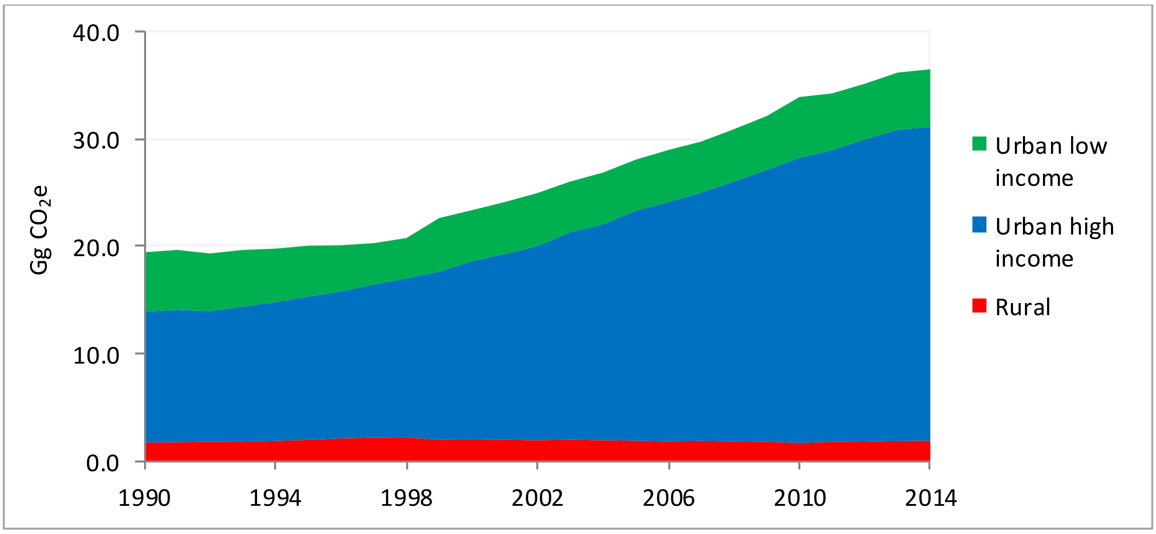

Figure 7-7: CH_4 emissions from domestic wastewater treatment, by income groups

7.3.2.2 Methodological issues

CH_4 Emissions

The methane emissions from industrial wastewater have been calculated using the IPCC Tier 1 methodology proposed by IPCC 2006.

In 2015, approximately 25.19% of households were connected to centralized aerobic wastewater treatment plants. 47.58% of households use latrines, 26.8% of households lack wastewater disposal points and only 0.42% use septic tanks.

Wastewater treatment and discharge systems usage differ for rural and urban residents. Hence, a factor U is introduced to express each income group fraction. It is good practice to treat the three categories: rural population, urban-high income population, and urban-low income population separately.

Mongolia administratively divided into the capital Ulaanbaatar, 21 provinces called aimag, and aimags into soums. Therefore, population of Ulaanbaatar city was considered as urban high income group, population of 21 provinces as urban low income group and population of soums as rural group.

Number of inhabitants included into various types of domestic wastewater treatment presented in Table 7-12.

Before 2015, unavailable research for degrees of treatment utilization (T) for each income group (U). Thus for emission calculations were used the result of research in 2015 (see Table 7-13).

Table 7-12: Number of inhabitants included into various types of domestic wastewater treatment

Year	*Number of inhabitants, person*			
	Urban high income	*Urban low income*	*Rural*	*Total*[14]
1990	533,116	565,645	372,553	1,471,314
1991	537,900	573,760	376,292	1,487,953
1992	533,500	558,836	377,449	1,469,785
1993	547,103	552,421	379,796	1,479,320
1994	565,244	515,948	402,437	1,483,629
1995	583,868	494,937	418,277	1,497,082
1996	603,142	457,598	440,018	1,500,758
1997	623,833	406,877	466,597	1,497,307
1998	649,909	393,588	474,241	1,517,738
1999	691,214	516,293	413,566	1,621,074
2000	722,727	500,481	418,734	1,641,943
2001	753,883	501,213	416,405	1,671,501
2002	792,564	499,958	413,248	1,705,771
2003	843,107	495,244	404,885	1,743,236
2004	882,681	492,276	399,453	1,774,410
2005	923,905	497,738	390,544	1,812,187
2006	958,069	501,920	386,473	1,846,462
2007	999,248	491,724	387,861	1,878,833
2008	1,043,691	499,519	382,963	1,926,174
2009	1,088,367	508,911	379,170	1,976,448
2010	1,131,702	588,606	341,722	2,062,029
2011	1,170,489	538,161	367,907	2,076,557
2012	1,198,707	537,544	378,255	2,114,506
2013	1,247,735	550,950	375,620	2,174,305
2014	1,239,489	554,198	404,182	2,197,869

[14] *Excluding population with lack of wastewater disposal points.*

Table 7-13: Degrees of treatment utilization (T) for each income group (U)

Income group	*Type of treatment and discharge pathways*	*Treatment utilization, (%)*
Urban high income	To centralized aerobic treatment plant	24.76
	Latrine	29.28
	Septic tank	0.33
Urban low income	To centralized aerobic treatment plant	8.20
	Latrine	18.69
	Septic tank	0.17
Rural	To centralized aerobic treatment plant	1.45
	Latrine	17.03
	Septic tank	0.08

Note: Columns do not add up to 100% due to rounding.

For domestic wastewater, biochemical oxygen demand (BOD) is the recommended parameter used to measure the degradable organic component of the wastewater. The BOD concentration indicates only the amount of carbon that is aerobically biodegradable. According to the Mongolian standard the BOD value[15] is 40g/cap/day (14600 kg/1000persons/yr). The IPCC default as well as national standards value of 40g BOD/person/day or 14600 kg BOD/1000 person/year was used for emission calculations.

The IPCC default values of correction factor for additional industrial BOD discharged into sewers were used for emission calculations. The BOD from industries assumed that are co-discharged with domestic wastewater in urban high and low income group by expert judgment, therefore was chosen default values as a 1.25 for urban high and low income group, 1 for rural area for emission calculations.

The methane producing potential (B_0) is the maximum amount of CH_4 that can be produced from a given quantity of organics (as expressed in BOD) in the wastewater. The CH_4 producing potential varies according to the composition of the wastewater and its degradability. The IPCC default of 0.6 kg CH_4/kg BOD was used for emission calculations.

The Ulaanbaatar Water Supply and Sewerage Company (USUG) manage the centralized system that serves the apartment area and a very small proportion of the ger areas. The main water treatment plant is the central wastewater treatment plant which has a capacity of 170,000 m^3 per day. The volume of wastewater now far exceeds the physical and technical capacity of these plants which have obsolete technical equipment dating from the socialist era. As a result 170,000 to 190,000m^3 of improperly treated wastewater is discharged into the Tuul River daily[16]. As reported above, 2/3 of the total urban population lives in Ulaanbaatar. Therefore methane correction factor for centralized aerobic treatment plant default IPCC value as 0.3 was used for emission calculations.

Methane conversion factors (MCFs) were applied depending of treatment type and level. The IPCC default values were used as source of MCF value. However, expert judgment was performed to choose values applicable for Mongolian conditions (Table 7-14).

[15] *БНбП 40-01-06, Water supply, outdoor sewerage network and facilities, Order no. 27/17.03.2006 of the Minister of Construction and Urban Development*
[16] *Green Development Strategic Action Plan for Ulaanbaatar 2020*

Table 7-14: MCF values applied depending on type and level of treatment

Type of treatment or discharge	*Maximum Methane Producing Capacity, B_0*	*Methane Correction Factor, MCF_j*	*Emission Factor, EF_j*
	(kg CH_4/kg BOD)	*(-)*	*(kg CH_4/kg BOD)*
Centralized aerobic treatment plant	0.6	0.3	0.18
Latrine	0.6	0.1	0.06
Septic system	0.6	0.5	0.3

In Mongolian case, even in the capital city and other main cities, wastewater treatment facilities do not have operational device for the methane recovery or gas combustion in as flare for energy. Originally, at the centralized aerobic treatment plants of big cities including Ulaanbaatar city has installed methane recovery devices and those are never used due to the lack of human capacity and later all of them became out of use[17].

Therefore for amount of methane recovered default IPCC value as zero was used for emission calculations.

N_2O Emissions

The N_2O emissions from industrial wastewater have been calculated using the IPCC Tier 1 methodology proposed by IPCC 2006, due to unavailable country specific parameters.

N_2O emissions from wastewater domestic sources for the period 1990-2014 are shown in Figure 7-9. The total amount of N_2O emission from domestic wastewater treatment in 2014 was 0.07 Gg. This represented a 69.71% increase from the 1990 and 8.14% increase from the 2013.

As seen from the Figure 7-4, the quantities of emitted nitrous oxide from domestic wastewater sources is in increasing trend, depends on the population increase especially in urban areas. Minor fluctuation in time series is related to the changes per capita protein consumption values. Due to a very high global warming potential of N_2O, relatively low amounts of N_2O formation can substantially contribute to GHG emissions.

Referring to the second IPCC assessment report (SAR), 1g N_2O has the greenhouse effect of 310 g CO_2.

