MONGOLIA'S INITIAL BIENNIAL UPDATE REPORT

UNDER UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Ulaanbaatar, Mongolia

This report was compiled by the Climate Change Project Implementing Unit (CCPIU) of Environment and Climate Fund (ECF) under the Ministry of Environment and Tourism (MET) to meet Mongolia's obligation to prepare and submit Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC).

The BUR has been prepared in accordance with the UNFCCC Biennial Update Report guidelines for Parties not included in Annex 1 to the Convention.

The official document of Mongolia's BUR was submitted to the UNFCCC Secretariat on August 6th 2017.

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FOREWORD

I am pleased to present the Initial Biennial Update Report (BUR) of Mongolia under the United Nations Framework Convention on Climate Change (UNFCCC).

As one of the most vulnerable countries to the impact of climate change, Mongolia demonstrates a strong solidarity to contribute to the ultimate objective of UNFCCC by submitting its Intended Nationally Determined Contribution (INDC) and ratifying Paris Agreement in 2015 and 2016 respectively. Mongolia has been actively communicating to regional and international dialogues to resolve the financial, technical and capacity challenges, along with strengthening the institutional capacity to build the robust mechanism to combating climate change.

The Initial BUR has updated the information contained in Mongolia's Second National Communication (SNC 2010) and National Inventory Report is being developed. First time Mongolia has set up the project management unit and permanent staff to develop this report. This report is prepared genuinely by national expert teams.

I believe that the information provided in this report will be practical resources for both national and international policy makers, donors and private sectors to mobilize potential resources of global climate initiatives.

Mongolia's initial BUR would not have been possible without hard work and dedication of the BUR project team and national experts in articulating the report. Also, the other key ministries, agencies, stakeholders, research institutions and nongovernmental organizations contributions were essential for successful completion of the report,

Finally, I would also like to take this opportunity to thank the Global Environment Facility, Secretariat of UNFCCC and United Nations Environment Programme for providing the funds and methodological support for producing this report.

OYUNKHOROL Dulamsuren
Member of the Parliament
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PREFACE

This report was compiled by the Climate Change Project Implementing Unit (CCPIU) of Environment and Climate Fund (ECF) under the Ministry of Environment and Tourism (MET) to meet Mongolia's obligation to prepare and submit Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC).

The BUR has been prepared in accordance with the UNFCCC Biennial Update Report guidelines for Parties not included in Annex 1 to the Convention.

This Initial BUR includes updated information on:

a). National circumstances and institutional arrangements,

b). National Greenhouse gas inventory from 1990 to 2014,

c). Mitigation actions and effects,

d). Domestic measurement reporting and verification

e). Financial, Technology and Capacity Needs and

f). Other related information.

Moreover, the BUR is presenting the projections of the climate change mitigation measures and their assessment up to 2030 considering the country's development priorities, objectives and capacities.

In addition, the National Inventory Report (NIR) has been developed and presented as an annex of the initial BUR. The NIR is included in this publication of the BUR as a separate part of it.

In the BUR, the inputs and reviews of related sectorial ministers, agencies and municipality have been considered to ensure the relevance of the priorities of different stakeholders.

Special note of appreciation and gratitude is extended to the thematic working groups leads Dr. Erdenesukh Sumya and Dr. Batimaa Punsalmaa. Ms. Saruul Dolgorsuren was responsible for overall implementation of the project under the general guidance of Dr. Batjargal Zamba, National Advisor of CCPIU and Mr. Batjargal Khandjav, National Project Director. The rest staff of CCPIU of ECF have provided invaluable support and contributed significantly to the success of the work. The valuable contribution of every entity and individual to this time consuming task and the skill and knowledge they have provided is highly appreciated.

CLIMATE CHANGE PROJECT IMPLEMENTING UNIT

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

BAU	Business as Usual
BEEP	Building Energy Efficiency Project
BSL	Baseline
BUR	Biennial Update Report
CDM	Clean Development Mechanism
CERs	Credit of emission Reductions
CHP	Combined Heat and Power
COMAP	Comprehensive Mitigation Assessment Process for forestry
GDP	Green Development Policy
GEC	Global Environment Center Foundation
GHG	Greenhouse Gas
GDP	Gross Domestic Product
ERC	Energy Regulatory Commission, Mongolia
EPR	Environmental performance review of Mongolia
HOB	Heat Only Boiler
HPP	Hydro Power Plant
HPP	Hydro Power Plan
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JICA	Japanese International Cooperation Agency
LEAP	Long-range Energy Alternative Planning
LULUCF	Land use, land use change and forestry
MASM	Mongolia's Agency of Standard and Meteorology
MED	Medium
MEGD	Ministry of Environment and Green Development
MET	Ministry of Environment and Tourism
MIT	Mitigation
MOU	Memorandum of Understanding
MNET	Ministry of Nature, Enviroment and Tourism
MRV	Monitoring, Reporting and Verification
MDG	Millennium Development Goals
MOFALI	Ministry of Food and Agriculture and Light Industry
NAPCC	National Action Programme on Climate Change
NAMA	Nationally Appropriate Mitigation Action
NREC	National Renewable Energy Center
NSO	National Statistics Office
NTC	National Transportation Center
OIE	The World Organization for Animal Health

PPR	Peste des Petites Ruminants
TPE	Third Party Entity
UB	Ulaanbaatar
SGKh	State Great Khural
UNFCCC	United Nations Framework Convention on Climate Change
UN	United Nations
WAM	With additional measures
WEM	With measures
WOM	Without measures

UNITS

%	percent
bln	billion
Gg	Gigagram
GWh	Gigawatt hour
km	kilometer
kWh	kilowatt hour
mln	million
MW	Megawatt
t	ton

EXECUTIVE SUMMARY

The initial Biennial Update Report of Mongolia under the United Nations Framework Convention on Climate Change (UNFCCC) offers updated information on climate change mitigation actions from Mongolia's Second National Communication submitted to the UNFCCC in 2010. Furthermore, it acknowledges Mongolia's efforts to mitigate Greenhouse Gas (GHG) emissions after the submission of the Intended Nationally Determined Contributions (INDC) to UNFCCC on September 24, 2015. The initial BUR has the comprehensive information on mitigation scenarios of GHG emissions from 2010 till 2030 by assessing the key national policy documents in the contexts of sustainable development and environment that the Government of Mongolia has approved.

National Circumstances

Mongolia is the 19th largest country in the world with a surface area of 1,564,116 square kilometers. It is also the world's second-largest landlocked country with mountains covering the northern and western regions and the Gobi Desert located in the south. Mongolia is one of the most sparsely populated countries in the world, as of January 2015 with a population of 3,057,778 with an average growth rate of 2.1%. Approximately 69% (2,096,180) of the total population lives in cities, out of which about 67% (1,396,288) accounts for Ulaanbaatar only. Ulaanbaatar is the capital and the largest city of Mongolia.

Mongolia's economic growth has been based on the production in mining and agricultural sectors. The Gross Domestic Product (GDP) in Mongolia was USD 11.8 billion in 2015. The GDP value of Mongolia represents 0.02 percent of the world's economy. GDP in Mongolia averaged to USD 3.79 billion from 1981 until 2015, reaching an all-time high of USD 12.55 billion in 2013 and a record low of USD 0.77 billion in 1993 at the beginning of transition to the market economy.

Since 1992, the Parliament has passed several laws, regulations and policy on environmental protection and most of them were amended in 2012 as a package. Some of the policy and legal documents related to climate change are listed below:

- Law on Environmental Protection (1995, amended in 2007, 2012),
- Water Law (1995 amended in 2004, 2010 and 2012),
- Forest Law (1995, amended in 2012 and 2013),
- Law on Air (1995, amended in 2012),
- Energy Law (2001, renewed in 2015),
- Law on Waste, 2012,
- Law on Renewable Energy, 2015,
- National Action Programme on Climate Change, 2000 (updated in 2011),
- Green Development Policy, 2014 (2014-2030),
- Sustainable Development Vision 2030, 2016 (2016-2030),
- National Agriculture Development Policy, 2010 (2010-2021),
- State Policy on Energy, 2015 (2015-2030),
- State Policy on Forest, 2015 (2016-2030),
- State Policy on Industry, 2015 (2015-2030).

The other important document pursuant to climate change is INDC. Mongolia INDC has outlined a series of policies and measures that the country commits to implement until 2030 in the energy, industry, agriculture and waste sectors. The expected mitigation impact of these policies and measures will have a 14% reduction in the total national GHG emissions excluding Land use, land-use change and forestry (LULUCF) by 2030, compared to the projected emissions under a business as usual scenario. Those and other potentially more ambitious commitments are contingent upon gaining access to new technologies and sources of finance through internationally agreed mechanisms and instruments under the auspices of the UNFCCC.

The **energy** system is considered to be a major branch of the economy and infrastructure sector of Mongolia and it strongly influences the social and economic viability of the country. About 96% of domestically generated electricity is from coal-fired power plants while only 3% by renewable energy sources.

Mongolia has an abundance of mineral resources and ranks as one of the world's leading mining nations. The mining **industry** plays an important role in the country's economy, accounting for 17% of GDP and 83% of export value in 2014. Over the last few years, mineral products have consistently accounted for more than 80% of the total export revenues, with copper and coal being the drivers of revenue.

Key **manufacturing industries** are the Cement and Lime industry which are the major contributors to GHG emissions. From 2011 onwards, the Cement and Lime production technology was changed from wet production technology to dry method technology.

The **construction industry** is also closely linked to other parts of the Mongolian economy, such as manufacturing, wholesale, retail, finance and insurance.

According to the National Statistical Office (NSO), works carried out in 2014 totaled to MNT 2.2 trillion (USD 1.3 billion), up by 16.3% from the level in 2013. Much of this growth took place in the residential segment, which has been the focus of an increasing number of large-scale, state-led development projects in recent years. Despite the rapid year-on-year jumps in construction output, the sector's share of total GDP has remained relatively constant, at around 5%.

Due to a sparse population and geographically complex and large territory, the Mongolian **transportation** sector is of a strategic importance which consists of road, rail, air and water transportation and other sub-sectors.

As of 2014, the total cargo traffic rail freight turnover was 63%, transportation 37%, total passenger automobile circulation 55%, while 22% and 23% was for rail and air transportation respectively.

Mongolian **crop-agriculture** is primarily rain-fed which is possible in the short raining period in summer time. The extreme fluctuation in temperature and precipitation provides limited potential for agricultural development. Crops produced in Mongolia are wheat, barley, potato and about 30 other types of vegetables. The agriculture sector, therefore, remains heavily focused on livestock husbandry with about 80% of the land allocated to pasture. Only 1% of the land in Mongolia is cultivated with crops, amounting to the potential of 1.3 million hectares in 2016. Depending on the climate, soil structure and fertility, the cultivation area is divided into five regions of different sizes.

The **livestock-agriculture** system has proven itself to be an efficient and sustainable means of utilizing available resources within the severe constraints of climate and limited natural productivity of the region. Livestock production is still the dominant economic activity for the majority of residents. The extensively managed pasture based livestock production system practiced by herders is a viable system that is well adapted to local conditions.

Institutional Arrangements

The Ministry of Environment and Tourism (MET) of Mongolia is the key ministry to develop, update and implement climate related policies. Thus, the MET is the national entity with the overall responsibility for organizing and coordinating the compilation of National Communications, Biennial updated reports, GHG inventory and submitting them to the UNFCCC Secretariat to integrate climate change-related issues in various sectors.

In 2015, the MET has set up Climate Change Project Implementation Unit (CCPIU) at the Nature Conservation Fund (name has changed as Environment and Climate Fund since 2017) engaging experienced professionals to facilitate smooth implementation of commitments under UNFCCC. The CCPIU is supervised by National focal point for the UNFCCC. There are three sectoral experts to conduct the GHG inventory. The major data provider is NSO (National Statistics Office). A number of other entities provide more specific data that is required for GHG estimation are not available at National Statistics, Such national entities include the Ministry of Energy (MoE), Ministry of Road and Transport Development (MRTD), Ministry of Agriculture and Light Industry (MoFALI), Ministry of Construction and Urban Development (MCUD), CDM Bureau, the National Renewable Energy Center, Ulaanbaatar Municipality, and National Customs Office.

National Greenhouse Gas Inventory

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 represented 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 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.

In general, emission and removal from each sector increased in 2014 comparing to the base year and differences are showed in the Table by percentage changes and absolute values of each GHG inventory sectors.

Table Mongolia's GHG emissions/removals by sectors in 1990 and 2014

Sector	Emissions, (Gg CO_2e)		Change from 1990 (Gg CO_2e)	Change from 1990 (%)
	1990	2014		
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 second highest sharing of the total emission were from the Agriculture sector with 16,726.98 Gg CO_2e accounting for 48.51%. 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

Comparing to the 1990, sectoral emission increase for the Energy sector were 55.69%, for the IPPU sector were 50.03%, for the Agriculture sector were 58.02, for the Waste sector 187.49% and removal for the LULUCF sector were 6.2% in 2014.

Two main sources of the total emission were Energy and Agriculture sector for all years of the inventory. However, percentage share of emission sources were varied year by year depending on economic and climatic factors such as demand increase in energy sector and natural disaster occurrence in agriculture sector.

Mitigation Actions and Effects

To assess overall mitigations actions to identify the future trends, the actions, policies and programs implemented or will be implemented through the national and sectorial policy framework and counter measures are considered. The assessment is based on the implementation of policies and programs which are implemented from 2007 to 2015. The key policies and actions are outlined to assess the future projections and current status of GHG mitigation actions and their effects.

If the actions described on the national policies and programs are implemented completely, GHG emissions can be reduced by about 25 percent in 2025 and about 28 percent in 2030. Due to lack of data availability on certain sectorial GHG emissions, the projected emission reduction could be higher.

In 2030, GHG emissions in BAU scenario using 2010 as the base year is projected that 2.7 times of reduction in energy sector, 5.0 times of reduction in cement production, 2.4 times of reduction in livestock sector, 1.5 times of reduction in agriculture, 1.9 times of reduction in waste sector, while removal of follow land decreased by 2.1 times and forest removal potential is expected to increase.

In 2030, GHG emissions by gases in BAU scenario using 2010 as the base year is projected that 3.3 times increase of carbon dioxide (CO_2), 2.3 times increase of methane (CH_4), 2.6

times increase of Nitrous oxide (N_2O).

Mongolia put the goal to reduce the GHG emissions by two percent from the current levels in 2020, by seven percent in 2025 and by 14 percent by 2030 by promoting the use of renewable energy sources and advanced technologies in liquefying and carbonating coal and shale. Increased energy efficiency and share of renewable energy are the two main approaches to policies and actions to mitigate GHG emissions.

GHG emissions in 2030 expected to increase 2.4 times in energy need, 3.0 times in energy production, 2.7 times in overall energy sector compared to the level of 2010.

The share of renewable energy percentage is reflected by net energy production and goals identified in the energy policies and programs. It is possible to reach the goals identified in the policies and programs if all planned activities of the projects will be implemented in their fixed timeframes.

GHG emissions will be reduced in 2015, 2020, 2025 and 2030 by 0.4, 2.7, 4.7, 7.2 mln t CO_2e respectively if projects are fully implemented in the energy sector.

Net GHG emission is projected to be reduced by 1.5 mln t CO_2e in 2020 and by 2.8 mln t CO_2e in 2030 through the improvement of energy efficiency.

Domestic MRV mechanism

Recognizing the role of mitigation actions in reducing GHG emissions while simultaneously promoting country's sustainable development objectives, Mongolia will advocate for a broader approach to MRV that establishes a robust mechanism in line with its commitment under the UNFCCC .The initial experience with different elements of the MRV for GHG emissions has already been gained through the implementation of Clean Development Mechanism (CDM) projects under the Kyoto Protocol. Moreover, significant effort has also been done under the preparation of the national GHG inventories, a crucial element of the overall MRV system. Mongolia has approved through its Agency of Standard and Metrology (MASM) ISO14064 and ISO 14065 standards as a national standard for MRV between 2012 and 2013. National renewable energy center (NREG) had become the first nationally accredited entity for MRV in 2014.

Further, the MRV methods for project based activities is expected to evolve and be simplified, allowing the necessary information for emission reductions from individual activities to be collected from the already existing information in the GHG inventory and statistical data.

Constraints and gaps, and related financial, technical and capacity needs

Mongolia, as many other developing countries, has specific barriers for the implementation of adaptation and mitigation measures such as financial and technical resources, human and institutional capacity, and public support. The biggest problems facing the electricity and heat production sectors in reducing GHG emissions are the use of obsolete techniques and technologies, the low coal quality, and insufficient funds.

The implementation of mitigation measures requires a high level of technical capacity and effective coordination across different sectorial agencies, which are currently a challenge for Mongolia. Most of the technologies applied in Mongolia's energy sector are still out of date and have low efficiency and high energy losses. The heat content of the feedstock coal is low and variable, which leads to combustion problems and poor plant performance. A lack of appropriate technologies and know-how is the most urgent technical problem.

Other key financial, technical and capacity barriers include a lack of support by financial institutions for renewable energy investments (particularly hydro power plants); lacks of domestic technological and technical resources for clean fuel production; and carbon capture and storage (CCS) plant.

Moreover, reporting of National Communications including GHG inventory and BUR is financed by GEF enabling activities through UNEP. In other words, there was no substantial government financing (except in-kind contribution) for these reporting requirements because of the economic difficulties in Mongolia, as the country is undergoing a transition period and the Government fails to resolve financing issues as required national circumstances and needs.

CHAPTER 1

National Circumstances and Institutional Arrangements

1. NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.1 National circumstances

1.1.1 Country profile

Mongolia is the 19th largest country in the world with a surface area of 1,564,116 square kilometers. It is also the world's second largest landlocked country with mountains covering the northern and western regions and the Gobi desert located in the south. Ulaanbaatar is the capital and the largest city of Mongolia.

Generally, average altitude in Mongolia is 1,580 m above the sea level. The highest point is the Khuiten Mountain peak (4,653 m) in the west and the lowest is the Khokh Nuur Lake in the east -518 m above sea level. Ulaanbaatar, the capital city is located at about 1,310 m above sea level. The country is located in a transition zone at the crossroads of the northern Asia and Boreal Arctic regions where the Siberian Taiga meets the Asian deserts and steppe (Figure 1-1). Therefore Mongolia has diverse geographical features such as high mountains, forest steppe, the steppe and the Gobi desert regions. The unique features of these ecosystems are widely recognized in comparison with those of other countries in the same latitude of the northern hemisphere. Geographical features and the dry and cold climate are associated with fragility of natural ecosystems. The nature and the environment, the flora and fauna of the country are being changed significantly due to socio-economic stress as well as climate change.

Figure 1-1: Location of Mongolia

The Constitution and the 1992 Law on Government Administration proclaims Mongolia as a unitary state with three tiers of local Government. Governance of the administrative and territorial units is based on the principle of centralized authority as well as a gradual transition toward a system of local Governments. The country is divided into 21 administrative units known as "*aimags*". *Aimags* are further divided in to smaller administrative units "*soums*", accordingly soums are also divided into smaller groups known as *"bags"* which is the lowest administrative unit in the country.

Demography

Mongolia is one of the most sparsely populated countries in the world, as of January 2015 with a population of 3,057,778 with an average growth rate of 2.1% (Figure 1-2). Average life expectancy rate at birth is 69.9 (75.8 for women and 66.0 for men). While Mongolia as a whole is famously known as the world's most sparsely populated nation, with a density of fewer than two people per square kilometer, according to the 2010 census, in Ulaanbaatar the figure is nearly 250 people per square kilometer. Urban area in Mongolia is defined in the Mongolia Law for Legal Status of Towns and Villages, as a settlement of over 15,000 people. The *aimag* centers inhabit about more than 15,000 populations compared to the urban category. About (2,096,180) 69% of total population lives in cities, out of which (1,396,288) about 67% accounts for Ulaanbaatar city only.

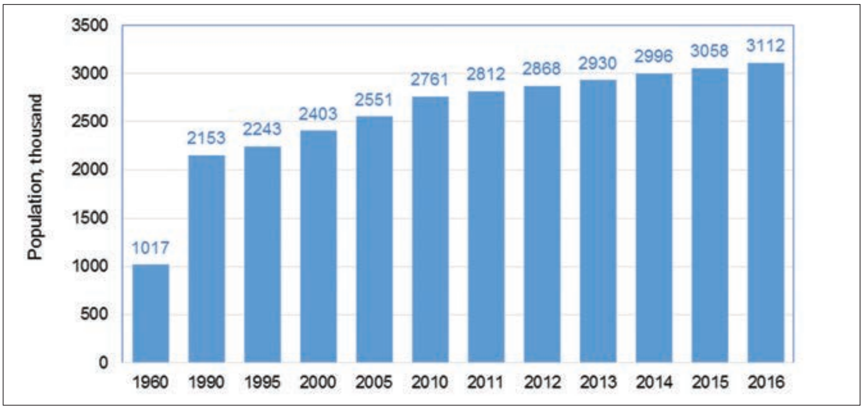

Figure 1-2: Population trend of Mongolia

Government

Mongolia is a democratic parliamentary republic. According to the 1992 Constitution, the President of the State is directly elected by all residents for a four-year term, eligible for a second term, and he/she presides over the army and the National Security Council. The unicameral legislature (State Great Khural) has 76 members, elected for a four-year term. After the legislative elections, the leader of the majority party or coalition chairs the Government. The Cabinet is established by the Prime Minister in consultation with the President and approved by the State Great Khural. Mongolia has four levels of governance – one central and three subnational tiers.

Economy

Mongolia's economic growth has been based on the production in mining and agricultural sectors. While these sectors are still important, the services sector, including the banking, finance, and retail sectors, is making an increasing contribution to the growth in country's economy. This trend mirrors the industrial profiles of most developed economies over recent decades.

The Gross Domestic Product (GDP) in Mongolia was USD 11.80 billion in 2015. The GDP value of Mongolia represents 0.02% of the world economy. GDP in Mongolia is averaged at USD 3.79 billion from 1981 until 2015, reaching an all-time high of USD 12.55 billion in 2013 and a record low of USD 0.77 billion in 1993.

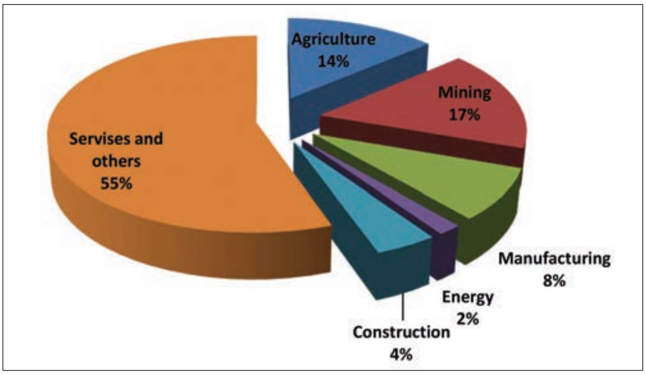

Figure 1-3: GDP by sectors in 2015

Table 1-1: Some socio-economy data of Mongolia

Parameters	2010	2011	2012	2013	2014	2015
Population (million)	2.7	2.8	2.8	2.9	2.9	3.0
GDP per capita	2,650.0	3,783.0	4,377.0	4,598.0	4,166.0	3,971.0
GDP (USD billion)	7.9	10.5	12.4	13.3	12.2	11.8
Share of industry in GDP	28.3	26.1	25.2	26.4	29.3	21.0
Share of agriculture in GDP	11.7	10.0	10.7	11.5	12.2	14.0
Agricultural land, thousand ha	1,155.0	1,155.0	1,154.0	1,154.0	1,150.0	1,150.0
Urban population, percent of total	69.2	67.4	67.2	68.1	66.4	68.6

Energy

Energy is one of the important aspects of the modern economy which makes the energy policy inseparable from the overall national developmental strategy. Per capita electricity in 2014 was 1,850 GWh which is 18% less than the Asia Pacific average (2,280 GWh/capita). In Mongolia, 60% of households are connected to the grid and 318 out of 330 *soums* are connected to transmission lines. Therefore, households of all *aimags* and 96% of *soums* are connected to the grid.

The power system is considered to be a major branch of the economy and infrastructure sector of Mongolia and it strongly influences the social and economic viability of the country. About 96% of domestically generated electricity is from coal fired power while only 3% by renewable energy sources. Three centralized power grids and two isolated systems supply electricity: (i) Central Energy System (CES); (ii) Eastern Energy System (EES); and (iii) Western Energy System (WES). The two isolated systems are (i) Dalanzhadgad CHP plant and local grid, and (ii) Zhavhan and Gobi-Altai aimags.

There are seven main coal-fired power plants in Mongolia with a total installed capacity of 856.3 MW. Three large sized coal fired power plants are located in Ulaanbaatar. Coal demand of these power plants is met through state-run operations at Shivee-Ovoo and Baganuur coal mines.

In 2015, 5.3 billion kWh of electricity was generated by thermal power plants and 5323.5 million kWh of electricity was generated by hydropower plants, 59.4 million kWh of electricity was generated by Wind Park, 5.8 million kWh of electricity was generated by solar PV (Table1.2). Moreover, 1.3 billion kWh of electricity was imported.