[17] *Namkhainyam B.et al. (2014), Studies on country specific GHG emission and removal factors for Mongolia, technical report*

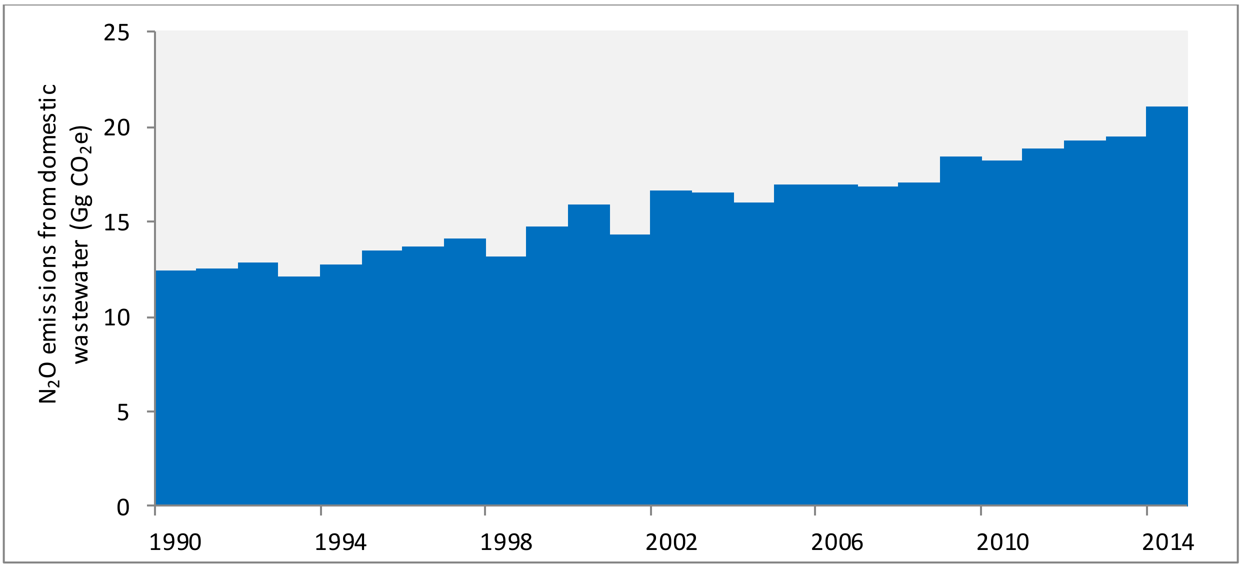

Figure 7-8: N_2O emissions from wastewater domestic sources

7.3.2.3 Activity data and emission factors

Annual number of country population has been obtained from NSO. Approximately 25.19% of population was connected to centralized aerobic wastewater treatment plants.

The average consumption of protein per inhabitant in every individual year has been obtained from the nutrition statistics of NSO. The consumption data has not been available for the years 1990 and 1991, average value for the years 1992-1994 have been applied for the years, where are missing data. Data on population and annual protein intake are presented in Table 7-15.

Table 7-15: Population and protein consumption in the period 1990-2014

Year	Population	Protein consumption (kg/person/year)	Year	Population	Protein consumption (kg/person/year)
1990	542,458	33.48	2003	628,513	38.54
1991	548,440	33.48	2004	635,225	37.01
1992	543,691	34.53	2005	642,617	38.73
1993	547,101	32.34	2006	650,722	38.11
1994	555,916	33.58	2007	660,090	37.56
1995	565,011	34.86	2008	671,554	37.30
1996	573,328	35.08	2009	684,230	39.53
1997	581,255	35.55	2010	695,488	38.47
1998	589,480	32.67	2011	708,259	38.98
1999	597,883	36.21	2012	722,385	39.13
2000	605,342	38.47	2013	738,137	38.62
2001	612,720	34.16	2014	754,680	40.84
2002	621,099	39.23			

Due to lack of national research results in order to use country specific activity data and emission factors, the IPCC 2006default values were used in calculations. The default values for N_2O emission calculations are reported in Table 7-16.

Table 7-16: Emission factors and parameters used in calculations

Activity data and emission factor	Default value	Reference
F_{NRP}	0.16	IPCC 2006 GL, vol 5, Table 6.11, p 6.27
$F_{NON-CON}$	1.4	IPCC 2006 GL, vol 5, Table 6.11, p 6.27
$F_{IND-COM}$	1.25	IPCC 2006 GL, vol 5, Table 6.11, p 6.27
$EF_{EFFLUENT}$	0.005	IPCC 2006 GL, vol 5, Table 6.11, p 6.27
N_{SLUDGE}	0	IPCC 2006 GL, Vol 5, pg. 6.25
R	0	IPCC 2006 GL, Vol 5, pg. 6.9

7.3.3 Industrial Wastewater Treatment and Discharge

7.3.3.1 Description

The GHG emissions from the Industrial wastewater treatment and discharge have increased by 7.57 Gg CO_2e (89.48%) from the 1990 level of 8.46 Gg CO_2e. The total CO_2 eq. emissions from waste sector in 2014 decreased 1.84% compared to 2013, due to a decrease in alcohol production. CH_4 emissions from industrial wastewater treatment for the period 1990-2014 are shown in Figure 3.5-10.

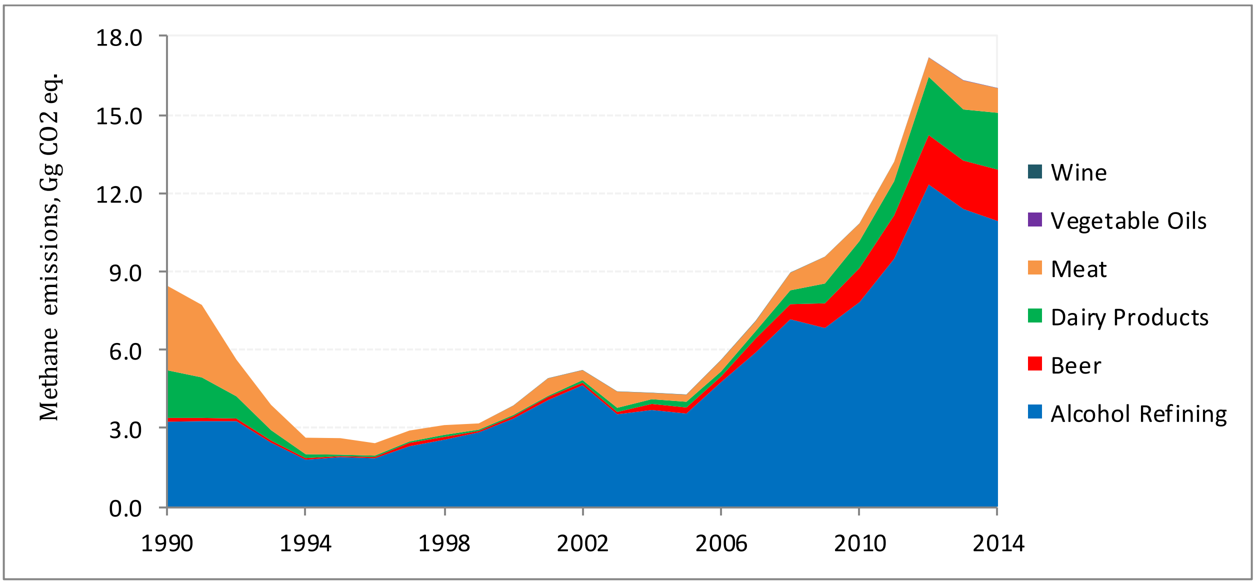

Figure 7-9: CH_4 emissions from industrial wastewater treatment, by industrial outputs

Fluctuations in aggregated methane emissions from industrial wastewater treatment and discharge could be explained with changes of economic situation. Meanwhile, some industry sectors were almost closed in the middle of 90s. Since 2012 emissions have been reduced due to the closure of some light industries (Figure 7-9).

7.3.3.2 Methodological issues

CH_4 Emissions

The CH_4 emissions from industrial wastewater have been calculated using the IPCC Tier 1 methodology proposed by IPCC 2006. Assessment of CH_4 production potential from industrial wastewater streams is based on the concentration of degradable organic matter in the wastewater is chemical oxygen demand (COD), the volume of wastewater, industrial sectors and ways of wastewater treatment. Data on industrial output for industries with the largest potential for wastewater methane emissions identified as follows:

- meat processing (slaughterhouse)
- alcohol production
- beer production
- dairy products
- wine production
- vegetable oil production.

Data on industrial output were taken from dataset of NSO, for the period 1990-2014. The missing data were assessed by interpolation/extrapolation method. Some industrial outputs were reported in cubic meters, therefore converted units from cubic meters to tons by using the density of alcohol, wine, beer, dairy products were taken as 0.789 kg/l, 0.9983 kg/l, 1.01 kg/l, 1.028 kg/l respectively.

The data of degradable organic component and wastewater produced for per ton production of those industries as a country specific value were taken from the IPCC 2006 and other sources. The above values are presented in the Table 7-17, which was used for entire period 1990 – 2014.

Table 7-17: Wastewater generation coefficient and COD concentration according to industrial product

Industry type	*Wastewater generation W, (m^3/t)*	*COD (kg/m^3)*	*Reference*
Alcohol	24	11	IPCC 2006, Vol 5, Table 6.9, p 6.22
Beer	6.3	2.9	IPCC 2006, Vol 5, Table 6.9, p 6.22
Dairy products	7	2.7	IPCC 2006, Vol 5, Table 6.9, p 6.22
Wine	23	1.5	IPCC 2006, Vol 5, Table 6.9, p 6.22
Vegetable oils	3.2	0.8*	IPCC 2006, Vol 5, Table 6.9, p 6.22
Meat	13	4.1	IPCC 2006, Vol 5, Table 6.9, p 6.22

**-IPCC default value is unavailable. Therefore COD for vegetable oils were taken from Russian NIR-2015 due to same technologies for this product.*

The wastewater production was estimated by multiplying the industrial production by the wastewater generation coefficients. Total organically degradable material was estimated by multiplying the wastewater production by the wastewater generated by the COD coefficient of each industrial product.

The total organically degradable material in industrial wastewater (total organic product TOW) is presented in Table 7-18.

Table 7-18: Total organic product TOW in t/COD/yr

Year	*Alcohol*	*Beer*	*Dairy Products*	*Meat*	*Vegetable Oils*	*Wine*	*Total*
1990	2,064.63	92.26	1157.98	3080.74	-	-	6,395.61
1991	2,078.56	78.62	983.12	2643.68	-	-	5,783.98
1992	2,078.13	64.98	538.19	1337.83	-	-	4,019.13
1993	1,556.03	51.34	252.58	922.09	-	-	2,782.04
1994	1,141.69	37.69	95.20	602.29	-	-	1,876.88
1995	1,204.72	24.05	34.97	602.29	-	-	1,866.04
1996	1,176.62	31.23	33.03	453.05	-	-	1,693.93
1997	1,469.19	83.52	31.09	399.75	-	-	1,983.55
1998	1,626.29	67.28	50.52	357.11	-	-	2,101.20
1999	1,805.45	34.19	31.09	229.19	-	-	2,099.91
2000	2,138.53	59.92	29.14	341.12	-	4.31	2,573.03
2001	2,588.51	78.75	23.32	639.60	-	5.65	3,335.83
2002	2,949.80	62.28	62.17	362.44	-	6.09	3,442.79
2003	2,245.37	55.87	101.03	591.63	-	5.89	2,999.79
2004	2,349.27	147.27	114.63	229.19	-	6.17	2,846.52
2005	2,263.53	147.56	137.95	255.84	-	6.33	2,811.22
2006	3,026.27	136.42	120.46	415.74	-	7.71	3,706.60
2007	3,746.27	339.12	178.75	362.44	-	11.28	4,637.85
2008	4,553.29	367.04	336.13	639.60	-	6.77	5,902.83
2009	4,341.64	598.70	481.84	975.39	-	3.74	6,401.32
2010	4,969.71	828.13	656.71	639.60	-	5.06	7,099.21
2011	6,022.61	1054.27	829.63	703.56	-	4.23	8,614.29

2012	7,826.91	1201.72	1414.45	703.56	4.63	2.75	11,154.02
2013	7,232.96	1176.83	1241.53	1053.15	7.32	2.70	10,714.48
2014	6,937.79	1250.00	1381.42	894.60	4.51	2.64	10,470.96

The main meat processing factory uses a septic tank + lagoon system for its wastewater treatment while the alcohol, beer and dairy production industry directly discharges into the central sewer systems with aerobic treatment. The MCF and EF were used for calculation are presented in the Table 7-19.

Table 7-19: Emission factors and parameters used in calculations

Type of treatment or discharge	*Maximum Methane Producing Capacity, B_0*	*Methane Correction Factor, MCF_j*	*Emission Factor, EF_j*
	(kg CH_4/kg COD)	*(-)*	*(kg CH_4/kg COD)*
Aerobic treatment plant	0.25	0.3	0.075
Anaerobic shallow lagoon	0.25	0.2	0.050

7.3.4 Source specific uncertainties and time-series consistency

For the purposes of uncertainty estimation, emissions from wastewater treatment and discharge are divided into the following subgroups: domestic wastewater sources (CH_4 and N_2O separately) and industrial wastewater sources (CH_4). Uncertainty in the emission estimates of wastewater treatment and discharge arises from uncertainties in activity data and emission factors. The IPCC recommended default values were used as source of uncertainty values. However, expert judgment was performed to choose values applicable for GHG emission calculations from wastewater treatment and discharge are presented in Table 7-20. The time series was checked for the consistency.

Table 7-20: Uncertainties in Wastewater treatment and discharge

Input	*Uncertainties*
CH_4 emissions from Domestic wastewater treatment and discharge	
Activity data	
Human Population	±5%
BOD per person	±30%
Fraction of population income group	±15%
Degree of utilization of treatment/discharge pathway or system for each income group	±50%
Correction factor for additional industrial BOD discharged into sewers (I)	±20%
Emission factor	
To centralized aerobic treatment plant, latrines	±10%; ±50%
Maximum Methane Producing Capacity (Bo)	±30%
Combined uncertainties	*91%*
N_2O emissions from Domestic wastewater treatment and discharge	
Activity data	
Human Population	±10%
Protein	±10%
F_{NRP} (kg N/year)	0.16 (0.15-0.17)
$F_{NON-CON}$	1.4 (1.0-1.05)
$F_{IND-COM}$	1.25 (1.0-1.5)

Emission factor	
$E_{EFFLUENT}$ (kg N_2O-N/kg-N)	0.005 (0.0005-0.25)

Combined uncertainties	*112%*

CH_4 emissions from Industrial wastewater treatment and discharge	
Activity data	
Industrial Production	±5%
Wastewater /unit production COD/unit wastewater	±50%
Emission factor	
Methane correction factor (MCF) Maximum Methane Producing Capacity (Bo)	±30%; ±30%

Combined uncertainties	*66%*

7.3.5 Source specific QA/QC and verification

General quality control (QC) procedures were applied in the waste sector according to the IPCC 2006 (Vol 1, Chapter 6, Table 6.1):

- Documentation on activity data and emission factors have been cross-checked with the corresponding data in the calculation model.
- Units and conversion factors were checked.
- The GHG emissions were estimated using the 2006 IPCC software and compared to the emissions calculated on the excel sheets as well. Results of this comparison typing errors were identified and corrected.
- Completeness and consistency of emission estimates and on the proper use of notation keys in the CRF tables were checked.
- Every annual inventory were archived both in hard copies and electronically.

7.3.6 Source specific recalculations

Recalculations were made due to use of IPCC 2006 all emission sources have been recalculated accordingly.

Table 7-21: Recalculated methane emissions under the Wastewater treatment and discharge for 1990-2006

Total Wastewater treatment and discharge		1990	1995	2000	2001	2002	2003	2004	2005	2006
SNC	*CH_4*	2.71	3.29	3.57	3.76	3.71	3.81	3.90	4.00	4.14
iBUR	*(Gg)*	1.33	1.09	1.30	1.40	1.44	1.45	1.49	1.54	1.65
Difference	*%*	-51%	-67%	-64%	-63%	-61%	-62%	-62%	-61%	-60%

Abbreviations: SNC – Second National Communication; iBUR – First Biennial Update Report

As shown in the Table 7-21, recalculated emission estimations of the methane from wastewater treatment and discharge for the iBUR are lower than results included in the second national communication (SNC) of Mongolia due to following updates on activity data and some factors:

- changes human population due to revision of population by income groups
- fraction of population income group
- degrees of treatment utilization/discharge pathway or system for each income group due to disaggregation of treatment system
- correction factor for additional industrial BOD discharged into sewers
- industrial production

- wastewater/ unit production
- COD/unit production

N_2O emissions from domestic wastewater treatment and discharge for the entire period have been calculated using methodology and EFs from IPCC 2006 for the first time in this submission.

7.3.7 Source specific planned improvements

All activity data and parameters of wastewater treatment plant and discharge for the emissions estimations will be kept under investigation and updated when the data become available, will consider using them in the calculation of the emissions.

Annex I: Summary tables

Inventory Year: 1990

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	-12,096.57	327.27	13.39	0	0	0	0	0	1.78	63.63	0	0
1 - Energy	10,708.95	13.56	0.31	0	0	0	0	0	0	0	0	0
1.A - Fuel Combustion Activities	10,708.95	7.33	0.31	0	0	0	0	0	0	0	0	0
1.A.1 - Energy Industries	5,178.13	0.08	0.10						0	0	0	0
1.A.2 - Manufacturing Industries and Construction	2,519.05	0.24	0.04						0	0	0	0
1.A.3 - Transport	1,385.81	0.52	0.14						0	0	0	0
1.A.4 - Other Sectors	1,076.30	3.83	0.02						0	0	0	0
1.A.5 - Non-Specified	549.66	2.67	0.02						0	0	0	0
1.B - Fugitive emissions from fuels	0	6.23	0	0	0	0	0	0	0	0	0	0
1.B.1 - Solid Fuels	0	6.23	0						0	0	0	0
1.B.2 - Oil and Natural Gas	0	0	0						0	0	0	0
1.B.3 - Other emissions from Energy Production	0	0	0						0	0	0	0
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0								0	0	0	0
1.C.2 - Injection and Storage	0								0	0	0	0
1.C.3 - Other	0								0	0	0	0
2 - Industrial Processes and Product Use	218.66	0	0	0	0	0	0	0	0	0	0	0
2.A - Mineral Industry	206.34	0	0	0	0	0	0	0	0	0	0	0
2.A.1 - Cement production	129.09								0	0	0	0
2.A.2 - Lime production	77.25								0	0	0	0
2.A.3 - Glass Production	0								0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0								0	0	0	0
2.A.5 - Other (please specify)	0	0	0						0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0								0	0	0	0