Table 1-2: Electricity production

Energy Sources		2010	2011	2012	2013	2014	2015
CHP	Electricity production, million kWh	4,256.0	4,450.0	4,778.0	5,014.0	5,191.0	5,323.5
	Percentage	98.7	98.4	98.4	97.7	97.6	96.2
Diesel Power	Electricity production, million kWh	21.4	20.2	28.7	5.4	8.2	0.5
	Percentage	0.50	0.45	0.59	0.11	0.15	0.01
Hydro Power	Electricity production, million kWh	20.0	35.3	52.6	59.9	66.3	59.4
	Percentage	0.46	0.78	1.08	1.17	1.25	1.07
Solar PV	Electricity production, million kWh	-	-	-	-	0.6	5.8
	Percentage	-	-	-	-	0.01	0.10
Wind Park	Electricity production, million kWh	-	-	-	52.3	52.9	152.5
	Percentage	-	-	-	1.02	0.99	2.75
Total	Electricity production, million kWh	4,312.7	4,522.8	4,856.3	5,131.6	5,318.4	5,536.0
	Percentage	100.00	100.00	100.00	100.00	100.00	100.00

Currently, use of renewable energy sources for power generation has initiated the "100,000 Solar Ger" national program. Herders living in rural areas use solar panels for their electricity. In 2013, new wind park with a capacity of 50 MW has been constructed and providing electricity to the central grid.

So far more than 70 large and middle-sized dams are proposed to be constructed in Mongolia, but only 2 of them have been built to date, namely, Durgun (12 MW) and Taishir (11 MW). Currently, hydroelectricity is produced by other 10 small plants. Most of the existing small hydropower plants have been constructed using water diversion channels; the installed capacity is relatively small. As none of these plants can operate in winter due to ice formation, the quoted production values are for the summer months only from May to October. Other two large hydro-dams such as "Egiin gol hydro-dam" and "Shuren hydro-dam" are under a plan to be constructed for more than ten years and have not been implemented due to transboundary water debate.

Mongolian forest, which covers 8.1% of the territory, is located in the southern border of the Siberian Taiga. However, Mongolian forest stretches for 2,000 km from the Altai Mountains in the west to Soyolz Mount of Ikh Khyangan Mountains in the east and also from Khuvsgul Mountains in the north to the Gobi steppe area in the south.

Industry

Mongolia has an abundance of mineral resources and ranks as one of the world's leading mining nations. The mining industry plays an important role in not an only industrial sector but also the country's economy, it is accounted for 17% of GDP and 83% of export value in 2014. Over the last few years, mineral products have consistently accounted for more than 80% of total export revenues, with copper and coal being the drivers of revenue.

Key manufacturing industries are the Cement and Lime industry which are the major contributors to GHG emissions. The Cement and Lime production is shown in Figure 1-4. From 2011 onwards, the Cement and Lime production technology was changed from wet production technology to dry method technology.

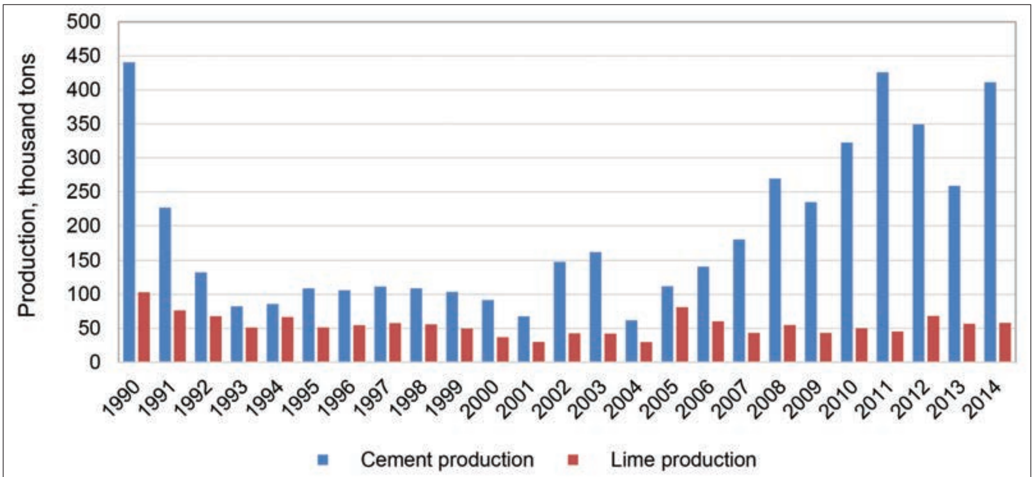

Figure 1-4: Cement and lime production

The construction industry is also closely linked to other parts of the Mongolian economy, such as manufacturing, wholesale, retail, finance and insurance. The construction industry undertakes activities related to three main categories: residential building such as apartments, and houses; non-residential building such as offices, shops, hotels, schools etc. and engineering construction like roads, bridges, water supply, sewerage, and mines. Construction activities are mainly carried out by private sectors.

According to the National Statistical Office (NSO), works carried out in 2014 totaled to MNT2.2trn ($1.3bn), up by 16.3% on 2013. Much of this growth took place in the residential segment, which has been the focus of an increasing number of large-scale, state-led development projects in recent years. Despite the rapid year-on-year jumps in construction output, the sector's share of total GDP has remained relatively constant, at around 5%.

Transportation

Due to a sparse population and geographically complex and large territory, the Mongolian transportation sector is of a strategic importance and it consists of road, rail, air and water transportation and other subsectors.

As of 2014, the total cargo traffic rail freight turnover was 63%, transportation 37%, total passenger automobile circulation 55%, while 22% and 23% was for rail and for air transportation accordanly (Table 1-3).

Table 1-3: All types of cargo transport turnover and passenger turnover

No.	Specifications and types of transport	2010	2011	2012	2013	2014
1	Cargo turnover, million t/km:	12,124.8	16,336.7	16,613.4	16,400.0	19,757.0
	rail transport	10,286.7	11,418.7	12,142.7	12,076.5	12,473.7
	automobiles	1,834.0	4,910.3	4,461.0	4,314.0	7,274.0
	air transport	4.2	7.7	9.7	9.6	9.4
2	Passenger turnover, million passenger per km:	3,607.4	4,695.4	4,971.8	4,625.7	5,395.8
	rail transport	1,220.0	1,399.7	1,485.4	1,394.4	1,194.5
	automobiles	1,480.2	2,321.6	2,263.1	1,941.9	2,965.3
	air transport	907.2	973.9	1,223.1	1,311.8	1,235.7
	maritime transport	0.044	0.252	0.198	0.265	0.307

Source: Mongolian Statistical Yearbook, 2014.

As given in Table 1-4, in 2014, amongst the total vehicle fleet 10 and more years old cars are accounted for 72.5%, while 4-9 years old cars are accounted for 20.6%. In 2010, the number of cars less than 3 years old are accounted for 3.4%, increasing to 6.9% by 2013.

Table 1-4: Number of cars, types and used period

No.	Specifications and types of transport	2010	2011	2012	2013	2014
1	Type of car:	254,486	312,542	345,473	384,864	437,677
	seat/sedan	172,583	208,514	228,650	259,309	303,724
	Truck	61,841	75,090	83,718	89,473	96,581
	Buses	16,366	22,547	21,642	20,400	20,650
	special Purpose	3,696	6,391	11,463	15,682	16,722
2	Used period:	-	-	-	-	-
	3 years	8,585	10,770	20,325	26,492	21,430
	4-9 years	54,283	46,114	79,022	79,470	86,337
	10 and above	191,618	255,658	246,126	278,902	329,910

Source: Mongolian Statistical Yearbook, 2014.

In recent years, the government has invested heavily in improving infrastructure, particularly, the national road network. As of late 2013, approximately 3,000 km of new roads were either under construction or in the midst of refurbishment, according to the NSO. The government is also in the final planning stages of an initiative aimed at extending the national rail system, which at present, consists of only a handful of major cross-country lines. By the end of 2018, the state hopes to have completed projects on 1,800 km of new lines, which will be dedicated, at least initially, to carrying freight.

Agriculture

Mongolian crop-agriculture is primarily rain-fed which only occurs in the short raining times in summer. The extreme fluctuation in temperature and precipitation provides limited potential for agricultural development. Crops produced in Mongolia are wheat, barley, potato and about 30 other types of vegetables. The agriculture sector, therefore, remains heavily focused on livestock husbandry with about 80% of the land allocated to pasture. Only 1% of the land in Mongolia is cultivated with crops, amounting to the potential of 1.3 million hectares in 2016. Depending on the climate, soil structure and fertility the cultivation area is divided into five regions. Cereals can be cultivated in 75% of the total land and the yield per hectare (1,647 tons) is almost two times less than the world average (3,886ton). National cereal production meets about 90% and vegetable production meets more than 60% of demand. The agriculture sector engages with 1,190 companies, and 34.5 thousand family-owned enterprises. Also more than 60% of the investment comes from private sectors (MoFALI, 2014).

The livestock-agriculture system has proven itself to be an efficient and sustainable means of utilizing available resources within the severe constraints of climate and limited natural productivity of the region. Livestock production is still the dominant economic activity for the majority of residents. The extensively managed livestock production system as practiced by herders is a viable system, well adapted to local conditions. It also presents both advantages and disadvantages relative to the economic development and conservation of wildlife and natural ecosystems. Animals raised commercially in Mongolia are horses, cattle, goats, sheep and camels. Livestock population is given in Figure 1-5. They are raised primarily for their meat, milk and traditional dairy products. Additionally, they are valued for their hair and skin. The livestock subsector accounts for almost 10% of export earnings, approximately 80% of the total agricultural production. About 26% of the work force and about 20% of households, more importantly, over 70% of employments in rural areas are directly engaged in the livestock sector providing food and goods to the remaining 3 million people. Livestock population is increasing from year to year.

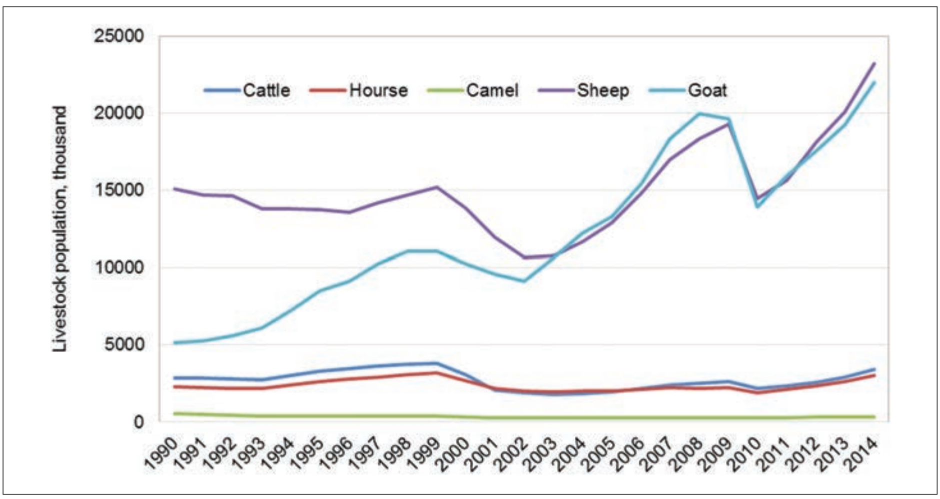

Figure 1-5: Livestock population

1.2 Institutional Arrangements

Preparation of the BUR

Pursuant to the COP decisions on reporting requirements for non-Annex I Parties to the UNFCCC, Mongolia has prepared its first Biennial Update Report (BUR) as an update to the information provided in Mongolia's Second National Communication.

Policy dimensions

Since 1992, the Parliament has passed several laws, regulations and policy on environmental protection and most of them were amended in 2012 as a package. Some of the policy and legal documents related to climate change are listed below:

- Law on Environmental Protection (1995, amended in 2007, 2012),
- Water Law (1995 amended in 2004, 2010 and 2012),
- Forest Law (1995, amended in 2012 and 2013),
- Law on Air (1995, amended in 2012),
- Energy Law (2001, renewed in 2015),
- Law on Waste, 2012,
- Law on Renewable Energy, 2015,
- National Action Programme on Climate Change, 2000 (updated in 2011),
- Green Development Policy, 2014 (2014-2030),
- Sustainable Development Vision 2030, 2016 (2016-2030),
- National Agriculture Development Policy, 2010 (2010-2021),
- State Policy on Energy, 2015 (2015-2030),
- State Policy on Forest, 2015 (2016-2030),
- State Policy on Industry, 2015 (2015-2030).

The **Environmental Protection Law** says that the citizens, economic entities and organizations shall compensate for direct damage caused to the environment and natural resources as a result of their unlawful conduct. The law imposes stricter sanctions against officials for their non-compliance with certain provisions and requirements. It means that the subject liable to pay compensation for damage caused to the environment will undergo an assessment by an environmental inspector who will decide the value of the compensation.

The renewed **Law on Air of Mongolia** clearly recognizes the power of the state and local self-governing bodies, the right of citizens, and the organization that is in charge of air quality matters to determine air quality, measure and test, as well as compile relevant data. Also, the law acted the actions to reduce air pollution.

The purpose of **Law on Forest** is to regulate the interrelation of protection, possession, sustainable use and reproduction of the forest and forest fire protection in Mongolia.

The purpose of the **Law on Waste** shall be to govern relationships related to the collection, transportation, storage, and landfill of waste and reusing of waste as a source of raw materials to prevent from and eliminate hazardous impact of wastes on public health and environment.

The new **Law on Soil Protection and Desertification Control** was adopted to combat desertification and mitigate the effects of drought, reduce environment pollution, improve land productivity and rehabilitation of land, enable human health and safety life and to set up the liability mechanism.

In June 2014, the Parliament approved the Green Development Policy (GDP). The GDP was drafted by a working group within the Ministry of Environment and Green Development in response to the Rio+20 Conference in 2012. Two high level documents were prepared to formally establish the GDP: the Green Development Concept, and the Mid-term Programme on Green Development. The concept paper determines the goals and purposes for green development until 2030, whereas the Mid-term Programme designs policy and strategies to ensure these goals and purposes are implemented.

The National Renewable Energy Programme (2015) established a long term goal of total installed capacity generated from renewable sources by 2030. The Renewable Energy Law (2015) further regulates the renewable energy power generation. It provides a feed-in tariff for the grid and the independent power generation from renewable energy. The new Law on Energy and Renewable energy target is to increase the share of renewable energy in total primary energy sources up to 20% by 2020, 25% by2025 and 30% by 2030.

Parliament also approved the Law on Hazardous and Toxic Chemicals (2006), the Law on Technology Transfer (1998) and the Law on Science and Technology (2006) to improve legal conditions for the transfer of modern technology for different sectors including transportation.

The Government has also introduced a number of action plans, including the National Action Programme on Climate Change, the Mongolian Environmental Action Plan, the National Action Plan to Combat Desertification, the National Biodiversity Action Plan, the Action Programme to Protect Air Quality, and the National Action Programme to Protect the Ozone Layer.

The **National Action Programme on Climate Change** (NAPCC) is the most relevant policy document addressing climate change. It was approved by Parliament initially in 2000 and upgraded in 2011 and aimed to meet UNFCCC obligations and commitments, establishing national policy and strategy to tackle the adverse impacts of climate change and to mitigate GHG emissions. The NAPCC is to be implemented in two phases. The first phase (2011-2016) aims to strengthen national mitigation and adaptation capacity, setting up the legal environment, structure, institutional and management system, and improving community and public awareness and participation in climate change activities. The second phase (2017-2021) aims to implement climate change adaptation and mitigation measures.

Mongolia has joined 14 environment related UN conventions and treaties, including the UNFCCC. Mongolia has submitted two National Communications and now preparing the third one. Mongolia has submitted NAMAs at the Conference of the Parties (COP) 15 Meeting in Copenhagen, Denmark in December 2009. Mongolia expressed its intention to agree to the Copenhagen Accord, and subsequently Mongolia submitted a list of proposed NAMAs to the UNFCCC Secretariat in January 2010. In its list of NAMAs, Mongolia submitted 22 mitigation options in six sectors towards reducing GHG emissions.

The other important document pursuant to climate change is INDC. Mongolia INDC has outlined a series of policies and measures that the country commits to implement until 2030, in the energy, industry, agriculture and waste sectors. The expected mitigation impact of these policies and measures will be a 14% (Figure 1-6) reduction in total national GHG emissions excluding land use, land use change and forestry (LULUCF) by 2030, compared to the projected emissions under a business as usual scenario. Those and other potentially more ambitious commitments are contingent upon gaining access to new technologies and sources of finance through internationally agreed mechanisms and instruments under the auspices of the UNFCCC.

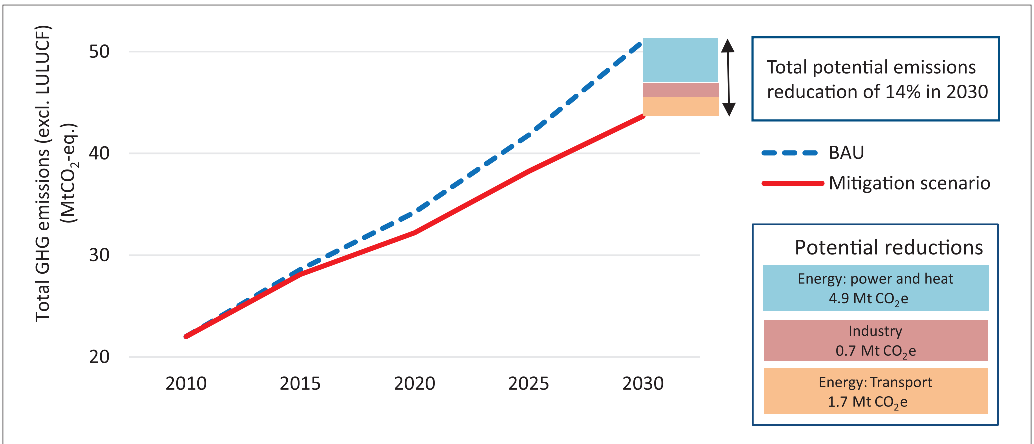

Figure 1-6: Indicative potential emissions reductions of the measures compared to BAU emissions

Institutional Arrangement

The Ministry of Environment and Tourism (MET) of Mongolia is the key ministry to develop, update and implement climate related policies. Thus, the MET is the national entity with the overall responsibility for organizing and coordinating the compilation of National Communications, Biennial updated reports, GHG inventory and submitting them to the UNFCCC Secretariat to integrate climate change related issues in various sectors.

The former Ministry of Environment and Green Development has established interdisciplinary and inter-sectorial National Climate Committee (NCC), led by the Ministry of Environment and Green Development in order coordinate and guide national activities and measures to adapt to climate change and mitigate GHG emissions. High level officials such as Deputy Ministers, State Secretaries and Director-Generals of the main Departments of all related ministries, agencies and other key officials were designated as members of the NCC. However, due to frequent changes in the Government, so far this Committee was not able to function as it was intended initially. There is a plan to create more simplified but more workable coordination mechanism with combined duties consistent with the new Government structure.

In 2016 given the importance of climate change adaptation and GHG mitigation, the MET has established "Climate Change and International Cooperation Department" merging mandate of the International Cooperation Division that was under State Policy and Administration Department of the MET and Climate Change Coordination Office to manage the implementation of the commitments and duties under the UNFCCC and the Kyoto Protocol, and to integrate climate change related issues in other development programmes.

In 2015, the MET has set up Climate Change Project Implementation Unit (CCPIU) at the Nature Conservation Fund (name has changed as Environment and Climate Fund since 2017) engaging experienced professionals to facilitate smooth implementation of commitments under UNFCCC. The CCPIU supervised by National focal point for the UNFCCC. There are three sectoral experts to conduct GHG inventory. The Institutional arrangement for climate change is shown in Figure 1-7.

The major data provider is NSO (National Statistics Office). A number of other entities provide more specific data that is required for GHG estimation which is not available at National Statistics. Such national entities include the Ministry of Energy (MoE), Ministry of Road and Transport Development (MRTD), Ministry of Food and Agriculture and Light Industry (MoFALI), Ministry of Construction and Urban Development (MCUD), CDM Bureau, the National Renewable Energy Center, Ulaanbaatar Municipality, and National Customs Office.

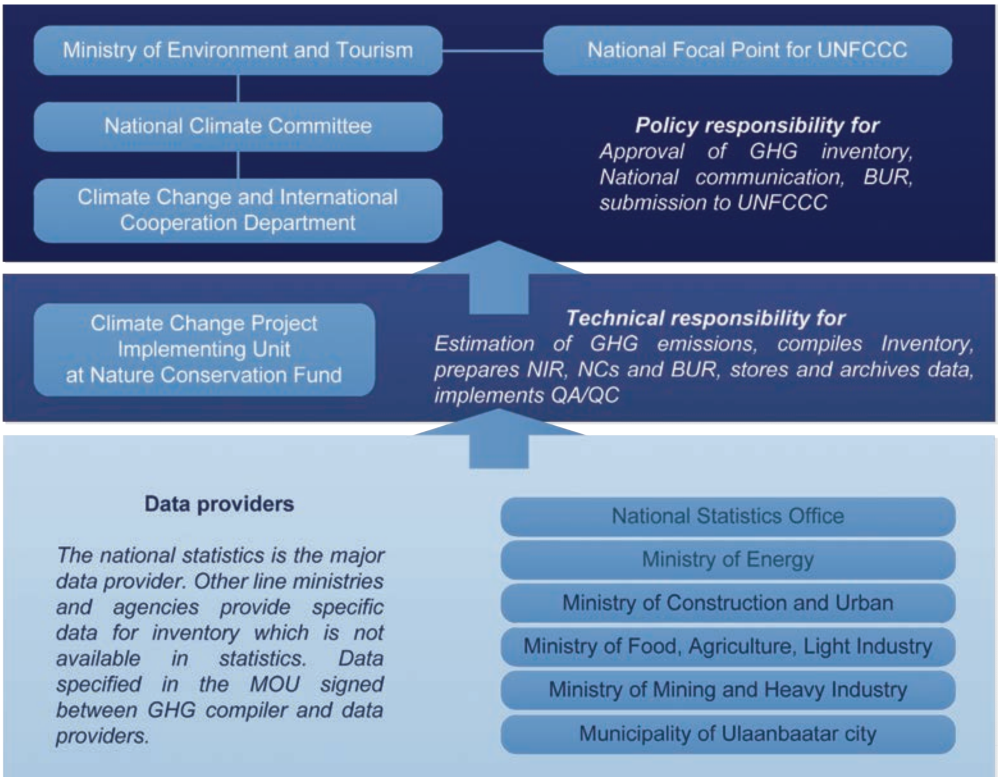

Figure 1-7: Institutional arrangement for climate change activities

Other entities involved in climate change and energy policy include the CDM Bureau, the National Renewable Energy Center, and the Clean Air Foundation. The National Agency for Meteorology and Environment Monitoring (NAMEM) monitors the environment and climate, carrying out a range of climate change studies and research. In addition, the government is promoting activities to raise public awareness of climate change and its impacts through professional and civil society communities and media.

BUR Implementation Arrangement

The preparation of GHG inventory, national communications and Biennial Update Report are financed by GEF enabling activities through UNEP. Depending on activities or tasks, the MET appoints a project manager to undertake day to day coordination of the project. The preparation arrangement of the first BUR of Mongolia is illustrated in Figure 1-8.

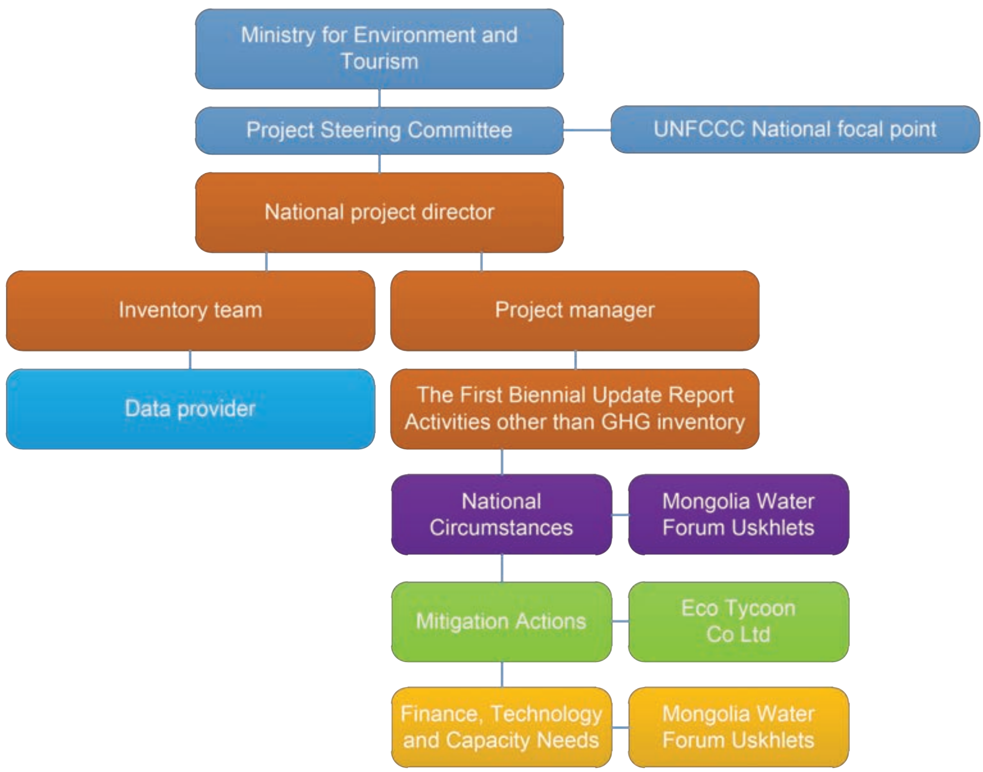

Figure 1-8: The First BUR implementation arrangement

For the improvement of the data collection and quality of GHG estimation, during the preparation of BUR, the MET of Mongolia signed a Memorandum of Understanding (MoU) on data exchange with major line ministries including MoE, MoFALI, MoI, MRTD, and MCUD. The Director of Nature Conservation Fund (Project executing organization) signed MoUs with major institutes and agencies such as CDM Bureau, the National Renewable Energy Center, Ulaanbaatar Municipality, and National Customs Office in April, 2016.

The Government of Mongolia is continuously striving to improve national GHG estimation and reporting to the UNFCCC from INC to SNC and from SNC to the first BUR. To achieve continuous improvement in national reporting, Government of Mongolia has made institutional arrangements, specific for the nature and scale of the BUR preparation.

A number of institutions were engaged to conduct various studies for BUR, including those that especially carry out studies to identify constraints and gaps and related financial, technical and capacity needs, including information on financial support needed and received.

1.3 Financial, Technology and Capacity Needs

According to decision 2/CP.17, non-Annex I Parties are to provide updated information on constraints and gaps, and related financial, technical and capacity building needs, as well as updated information on financial resources, technology transfer, capacity building and technical support received from the Global Environment Facility, Parties included in Annex II to the Convention and other developed country Parties, the Green Climate Fund and multilateral institutions for activities relating to climate change, including for the preparation of the current BUR.

Accordingly, this chapter presents information on the need for continued reporting of the GHG inventory under the Convention, and financial, technological and capacity building needs, constraints and finance received. The contents of this chapter should be read in conjunction with the information provided on technology and finance needs in SNC and TNC as the needs remain largely relevant for the present reporting as well.

CHAPTER 2

National Greenhouse Gas Inventory

CHAPTER 2

2. NATIONAL GREENHOUSE GAS INVENTORY

2.1 National Greenhouse Gas Inventory System

2.1.1 Overview of institutional arrangements for compiling GHG inventory

In accordance with Article 24 of the Law on Air (1995; 2012), the designated government authority shall estimate the emissions and removals of GHGs for Mongolia following the methodologies approved by the Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (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" is the national entity 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 implementation 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 the national GHG inventory and compiles supplementary information.

Figure 2-1 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 2-1.

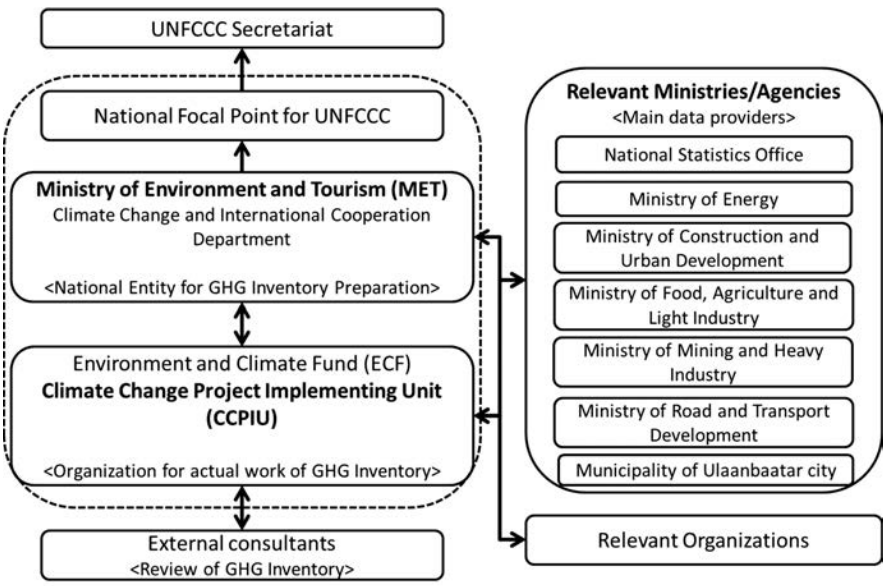

Figure 2-1: Institutional arrangement for the GHG inventory compilation of Mongolia

2.1.2 Overview of inventory preparation and management

As described above, the Mongolia's GHG inventory preparation system/institutional arrangement is not well developed, but in the near future it is planned to establish a national system for sustainable inventory preparation. Currently the preparation of national GHG inventory is centralized and is being compiled at CCPIU of ECF under the ministry. The improvement should be made in the near future is the decentralization of the inventory preparation process in terms of required activity data, and distribute the responsibilities of individual sectors fully under the external institutions and sectorial experts. Under the distribution of responsibilities can be understood through activity data collection and its analysis on continuous basis, and provide activity data to GHG inventory team at CCPIU, so that the GHG inventory can be compiled. The main source of activity data collection is the National Statistics Office (NSO) of Mongolia and the relevant institutions are shown above in the figure. 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.

The national system for sustainable inventory preparation is utmost important for the continuous, robust and decentralized preparation of a national GHG inventory. The next table 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 2-1: Activities and responsibilities of each entity involved in the preparation process

Phase	Activities	Responsible entities	Description
Measurement & Reporting	Revision of relevant guidelines and previous inventory	CCPIU	- Revise the activity and input data, taking into consideration data gaps and areas, where needed improvements, identified in previous GHG Inventories - Identify the major sectors and institutions holding data and information required for inventory
	Gather activity data, emission factors and coefficients	CCPIU & Relevant entities	- 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 entities	- Organize review and validation workshops with relevant ministries, agencies and organizations - Confirm data provided for the preparation of the inventory

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	Final review and approval	MET, CCICD	- Approval of the official version of the national GHG inventory
	Submission	MET, CCICD 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

CHAPTER 2

2.2 Trends in Greenhouse Gas (GHG) Emissions

2.2.1 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 represented 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 of 23.23% increase from the 2013 level with 8,139.60 Gg CO_2e (Figure 2-2 and Table 2-2).

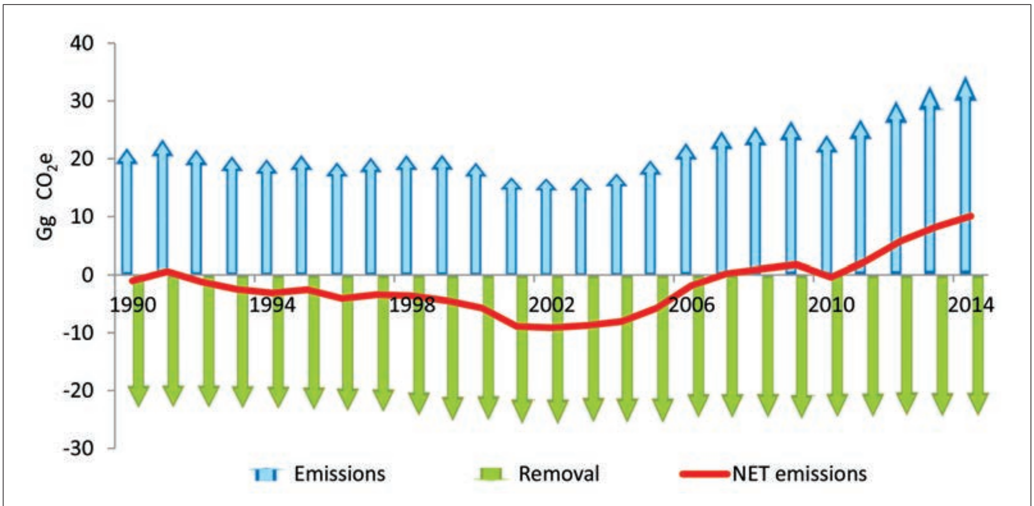

Figure 2-2: Mongolia's total and net GHG emissions and removals, 1990-2014 (Gg CO_2e)

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

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

Sector	Emissions, (Gg CO_2e)		Change from 1990 (Gg CO_2e)	Change from 1990 (%)
	1990	2014		
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 second highest sharing of the total emission were from the agriculture sector with 16,726.98 Gg CO_2e accounting for 48.51%. Emissions from IPPU and waste sector contributed 328.10 Gg CO_2e (0.95%) and 159.91 Gg CO_2e (0.46%) respectively to the national total in 2014 (Figure 2-3).

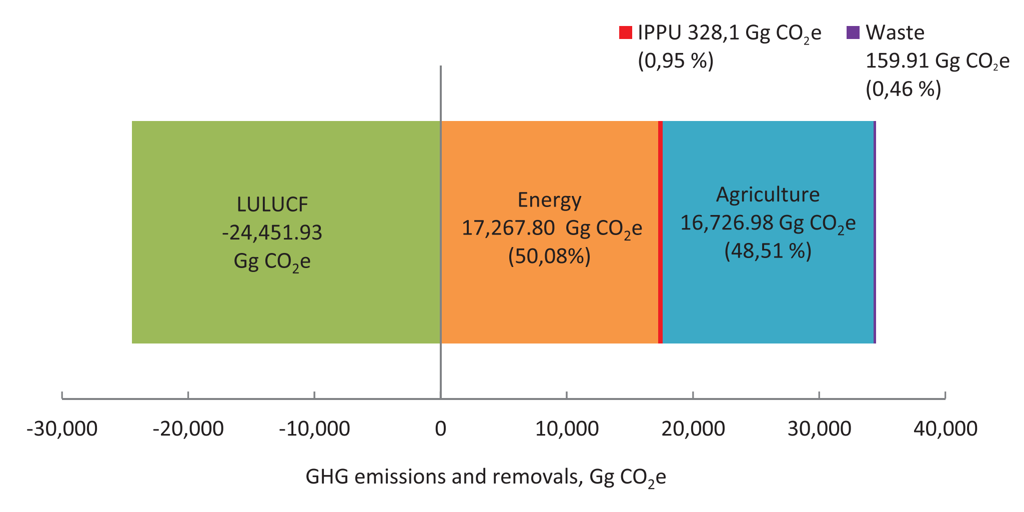

Figure 2-3: The composition of Mongolian GHG emissions by sectors in 2014

Table 2-3 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 increased up to 7.05% and 9.03% between 2011 and 2014. The agriculture sector's growth rate shows rise and decline between 1990 and 2014, the highest annual average growth rate percentage occurred from 2011 to 2014. On the Waste sector, the rapid increase of growth rate percentage observed from 1996 to 2014 continuously. In countrywide, from 1990 to 2014, the average annual growth in total emissions was 2.17% per year.

Table 2-3: 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	-15.20	-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

The aggregated GHG emissions and removals by sectors between 1990 and 2014 are shown in Table 2-4 including national total emissions with and without LULUCF. The trends of emission and removal from the sectors shows different patterns along the time series and main factors affected to trend fluctuation in each sector are written in the National Inventory Report.

Comparing to the 1990, sectoral emission increase for the energy sector were 55.69%, for the IPPU sector were 50.03%, for the agriculture sector were 58.02, for the waste sector 187.49% and removal for the LULUCF sector were 6.20% in 2014.

Comparing to the 2013, sectoral emission for the energy sector were -2.78%, for the IPPU sector were 37.72%, for the agriculture sector were 15.05%, for the waste sector 7.93% and for the LULUCF sector were -0.39% in 2014.

Table 2-4: The aggregated GHG emissions and removals by sectors, Gg CO2e

Year	Energy	IPPU	Agriculture	Waste	LULUCF	Total (incl. LULUCF)	Total (excl. LULUCF)
1990	11,091.10	218.70	10,585.30	55.62	-23,024.20	-1,073.46	21,950.73
1991	12,880.00	144.20	10,407.30	56.18	-22,950.70	537.04	23,487.74
1992	11,225.40	107.60	10,348.60	54.96	-22,992.00	-1,255.57	21,736.47
1993	10,407.60	70.20	10,021.90	53.66	-23,099.40	-2,546.15	20,553.30
1994	9,093.70	83.70	10,807.30	54.00	-23,212.80	-3,174.01	20,038.77
1995	8,920.70	82.80	11,719.80	55.71	-23,364.20	-2,585.18	20,778.97
1996	7,290.90	82.30	12,067.60	56.56	-23,596.90	-4,099.54	19,497.35
1997	7,094.50	86.90	13,093.50	58.27	-23,762.20	-3,429.03	20,333.19
1998	7,204.30	84.10	13,423.70	58.58	-24,407.40	-3,636.79	20,770.65
1999	7,174.90	78.40	13,525.30	62.71	-25,328.80	-4,487.43	20,841.39
2000	7,528.90	63.90	11,790.50	66.04	-25,188.40	-5,738.98	19,449.40
2001	7,547.50	50.40	9,224.50	68.45	-25,829.00	-8,938.13	16,890.83
2002	8,068.80	92.00	8,485.00	74.16	-25,884.40	-9,164.41	16,719.95
2003	7,967.00	97.00	8,646.20	76.52	-25,547.40	-8,760.70	16,786.74
2004	8,125.50	83.50	9,265.40	79.03	-25,639.70	-8,086.33	17,553.35
2005	9,738.30	140.50	9,881.30	83.33	-25,658.10	-5,814.68	19,843.41
2006	11,503.20	140.00	11,133.60	87.74	-24,750.20	-1,885.59	22,864.60

2007	11,930.80	155.70	12,729.70	92.25	-24,757.60	150.90	24,908.49
2008	11,919.80	182.30	13,451.40	97.65	-24,716.10	935.05	25,651.14
2009	12,491.40	157.60	13,909.40	103.10	-24,950.90	1,710.48	26,661.42
2010	13,227.30	251.60	10,635.70	108.26	-24,670.90	-447.93	24,222.94
2011	14,823.80	256.00	11,723.00	122.14	-24,636.30	2,288.64	26,924.97
2012	16,358.00	300.60	13,308.70	137.79	-24,377.00	5,728.00	30,105.05
2013	17,762.10	238.20	14,538.80	148.17	-24,547.70	8,139.60	32,687.27
2014	17,267.80	328.10	16,727.00	159.91	-24,451.90	10,030.80	34,482.73

Two main sources of the total emission were energy and agriculture sector for all years of the inventory. However, percentage share of emission sources were varied year by year depending on economic and climatic factors such as demand increase in energy sector and natural disaster occurrence in agriculture sector. Figure 2-4 shows that contribution of sectors to the Mongolia's total emissions for the period 1990-2014.

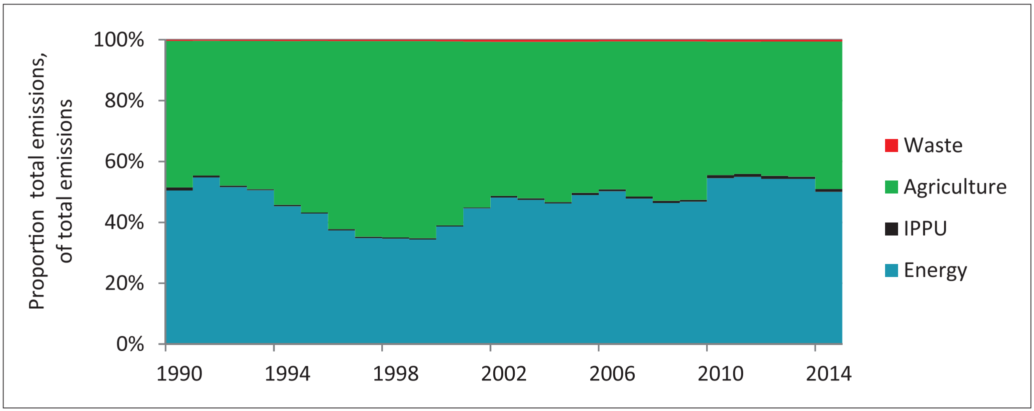

Figure 2-4: The contribution of sectors to Mongolia's total emissions for the period 1990-2014

CHAPTER 2

CHAPTER 3

Mitigation Actions and Their Effects

3. MITIGATION ACTIONS AND THEIR EFFECTS

Mongolia has submitted its Intended Nationally Determined Contributions (INDC) to UNFCCC on September 24, 2015. On its INDC, Mongolia set the target to mitigate GHG emission by 14% in economy-wide range excluding agriculture sector by 2030 compared to 2010 level. To assess overall mitigations actions to identify the future trends, the actions, policies and programs implemented or will be implemented through the national and sectorial policy framework and counter measures are considered. The assessment is based on the implementation of policies and programs which are implemented from 2007 to 2015. The key national policy documents on GHG mitigations actions are Sustainable Development Vision 2030 (2016), State Policy on Food and Agriculture (2016), State Policy on Forest (2015), State Policy on Energy (2015), Green Development Policy (2014) and National Program on Waste Management Improvement (2014). The key policies and actions are outlined to assess the future projections and current status of GHG mitigation actions and their effects.

3.1 International Market mechanism

3.1.1 Clean Development Mechanism (CDM)

Mongolia has five registered projects under the CDM. In total, 699,177 CERs were issued to the four CDM projects in Mongolia. Table 3-1 shows the overview of CDM projects in Mongolia.

Table 3-1: The status of Clean Development Mechanism project in Mongolia

№	Project title	Scale	Host parties	Registration status	Project status	Emission reduction per year
1	Project 5977: Salkhit Wind Farm	Large	Mongolia Sweden	Registered 30 Mar 12	Based on the monitoring reports (7) between 24 Jun 2013 - 31 Dec 2016, amount of 505,740 CERs were issued	178,778 metric tons CO_2
2	Project 0786: Durgun Hydropower Project in Mongolia	Small	Mongolia Japan	Registered 23 Mar 07	Based on the monitoring reports (3) between 01 Nov 2008 - 31 May 2012, 57,768 of CERs were issued.	30,400 metric tons CO_2
3	Project 0787: Taishir Hydropower Project in Mongolia	Small	Mongolia Japan	Registered 16 Mar 07	Based on the monitoring reports (4) between 01 Nov 2008 – 31 May 2012, 19,182 of CERs were issued	29,600 metric tons CO_2
4	Project 0295: A retrofit programme for tonesralized heating stations in Mongolia.	Small	Mongolia	Registered 28 Jul 06	No issuance requests	11,904 metric tons CO_2
5	PoA 8142: MicroEnergy Credits – Microfinance for Clean Energy Product Lines - Mongolia	Small	Mongolia, UK, Northern Ireland and Sweden	Registered 12 Nov 12	Based on the monitoring reports (2) between 01 Aug 2013 – 30 Apr 2016, 116,487 of CERs were issued	50,133 metric tons CO_2

Source: https://cdm.unfccc.int/Projects/projsearch.html

3.1.2 Joint crediting mechanism (JCM)

The Joint Crediting Mechanism (JCM) is a program in which Japan's initiative in pursuit of the ultimate objective of the UNFCCC. On January 8, 2013, Government of Mongolia and Japan signed in Ulaanbaatar, Mongolia, a bilateral document "Low Carbon Development Partnership" which concerning the JCM. Both countries are established a joint committee to operate the JCM. This Japan-Mongolia partnership is the first partnership signed by Japan for this purpose. Under the partnership, joint study has been taken in energy supply-improve Combined Heat and Power (CHP) Plant to identify Business as Usual (BAU) and NAMA scenario in the energy supply sector. Total of 18 projects have been taken between 2013-2017 fiscal year with contribution of Ministry of Environment Japan's subsidy and Ministry of Economy, Trade and Industry Japan. Out of total projects, 14 feasibility studies and demonstration and model projects are conducted. As of fiscal year 2017, three projects are selected as model project under the financing scheme for JCM model projects by the Ministry of Environment of Japan.

Mongolia has four registered JCM projects in the energy sector. The four projects' total volume of expected emission reduction is 13,465 tCO_2 per year. In 2016, Mongolia issued its first CERs from registered projects under the standards MN_001 and MN_002 which are equivalent to 157 CERs in total (Table 3-2). Upon the discussion between each side, Mongolia received 32 CERs while Japan received 125 CERs.

Table 3-2: Issuance of credits under the JCM scheme of Mongolia

№	Project title	Host parties	Registration status	Project status	Emission reduction per year
1	MN_001: Installation of high-efficiency Heat Only Boilers in 118th School of Ulaanbaatar City Project	Mongolia Japan	Registered 29 Sep 2016	50 CERs were issued	92 tons CO_2
2	MN_002: Centralization of heat supply system by installation of high-efficiency Heat Only Boilers in Bornuur soum Project	Mongolia Japan	Registered 29 Sep 2016	107 CERs were issued	206 tons CO_2
3	MN_003: Installation of 2.1MW Solar Power Plant for Power Supply In Ulaanbaatar Suburb	Mongolia Japan	Registered 26 May 17	Monitoring period	1,946 tons CO_2
4	MN_004: 10MW Solar Power Project in Darkhan City	Mongolia Japan	Registered 26 May 17	Monitoring period	11,221 tons CO_2

Source: https://www.jcm.go.jp/mn-jp.

3.2 Mitigation actions and their effects[1]

The key sectorial policies and measures toward to mitigate GHG emission are outlined in Figure 3-1. It includes the actions that reflected the previous assessments and updated documents at the national level to identify the status of current and future mitigation scenarios.

[1] Please see the Annex for the quantitative data used for estimating the mitigation actions and effects expressed by the figures in this section.

Table 3-3: Mongolia's' climate change mitigation policies and actions

	Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Total	Projected emissions level [BAU] (mln tons CO2eq.)	19.4	21.2	23.0	24.6	25.5	27.4	31.1	32.8	34.6	36.4	38.2	47.4	57.6
	Emission target (mln tons CO2eq.)	19.4	21.1	22.9	24.5	25.2	26.5	28.7	29.3	29.9	30.6	31.3	36.6	42.5
	Reduction rate, %	0.3	0.4	0.5	0.5	0.9	3.2	7.6	10.7	13.5	16.0	18.2	22.7	26.1
Energy	To increase the share of renewable energy in the energy production										20% by 2020		30% by 2030	
	To reduce system loss in distribution and delivery and ineffective consumption									Internal usage of CHP 11.2% and loss 10.8% in 2020			9.1% and 7.8% by 2030	
	To decrease heat loss in buildings and increase energy efficiency											20% by 2020		40% by 2030
	Reduce fuel consumption of vehicles and engines						Reach length of tarmac road at 8,000km by 2015				Reach length of tarmac road at 11,000km by 2021 and electrify main rail roads			
	Increase number of gas and fuel efficient vehicles											Increase share of public transportation 13% by 2030		
Industry	Introduce dry technology in cement production												Fully introduced by 2030	
	Increase productivity through advanced technology									Share of processing industry in export 15% by 2020			25% by 2025	
	Supply fuel demand by domestic production								Euro 4 standard 20% by 2020		Euro 5 standard 70% by 2025		Euro 5 standard 100% by 2030	

Livestock	To decrease livestock number		43,288.0 thous by 2008 and 35,298.9 thous by 2015	36,475.6 thous by 2021	1.5 times in 2021 and 5 times increase in export
	To improve livestock productivity and to increase the export of raw materials	In 2015 increase total supply of meat production by 1.6 times compared to the level of 2008, increase export three times			
	To retain the proper ratio of the number, type and structure of the herd		Increase number of camel by 0.2%, horse by 1.7%, cattle by 3.8%, sheep by 3% and decrease number of goat by 8.7% in herd stucture by 2015 compared to the level of 2008	Increase number of camel by 0.3%, horse by 3.1%, cattle by 8%, sheep by 2.7% and decrease number of goat by 14.1% in herd structure by 2021 compared to the level of 2008	
Agriculture	To establish forest strip zone in arable land	To ensure legal framework, to build enclosure to protect soil from erosion of wind and water			
	To increase the yield of 1 ha			17.3 centner/ha yield of 1 ha by 2020	Yield 20.0 centner/ha by 2025
	To reject traditional technology of plough	Encourage and support zero and reduced tillage technology			
Forest	To increase naturally regenerated and planted forest area			310 thous.ha by 2020	1,500.0 thous.ha by 2030
	To decline forest area affected by fire and insect			30% fire and 60% insect by 2020	70% fire and insect 100% by 2030
Waste	Reduction	To reduce depletion of resources and raw materials, to reduce waste through effective production, to introduce zero waste technology			
	Recycling		To increase four times by 2018 compared to 2013	To increase 7.6 times by 2022 compared to 2013	
	Reproduction		20% of waste in 2020	30% of waste in 2025	40% of waste in 2030
	Incineration			To reduce by 20% in 2020	To reduce by 40% in 2030

CHAPTER 3

The projected GHG emissions and removal by sources/sinks in BAU scenario is outlined in Figure 3-2. If the actions described on the national policies and programs (Figure 3-1) are implemented completely, GHG emissions can be reduced about 25% in 2025 and about 28% in 2030. Due to lack of data availability on certain sectorial GHG emissions, the projected emission reduction could be higher.