2.B.2 - Nitric Acid Production			0						0	0	0	0
2.B.3 - Adipic Acid Production			0						0	0	0	0
2.B.4 - Caprolactam. Glyoxal and Glyoxylic Acid Production			0						0	0	0	0
2.B.5 - Carbide Production	0	0							0	0	0	0
2.B.6 - Titanium Dioxide Production	0								0	0	0	0
2.B.7 - Soda Ash Production	0								0	0	0	0
2.B.8 - Petrochemical and Carbon Black Production	0	0							0	0	0	0
2.B.9 - Fluorochemical Production				0	0	0	0	0	0	0	0	0
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	0	0							0	0	0	0
2.C.2 - Ferroalloys Production	0	0							0	0	0	0
2.C.3 - Aluminium production	0				0			0	0	0	0	0
2.C.4 - Magnesium production	0					0		0	0	0	0	0
2.C.5 - Lead Production	0								0	0	0	0
2.C.6 - Zinc Production	0								0	0	0	0
2.C.7 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use	12.32	0	0	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	12.32								0	0	0	0
2.D.2 - Paraffin Wax Use	0								0	0	0	0
2.D.3 - Solvent Use									0	0	0	0
2.D.4 - Other (please specify)	0	0	0						0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0	0	0	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0	0	0	0	0	0
2.E.3 - Photovoltaics					0			0	0	0	0	0
2.E.4 - Heat Transfer Fluid					0			0	0	0	0	0
2.E.5 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	0	0	0	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning				0				0	0	0	0	0
2.F.2 - Foam Blowing Agents				0				0	0	0	0	0
2.F.3 - Fire Protection				0	0			0	0	0	0	0
2.F.4 - Aerosols				0				0	0	0	0	0
2.F.5 - Solvents				0	0			0	0	0	0	0
2.F.6 - Other Applications (please specify)				0	0			0	0	0	0	0

2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment					0	0		0	0	0	0	0
2.G.2 - SF6 and PFCs from Other Product Uses					0	0		0	0	0	0	0
2.G.3 - N2O from Product Uses			0						0	0	0	0
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0							0	0	0	0
2.H.2 - Food and Beverages Industry	0	0							0	0	0	0
2.H.3 - Other (please specify)	0	0	0						0	0	0	0
3 - Agriculture. Forestry. and Other Land Use	-23,024.18	311.65	13.03	0	0	0	0	0	1.78	63.63	0	0
3.A - Livestock	0	308.85	0	0	0	0	0	0	0	0	0	0
3.A.1 - Enteric Fermentation		300.51							0	0	0	0
3.A.2 - Manure Management		8.34	0						0	0	0	0
3.B - Land	-22,795.13	0	0	0	0	0	0	0	0	0	0	0
3.B.1 - Forest land	-22,795.13								0	0	0	0
3.B.2 - Cropland	0								0	0	0	0
3.B.3 - Grassland	0								0	0	0	0
3.B.4 - Wetlands	0		0						0	0	0	0
3.B.5 - Settlements	0								0	0	0	0
3.B.6 - Other Land	0								0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land	0	2.80	13.03	0	0	0	0	0	1.78	63.63	0	0
3.C.1 - Emissions from biomass burning		2.80	0.15						1.78	63.63	0	0
3.C.2 - Liming	0								0	0	0	0
3.C.3 - Urea application	0								0	0	0	0
3.C.4 - Direct N2O Emissions from managed soils			9.60						0	0	0	0
3.C.5 - Indirect N2O Emissions from managed soils			3.28						0	0	0	0
3.C.6 - Indirect N2O Emissions from manure management			0						0	0	0	0
3.C.7 - Rice cultivations		0							0	0	0	0
3.C.8 - Other (please specify)		0	0						0	0	0	0
3.D - Other	-229.05	0	0	0	0	0	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	-229.05								0	0	0	0
3.D.2 - Other (please specify)	0	0	0						0	0	0	0
4 - Waste	0	2.06	0.04	0	0	0	0	0	0	0	0	0
4.A - Solid Waste Disposal	0	0.73	0	0	0	0	0	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0	0	0	0	0	0	0	0	0	0	0

4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.33	0.04	0	0	0	0	0	0	0	0	0
4.E - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
5 - Other	0	0	0	0	0	0	0	0	0	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
Memo Items (5)												
International Bunkers	0.95	0.00	0.00	0	0	0	0	0	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	0.95	0.00	0.00						0	0	0	0
1.A.3.d.i - International water-borne navigation (International bunkers)	0	0	0						0	0	0	0
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0	0	0	0	0	0

Inventory Year: 2014

Categories	Emissions (Gg)			Emissions CO_2 Equivalents (Gg)				Emissions (Gg)				
	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	-8,447.80	540.08	22.71	96.43	0	0	0	0	0.04	1.54	0	0
1 - Energy	15,772.50	64.82	0.43	0	0	0	0	0	0	0	0	0
1.A - Fuel Combustion Activities	15,770.14	9.86	0.43	0	0	0	0	0	0	0	0	0
1.A.1 - Energy Industries	9,420.14	0.12	0.17						0	0	0	0
1.A.2 - Manufacturing Industries and Construction	2,301.20	0.17	0.03						0	0	0	0
1.A.3 - Transport	1,930.98	0.64	0.17						0	0	0	0
1.A.4 - Other Sectors	1,315.29	4.62	0.03						0	0	0	0
1.A.5 - Non-Specified	802.53	4.30	0.03						0	0	0	0
1.B - Fugitive emissions from fuels	2.36	54.97	0	0	0	0	0	0	0	0	0	0
1.B.1 - Solid Fuels	0	19.64	0						0	0	0	0
1.B.2 - Oil and Natural Gas	2.36	35.33	0						0	0	0	0
1.B.3 - Other emissions from Energy Production	0	0	0						0	0	0	0
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0								0	0	0	0
1.C.2 - Injection and Storage	0								0	0	0	0
1.C.3 - Other	0								0	0	0	0
2 - Industrial Processes and Product Use	231.63	0	0	96.43	0	0	0	0	0	0	0	0
2.A - Mineral Industry	225.89	0	0	0	0	0	0	0	0	0	0	0
2.A.1 - Cement production	182.39								0	0	0	0
2.A.2 - Lime production	43.50								0	0	0	0
2.A.3 - Glass Production	0								0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0								0	0	0	0
2.A.5 - Other (please specify)	0	0	0						0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0								0	0	0	0
2.B.2 - Nitric Acid Production			0						0	0	0	0
2.B.3 - Adipic Acid Production			0						0	0	0	0
2.B.4 - Caprolactam. Glyoxal and Glyoxylic Acid			0						0	0	0	0

Production												
2.B.5 - Carbide Production	0	0							0	0	0	0
2.B.6 - Titanium Dioxide Production	0								0	0	0	0
2.B.7 - Soda Ash Production	0								0	0	0	0
2.B.8 - Petrochemical and Carbon Black Production	0	0							0	0	0	0
2.B.9 - Fluorochemical Production				0	0	0	0	0	0	0	0	0
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	5.15	0	0	0	0	0	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	5.15	0							0	0	0	0
2.C.2 - Ferroalloys Production	0	0							0	0	0	0
2.C.3 - Aluminium production	0				0			0	0	0	0	0
2.C.4 - Magnesium production	0					0		0	0	0	0	0
2.C.5 - Lead Production	0								0	0	0	0
2.C.6 - Zinc Production	0								0	0	0	0
2.C.7 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use	0.59	0	0	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0.59								0	0	0	0
2.D.2 - Paraffin Wax Use	0								0	0	0	0
2.D.3 - Solvent Use									0	0	0	0
2.D.4 - Other (please specify)	0	0	0						0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0	0	0	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0	0	0	0	0	0
2.E.3 - Photovoltaics					0			0	0	0	0	0
2.E.4 - Heat Transfer Fluid					0			0	0	0	0	0
2.E.5 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	96.43	0	0	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning				94.87				0	0	0	0	0
2.F.2 - Foam Blowing Agents				0.13				0	0	0	0	0
2.F.3 - Fire Protection				1.13	0			0	0	0	0	0
2.F.4 - Aerosols				0.30				0	0	0	0	0
2.F.5 - Solvents				0	0			0	0	0	0	0
2.F.6 - Other Applications (please specify)				0	0			0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment					0	0		0	0	0	0	0

2.G.2 - SF6 and PFCs from Other Product Uses					0	0		0	0	0	0	0
2.G.3 - N2O from Product Uses			0						0	0	0	0
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0							0	0	0	0
2.H.2 - Food and Beverages Industry	0	0							0	0	0	0
2.H.3 - Other (please specify)	0	0	0						0	0	0	0
3 - Agriculture. Forestry. and Other Land Use	-24,451.93	468.64	22.21	0	0	0	0	0	0.04	1.54	0	0
3.A - Livestock	0	468.57	0	0	0	0	0	0	0	0	0	0
3.A.1 - Enteric Fermentation		456.61							0	0	0	0
3.A.2 - Manure Management		11.96	0						0	0	0	0
3.B - Land	-24,634.30	0	0	0	0	0	0	0	0	0	0	0
3.B.1 - Forest land	-24,634.30								0	0	0	0
3.B.2 - Cropland	0								0	0	0	0
3.B.3 - Grassland	0								0	0	0	0
3.B.4 - Wetlands	0		0						0	0	0	0
3.B.5 - Settlements	0								0	0	0	0
3.B.6 - Other Land	0								0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.07	22.21	0	0	0	0	0	0.04	1.54	0	0
3.C.1 - Emissions from biomass burning		0.07	0.00						0.04	1.54	0	0
3.C.2 - Liming	0								0	0	0	0
3.C.3 - Urea application	0								0	0	0	0
3.C.4 - Direct N2O Emissions from managed soils			16.25						0	0	0	0
3.C.5 - Indirect N2O Emissions from managed soils			5.96						0	0	0	0
3.C.6 - Indirect N2O Emissions from manure management			0						0	0	0	0
3.C.7 - Rice cultivations		0							0	0	0	0
3.C.8 - Other (please specify)		0	0						0	0	0	0
3.D - Other	182.37	0	0	0	0	0	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	182.37								0	0	0	0
3.D.2 - Other (please specify)	0	0	0						0	0	0	0
4 - Waste	0	6.61	0.07	0	0	0	0	0	0	0	0	0
4.A - Solid Waste Disposal	0	4.11	0	0	0	0	0	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0	0	0	0	0	0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	2.50	0.07	0	0	0	0	0	0	0	0	0