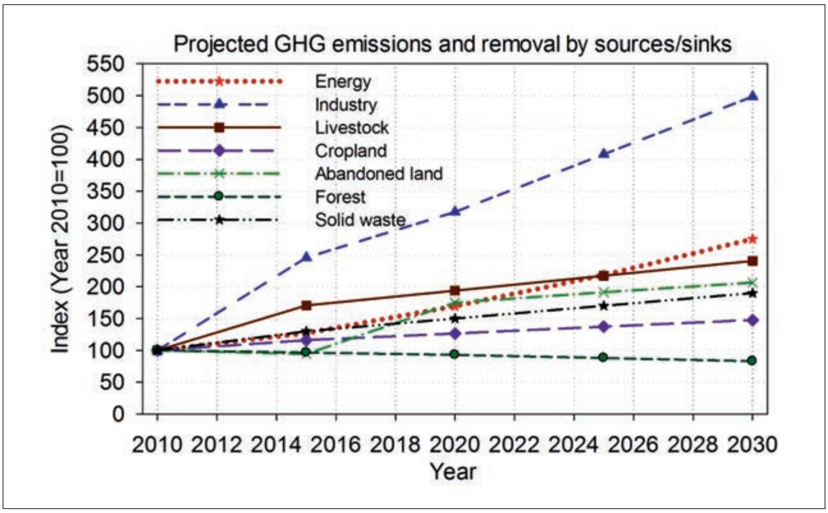

Figure 3-1: Projected GHG emissions and removal by sources/sinks by sectors, BAU

In 2030, GHG emissions in BAU scenario using 2010 as the base year is projected that 2.7 times of reduction in energy sector, 5.0 times of reduction in cement production, 2.4 times of reduction in livestock sector, 1.5 times of reduction in agriculture, 1.9 times in of reduction waste sector, while removal of follow land decreased by 2.1 times and forest removal potential is expected to increase.

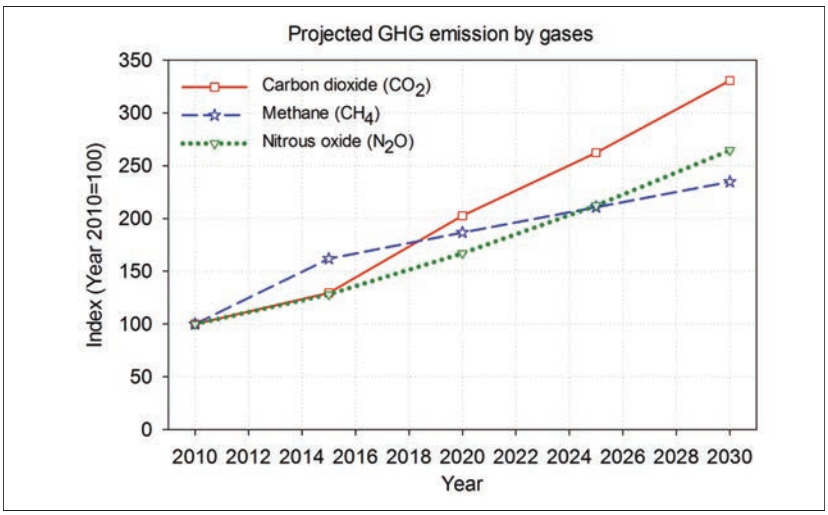

Figure 3-2: Projected total GHG emissions by gases, BAU

CHAPTER 3

In 2030, GHG emissions by gases in BAU scenario using 2010 as the base year is projected that 3.3 times increase of carbon dioxide (CO_2), 2.3 times increase of methane (CH_4), 2.6 times increase of nitrous oxide (N_2O).

3.2.1 Energy

The key policies toward to mitigate GHG emissions in the energy sector includes "Law on Energy" (approved on 2001, updated on 2015), "Law on renewable energy" (approved on 2007, updated on 2015) and "Law on energy saving" (2015). Green Development Policy, State policy on energy and Sustainable Development Vision 2030 are also considered as the key policy documents. Mongolia put the goal to reduce the GHG emissions by 2% from the current levels in 2020, by 7% in 2025 and by 14% by 2030 by promoting renewable energy sources and to introduce advanced technologies in liquefying and carbonating coal and shale. Increased energy efficiency and share of renewable energy are the two main approaches to policies and actions to mitigate GHG emissions. Table 3-4 outlines the policies and measures on mitigation and its status of implementation.

Table 3-4: Policies and measures to mitigate GHG emissions in energy sector

1. To increase share of renewable energy in total energy generation		
National Renewable energy program		Implementation
2005-2010	2011-2020	Three large scale and six small scale hydropower plants are in operation. Total power generation capacity is 25,975 MW (GM, 2015).
-To be commissioned Durgun and Taishir hydro power plants -To launch construction of Orkhon hydro power plant -To fully implements the national photovoltaic program "100,000 Solar Ger[2]" -To study the wind energy resources of Salkhit mountain and other potential sites	-To connect and operate Durgun and Taishir hydro power plants to Western Energy System -To commission Orkhon hydro power plants - To fully supply renewable energy sources to remote settlement areas -To build 30-50MW wind parks and connect to Central Energy System (CES)	11 MW Taishir Hydro Power Plant is in operation since 2008, due to scarcity of water current power generation is from 3.5 MW to 4.1 MW (GM 2015). Annual production is 12.4 GWh and total energy production was 87.2 GWh by 2015 (ERC, 2015). From November 2008 to May 2012, 19,182 t CO_2e of CERs are issued (UNFCCC, 2016).
National Action Program on Climate Change		
2011-2016	2017-2021	12 MW Durgun Hydro Power Plant is in operation since 2008, total energy production was 200.2 GWh by 2015 (ERC, 2015). From November 2008 to May 2012, 57,768 t CO_2e of CERs are issued (UNFCCC, 2016).
Renewable energy will account for 10% of total national energy production	Renewable energy will account for 20% of total national energy production	
Green Development Policy (State Policy on Energy)		
2014-2020 (2015-2023)	2021-2030 (2024-2030)	50 MW Salkhit wind park is in operation since 2013, total energy production was 330.8 GWh by 2015 (ERC, 2015). From June 2013 to June 2016, 437,538 t CO_2e of CERs are issued (UNFCCC, 2016).
Share of renewable energy will account for 20% of total national energy production	Share of renewable energy will account for 30% of total national energy production	

[2] Ger- Yurt, *Mongolian* traditional dwelling

<table>
<tr><th colspan="3">Sustainable Development Goal of Mongolia</th><td rowspan="3">From 2000 to 2012, 100,146 photovoltaics with 5MW capacity has been distributed to rural households through the "100,000 Solar Ger" program (IEA, 2016).
Since December 2016, solar PV with capacity of 10MB is operationalized in Darkhan city (GEC, 2016).
In 2014, the share of renewable energy in installed energy generation is 7.62% (State Great Khural 2015).</td></tr>
<tr><td>2016-2020</td><td>2021-2035</td><td>2026-2030</td></tr>
<tr><td>Share of renewable energy will account for 20% in total installed capacity of energy production</td><td>Share of renewable energy will account for 25% in total installed capacity of energy production</td><td>Share of renewable energy will account for 30% in total installed capacity of energy production</td></tr>
<tr><th colspan="4">2. Reduce inefficient use of energy and loss in transmission and distribution</th></tr>
</table>

<table>
<tr><th colspan="2">State Policy on Energy</th><th>Implementation</th></tr>
<tr><td>2015-2023</td><td>2024-2030</td><td rowspan="2">In 2015, following actions are executed: build a 17 km transmission line for 1,200 households, build new power substations and reduce overloads of five feeders in suburban areas of Ulaanbaatar (MET 2015).
The internal energy use of CHPs reduced from 14.4% in 2014 to 14.1% in 2015; electricity transmission and distribution losses are reduced from 14.7% in 2014 to 14.2% in 2015 (NSO, 2015).</td></tr>
<tr><td>Reduce internal energy use of CHP plants to 11.2% and electricity transmission losses to 10.8%</td><td>Reduce internal energy use of CHP plants to 9.1% and electricity transmission losses to 7.8%</td></tr>
<tr><th colspan="3">3. Reduce building heat loss and increase energy efficiency</th></tr>
</table>

<table>
<tr><th colspan="2">Green Development Policy
(State Policy on Energy) NAMA Construction, 2016</th><th>Implementation</th></tr>
<tr><td>2014-2020 (2015-2023)</td><td>2021-2030 (2024-2030)</td><td rowspan="7">In an effort to contribute to air pollution reduction in Ulaanbaatar and in frame of CDM, Xac Bank initiated Eco Product Distribution Program in 2009, and have provided energy efficient stoves and Ger insulation blankets with discount rate to ger area residents in Ulaanbaatar. As a result, 31,767 t CO_2e of CERs are issued from 2013 to 2016 (UNFCCC, 2016).
By 2016, "Heat innovation of panel apartment buildings in cities of central region technical project" unit is established with the purpose to reduce heat loss in substantial amount and to reduce heat consumption by 30%. However, due to lack of secure funding the implementation is in stagnation.
By the decision of the Government to support the usage of electric heat, reduced night tariff of electricity by 50% in December of 2015 and 120,000 households involved (MET 2015).
NAMA Construction project has been registered to NAMA Registry (UNFCCC, 2016).</td></tr>
<tr><td>Reduce building heat loss by 20%</td><td>Reduce building heat loss by 40%</td></tr>
<tr><th colspan="2">National Action Program on Climate Change</th></tr>
<tr><td>2011-2016</td><td>2017-2021</td></tr>
<tr><td colspan="2">Improvement in energy saving and efficiency through the introduction of policies, measures and environmentally friendly technologies</td></tr>
<tr><th colspan="2">NAMA Construction</th></tr>
<tr><td colspan="2">To remove barriers to increased adoption of energy efficiency technology in construction sector through establishment of baseline energy consumption and GHG emission in the construction sector, development and implementation of Measuring, Reporting and Verification (MRV) system</td></tr>
</table>

<table>
<tr><th colspan="7">4. Reduce consumption of solid and liquid fuels through improvement in infrastructures of road and transport</th></tr>
<tr><th colspan="6">Millennium Development Goals (MDGs)-based Comprehensive National Development Strategy of Mongolia</th><th>Implementation</th></tr>
<tr><td colspan="3">2007-2015</td><td colspan="3">2016-2021[4]</td><td rowspan="5">The length of paved roads reached from 2597.2km in 2007 to 7,125.3 km in 2015. Implementation status is 89.1% (NSO, 2015).
Made railway embankments in aimags[3] of Gobi region. Due to lack of secure funding the construction work is in stagnation (MET 2015)

NAMA Urban Passenger Transport Ulaanbaatar project has been registered to NAMA Registry (UNFCCC, 2016a) with focus to mitigate air pollution of Ulaanbaatar and thereby reducing GHG emissions.</td></tr>
<tr><td colspan="3">The length of paved roads reached 8,000 km. Construction of railroad in Gobi and Eastern region accomplished by 60% and 70% of the construction work of the second railroad completed. Electrification of the main railroad ensured</td><td colspan="3"></td></tr>
<tr><th colspan="6">Mongolia Sustainable Development Vision 2030</th></tr>
<tr><td colspan="2">2016-2020</td><td colspan="2">2021-2035</td><td colspan="2">2026-2030</td></tr>
<tr><td colspan="2">Build transportation and logistics centers at Zamiin-Uud, Khushigiin Khundii and Altanbulag, extend asphalt roads for international and domestic travels by 1600 km, build and use the railroad from Ukhaa Khudag to Gashuun Sukhait, initiate construction of railroads from Erdenet-Ovoot to Bogd khaan, and develop transit transportation</td><td colspan="2">Build and use transportation and logistics centers to serve the agricultural, industrial and mining sectors, develop new forms of transportation; extend the domestic asphalt roads length by 800 km, complete the construction of railroads from Erdenet - Ovoot to Bogd khaan, and initiate the railroad construction work in the regions</td><td colspan="2">Develop new transportation and logistics centers, extend asphalt roads for international and domestic travels by another 470 Km, and complete the construction of railroads in the regions</td></tr>
<tr><th colspan="7">5. Increase hydrogen and low fuel consumption vehicles</th></tr>
<tr><th colspan="6">National Action Program on Climate Change</th><th>Implementation</th></tr>
<tr><td colspan="3">2011-2016</td><td colspan="3">2017-2021</td><td rowspan="4">The decision made to shift 400 buses into hydrogen and hybrid fuel use with the support of "Clean Air Fund". Installed the equipment for gas fuel for 21 buses of "Bus 1" company, 22 buses of "Bus 3" company, 50 trolleybuses of "Electric transportation" company. In total 98 buses equiped with gas fuel as of 18 of January, 2015 (MET, 2013).

As of 2016, the total number of vehicle is 763,998 including 86 electric cars, 96,068 hybrid cars, 14,396 gas fuel cars (NTC, 2016) .</td></tr>
<tr><td colspan="3">Increase hydrogen and hybrid fuel use in vehicles and encourage low fuel consumption cars. Extend the number of buses and trolleybuses used for public transportation in cities</td><td colspan="3">Expand the liquid gas distribution network. Begin initial research into building an underground metro in Ulaanbaatar.</td></tr>
<tr><td colspan="6">Intended Nationally Determined Contribution of Mongolia (INDC), 2015
NAMA Urban Passenger Transport Ulaanbaatar, 2016</td></tr>
<tr><td colspan="6">Increase the share of private hybrid road vehicles from approximately 6.5% in 2014 to approximately 13% by 2030.</td></tr>
</table>

[3] Aimag- Prefectures of Mongolia
[4] In pursuant with the approval of the resolution, the Mongolian Parliament Resolution No. 26 dated May 3, 1996 on the approval of "Mongolia's Development Vision," and the Mongolian Parliament Resolution No. 12 dated January 31, 2008 on the approval of "Millennium Development Goals (MDGs)-based Comprehensive National Development Strategy of Mongolia" shall be nullified.

A Long-range Energy Alternatives Planning system (LEAP) model was used to estimate projections of GHG emissions between 2010 and 2030 in Mongolia. The assessments are made using social-economic data before 2010 to 2015. Population, number of households, GDP and their future changes are the key indicators to estimate energy intensity and to plan energy (Table 3-5).

Table 3-5: Baseline scenario of social and economic indicators

Indicators	2010	2015	2020	2025	2030
Population, mln (NSO, 2015)	2.739	3.004	3.262	3.488	3.688
GDP, bln USD	7.11	12.2	17.3	22.7	28.5
Household number, 1,000 households	742.3	808.5	880.5	959	1,044.4
Household income, USD	2,650.3	4,061.2	5,303.5	6,508.08	7,727.8

Table 3-6 outlines the capacity of current and planned CHPs. This is information is significant to estimate GHG emissions from the energy sector to the baseline scenario.

Table 3-6: CHPs currently under operation and planned

№	Name	Installed capacity, MW	Commissioning year	Energy Source	Remarks	Annual energy production, GWh
1	CHP2	21.5	Operating	Coal		Installed capacity of CHP 905.7 MW, 4,312.8 GWh in 2010 and 1,078.7 MW, 5,323.5 GWh in 2015
2	CHP3	148	Operating	Coal	Increased the capacity by 50MW in 2014	
3	CHP4	580	Operating	Coal	Increased the capacity by 123MW in 2014	
4	Darkhan CHP	48	Operating	Coal	Will be increased the capacity	
5	Erdenet CHP	28.8	Operating	Coal	Will increase the capacity	
6	Erdenet factory CHP	5	Operating	Coal		
7	Choibalsan CHP	36	Operating	Coal	Will increase the capacity	
8	Dalanzadgad CHP	6	Operating	Coal		
9	Uhaa Hudag CHP	18	Operating	Coal	Since 2011	
10	Diesel	14.4	Operating	Diesel	Will decrease the capacity	
11	CHP5	450	2020	Coal		New 1,690 MW, 7,670.9 GWh and 2,768.7 MW, 12,878.4 GWh in 2030
12	Baganuur CHP	700	2019	Coal		
13	Oyutolgoi/Tavan tolgoi CHP	450	2020	Coal		
14	Telmen CHP	90	2023	Coal		

Source: "Preparation of an Investment Plan for Scaling up Renewable Energy in Mongolia" project", 2015; NSO, 2016; "Energy Statistics 2015", ERC.

The current capacity, production, efficiency coefficient of the renewable energy source is used as the baseline scenario for estimating the GHG emission of the energy sector. Figure 3-4 outlined the baseline scenario of energy sector. Energy sector GHG emissions are expected to increase by 17.4, 23.2, 29.9 and 37.7 mln t CO_2e in 2015, 2020, 2025 and 2030 respectively.

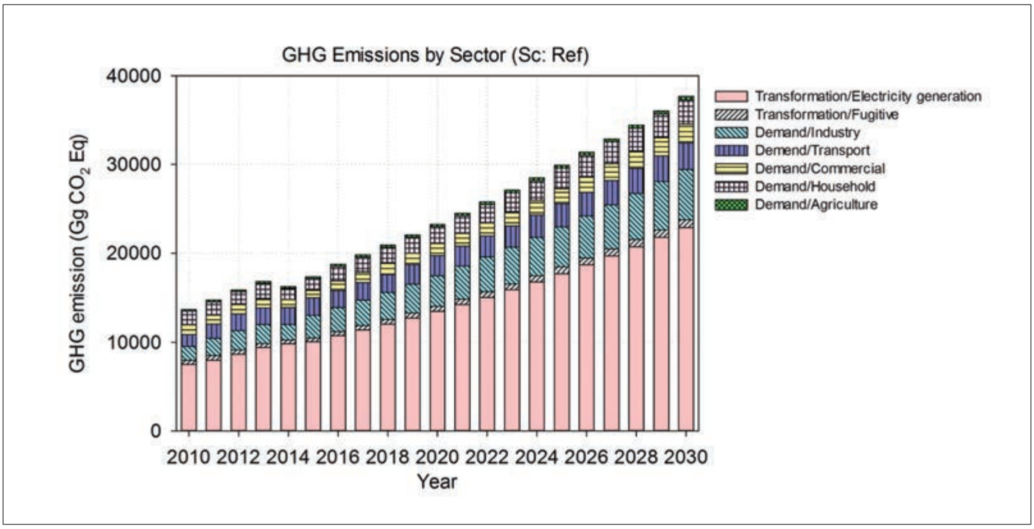

Figure 3-3: GHG emissions in energy sector

By the energy demand of the sectors, heat and electricity production and industry sectors are dominant and continue to increase intensively until 2030. The share of the net emissions in the energy sector will be decreased although GHG emissions from other sectors will be increased (Figure 3-4). The rising demand for energy reflects to the production intensity thus GHG emissions will increase (Table 3-7).

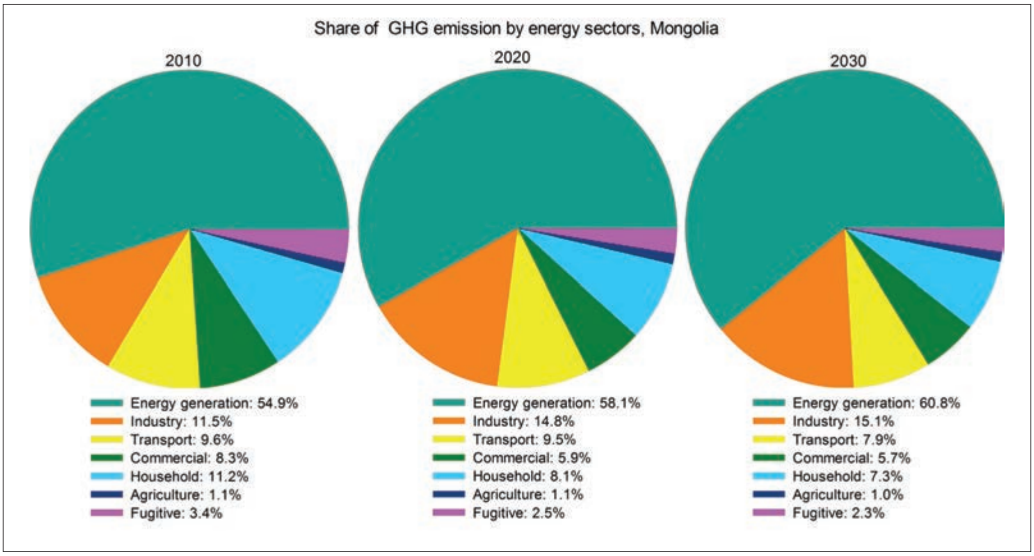

Figure 3-4: Share of GHG emissions by energy sectors

Table 3-7: GHG emissions energy demand and energy transformation

Branch	2010	2015	2020	2025	2030
Energy transformation, 1,000 Gg CO_2e	8.0	10.5	14.1	18.5	23.8
Energy demand, 1,000 Gg CO_2e	5.7	6.9	9.2	11.4	13.9
Total emission, 1,000 Gg CO_2e	13.7	17.4	23.2	29.9	37.7
Emission index (2010=1)	1.0	1.3	1.7	2.2	2.7

GHG emissions expected to increase 2.4 times in energy need, 3.0 times in energy production, 2.7 times in overall energy sector compared to the level of 2010 in 2030. Renewable energy plants that are not commissioned are not included in the projection GHG emissions of the energy sector. Information of solar, wind and hydro power plants in last part of Table 3-8 is a reference for the actions to increase renewable energy generation.

Table 3-8: Information of implemented and planned renewable energy stations

№	Name	Installed capacity, MW	Commissioning year	Energy Source	Remarks, cost, mln USD	Annual energy production, GWh
1	Salkhit wind park	50	Operating	Wind	2013 since	168.5
2	Durgun CHP	12	Operating	Hydro		38.0
3	Taishir CHP	4 (11)	Operating	Hydro	Due to water scarcity	37.0
4	Darkhan CHP	10	Operating	Solar		14.2
5	Eg river	315	2022-2023	Hydro	827	606.0
6	Ulaanbaatar water accumulating power station	100	2020	Hydro	285	300.0
7	Shuren HPP	245	2020	Hydro	780	930.0
8	Maikhan HPP	12	2017	Hydro	14.2	57.0
9	Chargait HPP	24.6	2023	Hydro	95.6	116.0
10	Orkhon HPP	100	2023	Hydro	160	216.0
11	Khovd HPP	88.7	2023	Hydro	160	418.8
12	Sainshand wind park	52	2016 construction	Wind	110	200.0
13	Oyutolgoi wind park	102	2016 construction	Wind	200	370.0
14	Choir wind park	50.4	2016 construction	Wind	100	123.0
14	Tsetsii wind park	50	2016 construction	Wind	118	142.0
15	AB Solar Wind	100	2016 construction	Wind		200.0
16	Taishir Solar PV	10	2017	Solar	22-24	14.0
17	Altai Solar PV	10	2016 construction	Solar	26.8	15.0
18	Desert Solar power one	30	2017	Solar	70	52.0
19	Bayanteeg Solar PV	8	2016	Solar	24.2	13.2
20	Sumber Solar PV	10	2016	Solar	22.5	17.5
21	Galbiin Gobi	50	2017	Solar	140	94.2

Total installed renewable energy station 23 MW, 75 GWh in 2010 and 73 MW, 257.682 GWh in 2015.	Planed installation of 912.4 MW from 2017 to 2023, 1,555.6 GWh in 2020 and 1,440.7 MW, 4,142.4 GWh from 2025 to 2030.

Source: "Preparation of an Investment Plan for Scaling up Renewable Energy in Mongolia" project", 2015; NSO, 2016; "Energy Statistics 2015", ERC.

Table 3-9 outlines the share of renewable energy percentage reflected by net energy production and goals identified in the energy policies and programs. It is possible to reach the goals identified in the policies and programs if all planned activities of the projects will be implemented in its timeframes.

Table 3-9: Share of renewable energy percentage

Indicators	2010	2015	2020	2025	2030
Total energy production, GWh	4312.8	5541.7	7737.4	10169.9	13122.6
According to policies and measures, GWh	75.0	554.2	1547.5	2542.5	3936.8
Implemented and planned renewable energy project, GWh	75.0	243.5	1555.6	2785.6	4142.4
Share of renewable energy, %	1.7	4.4	20.1	27.3	31.6

GHG emissions will be reduced in 2015, 2020, 2025 and 2030 by 0.4, 2.7, 4.7, 7.2 mln t CO_2e respectively if projects are fully implemented in the energy sector. See Figure 3-5 for the details.

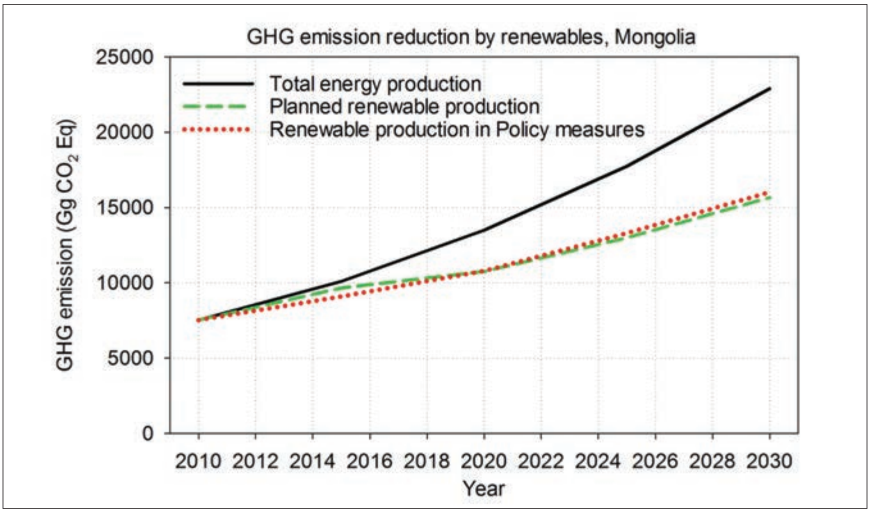

Figure 3-5: Potential emission reduction of energy production by increasing share of renewable energy

Actions described from two to five in Table 3-4 used as a reference to project the scenario.