4.E - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
5 - Other	0	0	0	0	0	0	0	0	0	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
Memo Items (5)												
International Bunkers	42.25	0.00	0.00	0	0	0	0	0	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	42.25	0.00	0.00						0	0	0	0
1.A.3.d.i - International w ater-borne navigation (International bunkers)	0	0	0						0	0	0	0
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0	0	0	0	0	0

Annex II: General Key category analysis

2014 year Key Category Tier 1 Analysis – Level Assessment, with LULUCF

IPCC Category code	IPCC Category	Greenhouse gas	2014 Ex.t (Gg CO2 Eq)	|Ex.t| (Gg CO2 Eq)	Lx.t	Cumulative Total of Column F
3.B.1.a	Forest land Remaining Forest land	CO_2	-24,634.30	24,634.30	0.415	0.415
3.A.1	Enteric Fermentation	CH_4	9,588.82	9,588.82	0.162	0.577
1.A.1	Energy Industries - Solid Fuels	CO_2	9,162.23	9,162.23	0.155	0.732
3.C.4	Direct N2O Emissions from managed soils	N_2O	5,037.18	5,037.18	0.085	0.817
3.C.5	Indirect N2O Emissions from managed soils	N_2O	1,847.19	1,847.19	0.031	0.848
1.A.3.b	Road Transportation	CO_2	1,637.17	1,637.17	0.028	0.875
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	1,166.19	1,166.19	0.020	0.895
1.A.4	Other Sectors - Solid Fuels	CO_2	1,140.05	1,140.05	0.019	0.914
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	1,135.02	1,135.02	0.019	0.933
1.A.5	Non-Specified - Solid Fuels	CO_2	802.53	802.53	0.014	0.947
1.B.2.a	Oil	CH_4	741.92	741.92	0.013	0.959
1.B.1	Solid Fuels	CH_4	412.35	412.35	0.007	0.966
1.A.1	Energy Industries - Liquid Fuels	CO_2	257.91	257.91	0.004	0.971
1.A.3.c	Railways	CO_2	253.45	253.45	0.004	0.975
3.A.2	Manure Management	CH_4	251.22	251.22	0.004	0.979
2.A.1	Cement production	CO_2	182.39	182.39	0.003	0.982
3.D.1	Harvested Wood Products	CO_2	182.37	182.37	0.003	0.985
1.A.4	Other Sectors - Liquid Fuels	CO_2	175.25	175.25	0.003	0.988
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	94.87	94.87	0.002	0.990
4.A	Solid Waste Disposal	CH_4	86.39	86.39	0.001	0.991
1.A.4	Other Sectors - Solid Fuels	CH_4)	77.88	77.88	0.001	0.993
1.A.5	Non-Specified - Solid Fuels	CH_4	59.47	59.47	0.001	0.994
4.D	Wastewater Treatment and Discharge	CH_4	52.50	52.50	0.001	0.995
1.A.1	Energy Industries - Solid Fuels	N_2O	51.37	51.37	0.001	0.995
2.A.2	Lime production	CO_2	43.50	43.50	0.001	0.996
1.A.3.a	Civil Aviation	CO_2	40.36	40.36	0.001	0.997
1.A.5	Non-Specified - Biomass	CH_4	30.90	30.90	0.001	0.997
1.A.3.c	Railways	N_2O	28.31	28.31	0.000	0.998
1.A.3.b	Road Transportation	N_2O	24.16	24.16	0.000	0.998
4.D	Wastewater Treatment and Discharge	N_2O	21.02	21.02	0.000	0.999

1.A.4	Other Sectors - Biomass	CH_4	18.65	18.65	0.000	0.999
1.A.3.b	Road Transportation	CH_4	13.17	13.17	0.000	0.999
1.A.5	Non-Specified - Biomass	N_2O	6.08	6.08	0.000	0.999
1.A.4	Other Sectors - Solid Fuels	N_2O	5.94	5.94	0.000	0.999
1.A.2	Manufacturing Industries and Construction - Solid Fuels	N_2O	5.76	5.76	0.000	0.999
2.C.1	Iron and Steel Production	CO_2	5.15	5.15	0.000	1.000
1.A.5	Non-Specified - Solid Fuels	N_2O	4.39	4.39	0.000	1.000
1.A.4	Other Sectors - Biomass	N_2O	3.67	3.67	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	N_2O	2.93	2.93	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CH_4	2.60	2.60	0.000	1.000
1.B.2.a	Oil	CO_2	2.36	2.36	0.000	1.000
1.A.1	Energy Industries - Solid Fuels	CH_4	2.32	2.32	0.000	1.000
3.C.1	Emissions from biomass burning	CH_4	1.42	1.42	0.000	1.000
3.C.1	Emissions from biomass burning	N_2O	1.16	1.16	0.000	1.000
2.F.3	Fire Protection	HFCs, PFCs	1.13	1.13	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CH_4	0.99	0.99	0.000	1.000
1.A.1	Energy Industries - Liquid Fuels	N_2O	0.65	0.65	0.000	1.000
2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	0.59	0.59	0.000	1.000
1.A.4	Other Sectors - Liquid Fuels	CH_4	0.50	0.50	0.000	1.000
1.A.4	Other Sectors - Liquid Fuels	N_2O	0.44	0.44	0.000	1.000
1.A.3.a	Civil Aviation	N_2O	0.35	0.35	0.000	1.000
2.F.4	Aerosols	HFCs, PFCs	0.30	0.30	0.000	1.000
1.A.3.c	Railways	CH_4	0.29	0.29	0.000	1.000
1.A.1	Energy Industries - Liquid Fuels	CH_4	0.22	0.22	0.000	1.000
2.F.2	Foam Blowing Agents	HFCs (HFCs)	0.13	0.13	0.000	1.000
1.A.3.a	Civil Aviation	CH_4	0.01	0.01	0.000	1.000
Total						
			10,030.80	59,299.40		

2014 year Key Category Tier 1 Analysis – Level Assessment, without LULUCF

IPCC Category code	IPCC Category	Greenhouse gas	2014 Ex.t (Gg CO2 Eq)	|Ex.t| (Gg CO2 Eq)	Lx.t	Cumulative Total of Column F
3.A.1	Enteric Fermentation	CH_4	9,588.82	9,588.82	0.278	0.278
1.A.1	Energy Industries - Solid Fuels	CO_2	9,162.23	9,162.23	0.266	0.544
3.C.4	Direct N_2O Emissions from managed soils	N_2O	5,037.18	5,037.18	0.146	0.690
3.C.5	Indirect N_2O Emissions from managed soils	N_2O	1,847.19	1,847.19	0.054	0.743
1.A.3.b	Road Transportation	CO_2	1,637.17	1,637.17	0.047	0.791
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	1,166.19	1,166.19	0.034	0.825
1.A.4	Other Sectors - Solid Fuels	CO_2	1,140.05	1,140.05	0.033	0.858
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	1,135.02	1,135.02	0.033	0.891
1.A.5	Non-Specified - Solid Fuels	CO_2	802.53	802.53	0.023	0.914
1.B.2.a	Oil	CH_4	741.92	741.92	0.022	0.935
1.B.1	Solid Fuels	CH_4	412.35	412.35	0.012	0.947
1.A.1	Energy Industries - Liquid Fuels	CO_2	257.91	257.91	0.007	0.955
1.A.3.c	Railways	CO_2	253.45	253.45	0.007	0.962
3.A.2	Manure Management	CH_4	251.22	251.22	0.007	0.970
2.A.1	Cement production	CO_2	182.39	182.39	0.005	0.975
1.A.4	Other Sectors - Liquid Fuels	CO_2	175.25	175.25	0.005	0.980
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	94.87	94.87	0.003	0.983
4.A	Solid Waste Disposal	CH_4	86.39	86.39	0.003	0.985
1.A.4	Other Sectors - Solid Fuels	CH_4	77.88	77.88	0.002	0.987
1.A.5	Non-Specified - Solid Fuels	CH_4	59.47	59.47	0.002	0.989
4.D	Wastewater Treatment and Discharge	CH_4	52.50	52.50	0.002	0.991
1.A.1	Energy Industries - Solid Fuels	N_2O	51.37	51.37	0.001	0.992
2.A.2	Lime production	CO_2	43.50	43.50	0.001	0.993
1.A.3.a	Civil Aviation	CO_2	40.36	40.36	0.001	0.995
1.A.5	Non-Specified - Biomass	CH_4	30.90	30.90	0.001	0.996
1.A.3.c	Railways	N_2O	28.31	28.31	0.001	0.996
1.A.3.b	Road Transportation	N_2O	24.16	24.16	0.001	0.997
4.D	Wastewater Treatment and Discharge	N_2O	21.02	21.02	0.001	0.998
1.A.4	Other Sectors - Biomass	CH_4	18.65	18.65	0.001	0.998
1.A.3.b	Road Transportation	CH_4	13.17	13.17	0.000	0.999
1.A.5	Non-Specified - Biomass	N_2O	6.08	6.08	0.000	0.999
1.A.4	Other Sectors - Solid Fuels	N_2O	5.94	5.94	0.000	0.999