The loss in distribution and transmission and internal energy use of CHPs are projected in BAU scenario without any actions referenced in policies and programs.

CHAPTER 3

Net GHG emission is projected to reduce to 1.5 mln t CO_2e in 2020 and 2.8 mln t CO_2e in 2030 through the improvement of energy efficiency (Table 3-10).

Table 3-10: Baseline scenario of GHG emission reduction through increase of energy efficiency

Indicators		2010	2015	2020	2025	2030
Transmission and distribution loss	Total resource electricity %	13.5	14.2	10.8		7.8
	Reduction, 1,000 Gg CO_2e	-	-	0.1		0.3
Internal energy use of CHP plants	Produced electricity %	15.6	14.1	11.2		9.1
	Reduction 1,000 Gg CO_2e	-	-	0.3		0.9
Insulation of building and apartment	Apartment number, %			50		90
	Reduction 1,000 Gg CO_2e	-	-	0.9		1.3
Number of households with LED light	Urban households, %			60		90
	Reduction 1,000 Gg CO_2e	-	-	0.1		0.1
Share of low fuel consumption vehicles in total number of vehicle, %	Hybrid, gas and electric transportation, %	-	6.5	8.7		13
	Reduction 1,000 Gg CO_2e	-		0.1		0.2
Total GHG emission reduction, 1000 Gg CO_2e				1.5		2.8

Total GHG emission reduction from energy sector is expressed in the Figure 3-6.

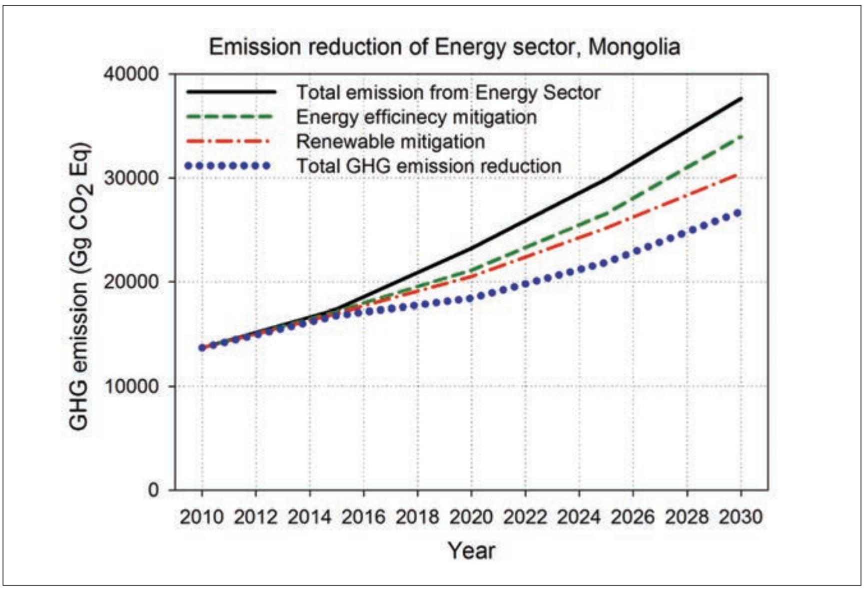

Figure 3-6: Total GHG emission reduction from energy sector

GHG emissions will be reduced potentially in 2020, 2025 and 2030 by 4.2, 6.9, 10.0 mln t CO_2e respectively if policies and measures are fully implemented in the energy sector.

3.2.2 Industry

State Great Khural has approved "State Policy on Industry" in 2015. A key measure to mitigate GHG emission is to convert cement production from wet to dry processing. Cement production accounts for 70% of import even domestic cement production increased between 2007 and 2015. In 2015, net production of cement was 410.1thous tons equals to 10% of the installed capacity of the production. The cement factories that have the capacity to fully meet domestic demand have commissioned since 2016. Total installed capacity reached to four million tons but unable to work in full capacity due to poor sale and purchase in the market and import from China.

Table 3-11 outlines the current status of implementation of policies and measures to mitigate GHG emissions in the industry sector.

Table 3-11: Policies and measures to mitigate GHG emissions in industry sector

<table>
<tr><td colspan="4">1. Adopt dry processing technology in cement production</td></tr>
<tr><td colspan="2">National Action Plana on Climate Change</td><td colspan="2" rowspan="2">Implementation and outcome</td></tr>
<tr><td>2011-2016</td><td>2016-2020</td></tr>
<tr><td>Programme to support construction material production:
- Adopt dry processing technology in cement production
- Fully converted into dry processing technology, reduce consumption of fuel, electricity, water consumption and reduce price by 30 to 40%.
- By 2015, an annual capacity of cement production will reach four million ton and fully meet domestic need.</td><td>Fully adopt dry processing technology in cement production and reduce price by 30% to 40%.</td><td colspan="2">Implementation:
-"Cement and Lime" Co.ltd., in Khutul fully adopted dry processing technology in 2014 and amount of production dramatically increased. Reduced 8,400 t CO_2 in 2014 and 10,200 t CO_2 in 2015 respectively.
- In 2016, installed capacity in cement production reached four million ton. It include: "Cement and Lime" Co.ltd., in Khutul, "Moncement" of Monpoliment Co.ltd., "Munkhin bayan gal" Co.ltd., and "MAK Cement" Co.ltd., with an installed capacity to produce one million ton cement per year respectively.

Expected outcome:
In 2020, cement production will reach 3.6 million ton and GHG emission reduction is 664,000 t CO_2e by technology improvement and 91,000 tCO2e by energy saving. In 2030, cement production will reach 6.2 million ton and GHG emission reduction is 1,147,400 t CO_2e by technology improvement and 157,000 t CO_2e by energy saving.</td></tr>
<tr><td colspan="4">2. Develop chemical industry and supply demands of petroleum by domestic product meeting international standard</td></tr>
<tr><td colspan="2">Mongolia Sustainable Development Vision 2030</td><td colspan="2">Implementation and outcome</td></tr>
<tr><td>2016-2020</td><td>2021-2025</td><td>2026-2030</td><td></td></tr>
<tr><td>Meet up to 20% of the national demand for main fuels from domestic production meeting the Euro-4 standards</td><td>Meet up to 70% of the national demand for main fuels from domestic production meeting the Euro-5 standards</td><td>Meet up to 100% of the national demand for main fuels from domestic production meeting the Euro-5 standards</td><td>Mongolia Sustainable Development Vision 2030 is approved by State Great Khural by 2016 and thus no information is available on its implementation.

Expected outcome:
Decrease fuel consumption, an increase in GDP and labor force.</td></tr>
</table>

3. Develop the processing industry and reach full coverage of processing of raw materials such as leather, cashmere and others			
Mongolia Sustainable Development Vision 2030		Implementation and outcome	
2016-2020	2021-2025	2026-2030	
In 2020, increase the share of processed produce in leather, wool and cashmere up to 60% in the total raw material produced	In 2025, increase the share of processed produce in leather, wool and cashmere up to 70% in the total raw material produced	In 2030, increase the share of processed produce in leather, wool and cashmere up to 80% in the total raw material produced	Mongolia Sustainable Development Vision 2030 is approved by State Great Khural by 2016 and thus no information is available on its implementation. Expected outcome: Transfer clean and advanced technology, decrease energy intensity per unit of GDP, increase domestic revenue. Reduce the unemployment rate.

The future demand projection is based on the estimation of demand that will reach to 3.5-4.4 mln tons by 2020 in line with implementation of infrastructure policy and "Taliin Zam" mega project.

To select emission factor used these calculation (*energy consumption 0.05/ton + de-carbonization 0.4985/ton + 0.335/ton) [Source: technology/energy-saving-cement]* for one ton of cement production. The calculations suggest that this will reduce energy consumption by 50% in the first scenario, by 30% in the second scenario and reduce fuel consumption two times by adopting dry processing technology.

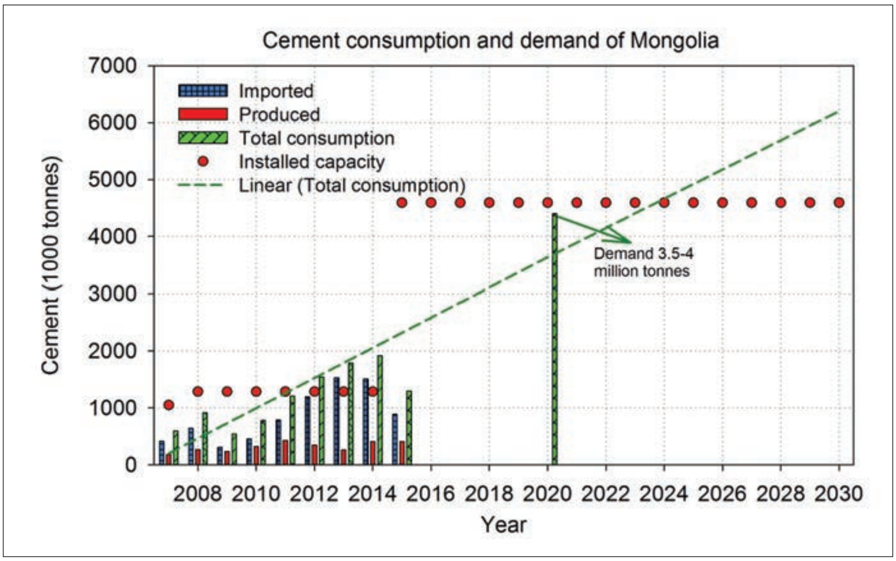

Figure 3-7: Cement consumption and demand

Source: NSO, 2016 and Activity report of factories

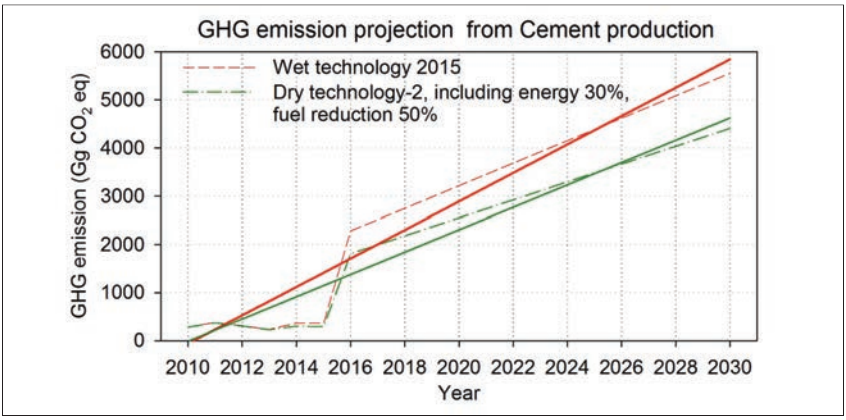

Figure 3-8: CO_2 emission projection from cement production

In early 2016, Mongolia was able to supply its gross domestic product by cement produced by dry technology. "Cement and Lime" Co.ltd, in Khutul adopted dry processing technology in 2014 with the capacity to produce one million ton cement in dry technology and stopped production of the two plants with wet technology. It made possible to fully meet the domestic needs by the end of 2016 by operationalizing four factors in dry processing. This will have an effect on the increase of labor force, decrease the price of cement and energy consumption of cement production by 30% and fuel consumption by two times. By shifting to dry processing technology, GHG emission reduction will be 664,000 t CO_2e in 2020 and 1,147,400 t CO_2e in 2030 respectively.

3.2.3 Livestock

The State Great Khural has approved "Mongolian Livestock" National Program in 2010 and the measures to be implemented through 2010-2021 are identified.

The State Great Khural has approved "State Policy on Food and Agriculture" in 2015. The goal of the policy in livestock sector is to promote intensified livestock production in crop cultivated regions, suburban and settled areas while preserving traditional animal husbandry patterns, improve livestock sector economic growth, productivity and competitiveness, and ensure openness of domestic and foreign trade.

The State policies and measures to mitigate GHG emissions in livestock sector are outlined in Table 3-12 below.

Table 3-12: Policies and measures to mitigate GHG emissions in livestock sector

Adjust the composition and number of livestock through improving the productivity of livestock		
National Action Program on Climate Change 2011		Implementation and expected outcome
2011-2016	2017-2021	
Improve traditional pastoral livestock management and reduce the number of deaths in large animals (cattle, camel etc.)	Establish animal husbandry systems with a balance of traditional pastoral and intensive farming techniques	The livestock loss was 25% or more than 10 mln between 2009 to 2010 compared to the level of 2008.

CHAPTER 3

<table>
<tr><th colspan="4">Mongolian Livestock National Program 2010</th><td rowspan="13">The livestock number increased by 29% and increased milk production by 1.9 times from 2008 to 2015.

Increase the head of pure breed cattle and sheep and decreased number of goat.

Increased number of hybrid cattle, sheep, and goat, the all types of livestock number in selected species increased by the previous year.

Mongolia received Peste des Petites Ruminants (PPR) free status in 2005, and PPR undisturbed status in 2006 from the OIE respectively.

Composition of large animals in herd increased in 2015 compared to 2008 level: camel 0.1%, horse 0.6% cattle 0.5%, sheep 0.9% and goat number was decreased by 2.2%.

Production of milk and meat increased but not yet reached to targeted outcome

Expected outcome:
Adjust the number and type of livestock through improving the productivity of livestock, decrease number of livestock 36,475.6 thous by 2021.

Effectiveness:
Ensures sustainable development of livestock sector, increase livestock productivity and improve herders' livelihoods.

Increase domestic production of raw material processing and volume of exports</td></tr>
<tr><th colspan="2">2010-2015</th><th colspan="2">2015-2021</th></tr>
<tr><td colspan="2">Decrease number of livestock from 43,288.0 thous. to 35,298.9 thous. between 2008 and 2015.
Increase percentage of large livestock number. Make herd ratio; camel 0.2%, horse 1.7%, cattle 3.8%, and sheep 3.0%. Reduce number of goat by 8.7%.
Increase meat and milk production.</td><td colspan="2">Number of livestock 36,475.6 thous. by 2021.
Make herd ratio; camel 0.3%, horse 3.1%, cattle 8%, and sheep 2.70%. Reduce number of goat by 14.1%.</td></tr>
<tr><th colspan="4">State Policy on Food and Agriculture 2015</th></tr>
<tr><th colspan="2">2015-2020</th><th colspan="2">2020-2025</th></tr>
<tr><td colspan="4">Adjust the number, type, and composition of livestock based on assessment of pasture carrying capacity and status</td></tr>
<tr><td colspan="2">Composition of cattle from 6.7 to 8% and processed meat 16.8 thous. tons to 100 thous. tons compared to 2014</td><td colspan="2">Composition of cattle from 6.7 to 10% and processed meat 16.8 thous. ton to 200 thous. ton compared to 2014</td></tr>
<tr><th colspan="4">Millennium Development Goals (MDGs)-based Comprehensive National Development Strategy of Mongolia</th></tr>
<tr><th colspan="2">2007-2015</th><th colspan="2">2016-2021</th></tr>
<tr><td colspan="2">Develop a combination of pastoral and intensive livestock husbandry considering the region's unique features, reduce dramatically infectious diseases, promote livestock health, and increase exports of production and processing of animal husbandry products</td><td colspan="2"></td></tr>
<tr><th colspan="4">Mongolia Sustainable Development Vision 2030</th></tr>
<tr><th>2016-2020</th><th colspan="2">2021-2025</th><th>2026-2030</th></tr>
<tr><td>Ensure appropriate numbers and flock structure in the total livestock, have no less than 10% of Mongolia's territory as disease free, for trade and quarantine, confirmed by the World Organization for Animal Health (OIE), develop veterinary services that are compliant with animal health standards for the export of livestock and livestock products to the neighboring countries, and increase the head of pure breed cattle to 100,000 in intensive livestock farming</td><td colspan="2">Ensure appropriate numbers and flock structure in the total livestock, have no less than 30% of Mongolia's territory as disease free, for trade and quarantine, confirmed by the OIE, develop veterinary services that are compliant with animal health standards for the export of livestock and livestock products to the neighboring countries, and increase the head of pure breed cattle to 150,000 in intensive livestock farming</td><td>Ensure appropriate numbers and flock structure in the total livestock, have no less than 60% of Mongolia's territory as disease free, for trade and quarantine, confirmed by the OIE, develop veterinary services that are compliant with animal health standards for the export of livestock and livestock products to the neighboring countries, and increase the head of pure breed cattle to 200,000 in intensive livestock farming</td></tr>
</table>

For forecasting GHG emission of the livestock sector, the historic data on livestock number from NSO, indicators of "Mongolian Livestock" National Program and "State Policy on Food and Agriculture", the actual number of livestock before the start of "Mongolian Livestock Program" in 2010 and until 2015 were used. Three different estimations of change of livestock number (Figure 3-9 - 11) and methane emission of internal fermentation (Figure 3-12, 13) were estimated using IPCC Guidelines 2006 Tier 1 emission factors[5].

The results of projection suggested that if the "Mongolian Livestock Program" is fully implemented number of livestock will be 36,475.6 thous thus GHG emission from the livestock sector will be decreased by 15% or 1,700 Gg CO_2e in 2020 and 21% or 3,070 Gg CO_2e in 2030 from BAU scenario respectively.

By implementing these policies and programs, a certain increase of production can be expected by 2021 from the 2008 level: meat supply by 1.4 times, meat export by 1.5 times, and cow milk per year 1.8 times (SGKh, 2010). Furthermore, herders' revenue is estimated to increase by 80% in 2020 and carrying capacity of the pasture could be improved.

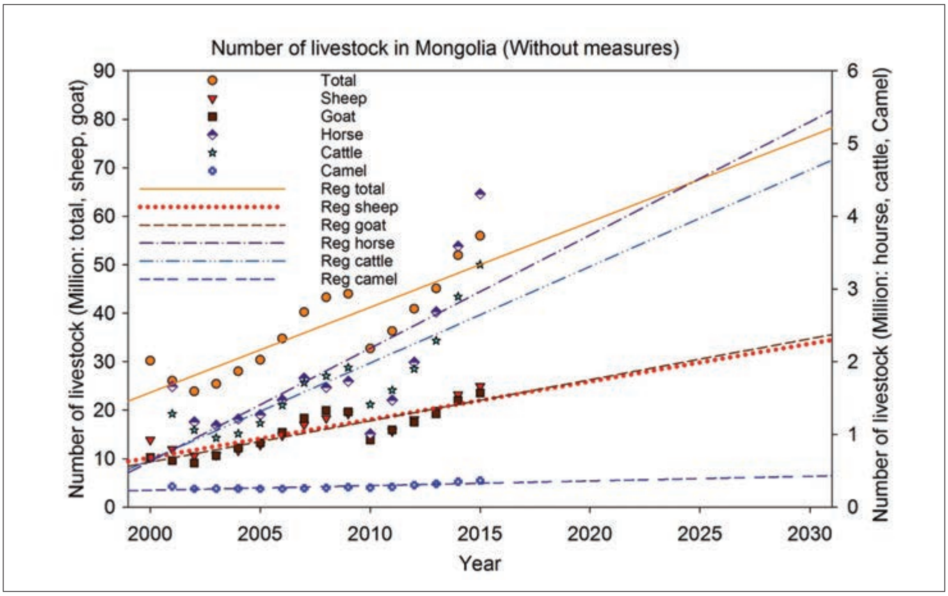

Figure 3-9: Number of livestock in BAU scenario

Source: NSO, 2015

[5] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

CHAPTER 3

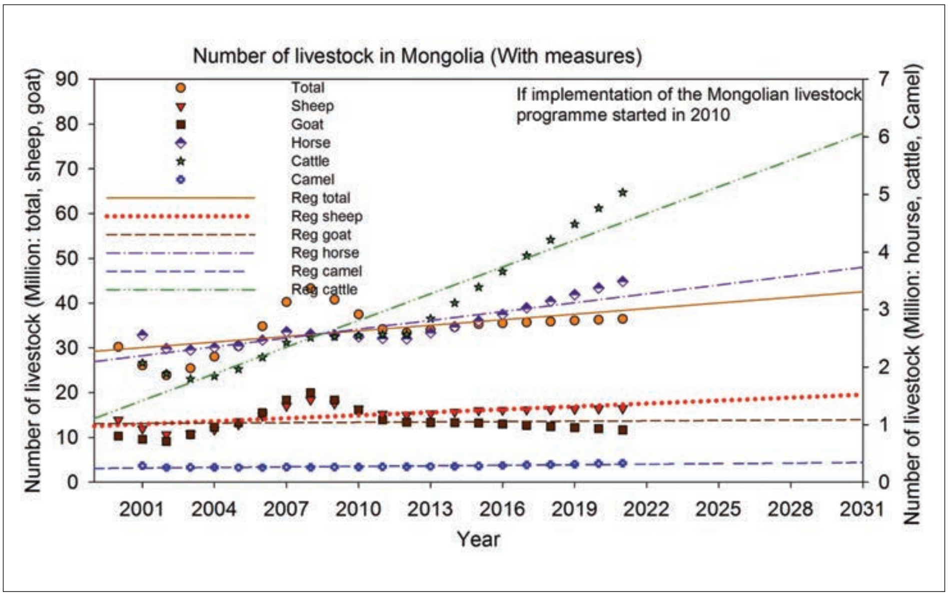

Figure 3-10: Livestock number in scenario of "Mongolian livestock" program 2010 targets assumed to be fully implemented and reached

Source: NSO, 2015

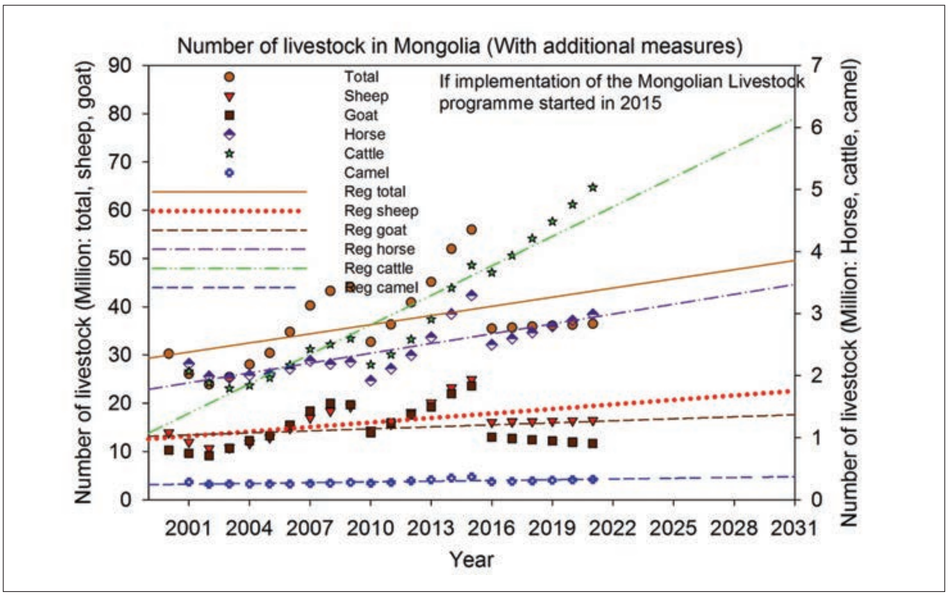

Figure 3-11: Livestock number in scenario of "Mongolian livestock" program targets since 2015 are fully implemented and reached

Source: NSO, 2015

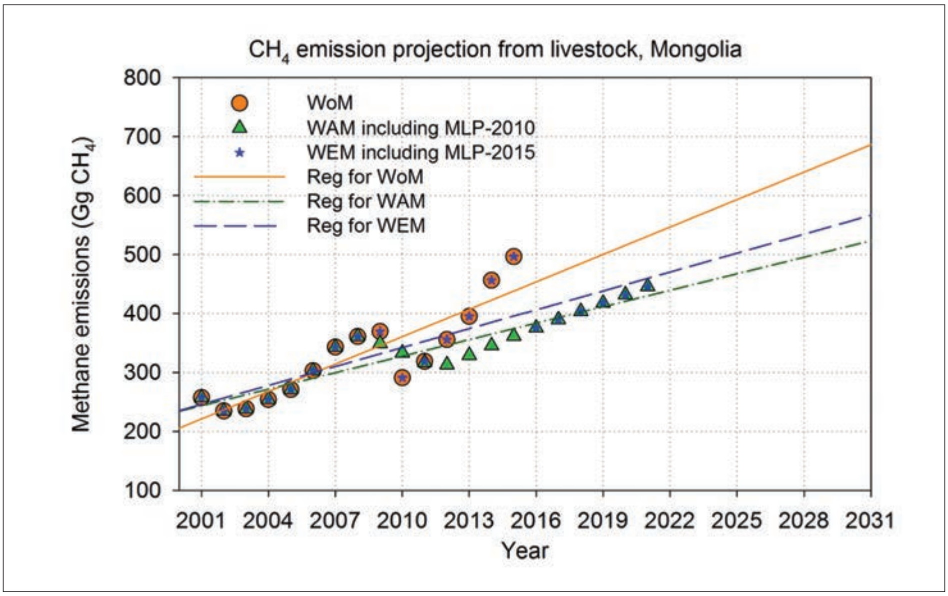

Figure 3-12: CH_4 emission from livestock (in three different estimation scenarios)

Source: IPCC Guidelines 2006 Tier1 emission factors

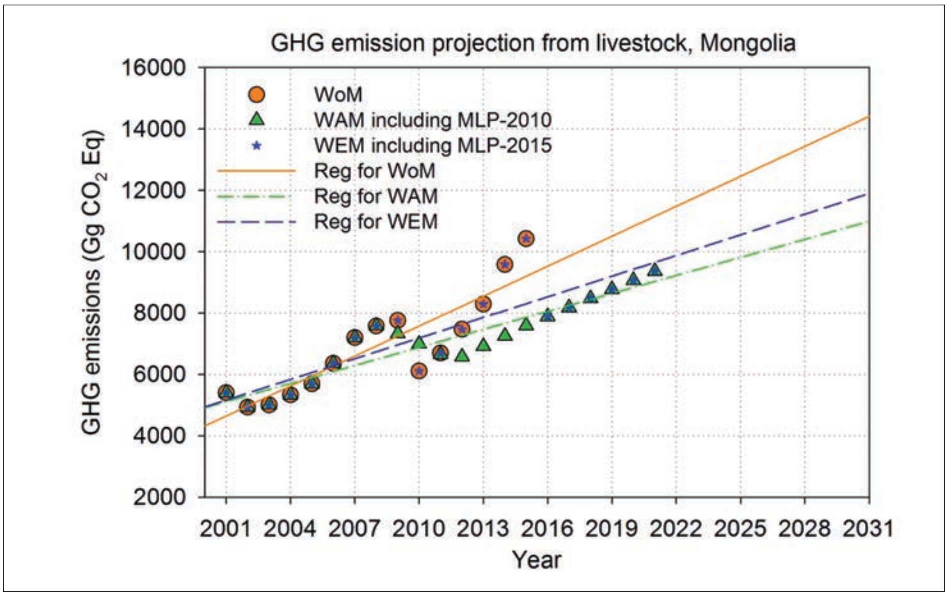

Figure 3-13: GHG emissions from livestock (in three different estimation scenarios)

3.2.4 Agriculture

The State Great Khural has approved "State Policy on Food and Agriculture" in 2003 and the steps to be implemented through 2003-2015 are identified.