1.A.2	Manufacturing Industries and Construction - Solid Fuels	N_2O	5.76	5.76	0.000	0.999
2.C.1	Iron and Steel Production	CO_2	5.15	5.15	0.000	0.999
1.A.5	Non-Specified - Solid Fuels	N_2O	4.39	4.39	0.000	0.999
1.A.4	Other Sectors - Biomass	N_2O	3.67	3.67	0.000	0.999
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	N_2O	2.93	2.93	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CH_4	2.60	2.60	0.000	1.000
1.B.2.a	Oil	CO_2	2.36	2.36	0.000	1.000
1.A.1	Energy Industries - Solid Fuels	CH_4	2.32	2.32	0.000	1.000
3.C.1	Emissions from biomass burning	CH_4	1.42	1.42	0.000	1.000
3.C.1	Emissions from biomass burning	N_2O	1.16	1.16	0.000	1.000
2.F.3	Fire Protection	HFCs, PFCs	1.13	1.13	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CH_4	0.99	0.99	0.000	1.000
1.A.1	Energy Industries - Liquid Fuels	N_2O)	0.65	0.65	0.000	1.000
2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	0.59	0.59	0.000	1.000
1.A.4	Other Sectors - Liquid Fuels	CH_4	0.50	0.50	0.000	1.000
1.A.4	Other Sectors - Liquid Fuels	N_2O	0.44	0.44	0.000	1.000
1.A.3.a	Civil Aviation	N_2O	0.35	0.35	0.000	1.000
2.F.4	Aerosols	HFCs, PFCs	0.30	0.30	0.000	1.000
1.A.3.c	Railways	CH_4	0.29	0.29	0.000	1.000
1.A.1	Energy Industries - Liquid Fuels	CH_4	0.22	0.22	0.000	1.000
2.F.2	Foam Blowing Agents	HFCs (HFCs)	0.13	0.13	0.000	1.000
1.A.3.a	Civil Aviation	CH_4	0.01	0.01	0.000	1.000
Total						
			34,482.73	34,482.73		

2014 year Key Category Tier 1 Analysis – Trend Assessment, with LULUCF

IPCC Category code	IPCC Category	Greenhouse gas	1990 Year Estimate Ex0 (Gg CO_2 Eq)	2014 Year Estimate Ext (Gg CO2 Eq)	Trend Assessment (Txt)	Contribution to Trend %	Cumulative Total of Column G
3.B.1.a	Forest land Remaining Forest land	CO_2	22,795.13	-24,634.30	5.284	0.521	0.521
3.A.1	Enteric Fermentation	CH_4	6,310.67	9,588.82	1.379	0.136	0.657
1.A.1	Energy Industries - Solid Fuels	CO_2	4,850.49	9,162.23	1.020	0.101	0.758
3.C.4	Direct N2O Emissions from managed soils	N_2O	2,974.67	5,037.18	0.638	0.063	0.821
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	1,900.91	1,135.02	0.454	0.045	0.866
1.A.3.b	Road Transportation	CO_2	1,142.46	1,637.17	0.252	0.025	0.891
1.A.4	Other Sectors - Solid Fuels	CO_2	980.71	1,140.05	0.222	0.022	0.913
3.C.5	Indirect N2O Emissions from managed soils	N_2O	1,018.10	1,847.19	0.216	0.021	0.934
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	618.14	1,166.19	0.130	0.013	0.947
1.A.5	Non-Specified - Solid Fuels	CO_2	549.66	802.53	0.121	0.012	0.959
1.A.1	Energy Industries - Liquid Fuels	CO_2	327.64	257.91	0.077	0.008	0.966
1.A.3.c	Railw ays	CO_2	232.94	253.45	0.053	0.005	0.971
3.D.1	Harvested Wood Products	CO_2	229.05	182.37	0.044	0.004	0.976
3.A.2	Manure Management	CH_4	175.23	251.22	0.039	0.004	0.979
2.A.1	Cement production	CO_2	129.09	182.39	0.029	0.003	0.982
1.B.1	Solid Fuels	CH_4	130.91	412.35	0.024	0.002	0.985
1.A.4	Other Sectors - Liquid Fuels	CO_2	95.59	175.25	0.020	0.002	0.987
2.A.2	Lime production	CO_2	77.25	43.50	0.019	0.002	0.988
1.B.2.a	Oil	CH_4	0.00	741.92	0.016	0.002	0.990
1.A.4	Other Sectors - Solid Fuels	CH_4	71.52	77.88	0.016	0.002	0.992
3.C.1	Emissions from biomass burning	CH_4	58.70	1.42	0.015	0.001	0.993
3.C.1	Emissions from biomass burning	N_2O	47.93	1.16	0.012	0.001	0.994
1.A.5	Non-Specified - Solid Fuels	CH_4	44.45	59.47	0.010	0.001	0.995
1.A.1	Energy Industries - Solid Fuels	N2O	28.95	51.37	0.006	0.001	0.996
1.A.3.c	Railw ays	N_2O	26.38	28.31	0.006	0.001	0.997
4.D	Wastew ater Treatment and Discharge	CH_4	27.90	52.50	0.006	0.001	0.997
1.A.3.b	Road Transportation	N_2O	16.55	24.16	0.004	0.000	0.997
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	0.00	94.87	0.002	0.000	0.998

2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	12.32	0.59	0.003	0.000	0.998
4.D	Wastewater Treatment and Discharge	N_2O	12.39	21.02	0.003	0.000	0.998
1.A.3.b	Road Transportation	CH_4	10.57	13.17	0.002	0.000	0.998
1.A.2	Manufacturing Industries and Construction - Solid Fuels	N2O	9.82	5.76	0.002	0.000	0.999
1.A.5	Non-Specified - Biomass	CH4	11.69	30.90	0.002	0.000	0.999
4.A	Solid Waste Disposal	CH_4	15.33	86.39	0.002	0.000	0.999
1.A.4	Other Sectors - Biomass	CH4	8.57	18.65	0.002	0.000	0.999
1.A.3.a	Civil Aviation	CO_2	10.41	40.36	0.002	0.000	0.999
1.A.4	Other Sectors - Solid Fuels	N_2O	5.77	5.94	0.001	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CH_4	4.43	2.60	0.001	0.000	1.000
1.A.5	Non-Specified - Solid Fuels	N_2O	3.28	4.39	0.001	0.000	1.000
1.A.5	Non-Specified - Biomass	N_2O	2.30	6.08	0.000	0.000	1.000
1.A.4	Other Sectors - Biomass	N_2O	1.69	3.67	0.000	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	N_2O	1.55	2.93	0.000	0.000	1.000
1.A.1	Energy Industries - Solid Fuels	CH4	1.31	2.32	0.000	0.000	1.000
1.A.1	Energy Industries - Liquid Fuels	N_2O	0.80	0.65	0.000	0.000	1.000
2.C.1	Iron and Steel Production	CO_2	0.00	5.15	0.000	0.000	1.000
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CH_4	0.53	0.99	0.000	0.000	1.000
1.A.1	Energy Industries - Liquid Fuels	CH_4	0.27	0.22	0.000	0.000	1.000
1.A.3.c	Railways	CH_4	0.26	0.29	0.000	0.000	1.000
1.A.4	Other Sectors - Liquid Fuels	CH_4	0.27	0.50	0.000	0.000	1.000
1.B.2.a	Oil	CO_2	0.00	2.36	0.000	0.000	1.000
1.A.4	Other Sectors - Liquid Fuels	N_2O	0.24	0.44	0.000	0.000	1.000
2.F.2	Foam Blowing Agents	HFCs (HFCs)	0.00	0.13	0.000	0.000	1.000
2.F.3	Fire Protection	HFCs, PFCs	0.00	1.13	0.000	0.000	1.000
1.A.3.a	Civil Aviation	N_2O	0.09	0.35	0.000	0.000	1.000
2.F.4	Aerosols	HFCs, PFCs	0.00	0.30	0.000	0.000	1.000
1.A.3.a	Civil Aviation	CH_4	0.00	0.01	0.000	0.000	1.000
Total			-1,073.46	10,030.80			

2014 year Key Category Tier 1 Analysis – Trend Assessment, without LULUCF

IPCC Category code	IPCC Category	Greenhouse gas	1990 Year Estimate Ex0 (Gg CO_2 Eq)	2014 Year Estimate Ext (Gg CO_2 Eq)	Trend Assessment (Txt)	Contribution to Trend %	Cumulative Total of Column G
3.A.1	Enteric Fermentation	CH_4	6,310.67	9,588.82	0.015	0.046	0.046
1.A.1	Energy Industries - Solid Fuels	CO_2	4,850.49	9,162.23	0.070	0.217	0.263
3.C.4	Direct N2O Emissions from managed soils	N_2O	2,974.67	5,037.18	0.017	0.051	0.314
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	1,900.91	1,135.02	0.084	0.261	0.575
1.A.3.b	Road Transportation	CO_2	1,142.46	1,637.17	0.007	0.022	0.597
1.A.4	Other Sectors - Solid Fuels	CO_2	980.71	1,140.05	0.018	0.056	0.653
3.C.5	Indirect N2O Emissions from managed soils	N_2O	1,018.10	1,847.19	0.011	0.035	0.688
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	618.14	1,166.19	0.009	0.027	0.716
1.A.5	Non-Specified - Solid Fuels	CO_2	549.66	802.53	0.003	0.009	0.724
1.A.1	Energy Industries - Liquid Fuels	CO_2	327.64	257.91	0.012	0.036	0.760
1.A.3.c	Railw ays	CO_2	232.94	253.45	0.005	0.016	0.776
3.A.2	Manure Management	CH_4	175.23	251.22	0.001	0.003	0.779
2.A.1	Cement production	CO_2	129.09	182.39	0.001	0.003	0.782
1.B.1	Solid Fuels	CH_4	130.91	412.35	0.009	0.029	0.811
1.A.4	Other Sectors - Liquid Fuels	CO_2	95.59	175.25	0.001	0.004	0.815
2.A.2	Lime production	CO_2	77.25	43.50	0.004	0.011	0.826
1.B.2.a	Oil	CH_4	0.00	741.92	0.034	0.104	0.930
1.A.4	Other Sectors - Solid Fuels	CH_4	71.52	77.88	0.002	0.005	0.935
3.C.1	Emissions from biomass burning	CH_4	58.70	1.42	0.004	0.013	0.948
3.C.1	Emissions from biomass burning	N_2O	47.93	1.16	0.003	0.010	0.958
1.A.5	Non-Specified - Solid Fuels	CH_4	44.45	59.47	0.000	0.001	0.960
1.A.1	Energy Industries - Solid Fuels	N2O	28.95	51.37	0.000	0.001	0.961
1.A.3.c	Railw ays	N_2O	26.38	28.31	0.001	0.002	0.963
4.D	Wastew ater Treatment and Discharge	CH_4	27.90	52.50	0.000	0.001	0.964
1.A.3.b	Road Transportation	N_2O	16.55	24.16	0.000	0.000	0.964
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	0.00	94.87	0.004	0.013	0.977
2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	12.32	0.59	0.001	0.003	0.980
4.D	Wastew ater Treatment and Discharge	N_2O	12.39	21.02	0.000	0.000	0.980

1.A.3.b	Road Transportation	CH_4	10.57	13.17	0.000	0.000	0.981
1.A.2	Manufacturing Industries and Construction - Solid Fuels	N2O	9.82	5.76	0.000	0.001	0.982
1.A.5	Non-Specified - Biomass	CH4	11.69	30.90	0.001	0.002	0.984
4.A	Solid Waste Disposal	CH_4	15.33	86.39	0.003	0.009	0.993
1.A.4	Other Sectors - Biomass	CH4	8.57	18.65	0.000	0.001	0.993
1.A.3.a	Civil Aviation	CO_2	10.41	40.36	0.001	0.003	0.997
1.A.4	Other Sectors - Solid Fuels	N_2O	5.77	5.94	0.000	0.000	0.997
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CH_4	4.43	2.60	0.000	0.001	0.998
1.A.5	Non-Specified - Solid Fuels	N_2O	3.28	4.39	0.000	0.000	0.998
1.A.5	Non-Specified - Biomass	N_2O	2.30	6.08	0.000	0.000	0.998
1.A.4	Other Sectors - Biomass	N_2O	1.69	3.67	0.000	0.000	0.998
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	N_2O	1.55	2.93	0.000	0.000	0.998
1.A.1	Energy Industries - Solid Fuels	CH4	1.31	2.32	0.000	0.000	0.999
1.A.1	Energy Industries - Liquid Fuels	N_2O	0.80	0.65	0.000	0.000	0.999
2.C.1	Iron and Steel Production	CO_2	0.00	5.15	0.000	0.001	0.999
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CH_4	0.53	0.99	0.000	0.000	0.999
1.A.1	Energy Industries - Liquid Fuels	CH_4	0.27	0.22	0.000	0.000	0.999
1.A.3.c	Railw ays	CH_4	0.26	0.29	0.000	0.000	0.999
1.A.4	Other Sectors - Liquid Fuels	CH_4	0.27	0.50	0.000	0.000	0.999
1.B.2.a	Oil	CO_2	0.00	2.36	0.000	0.000	1.000
1.A.4	Other Sectors - Liquid Fuels	N_2O	0.24	0.44	0.000	0.000	1.000
2.F.2	Foam Blow ing Agents	HFCs (HFCs)	0.00	0.13	0.000	0.000	1.000
2.F.3	Fire Protection	HFCs, PFCs	0.00	1.13	0.000	0.000	1.000
1.A.3.a	Civil Aviation	N_2O	0.09	0.35	0.000	0.000	1.000
2.F.4	Aerosols	HFCs, PFCs	0.00	0.30	0.000	0.000	1.000
1.A.3.a	Civil Aviation	CH_4	0.00	0.01	0.000	0.000	1.000
Total							
			21,950.73	34,482.73			

Annex III: General Uncertainty assessment

Base year for assessment of uncertainty in trend: 1990, Year T: 2014

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year T	Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A - Fuel Combustion Activities												
1.A.1.a.i - Electricity Generation - Liquid Fuels	CO_2	130.64	248.53	5	5	7.071	0.026	2.852	0.331	14.259	2.340	208.796
1.A.1.a.i - Electricity Generation - Liquid Fuels	CH_4	0.11	0.21	5	5	7.071	0.000	0.002	0.000	0.012	0.002	0.000
1.A.1.a.i - Electricity Generation - Liquid Fuels	N_2O	0.33	0.62	5	5	7.071	0.000	0.007	0.001	0.036	0.006	0.001
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Liquid Fuels	CO_2	197.00	9.38	5	5	7.071	0.000	3.816	0.012	19.082	0.088	364.119
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Liquid Fuels	CH_4	0.16	0.01	5	5	7.071	0.000	0.003	0.000	0.015	0.000	0.000
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Liquid Fuels	N_2O	0.47	0.02	5	5	7.071	0.000	0.009	0.000	0.046	0.000	0.002
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Solid Fuels	CO_2	4850.49	9162.23	5	5	7.071	35.597	112.907	12.202	564.533	86.279	326141.671
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Solid Fuels	CH_4	1.31	2.32	5	5	7.071	0.000	0.028	0.003	0.141	0.022	0.020
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Solid Fuels	N_2O	28.95	51.37	5	5	7.071	0.001	0.626	0.068	3.131	0.484	10.039
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CO_2	618.14	1166.19	5	5	7.071	0.577	13.569	1.553	67.845	10.982	4723.579
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CH_4	0.53	0.99	5	5	7.071	0.000	0.011	0.001	0.057	0.009	0.003
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	N_2O	1.55	2.93	5	5	7.071	0.000	0.034	0.004	0.169	0.028	0.029
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	CO_2	1900.91	1135.02	5	5	7.071	0.546	39.110	1.512	195.548	10.688	38353.416
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	CH_4	4.43	2.60	5	5	7.071	0.000	0.089	0.003	0.444	0.024	0.198

1.A.2 - Manufacturing Industries and Construction - Solid Fuels	N_2O	9.82	5.76	5	5	7.071	0.000	0.197	0.008	0.984	0.054	0.971
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CO_2	0.95	42.25	5	5	7.071	0.001	0.074	0.056	0.372	0.398	0.297
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CH_4	0.00	0.01	5	5	7.071	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	N_2O	0.01	0.37	5	5	7.071	0.000	0.001	0.000	0.003	0.003	0.000
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CO_2	10.41	40.36	5	5	7.071	0.001	0.254	0.054	1.271	0.380	1.760
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CH_4	0.00	0.01	5	5	7.071	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	N_2O	0.09	0.35	5	5	7.071	0.000	0.002	0.000	0.011	0.003	0.000
1.A.3.b - Road Transportation - Liquid Fuels	CO_2	1142.46	1637.17	5	5	7.071	1.137	24.556	2.180	122.778	15.417	15312.003
1.A.3.b - Road Transportation - Liquid Fuels	CH_4	10.57	13.17	5	5	7.071	0.000	0.221	0.018	1.106	0.124	1.239
1.A.3.b - Road Transportation - Liquid Fuels	N_2O	16.55	24.16	5	5	7.071	0.000	0.351	0.032	1.754	0.227	3.130
1.A.3.c - Railways - Liquid Fuels	CO_2	219.85	235.79	5	5	7.071	0.024	4.561	0.314	22.807	2.220	525.081
1.A.3.c - Railways - Liquid Fuels	CH_4	0.26	0.28	5	5	7.071	0.000	0.005	0.000	0.027	0.003	0.001
1.A.3.c - Railways - Liquid Fuels	N_2O	26.31	28.21	5	5	7.071	0.000	0.544	0.038	2.722	0.266	7.479
1.A.3.c - Railways - Solid Fuels	CO_2	13.09	17.66	5	5	7.071	0.000	0.276	0.024	1.378	0.166	1.927
1.A.3.c - Railways - Solid Fuels	CH_4	0.01	0.01	5	5	7.071	0.000	0.000	0.000	0.001	0.000	0.000
1.A.3.c - Railways - Solid Fuels	N_2O	0.07	0.09	5	5	7.071	0.000	0.001	0.000	0.007	0.001	0.000
1.A.4.a - Commercial/Institutional - Solid Fuels	CO_2	84.36	32.76	5	5	7.071	0.000	1.670	0.044	8.350	0.308	69.822
1.A.4.a - Commercial/Institutional - Solid Fuels	CH_4	0.23	0.09	5	5	7.071	0.000	0.004	0.000	0.022	0.001	0.001
1.A.4.a - Commercial/Institutional - Solid Fuels	N_2O	0.50	0.20	5	5	7.071	0.000	0.010	0.000	0.050	0.002	0.002
1.A.4.b - Residential - Solid Fuels	CO_2	718.00	1087.52	5	5	7.071	0.502	15.423	1.448	77.116	10.241	6051.683
1.A.4.b - Residential - Solid Fuels	CH_4	56.86	76.48	5	5	7.071	0.002	1.198	0.102	5.989	0.720	36.390
1.A.4.b - Residential - Solid Fuels	N_2O	4.20	5.64	5	5	7.071	0.000	0.088	0.008	0.442	0.053	0.198
1.A.4.b - Residential - Biomass	CO_2	117.80	256.10	5	5	7.071	0.028	2.614	0.341	13.069	2.412	176.611
1.A.4.b - Residential - Biomass	CH_4	7.42	16.13	5	5	7.071	0.000	0.164	0.021	0.822	0.152	0.699
1.A.4.b - Residential - Biomass	N_2O	1.46	3.18	5	5	7.071	0.000	0.032	0.004	0.162	0.030	0.027
1.A.4.c.i - Stationary - Solid Fuels	CO_2	178.36	19.77	5	5	7.071	0.000	3.469	0.026	17.347	0.186	300.963
1.A.4.c.i - Stationary - Solid Fuels	CH_4	14.42	1.32	5	5	7.071	0.000	0.280	0.002	1.398	0.012	1.955
1.A.4.c.i - Stationary - Solid Fuels	N_2O	1.06	0.10	5	5	7.071	0.000	0.021	0.000	0.103	0.001	0.011
1.A.4.c.i - Stationary - Biomass	CO_2	18.30	39.90	5	5	7.071	0.001	0.406	0.053	2.028	0.376	4.255