The State Great Khural has updated and approved a new "State Policy on Food and Agriculture" in 2015. The goal of the policy is to promote sustainable development of crop production based on advanced technologies for climate change adaptation. State policies and measures to mitigate GHG emissions in agriculture sector are outlined in Table 3-13 below.

Table 3-13: Policies and measures to mitigate GHG emissions in agriculture

<table>
<tr><td colspan="3">Sustainably develop and promote production of cultivation based on the advanced technologies for climate change adaptation</td></tr>
<tr><td colspan="2">State policy on food and agriculture 2003</td><td>Implementation and expected outcome</td></tr>
<tr><td>2003-2008</td><td>2008-2015</td><td rowspan="13">Fully implemented "Third Campaign for Reclamation" National Program for development of crop production, cultivated area increased 2.3 times, volume of yield increased 3.2 times in 2010 from the level of 2007.
Implementation:
Irrigated farming area reached to 54 thous ha, increased 2.1 times in 2010
In 2014, domestic demands of wheat and potato are fully supplied.
Croplands cycle have reached 769 thous ha.
In the implementation framework of the campaign, three type of power range tractors (501), harvest combine (144), grain wagon and cars (620) were purchased with state budget and granted to businesses and citizens with a favorable conditions.

Expected outcome:
The harvest rate is expected to reach 0.865 t ha in 2020 and 1 t ha in 2025.</td></tr>
<tr><td>Break the crises of the agriculture sector, increase irrigated areas 2.5 times compared to 2003.
Create condition to supply domestic demand of 50% flour, no less than 70% of vegetable and 5-7% of fruit and oil through introducing proper technology that support efficient use of snow and rain water in non-irrigated areas.</td><td>Production intensifies, yield 25-30% of wheat and crop production from irrigated area
Fully supply domestic demand of flour, potato and vegetable and supply 40% of cereal, 10-15% of fruits and oil.
Create opportunity to compete for eco-products in the foreign market.</td></tr>
<tr><td colspan="2">National Action Program on Climate Change 2011</td></tr>
<tr><td>2011-2016</td><td>2017-2021</td></tr>
<tr><td>Extend irrigated agriculture through the use of drought resistant crops, and water saving and soil protection technologies</td><td>To extend irrigated agriculture through the use of drought resistant crops, and water saving and soil protection technologies</td></tr>
<tr><td colspan="2">Green Development Policy 2014</td></tr>
<tr><td colspan="2">Share of the agriculture and manufacturing sector in total GDP 28% in 2020 and 30% in 2030</td></tr>
<tr><td colspan="2">"Third Campaign for Reclamation" National program for development of crop production (2008-2010)</td></tr>
<tr><td colspan="2">Expand the area of cropland no less than 600 thous ha:
- 50 thous ha in 2008
- 80 thous ha in 2009
- 100 thous ha in 2010 convert abandoned land into cultivated land</td></tr>
<tr><td colspan="2">State Policy on Food and Agriculture 2015</td></tr>
<tr><td>2015-2020</td><td>2020-2025</td></tr>
<tr><td colspan="2">Increase efficiency and economic value of agriculture land</td></tr>
<tr><td>Increase cropland from 769 thous ha to 960 thous ha by 2014. Increase crop yield 0.845 tons to 0.865 tons per ha.</td><td>Increase cropland from 769 thous ha to 1,050 thous ha. increase crop yield to one ton per ha.</td></tr>
</table>

<table>
<tr><th colspan="3">Millennium Development Goals (MDGs)-based Comprehensive National Development Strategy of Mongolia</th><td rowspan="6">The zero tillage technology used 70% in 2020, 85% 2025, 90% in 2030 and improve soil fertility and quality, decrease erosion. By the result, amount of CO_2 in the crop will be increase and CO_2 emission from soil will be decrease.
By rejecting traditional technology and introducing planned zero and reduced tillage technology, and re-use abandoned area, GHG emission will be reduced by 323 Gg in 2020, 400 Gg in 2025 and 485 Gg in 2030.

Benefit:
Improved food supply and increased opportunities to export crops.</td></tr>
<tr><th>2007-2015</th><th colspan="2">2016-2021</th></tr>
<tr><td>Increase agricultural production by improving land farming, developing irrigated cultivation and introducing biotechnology</td><td colspan="2"></td></tr>
<tr><th colspan="3">Mongolia Sustainable Development Vision 2030</th></tr>
<tr><th>2016-2020</th><th>2021-2025</th><th>2026-2030</th></tr>
<tr><td>Increase the use rate of zero-tillage farming technology to 70% in grain fields, adopt new and efficient irrigation technologies, increase the area of irrigated arable land to 65 thous hectares, increase the supply of fertilizer demand to 50%, raise the supply of high quality local seeds to 75%, increase the fertility of farmlands, and reduce soil degradation and erosion.</td><td>Increase the use rate of zero-tillage farming technology to 80% in grain fields, adopt new and efficient irrigation technologies, increase the area of irrigated arable lands to 100 thous hectares, increase the supply of fertilizer demand to 70%, raise the supply of high quality local seeds to 90%, increase the fertility of farmlands, and reduce soil degradation and erosion.</td><td>Increase the use rate of zero-tillage farming technology to 90% in grain fields, adopt new and efficient irrigation technology, increase the area of irrigated arable land to 120 thous. hectares, increase the fertilizers demand to 100%, raise the supply of high quality local seeds to 100%, increase the fertility of farmlands, and reduce soil degradation and erosion.</td></tr>
</table>

The projection of GHG emissions of agriculture sector is estimated by absorption of abandoned land and GHG emission amount from the soil due to plowing. Biomass change of cultivated area is estimated by COMAP model (Sathaye et al., 1995) using data of NSO and objectives of key policies in Figure 3-14.

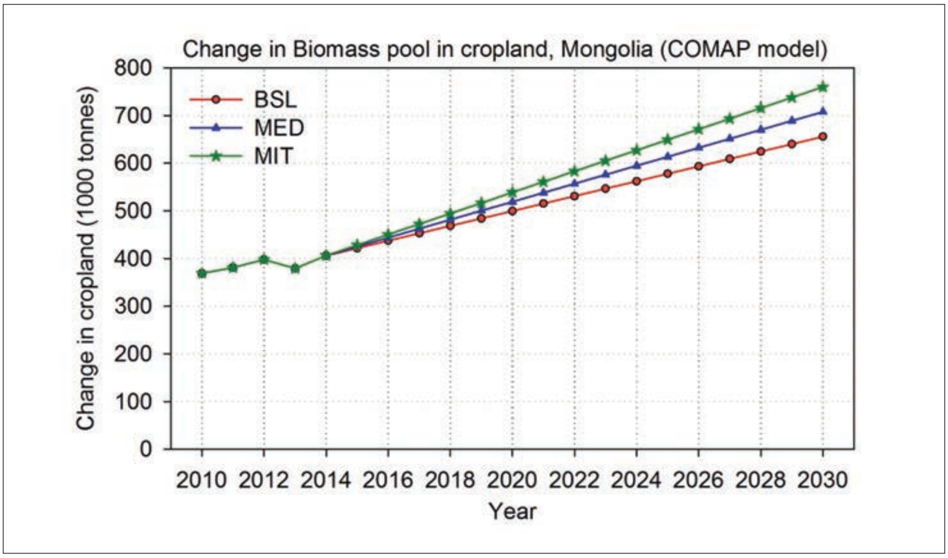

Figure 3-14: Change in Biomass Pool of Cropland (COMAP model)

Source: NSO, 2015

The projection of GHG emission is made in crop lands based on the progress of implementation of "Third Campaign for Reclamation" national program for development of crop production in 2008 and strategic objectives of State policy on food and agriculture.

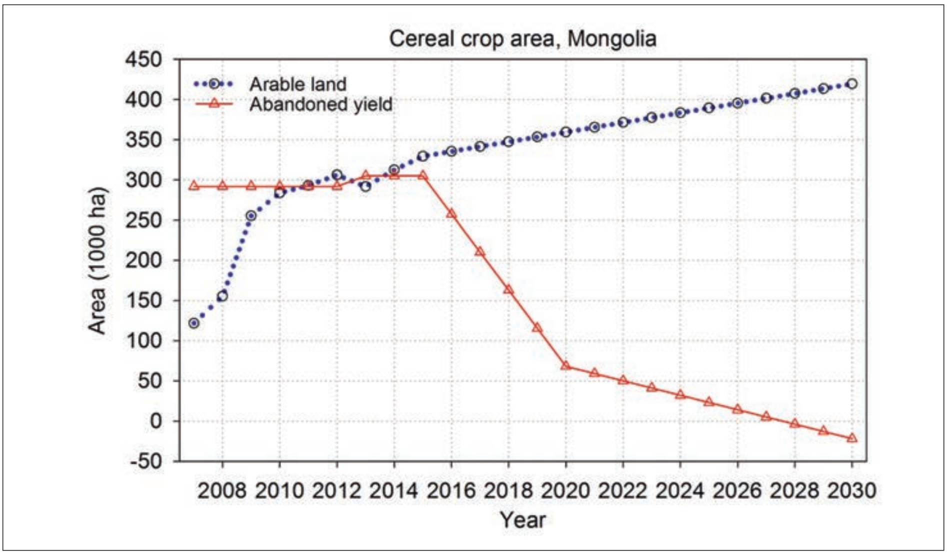

Figure 3-15: Change of arable land area and decrease of abandoned yield

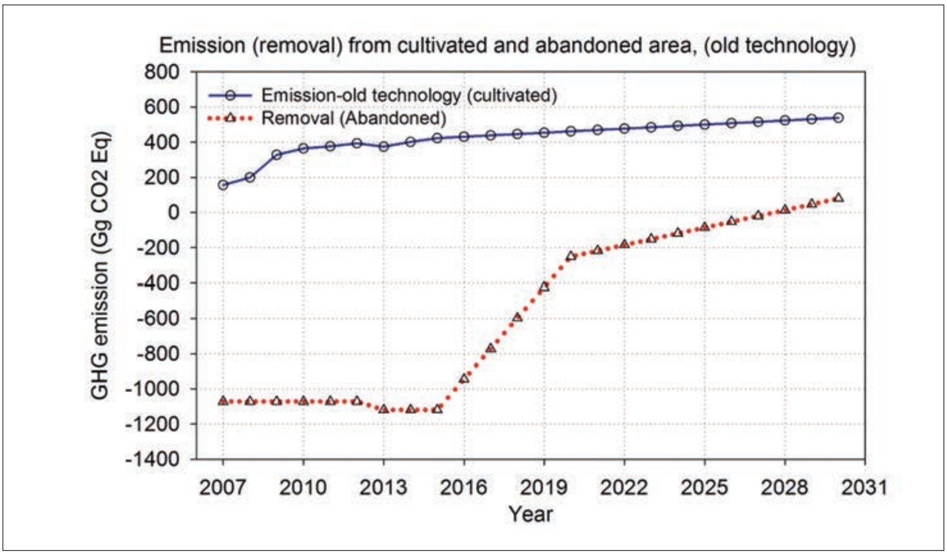

Figure 3-16: GHG emission, cultivated by old technology and removal (abandoned land)

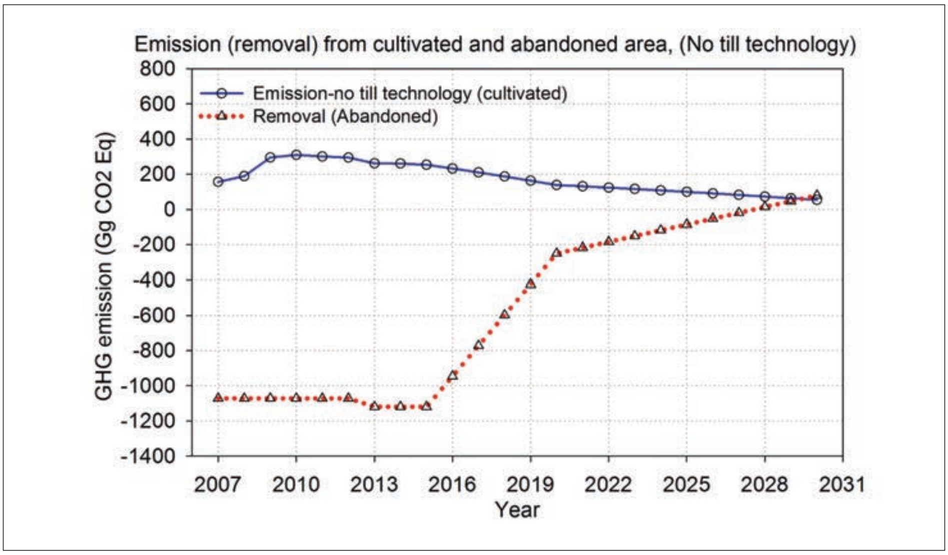

Figure 3-17: GHG emissions and removals, cultivated by new technology (abandoned land)

GHG emissions and removals are projected based on the objectives of Mongolia Sustainable Development Vision 2030 as introduced new technologies.

Potential to reduce GHG emissions is estimated based on the difference between these two projections.

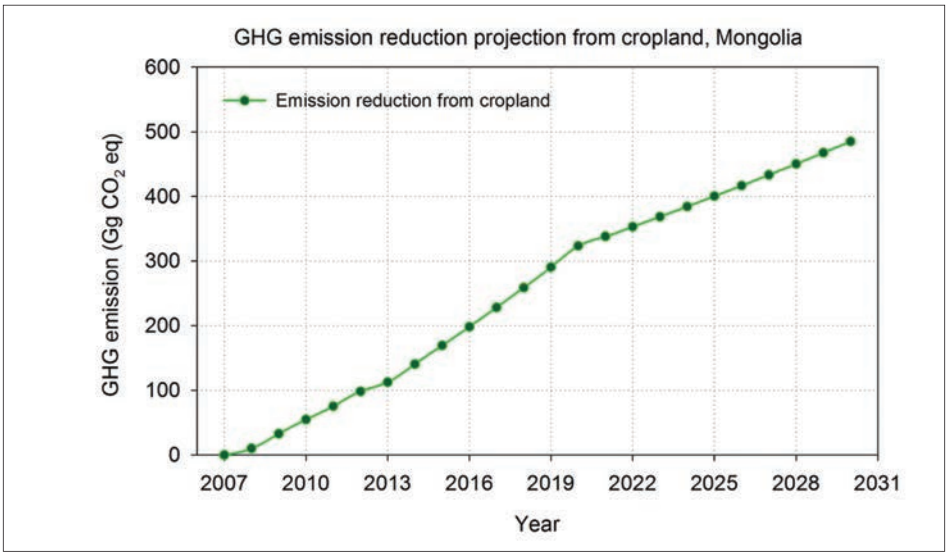

Figure 3-18: CO_2 equivalent emission reduction projection from cropland

By rejecting traditional technology and introducing planned zero and reduced tillage technology, and the re-use of abandoned area, GHG emission will be reduced by 323 Gg in 2020, 400 Gg in 2025 and 485 Gg in 2030.

3.2.5 Forest

The key policy document on forest management is "State Policy on Forest" 2015 and objectives is focused to mitigate deforestation and degradation of the forest, reclamation of the forest, and to promote robust management of the forest. State policies and measures to mitigate GHG emissions in the forest sector are outlined in Table 3-14 below.

Table 3-14: Policies and measures to mitigate GHG emission in Forest

<table>
<tr><th colspan="6">National Action Program on Climate Change 2011</th><th>Implementation and expected outcome</th></tr>
<tr><td colspan="3">2011-2016</td><td colspan="3">2017-2021</td><td rowspan="14">Implementation:
Rearranged in 14.2 mln ha of forest from 2000 to 2010, took actions against forest pest and disease in 675 thous ha, supported forest regrowth in 72.9 thous ha and it reached 230.5thous ha in 2014 Overall sink of GHG is 172.5 thous ha.
Parliament had approved "Forest Law" in 2007. By 2014, 1,179 forest coalition or local community groups have been established and 3,034,744 ha forest land is owned and managed by them under the agreement.
By the Environment Minister order to prohibit the usage of railroad sleepers, 25 thous m^2 or 225 ha forest is saved (EPR 2013-2014).

Expected outcome:
Increase by 310 thous ha forest and sink 232thous tons of CO_2.
Increase by 1,500 thous ha forest and sink 1,123thous tons of CO_2.
Decrease forest fire area from 1,196.8 thous ha to 359.0 ha in 2020 and 837.8 thous ha in 2030.

Decrease epicenters of pests and disease and reclaim the areas from 95.7 thous ha to 38.2 thous ha in 2020 and 95.7 thous ha in 2030.
Logging area is accounted 124.1 thous ha. Reclaim 2.5 thous ha in 2020 and 6.2 thous ha in 2030.
Forest cover area will be increased by 1,524.14 thous ha in 2030 and share of forest area will reach 9% of the territory (GDP, 2014).</td></tr>
<tr><td colspan="3">Forest plantation area will be increased by 30 thous ha compared to 2010</td><td colspan="3">Forest plantation area will be increased by 60 thous ha compared to 2010</td></tr>
<tr><th colspan="6">State Policy on Forest 2015</th></tr>
<tr><td colspan="3">2015-2020</td><td colspan="3">2021-2030</td></tr>
<tr><td colspan="3">Reduced area affected by forest fire by up to 30% in 2020.
Increased naturally grown and cultivated forests areas by 310 thous ha in 2020.
Reduce GHG emissions from deforestation and forest degradation by 2% in 2020.
Reduce epicenters of forest pest and disease by 60% in 2020.</td><td colspan="3">Reduce area affected by forest fire by up to 70% in 2030
Increase naturally grown and cultivated forests areas by 1,500 thous ha in 2030
Reduce GHG emission from deforestation and forest degradation by 5% in 2030.
Fully take control on epicenters of forest pest and disease in 2030.</td></tr>
<tr><th colspan="6">Green Development Policy 2014</th></tr>
<tr><td colspan="3">2015-2020</td><td colspan="3">2020-2030</td></tr>
<tr><td colspan="6">Enhance forest absorption of GHGs by intensifying reforestation efforts and expanding forest areas by 8.5% in 2020 and 9% in 2030</td></tr>
<tr><th colspan="6">Millennium Development Goals (MDGs)-based Comprehensive National Development Strategy of Mongolia</th></tr>
<tr><td colspan="3">2007-2015</td><td colspan="3">2016-2021</td></tr>
<tr><td colspan="6">Create conditions for sustainable use and protection of forest reserves, reforestation and maintenance of ecological balance; Increase total forest area by 18 mln ha</td></tr>
<tr><th colspan="6">Mongolia Sustainable Development Vision 2030</th></tr>
<tr><td colspan="2">2016-2020</td><td colspan="2">2021-2025</td><td colspan="2">2026-2030</td></tr>
<tr><td colspan="2">Raise the forest cover to 8.5% of the country's total territory</td><td colspan="2">Raise the forest cover to 8.7% of the country's total territory</td><td colspan="2">Raise the forest cover to 9.0% of the country's total territory</td></tr>
</table>

To estimate forest biomass change using COMAP model, data from NSO and objectives of key policy and programs were considered.

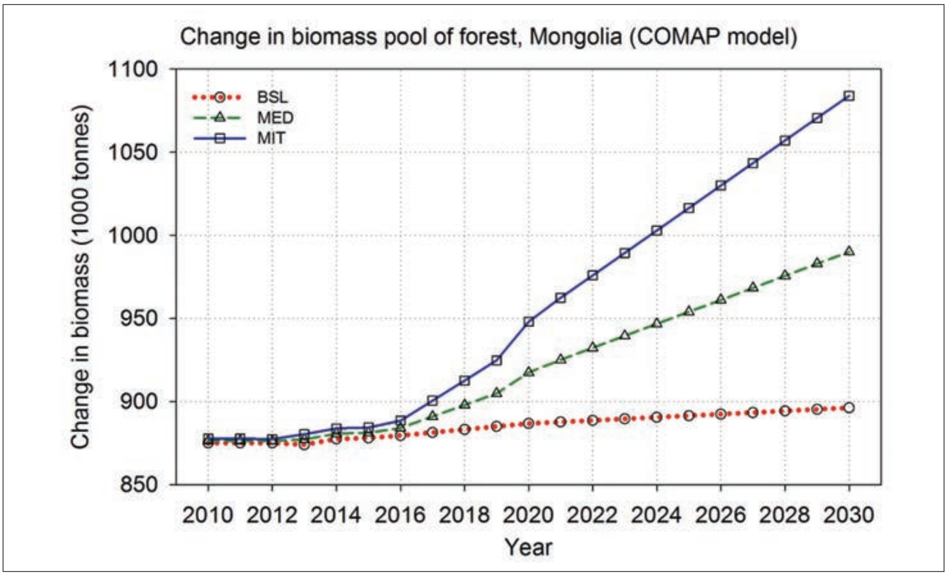

Figure 3-19: Change in biomass of forest, COMAP model

As indicated in the estimation, carbon sink potential will increase by 7% in 2020 and 17% in 2030 in BAU scenario.

3.2.6 Waste

The GHG emission from the waste sector is classified as solid waste and waste water from industry and municipality. Population growth, urbanization and industrialization lead to the increase of waste and change of components of the waste that average volume of waste is increased by 500 thous tons per year in Mongolia. The State Greate Khural stated that thevolume of the waste has tripled in the fouryear period, 820 thous tons in 2009 and 2.4 mln tons in 2013 (SGKh 2014). Based on the data of national GHG inventory, methane emission from solid waste disposal center accounts for more than 45% of waste sector.

State policies and measures to mitigate GHG emissions in the waste sector are outlined in Table 3-15 below.

Table 3-15: Policies and measures to mitigate GHG emission in Waste

Solid waste management improvement program, 2014		Implementation
2014-2017	2018-2022	
Construction of treatment plants; Introduce ISO 14000 standard	Promote and increase recycling of packages by 135.0 thous ton or 7.6 times than a level of 2013	

CHAPTER 3

<table>
<tr><th colspan="3">National Action Program on Climate Change, 2011</th><td rowspan="4">Constructed a solid waste classification, processing and recycling factory to produce solid fuel. To build a waste recycling industrial park in the waste landfill site is under discussion. Since 2010</td></tr>
<tr><th>2011-2016</th><th colspan="2">2017-2021</th></tr>
<tr><td>To build a solid waste classification, processing and recycling industry</td><td colspan="2"></td></tr>
<tr><th colspan="3">Green development Policy 2014</th></tr>
<tr><th>2014-2020</th><th colspan="2">2021-2030</th><td rowspan="4">Since 2010, the total waste generated at the central waste disposal site has been fully landfilled in accordance with technology. Average landfill area is 8-10 ha.</td></tr>
<tr><td>Share of waste recycling by 20%.
Reduce solid waste in landfills by 20%</td><td colspan="2">Share of waste recycling by 40%.
Reduce solid waste in landfills by 40%</td></tr>
<tr><th colspan="3">Mongolia Sustainable Development Vision 2030</th></tr>
<tr><th>2016-2020</th><th>2021-2025</th><th>2026-2030</th></tr>
<tr><td>Increase the area of green facilities in urban areas and settlements to 15% of the total area, increase the amount of recycled waste to 20% of total waste, and have no air pollution (reduce the air pollution in Ulaanbaatar to a tolerable level of health standards) in Ulaanbaatar city, 40% of the population uses improved sanitation and hygiene facilities</td><td>Increase the area of green facilities in urban areas and settlements to 25% of the total area, and increase the amount of recycled waste to 30% of the total waste, 50% of the population uses improved sanitation and hygiene facilities.</td><td>Increase the area of green facilities in urban areas and settlements to 30% of the total area, and increase the amount of recycled waste to 40% of the total waste, 50% of the population uses improved sanitation and hygiene facilities.</td><td>Recycled 338 thous tons of waste which is 23.4% of a total waste from 2010-2015.</td></tr>
</table>

The projection of GHG emission of solid waste (Figure 3-20) is estimated using data of total population and equation of multiple variables regression (regression coefficient 0.97). Future projections of GHG emission until 2030 is estimated using three different scenarios of population growth, main export products and value of GDP reflected to price stated by NSO.

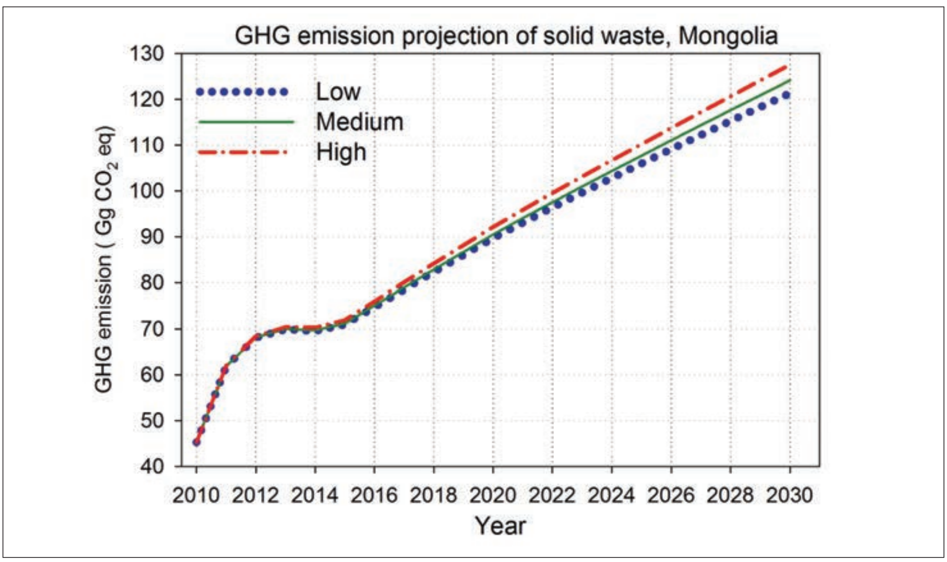

Figure 3-20: Projected GHG emission of solid waste

Figure 3-21 shows the future GHG emission reduction potential of solid waste in BAU scenario taking into account the outcome of actions to recycle and reuse reflected in national policies and programs. Based on the estimation, Mongolia is able to fully recycle and reuse solid waste by 2027.

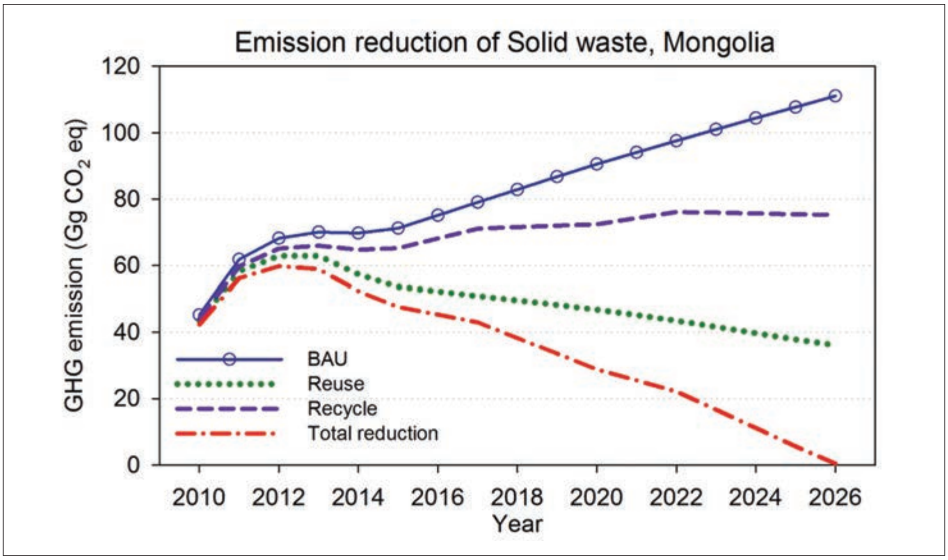

Figure 3-21: GHG emission reduction from solid waste

3.3 Domestic MRV mechanism

A critical requirement for mitigation actions is that actions be implemented in a measurable, reportable and verifiable (MRV) manner. Recognizing the role of mitigation actions to reducing GHG emissions while simultaneously promoting country's sustainable development objectives, Mongolia will advocate for a broader approach to MRV that establishes a robust mechanism in line with its commitment under the UNFCCC .The initial experience with different elements of the MRV for GHG emissions has already been gained through the implementation of Clean Development Mechanism (CDM) projects under the Kyoto Protocol. Moreover, significant effort has also been done under the preparation of the national GHG inventories, a crucial element of the overall MRV system. Mongolia has approved through its Agency of Standard and Metrology (MASM) ISO14064 and ISO 14065 standards as a national standars for MRV between 2012 and 2013. National renewable energy center (NREC) had become the first nationally accredited entity for MRV in 2014.

Further, the MRV methods for project based activities is expected to evolve and be simplified, allowing the necessary information for emission reductions from individual activities to be collected from the already existing information in the GHG inventory and statistical data.

Under the JCM bilateral framework, third party entity (TPE) assesses the information and applies the means of validation and currently CERs is 107 tons of CO_2.

CHAPTER 3

CHAPTER 4

Constraints and Gaps, and Related Financial, Technical and Capacity Needs

4. CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

Mongolia, as many other developing countries, has specific barriers for the implementation of adaptation and mitigation measures such as financial and technical resources, human and institutional capacity, and public support. The biggest problems facing the electricity and heat production sectors in reducing GHG emissions are the use of obsolete techniques and technologies, low coal quality, and insufficient funds. The most widely recognized constraints are considered below:

In the second national communication, Mongolia has reported that in the near future, while coal will remain the basis of energy production, the following technologies need to be introduced and implemented:

- Clean coal technology and clean fuel production
- Establishing a power plant with integrated coal gasification combined cycle
- Setting up a Carbon capture and storage (CCS) plant.

The above measures are subject to very high upfront investment and recurring operating costs. Particularly the costs of technologies and infrastructures have been a major constraint to successful implementation.

The implementation of mitigation measures requires a high level of technical capacity and effective coordination across different sectorial agencies, which are currently a challenge for Mongolia. Most of the technologies applied in Mongolia's energy sector are still old and have low efficiency and high energy losses. The heat content of the feedstock coal is low and variable, which leads to combustion problems and poor plant performance. A lack of appropriate technologies and know-how is the most urgent technical problem.

Other key financial, technical and capacity barriers include a lack of support by financial institutions for renewable energy investments (particularly hydro-power plants); lacks of domestic technological and technical resources for clean fuel production; and CCS plant.

As mentioned before, reporting of National Communications including GHG inventory and BUR is financed by GEF enabling activities through UNEP. In other words, there was no substantial government financing (except in kind contribution) for these reporting requirements because of the economic difficulties in Mongolia, as the country is undergoing a transition period, the Government fails to resolve financing issues.

Further financial, technical and capacity-building needs of Mongolia for preparing and implementing mitigation projects are listed in NAMA is given in Table 4-1.

Table 4-1: Financial, technical and capacity building needs

Activities	Status - ongoing - planned - completed	Support needed (USD)	Support received	Additional support needed
Technical and capacity building needs				
Improved insulation of 300 existing panel apartment buildings in Ulaanbaatar	planned	90,000,000	-	-
	planned	-	-	-
	planned	-	-	-
Financial needs				
Transforming construction in Mongolia using supplementary cementitious materials	planned	15,000,000	-	-
National Energy Efficient Lighting Program in Mongolia	planned	7,000,000	-	-
Installation of 675 MW capacity large hydro power facilities	planned	1,350,000,000	-	-
Installation of 354 MW wind power facilities	planned	584,000,000	-	-
Installation of 145 MW solar PV power facilities	planned	573,000,000	-	-
Technology transfer needs				
Improved efficiency of coal fired power plants.	planned	900,000,000	-	-
	planned	-	-	-
	planned	-	-	-

4.1 Information on the Support Received

Financial support from the Global Environment Facility (GEF) towards the preparation of BUR was received in December 2015, while as per UNFCCC decision 2/CP.17 as reported in document number UNFCCC/CP/2011/9/Add.1 clause 44, it should have been received as early as possible in 2012.

During 2011-2013, MET implemented a project on Strengthening Carbon Financing for Regional Grassland Management in NE Asia/2011-2013 with a support of the Asian Development Bank (ADB). ADB supported regional cooperation among countries of Northeast Asia to combat dust and sandstorms resulting from desertification. ADB has strengthened the capacity of the government of Mongolia in accessing carbon financing to sustainably manage grassland. The project recognizes that healthy ecosystems are more productive, more resilient, and provides valuable ecosystem services, such as carbon sequestration (ADB, 2013).

Mongolia is seeking alternatives to replace fossil fuels such as coal that power its industry and mines. The Government has set a target to get 20% to 25% of its energy from renewables by 2020, whereas the reliance on energy from renewable sources is 2%. Coal contribution is about 80% of the nation's energy production.

The Salkhit wind farm with capacity 50 MW is a flagship project for Mongolia's renewable energy sector and the energy sector as a whole. The project has introduced a new and advanced technology and know-how to the industry. The wind farm will offset 180 thousand tons of CO_2 emissions, save 1.6 million tons of fresh water, and reduce coal usage by 122 thousand tons annually.

Low emission and energy efficient approaches in Mongolia's construction and housing sector were implemented during 2009-2013. The objective of Building energy efficiency project (BEEP) was to reduce the annual growth rate of greenhouse gas (GHG) emissions from building sectors in Mongolia, by improving the energy utilization efficiency in new construction in the residential and commercial buildings.

In 2012, the Government of Mongolia announced that green development would be the new economic development strategy for the country. To facilitate this, the Government established the Ministry of Environment and Green Development (MEGD). The Global Green Growth Institute (GGGI) is assisting Mongolia in developing and implementing a national green growth plan within the transport and energy sectors. The Strategies for Development of Green Energy Systems in Mongolia project was completed in early 2014 by the GGGI in collaboration with the Mongolian government, Stockholm Environment Institute, and the United States (GGGI, 2014).

A new initiative to develop and incentivize ecological, low emission and energy efficient approaches in Mongolia's construction and housing sector is being launched in 2016. The "Nationally Appropriate Mitigation Actions in the construction sector in Mongolia" (NAMA) Project will run until 2020. It aims to limit the need for coal powered heating and reduce the country's winter air pollution.

The objective of the project is to facilitate market transformation for energy efficiency in the construction sector through the development and implementation of NAMA in Mongolia. This objective will be achieved by removing barriers to increased adoption of energy efficient technology in construction sector through three components; i) establishment of baseline energy consumption and GHG emission in the construction sectors ii) development and implementation of NAMA in the construction sector iii) measuring, reporting and verification (MRV) systems for NAMA. This project will be implemented over a 40 months period and is expected to achieve GHG emission reductions through the displacement of electricity heat generation from coal power plants and CHPs. Direct GHG emission reduction over the lifetime of the project is estimated to be 64,219 t CO_2e. The estimated range of potential indirect emission reduction is 57,435 to 438,926 t CO_2e that is cumulative for a 10-year period after the end of the project.

MET has also implemented project on Improving Energy Efficiency in Public Buildings in Khovd and Zavkhan aimags in 2014-2016 which is supported by the German Federal Enterprise for International Cooperation (GIZ). The energy savings in the renovated buildings were estimated to be up to 50%. This study proved that large cross cutting benefits are achievable and result in improved health, energy savings, and reduce air pollution and CO_2 emissions (GIZ, 2016).

The Multipurpose National Forest Inventory (MPNFI) implemented in 2014-2016 is the first exercise of its kind in Mongolia. The inventory was supported by technical assistance from international expertise mobilized through a collaboration project between the MET and the GIZ and was implemented under the responsibility of the Forest Research and Development Center (FRDC), which ensures the long-term sustainability of the MPNFI.

Japan initiated the Joint Crediting Mechanism (JCM) as a tool to complement CDM under the UNFCCC, with the aim of facilitating widespread applications of low carbon technologies, and ultimately reduce emissions of greenhouse gases. Implementation in Mongolia has been focused on high-tech low carbon technologies that can be applied by the private sector in 13 identified sectors. Japan will cover 50% of the project costs and in return will take the carbon reduction credits generated from the subsidized projects until 2020. Three methodologies are approved such as Installation of energy-saving transmission lines in the Mongolian Grid, Replacement and Installation of High Efficiency Heat Only Boiler (HOB) for Hot Water Supply Systems and Installation of Solar PV System.

Table 4-2: Information on financial resources, technology transfer, capacity building and technical support received in USD

Type		GEF	Annex II & other developed country Parties	Multilateral institutions	Green Climate Fund	Other sources
Preparation of BUR						
Preparation of BUR	Financial resources	352,000				N/A
	Capacity-building					N/A
	Technical support					
	Technology transfer					
Activities covered by BUR						
Capacity Building cooperation for NAMAs in a MRV manner	Capacity building		√			
Building Energy Efficiency Project (2009-2013)	Capacity building	975,000				340,000
Improving Energy Efficiency in Public Buildings in Khovd and Zavkhan aimags (2014-2016)	Technology transfer					1,200,000
Nationally Appropriate Mitigation Actions in the construction sector in Mongolia (2016-2020)	Technology transfer		1,269.8			5,630.1

Green Public Transportation (2012-2013)	Technical support	√
Multipurpose National Forest Inventory	Capacity building	

CHAPTER 5

Other

5. OTHER

UN-REDD

Mongolia is participating in the UN-REDD (Reducing Emissions from Deforestation and forest Degradation). A National REDD+ Roadmap Taskforce in Mongolia was established in September 2011 and consists of 20 members representing different government, private sectors and civil society.

The MET coordinates UN-REDD+ activities and thus is responsible for mitigation in the forestry sector. The UN-REDD National Programme for Mongolia was launched in February 2016 with the overall objective: "To support the Government of Mongolia in designing and implementing its National REDD+ Strategy and in meeting the requirements under the UNFCCC Warsaw Framework to receive REDD+ results-based payments".

The UN-REDD Programme, an initiative jointly implemented by the Food and Agriculture Organization of the United Nation, the United Nations Development Programme and the United Nations Environment Programme, is providing support to the Government of Mongolia, to get ready for REDD+. It will work together with the Ministry of Environment and Tourism and other stakeholders over the next three years to assist Mongolia in meeting all the requirements to ultimately be eligible for results-based payments. Mongolia REDD+ national programme has four main outcomes.

Under Outcome One of the Roadmap, the National Programme will support the establishment of Mongolia's REDD+Readiness management structure to oversee the delivery of the key results described in the Roadmap and to prepare its National REDD+Strategy.

Under Outcome Two of the Roadmap, the National Programme will support the preparation of Mongolia's National REDD+ Strategy through which key drivers of deforestation and forest degradation in Mongolia will be analyzed through detailed studies, and specific policies and measures to address those key identified drivers.

Under Outcome Three of the Roadmap, the National Programme will support the establishment of national forest Reference Emission Level and/or forest Reference Level (REL/RL), with sub-national forest RELs/RLs as potential interim measures.

Under Outcome Four of the Roadmap, the National Programme will support the development of a national forest monitoring system, comprising a monitoring function and a Measurement, Reporting and Verification (MRV) function

Reduction of air pollution

In addition to long-term benefits of greenhouse gas (GHG) reductions in the form of avoided health and ecosystem damage, there are important near-term benefits resulting reduction of air pollution.

The Government of Mongolia has been taking a series of measures to reduce air pollution in the urban area, especially in Ulaanbaatar, such as low-smoke stoves, promoting electric cars setting "0" customs tax, and collecting air pollution fees from motor vehicles. For implementation of air pollution reduction measures, the government is cooperating with international organization such as Millennium Challenge Account – Mongolia.

The Energy and Environment Project or as known Clean Air Project in Mongolian is implemented by the Millennium Challenge Account – Mongolia (MCA-Mongolia) and funded by the U.S. Government's Millennium Challenge Corporation (MCC). The energy efficient stoves subsidized by the project use 20% to 30% less fuel, and emit 70% to 90% less pollution than traditional stoves. During the course of the project, nearly 100,000 improved stoves, 20,000 Ger insulation kits, 4500 vestibules, and 100 energy efficient homes were subsidized.

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National Policy Documents:

Law on Air

Law on Energy

Law on Environmental Protection

Law on Renewable Energy

Law on Waste

Energy Law

Forest Law

Water Law

Green Development Policy

National Agriculture Development Policy

State Policy on Energy

State Policy on Forest

State Policy on Industry

Sustainable Development Vision 2030, Mongolia

National Action Plan on Biodiversity

National Action Plan to Combat Desertification

National Action Programme on Climate Change

Mongolian Action Plan on Environmental

National Action Programme to Protect Air Quality

National Action Programme to Protect the Ozone Layer

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CHAPTER 5

ANNEX

The quantitative data used for estimations expressed by the figures in the section of Mitigation Actions and Their Effects.

Note: In some tables, the numbers may vary due to rounding.

Projected GHG emissions and removal by sources/sinks, BAU by sectors

Year	Energy	Industry	Livestock	Cropland	Abandoned Land	Forest	Waste
2010	100	100	100	100	100	100	100
2015	127	246	171	116	94	97	130
2020	170	318	194	127	175	93	150
2025	218	408	217	137	191	88	170
2030	275	499	240	148	206	83	190

Index Year 2010=100

Projected total GHG emissions by gases, BAU

Year	Gg CO_2e				Index: 2010=100		
	CO_2	CH_4	N_2O		CO_2	CH_4	N_2O
2010	12,469.9	326.9	0.3	2010	100.0	100.0	100.0
2011	13,534.4	358.6	0.3	2011	108.5	109.7	107.2
2012	14,632.6	393.2	0.4	2012	117.3	120.3	117.8
2013	15,440.5	432.9	0.4	2013	123.8	132.4	123.9
2014	15,065.1	489.6	0.4	2014	120.8	149.8	120.3
2015	16,144.5	529.2	0.4	2015	129.5	161.9	128.0
2016	19,419.9	548.3	0.4	2016	155.7	167.8	136.3
2017	20,820.6	563.8	0.4	2017	167.0	172.5	143.6
2018	22,262.3	579.4	0.5	2018	178.5	177.3	151.2
2019	23,749.8	594.9	0.5	2019	190.5	182.0	159.0
2020	25,269.1	610.5	0.5	2020	202.6	186.8	167.2
2021	26,660.5	626.1	0.5	2021	213.8	191.6	175.6
2022	28,099.3	641.7	0.6	2022	225.3	196.3	184.3
2023	29,585.4	657.4	0.6	2023	237.3	201.1	193.3
2024	31,118.4	673.0	0.6	2024	249.5	205.9	202.7
2025	32,697.7	688.7	0.6	2025	262.2	210.7	212.3
2026	34,322.6	704.4	0.7	2026	275.2	215.5	222.2
2027	35,992.1	720.1	0.7	2027	288.6	220.3	232.4
2028	37,702.0	735.9	0.7	2028	302.3	225.1	242.9
2029	39,449.1	751.7	0.8	2029	316.4	230.0	253.6
2030	41,236.8	767.5	0.8	2030	330.7	234.8	264.7

Unit: Gg CO_2e

GHG emissions in energy sector

Year	Transformation/Electricity Generation	Transformation/ Fugitive	Demand/ Industry	Demand/ Transport	Demand/ Commercial	Demand/ Household	Demand/ Agriculture	Total Energy Sector
2010	7,523.8	461.2	1,573.6	1,320.0	1,139.5	1,540.3	146.5	13,704.9
2011	7,988.8	541.4	1,936.0	1,587.2	1,048.8	1,478.6	196.0	14,776.8
2012	8,684.9	483.1	2,166.6	1,884.1	1,135.6	1,354.7	198.4	15,907.4
2013	9,427.3	473.7	2,123.2	1,870.8	1,076.7	1,674.9	220.1	16,866.7
2014	9,846.1	412.4	1,760.4	1,900.2	945.3	1,226.1	200.4	16,290.9
2015	10,095.9	398.0	2,561.9	1,962.0	851.6	1,315.1	210.0	17,394.5
2016	10,767.6	476.0	2,677.2	1,907.3	1,129.2	1,559.4	208.9	18,725.6
2017	11,396.0	502.4	2,858.4	1,982.9	1,188.8	1,639.7	219.8	19,788.0
2018	12,060.3	529.1	3,046.0	2,054.7	1,250.1	1,720.7	230.8	20,891.7
2019	12,760.9	556.1	3,239.6	2,127.4	1,313.2	1,802.2	241.9	22,041.3
2020	13,498.2	583.5	3,439.1	2,200.8	1,377.9	1,884.3	253.1	23,236.9
2021	14,272.5	611.1	3,644.2	2,275.1	1,444.4	1,967.0	264.6	24,478.9
2022	15,084.0	639.1	3,854.7	2,350.2	1,512.6	2,050.1	276.1	25,766.8
2023	15,932.8	667.3	4,070.3	2,426.1	1,582.7	2,133.8	287.8	27,100.8
2024	16,818.9	695.9	4,290.4	2,502.8	1,654.5	2,218.0	299.6	28,480.1
2025	17,741.8	724.7	4,514.8	2,580.4	1,728.4	2,302.7	311.6	29,904.4
2026	18,701.3	753.9	4,743.0	2,658.7	1,804.2	2,388.0	323.7	31,372.8
2027	19,696.8	783.3	4,974.3	2,737.9	1,882.3	2,474.0	335.9	32,884.5
2028	20,727.6	813.1	5,208.2	2,817.9	1,962.8	2,560.6	348.3	34,438.5
2029	21,793.1	843.1	5,444.0	2,898.7	2,045.8	2,648.0	360.8	36,033.5
2030	22,892.8	873.5	5,680.7	2,980.3	2,131.4	2,736.3	373.4	37,668.4

Unit: Gg CO_2e

Share of GHG emission by energy sectors

Sectors	2010	2020	2030
Electricity production	54.8992	58.0893	60.7746
Industry	11.4818	14.8001	15.0807
Transport	9.6316	9.4713	7.9120
Commercial	8.3148	5.9298	5.6583
Household	11.2390	8.1091	7.2641
Agriculture	1.0686	1.0894	0.9913
Fugitive emission	3.3650	2.5110	2.3190

Unit: Percent

GHG emission reduction by renewables							
Year	Baseline	Planned	Policy	Year	Baseline	Planned	Policy
2010	7,523.8	7,523.8	7,523.8	2010	7,523.8	7,523.8	7,523.8
2015	10,095.9	9,652.3	9,086.3	2011	7,988.8		
2020	13,498.2	10,760.9	10,798.6	2012	8,684.9		
2025	17,741.8	13,002.3	13,306.4	2013	9,427.3		
2030	22,892.8	15,666.3	16,025.0	2014	9,846.1		
			Unit: Gg CO_2e	2015	10,095.9	9,652.3	9,086.3
				2016	10,767.6		
				2017	11,396.0		
				2018	12,060.3		
				2019	12,760.9		
				2020	13,498.2	10,760.9	10,798.6
				2021	14,272.5		
				2022	15,084.0		
				2023	15,932.8		
				2024	16,818.9		
				2025	17,741.8	13,002.3	13,306.4
				2026	18,701.3		
				2027	19,696.8		
				2028	20,727.6		
				2029	21,793.1		
				2030	22,892.8	15,666.3	16,025.0
							Unit: Gg CO_2e

GHG emission reduction by renewables

Year	Total energy sector emission	Energy efficien-cy	Renew-able	Total emission reduc-tion	Year	Total energy sector emission	Energy efficien-cy	Renew-able	Total emission reduc-tion
2010	13,704.8	13,704.8	13,704.8	13,704.8	2010	13.7048	13.7048	13.7048	13.7048
2015	17,394.5	17,194.5	16,994.5	16,794.5	2011	14.7766	14.7766	14.7766	14.7766
2020	23,237.0	21,136.0	20,537.0	18,436.0	2012	15.9074	15.9074	15.9074	15.9074
2025	29,904.4	26,586.9	25,204.4	21,886.9	2013	16.8668	16.8668	16.8668	16.8668
2030	37,668.4	33,980.4	30,468.4	26,780.4	2014	16.2909	16.2909	16.2909	16.2909
				Unit: Gg CO_2e	2015	17.3945	16.9945	17.1945	16.7945
					2016	18.7256	17.6524	17.8136	16.7403
					2017	19.7880	18.3103	18.4327	16.9550
					2018	20.8916	18.9682	19.0518	17.1284
					2019	22.0412	19.6262	19.6709	17.2558
					2020	23.2370	20.5370	20.2900	17.5900
					2021	24.4789	21.4705	21.5494	18.5410
					2022	25.7669	22.4040	22.8088	19.4458
					2023	27.1008	23.3374	24.0681	20.3048
					2024	28.4801	24.2709	25.3275	21.1183
					2025	29.9044	25.2044	26.5869	21.8869
					2026	31.3729	26.2572	28.0656	22.9500
					2027	32.8846	27.3100	29.5443	23.9697
					2028	34.4385	28.3628	31.0230	24.9473
					2029	36.0335	29.4156	32.5017	25.8838
					2030	37.6684	30.4684	33.9804	26.7804
									Unit: Gg CO_2e