1.A.4.c.i - Stationary - Biomass	CH_4	1.15	2.51	5	5	7.071	0.000	0.026	0.003	0.128	0.024	0.017
1.A.4.c.i - Stationary - Biomass	N_2O	0.23	0.49	5	5	7.071	0.000	0.005	0.001	0.025	0.005	0.001
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CO_2	95.59	175.25	5	5	7.071	0.013	2.077	0.233	10.384	1.650	110.561
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CH_4	0.27	0.50	5	5	7.071	0.000	0.006	0.001	0.029	0.005	0.001
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	N_2O	0.24	0.44	5	5	7.071	0.000	0.005	0.001	0.026	0.004	0.001
1.A.5.a - Stationary - Solid Fuels	CO_2	549.66	802.53	5	5	7.071	0.273	11.740	1.069	58.701	7.557	3502.919
1.A.5.a - Stationary - Solid Fuels	CH_4	44.45	59.47	5	5	7.071	0.001	0.936	0.079	4.679	0.560	22.208
1.A.5.a - Stationary - Solid Fuels	N_2O	3.28	4.39	5	5	7.071	0.000	0.069	0.006	0.345	0.041	0.121
1.A.5.a - Stationary - Biomass	CO_2	185.50	490.50	5	5	7.071	0.102	4.236	0.653	21.180	4.619	469.943
1.A.5.a - Stationary - Biomass	CH4	11.69	30.90	5	5	7.071	0.000	0.266	0.041	1.331	0.291	1.857
1.A.5.a - Stationary - Biomass	N_2O	2.30	6.08	5	5	7.071	0.000	0.052	0.008	0.262	0.057	0.072
1.B.1 - Fugitive Emissions from Fuels - Solid Fuels												
1.B.1.a.ii.1 - Mining	CH_4	120.84	380.63	0	0	0.000	0.000	2.839	0.507	0.000	0.000	0.000
1.B.1.a.ii.2 - Post-mining seam gas emissions	CH_4	10.07	31.72	0	0	0.000	0.000	0.236	0.042	0.000	0.000	0.000
1.B.2 - Fugitive Emissions from Fuels - Oil and Natural Gas												
1.B.2.a.iii.2 - Production and Upgrading	CO_2	0.00	2.36	0	0	0.000	0.000	0.003	0.003	0.000	0.000	0.000
1.B.2.a.iii.2 - Production and Upgrading	CH_4	0.00	741.92	0	0	0.000	0.000	0.988	0.988	0.000	0.000	0.000
2.A - Mineral Industry												
2.A.1 - Cement production	CO_2	129.09	182.39	35	0	35.000	0.346	2.734	0.243	0.000	12.023	144.541
2.A.2 - Lime production	CO_2	77.25	43.50	15	0	15.000	0.004	1.547	0.058	0.000	1.229	1.510
2.C - Metal Industry												
2.C.1 - Iron and Steel Production	CO_2	0.00	5.15	10	0	10.000	0.000	0.007	0.007	0.000	0.097	0.009
2.D - Non-Energy Products from Fuels and Solvent Use												
2.D.1 - Lubricant Use	CO_2	12.32	0.59	10	0	10.000	0.000	0.238	0.001	0.000	0.011	0.000
2.F - Product Uses as Substitutes for Ozone Depleting Substances												
2.F.1.a - Refrigeration and Stationary Air Conditioning	CHF_3	0.00	0.02	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.a - Refrigeration and Stationary Air Conditioning	CH_2F_2	0.00	1.04	0	0	0.000	0.000	0.001	0.001	0.000	0.000	0.000
2.F.1.a - Refrigeration and Stationary Air Conditioning	CHF_2CF_3	0.00	6.77	0	0	0.000	0.000	0.009	0.009	0.000	0.000	0.000
2.F.1.a - Refrigeration and Stationary Air Conditioning	CH_2FCF_3	0.00	8.68	0	0	0.000	0.000	0.012	0.012	0.000	0.000	0.000
2.F.1.a - Refrigeration and Stationary Air Conditioning	CF_3CH_3	0.00	2.72	0	0	0.000	0.000	0.004	0.004	0.000	0.000	0.000

2.F.1.b - Mobile Air Conditioning	CH_2FCF_3	0.00	75.64	5	0	5.000	0.001	0.101	0.101	0.000	0.712	0.507
2.F.2 - Foam Blowing Agents	CH_3CHF_2	0.00	0.13	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.F.4 - Aerosols	CH_2FCF_3	0.00	0.30	10	10	14.142	0.000	0.000	0.000	0.004	0.006	0.000
3.A - Livestock												
3.A.1.a.ii - Other Cattle	CH_4	2811.67	3369.52	20	50	53.852	279.236	60.916	4.487	3045.794	126.920	9,292,967.468
3.A.1.c - Sheep	CH_4	1583.72	2437.55	20	50	53.852	146.131	34.473	3.246	1723.637	91.816	2,979,353.122
3.A.1.d - Goats	CH_4	538.20	2310.93	20	50	53.852	131.344	13.539	3.078	676.966	87.046	465,860.213
3.A.1.e - Camels	CH_4	519.23	337.42	20	50	53.852	2.800	10.521	0.449	526.073	12.710	276,913.830
3.A.1.f - Horses	CH_4	855.04	1132.41	20	50	53.852	31.539	18.182	1.508	909.078	42.655	828,241.815
3.A.1.h - Swine	CH_4	2.83	0.97	20	50	53.852	0.000	0.056	0.001	2.788	0.037	7.777
3.A.2.a.ii - Other cattle	CH_4	59.82	71.69	20	30	36.056	0.057	1.249	0.095	37.456	2.700	1410.274
3.A.2.c - Sheep	CH_4	31.67	48.75	20	30	36.056	0.026	0.675	0.065	20.256	1.836	413.675
3.A.2.d - Goats	CH_4	11.84	50.84	20	30	36.056	0.028	0.296	0.068	8.873	1.915	82.403
3.A.2.e - Camels	CH_4	14.45	9.39	20	30	36.056	0.001	0.291	0.013	8.724	0.354	76.234
3.A.2.f - Horses	CH_4	51.78	68.57	20	30	36.056	0.052	1.089	0.091	32.676	2.583	1,074.409
3.A.2.h - Swine	CH_4	5.66	1.94	20	30	36.056	0.000	0.112	0.003	3.346	0.073	11.203
3.A.2.i - Poultry	CH_4	0.01	0.03	20	30	36.056	0.000	0.000	0.000	0.008	0.001	0.000
3.B - Land												
3.B.1.a - Forest land Remaining Forest land	CO_2	-22795.13	-24634.30	20	30	36.056	6690.531	361.929	32.806	10857.863	927.902	118,754,190.048
3.C - Aggregate sources and non-CO2 emissions sources on land												
3.C.1.a - Biomass burning in forest lands	CH_4	58.70	1.42	20	30	36.056	0.000	1.133	0.002	33.995	0.053	1155.669
3.C.1.a - Biomass burning in forest lands	N_2O	47.93	1.16	20	30	36.056	0.000	0.925	0.002	27.757	0.044	770.450
3.C.4 - Direct N2O Emissions from managed soils	N_2O	2974.67	5037.18	20	6	20.881	93.821	66.635	6.708	399.808	189.736	195846.068
3.C.5 - Indirect N2O Emissions from managed soils	N_2O	1018.10	1847.19	20	80	82.462	196.774	22.370	2.460	1789.600	69.578	3,207,510.076
3.D - Other												
3.D.1 - Harvested Wood Products	CO_2	-229.05	182.37	20	30	36.056	0.367	4.156	0.243	124.667	6.869	15,589.031
4.A - Solid Waste Disposal												
4.A - Solid Waste Disposal	CH_4	15.33	86.39	52	78	93.847	0.557	0.410	0.115	32.076	8.454	1,100.322
4.D - Wastewater Treatment and Discharge												
4.D.1 - Domestic Wastewater Treatment and Discharge	CH_4	19.45	36.48	64	64	90.568	0.093	0.423	0.049	27.269	4.372	762.713
4.D.1 - Domestic Wastewater Treatment and Discharge	N_2O	12.39	21.02	50	100	111.504	0.047	0.267	0.028	26.606	1.969	711.756
4.D.2 - Industrial Wastewater Treatment and Discharge	CH_4	8.46	16.02	50	42	65.768	0.009	0.184	0.021	7.816	1.516	63.383
4.E - Other (please specify)												

5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3						
5.B - Other (please specify)						
Total						
	-750.901	10,858.795		7,612.595		136,420,664.586
				87.250		11,679.926