CHAPTER 5

Cement consumption and demand				
Year	Imported	Produced	Total consumption	Installed capacity
2007	415.3	179.9	595.2	1,050
2008	643.7	269.3	913.0	1,285
2009	307.7	234.9	542.6	1,285
2010	455.9	322.5	778.4	1,285
2011	785.9	425.7	1,211.6	1,285
2012	1,192.3	349.2	1,541.5	1,285
2013	1,525.4	259.0	1,784.4	1,285
2014	1,506.0	411.3	1,917.3	1,285
2015	884.3	410.1	1,294.4	4,595
2016				4,595
2017				4,595
2018				4,595
2019				4,595
2020			4,400.0	4,595
2021				4,595
2022				4,595
2023				4,595
2024				4,595
2025				4,595
2026				4,595
2027				4,595
2028				4,595
2029				4,595
2030				4,595
				Unit: 1,000 tons

CHAPTER 5

GHG emission projection from cement production		
Year	Wet technology	Dry technology
2010	284.9288	279.9648
2011	376.1060	370.0105
2012	308.5182	301.6562
2013	228.8618	222.1203
2014	363.3836	301.3883
2015	362.3234	287.8451
2016	2,282.1123	1,810.7082
2017	2,515.9571	1,996.2489
2018	2,749.8019	2,181.7896
2019	2,983.6466	2,367.3303
2020	3,217.4914	2,552.8710
2021	3,451.3362	2,738.4116
2022	3,685.1810	2,923.9523
2023	3,919.0258	3,109.4930
2024	4,152.8705	3,295.0337
2025	4,386.7153	3,480.5744
2026	4,620.5601	3,666.1150
2027	4,854.4049	3,851.6557
2028	5,088.2497	4,037.1964
2029	5,322.0944	4,222.7371
2030	5,555.9392	4,408.2778
		Unit: Gg CO_2e

Number of livestock in Mongolia						
Year	Total	Horse	Cattle	Camel	Sheep	Goat
2000	30.2275				13.8764	10.2698
2001	26.0753	2.1918	2.0696	0.2852	11.9373	9.5913
2002	23.8976	1.9889	1.8843	0.2530	10.6366	9.1348
2003	25.4277	1.9689	1.7928	0.2567	10.7564	10.6529
2004	28.0279	2.0053	1.8416	0.2566	11.6864	12.2380
2005	30.3988	2.0291	1.9636	0.2542	12.8845	13.2674
2006	34.8029	2.1148	2.1679	0.2535	14.8151	15.4517
2007	40.2638	2.2395	2.4258	0.2606	16.9901	18.3478
2008	43.2885	2.1869	2.5034	0.2664	18.3623	19.9694
2009	44.0239	2.2213	2.5993	0.2771	19.2747	19.6515
2010	32.7295	1.9203	2.1760	0.2696	14.4804	13.8832
2011	36.3358	2.1129	2.3397	0.2801	15.6685	15.9346
2012	40.9209	2.3304	2.5846	0.3058	18.1414	17.5587
2013	45.1443	2.6194	2.9095	0.3215	20.0664	19.2276
2014	51.9826	2.9958	3.4139	0.3493	23.2148	22.0089
2015	55.9798	3.2953	3.7804	0.3680	24.9431	23.5929
						Unit: Million livestock

Number of livestock in Mongolia (WAM) / "Mongolian livestock" program 2010 targets assumed to be fully implemented and reached

Year	Total	Horse	Cattle	Camel	Sheep	Goat
2000	30.2275				13.8764	10.2698
2001	26.0753	2.1918	2.0696	0.2852	11.9373	9.5913
2002	23.8976	1.9889	1.8843	0.2530	10.6366	9.1348
2003	25.4277	1.9689	1.7928	0.2567	10.7564	10.6529
2004	28.0279	2.0053	1.8416	0.2566	11.6864	12.2380
2005	30.3988	2.0291	1.9636	0.2542	12.8845	13.2674
2006	34.8029	2.1148	2.1679	0.2535	14.8151	15.4517
2007	40.2638	2.2395	2.4258	0.2606	16.9901	18.3478
2008	43.2880	2.2077	2.5107	0.2597	18.3541	19.9558
2009	40.8019	2.1893	2.5249	0.2615	17.5084	18.3178
2010	37.4870	2.1647	2.5438	0.2638	16.3807	16.1339
2011	34.1721	2.1401	2.5627	0.2662	15.2531	13.9500
2012	33.3434	2.1340	2.5674	0.2667	14.9712	13.4041
2013	33.9952	2.2228	2.8412	0.2720	15.3227	13.3366
2014	34.6471	2.3115	3.1149	0.2772	15.6742	13.2692
2015	35.2989	2.4003	3.3887	0.2824	16.0257	13.2018
2016	35.4950	2.4988	3.6629	0.2900	16.0965	12.9469
2017	35.6911	2.5972	3.9370	0.2977	16.1673	12.6919
2018	35.8873	2.6957	4.2112	0.3053	16.2381	12.4370
2019	36.0834	2.7941	4.4853	0.3130	16.3089	12.1821
2020	36.2795	2.8926	4.7595	0.3206	16.3797	11.9271
2021	36.4756	2.9910	5.0336	0.3283	16.4505	11.6722
						Unit: Million livestock

Number of livestock in Mongolia (WEM) / "Mongolian livestock" program 2010 targets assumed to be fully implemented and reached						
Years	Total	Horse	Cattle	Camel	Sheep	Goat
2000	30.2275				13.8764	10.2698
2001	26.0753	2.1918	2.0696	0.2852	11.9373	9.5913
2002	23.8976	1.9889	1.8843	0.2530	10.6366	9.1348
2003	25.4277	1.9689	1.7928	0.2567	10.7564	10.6529
2004	28.0279	2.0053	1.8416	0.2566	11.6864	12.2380
2005	30.3988	2.0291	1.9636	0.2542	12.8845	13.2674
2006	34.8029	2.1148	2.1679	0.2535	14.8151	15.4517
2007	40.2638	2.2395	2.4258	0.2606	16.9901	18.3478
2008	43.2885	2.1869	2.5034	0.2664	18.3623	19.9694
2009	44.0239	2.2213	2.5993	0.2771	19.2747	19.6515
2010	32.7295	1.9203	2.1760	0.2696	14.4804	13.8832
2011	36.3358	2.1129	2.3397	0.2801	15.6685	15.9346
2012	40.9209	2.3304	2.5846	0.3058	18.1414	17.5587
2013	45.1443	2.6194	2.9095	0.3215	20.0664	19.2276
2014	51.9826	2.9958	3.4139	0.3493	23.2148	22.0089
2015	55.9798	3.2953	3.7804	0.3680	24.9431	23.5929
2016	35.4950	2.4988	3.6629	0.2900	16.0965	12.9469
2017	35.6911	2.5972	3.9370	0.2977	16.1673	12.6919
2018	35.8873	2.6957	4.2112	0.3053	16.2381	12.4370
2019	36.0834	2.7941	4.4853	0.3130	16.3089	12.1821
2020	36.2795	2.8926	4.7595	0.3206	16.3797	11.9271
2021	36.4756	2.9910	5.0336	0.3283	16.4505	11.6722
						Unit: Million livestock

CH_4 emission projection from livestock, Mongolia			
Year	Total/BAU	Including Mongolian livestock program	Mongolian livestock program 2015
2001	257.4858	257.4858	257.4858
2002	234.8573	234.8573	234.8573
2003	238.5565	238.5565	238.5565
2004	254.0762	254.0762	254.0762
2005	271.2657	271.2657	271.2657
2006	302.9527	302.9527	302.9527
2007	343.0007	343.0007	343.0007
2008	360.9369	361.2384	360.9369
2009	369.5281	349.2357	369.5281
2010	291.0570	333.2323	291.0570
2011	318.8982	317.2288	318.8982
2012	355.9907	313.2279	355.9907
2013	395.1547	329.3526	395.1547
2014	456.5640	345.4773	456.5640
2015	496.6022	361.6019	496.6022
2016		375.6905	375.6905
2017		389.7790	389.7790
2018		403.8675	403.8675
2019		417.9560	417.9560
2020		432.0445	432.0445
2021		446.1331	446.1331
			Unit : Gg CH_4

CHAPTER 5

GHG emission projection from livestock, Mongolia Gg CO_2e			
Year	WOM	WAM	WEM
2001	5,407.202	5,407.202	5,407.202
2002	4,932.003	4,932.003	4,932.003
2003	5,009.687	5,009.687	5,009.687
2004	5,335.600	5,335.600	5,335.600
2005	5,696.580	5,696.580	5,696.580
2006	6,362.007	6,362.007	6,362.007
2007	7,203.015	7,203.015	7,203.015
2008	7,579.675	7,586.006	7,579.675
2009	7,760.090	7,333.951	7,760.090
2010	6,112.197	6,997.877	6,112.197
2011	6,696.862	6,661.804	6,696.862
2012	7,475.805	6,577.786	7,475.805
2013	8,298.249	6,916.404	8,298.249
2014	9,587.844	7,255.022	9,587.844
2015	10,428.650	7,593.641	10,428.650
2016		7,889.500	7,889.500
2017		8,185.358	8,185.358
2018		8,481.217	8,481.217
2019		8,777.076	8,777.076
2020		9,072.935	9,072.935
2021		9,368.794	9,368.794
			Unit : Gg CO_2e

CHAPTER 5

Change in Biomass pool in cropland, Mongolia (COMAP model)			
Year	BAU	MIT	MED
2010	369.33	369.33	369.33
2011	381.16	381.16	381.16
2012	398.19	398.19	398.19
2013	379.47	379.47	379.47
2014	406.38	406.38	406.38
2015	421.98	428.48	425.23
2016	437.58	450.58	444.08
2017	453.18	472.68	462.93
2018	468.78	494.78	481.78
2019	484.38	516.88	500.63
2020	499.98	538.98	519.48
2021	515.58	561.08	538.33
2022	531.18	583.18	557.18
2023	546.78	605.28	576.03
2024	562.38	627.38	594.88
2025	577.98	649.48	613.73
2026	593.58	671.58	632.58
2027	609.18	693.68	651.43
2028	624.78	715.78	670.28
2029	640.38	737.88	689.13
2030	655.98	759.98	707.98
			Unit: 1,000 tons

Cereal crops area		
Year	Arable land	Abandoned yield
2007	121.8	292.0
2008	155.4	292.0
2009	255.5	292.0
2010	284.1	292.0
2011	293.2	292.0
2012	306.3	292.0
2013	291.9	305.0
2014	312.6	305.0
2015	329.6	305.0
2016	335.6	257.6
2017	341.6	210.9
2018	347.6	162.9
2019	353.6	115.6
2020	359.6	68.2
2021	365.6	59.2
2022	371.6	50.2
2023	377.6	41.2
2024	383.6	32.2
2025	389.6	23.2
2026	395.6	14.2
2027	401.6	5.2
2028	407.6	-3.8
2029	413.6	-12.8
2030	419.6	-21.8
		Unit: 1,000 ha

Emission (removal) from cultivated and abandoned area, Mongolia (by old technology)		
Year	Emission-old technology (cultivated)	Removal (Abandoned)
2007	156.4521	-1,071.6400
2008	199.6113	-1,071.6400
2009	328.1898	-1,071.6400
2010	364.9265	-1,071.6400
2011	376.6154	-1,071.6400
2012	393.4424	-1,071.6400
2013	374.9456	-1,119.3500
2014	401.5347	-1,119.3500
2015	423.3712	-1,119.3500
2016	431.0782	-945.5390
2017	438.7852	-771.7280
2018	446.4922	-597.9160
2019	454.1992	-424.1050
2020	461.9062	-250.2940
2021	469.6132	-217.2640
2022	477.3202	-184.2340
2023	485.0272	-151.2040
2024	492.7342	-118.1740
2025	500.4412	-85.1440
2026	508.1482	-52.1140
2027	515.8552	-19.0840
2028	523.5622	13.9460
2029	531.2692	46.9760
2030	538.9762	80.0060
		Unit: Gg CO_2e

CHAPTER 5

Emission (removal) from cultivated and abandoned area, Mongolia (by no till technology)		
Year	Emission-old technology (cultivated)	Removal (Abandoned)
2007	156.4521	-1,071.6400
2008	189.6307	-1,071.6400
2009	295.3708	-1,071.6400
2010	310.1875	-1,071.6400
2011	301.2923	-1,071.6400
2012	295.0818	-1,071.6400
2013	262.4619	-1,119.3500
2014	260.9976	-1,119.3500
2015	254.0227	-1,119.3500
2016	232.7822	-945.5390
2017	210.6169	-771.7280
2018	187.5267	-597.9160
2019	163.5117	-424.1050
2020	138.5719	-250.2940
2021	131.4917	-217.2640
2022	124.1033	-184.2340
2023	116.4065	-151.2040
2024	108.4015	-118.1740
2025	100.0882	-85.1440
2026	91.4667	-52.1140
2027	82.5368	-19.0840
2028	73.2987	13.9460
2029	63.7523	46.9760
2030	53.8976	80.0060
		Unit: Gg CO_2e

GHG emission reduction projection from cropland	
Year	Emission reduction
2007	0.0000
2008	9.9806
2009	32.8190
2010	54.7390
2011	75.3231
2012	98.3606
2013	112.4837
2014	140.5371
2015	169.3485
2016	198.2960
2017	228.1683
2018	258.9655
2019	290.6875
2020	323.3343
2021	338.1215
2022	353.2169
2023	368.6207
2024	384.3327
2025	400.3530
2026	416.6815
2027	433.3184
2028	450.2635
2029	467.5169
2030	485.0786
	Unit: Gg CO_2e

Change in biomass pool of forest (COMAP model)			
Year	BSL	MIT	MED
2000	874.8615	877.4768	876.1691
2001	874.9102	877.5254	876.2178
2002	874.9534	877.5687	876.2610
2003	874.9913	877.6065	876.2989
2004	875.0237	877.6390	876.3313
2005	875.0507	877.6660	876.3584
2006	875.0724	877.6876	876.3800
2007	875.0886	877.7038	876.3962
2008	875.0994	877.7146	876.4070
2009	875.1048	877.7200	876.4124
2010	875.1048	877.7200	876.4124
2011	875.1048	877.7146	876.4097
2012	875.1048	877.4305	876.2677
2013	874.1379	880.4210	877.2794
2014	877.5080	883.9090	880.7085
2015	878.0772	884.4247	881.2510
2016	879.6367	888.5205	884.0786
2017	881.4281	900.6071	891.0176
2018	883.2252	912.7037	897.9644
2019	885.0280	924.8105	904.9193
2020	886.8365	948.0714	917.4539
2021	887.7597	962.5172	925.1384
2022	888.6886	975.9889	932.3387
2023	889.6232	989.4727	939.5479
2024	890.5635	1,002.9690	946.7663
2025	891.5094	1,016.4780	953.9939
2026	892.4610	1,030.0010	961.2310
2027	893.4184	1,043.5370	968.4778
2028	894.3815	1,057.0880	975.7345
2029	895.3503	1,070.6520	983.0013
2030	896.3249	1,083.9290	990.1271
			Unit: 1,000 tons

GHG emission projection of solid waste			
Year	LOW	MED	HIGH
2010	45.2679	45.2679	45.2679
2011	61.7930	61.8248	61.9221
2012	68.1099	68.1802	68.4113
2013	69.9091	70.0256	70.4177
2014	69.5474	69.7196	70.2860
2015	70.9469	71.1861	71.9358
2016	74.7936	75.1126	76.0502
2017	78.6008	79.0138	80.1399
2018	82.3621	82.8845	84.1976
2019	86.0715	86.7197	88.2167
2020	89.7237	90.5139	92.1910
2021	93.1105	94.0582	95.9111
2022	96.4318	97.5519	99.5763
2023	99.6885	100.9930	103.1851
2024	102.8840	104.3818	106.7391
2025	106.0225	107.7214	110.2435
2026	109.1577	111.0641	113.7536
2027	112.2497	114.3691	117.2317
2028	115.3078	117.6461	120.6900
2029	118.3411	120.9050	124.1407
2030	121.3569	124.1531	127.5930
			Unit: Gg CO_2e

Emission reduction of Solid waste				
Year	BAU	Total reduction	Reuse	Recycle
2010	45.2679	42.3779	43.4979	44.1479
2011	61.8248	56.1960	58.2848	59.7360
2012	68.1802	59.8127	62.8702	65.1227
2013	70.0256	58.9193	62.9456	65.9993
2014	69.7196	52.3946	57.3896	64.7246
2015	71.1861	47.6423	53.6061	65.2223
2016	75.1126	45.3500	52.2826	68.1800
2017	79.0138	43.0324	50.9338	71.1124
2018	82.8845	38.3186	49.6205	71.5826
2019	86.7197	33.5694	48.2717	72.0174
2020	90.5139	28.7791	46.8819	72.4111
2021	94.0582	25.4601	45.2422	74.2761
2022	97.5519	22.0905	43.5519	76.0905
2023	100.9930	16.6345	41.7143	75.9132
2024	104.3818	11.1264	39.8245	75.6838
2025	107.7214	5.5689	37.8853	75.4050
2026	111.0641	0.3707	36.1561	75.2787
				Unit: Gg CO_2e

MONGOLIA'S NATIONAL INVENTORY REPORT – 2017

ANNEX TO INITIAL BIENNIAL
UPDATE REPORT TO UNFCCC

Table of Contents

List of Figures

LIST OF TABLES

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

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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
Waste Sector Lead	Gerelmaa Shaariibuu
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 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, are not obligated to reduce its GHG emissions under the 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 a part of its initial Biennial Update Report (iBUR). The NIR contains updated accounts of net greenhouse gas (GHG) emissions estimate for the period of 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 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 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.

[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)

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 a national emissions reduction targets and MRV system for tracking them in national development policies, sustainable institutional arrangement, GHG inventory system and capacity building.

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 are 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.

[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 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.

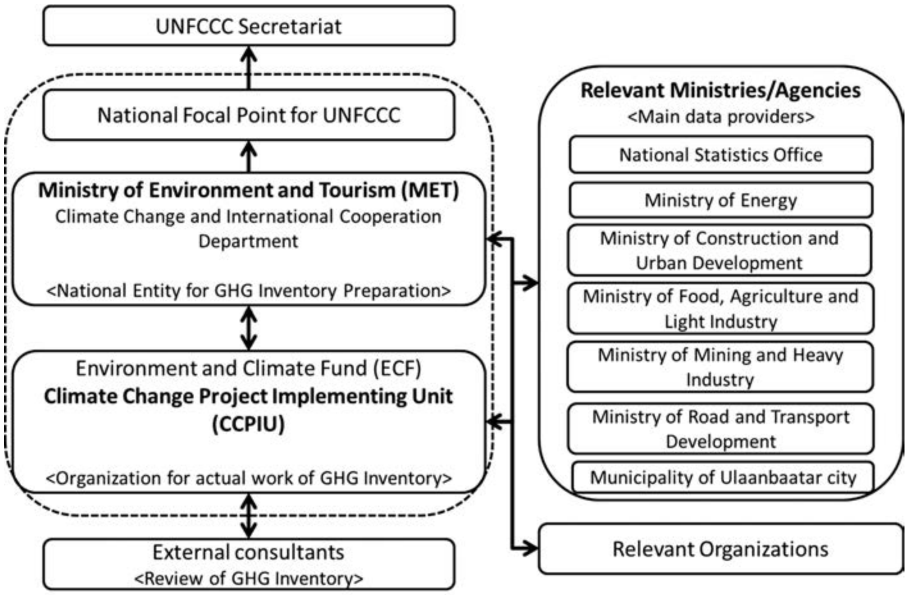

Figure 1-1: Institutional arrangement for the GHG inventory compilation of Mongolia

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 are shown above in figure1-1. Additional statistics from international sources were used such as the 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

Measurement & Reporting	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 entities	- Organise review and validation workshops with relevant ministries, agencies and organizations - Confirm data provided for the preparation of the 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 sources 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 for 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 and 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 causes 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 is 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 levels 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 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 is 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 the data from NSO.

In some cases, NSO data differ from the data directly provided by questioned organizations/institutions. The IPCC 2006 recommends that if there is availability of several sources of the activity data, it is 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 from 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 sources of 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 due to 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 been 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 the 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)[1]	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 [2]	CO_2 from biomass combustion for energy production	CO_2
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
- 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 Mongolia used the methodologies consistent with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) for this submission. Thus this is a 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).

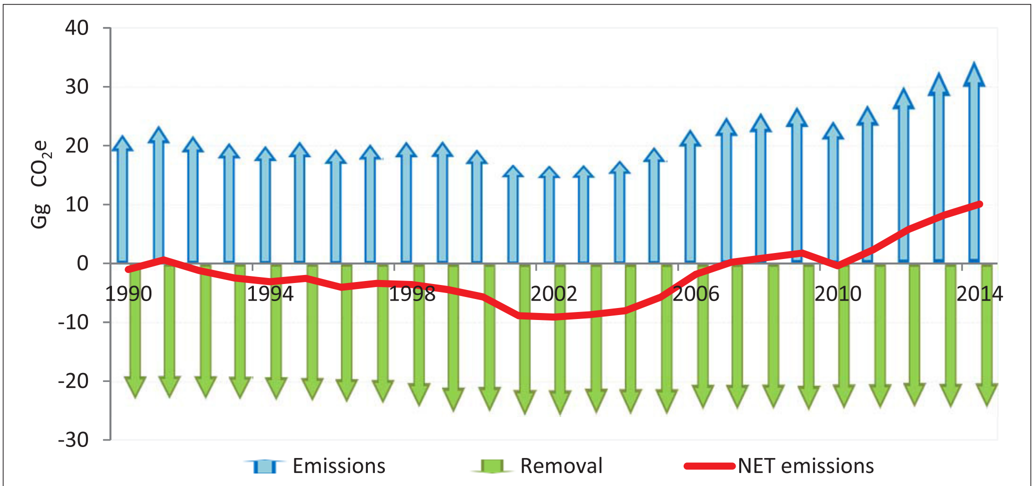

Figure 2-1: Mongolia's total and net GHG emissions and removals, 1990-2014 (Gg CO_2e)

In general, emissions and removals from each sector are increased in 2014 compared to the base year and the 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)		Change from 1990 (Gg CO_2e)	Change from 1990 (%)
	1990	2014		
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).

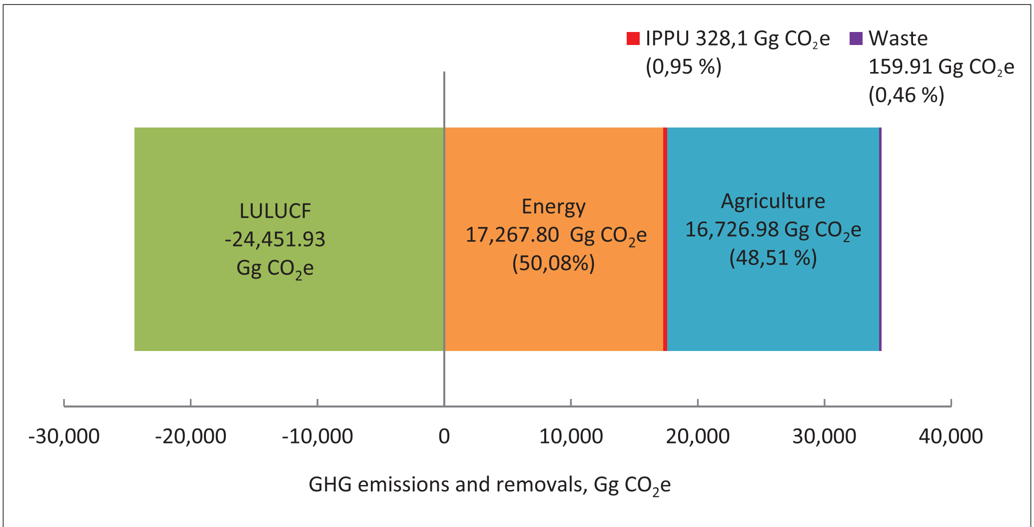

Figure 2-2: The composition of Mongolian GHG emissions by sectors in 2014

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 increased gradually in energy sector, while in IPPU sector it is increased rapidly in 2001-2005.. The agriculture sector's growth rate mainly depends on livestock populations. Livestock population were dropped rapidly during 2000-2002 and 2009-2010 due to harsh winter. In the waste sector, GHG growth rate is gradually increasing from 1996 to 2014 due to an increase in 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 emissions and removals from the sectors show different patterns 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 sources for emissions for the 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 occurrences in the agriculture sector. Figure 2-3 shows that contribution of sectors to the Mongolia's total emissions for the period 1990-2014.

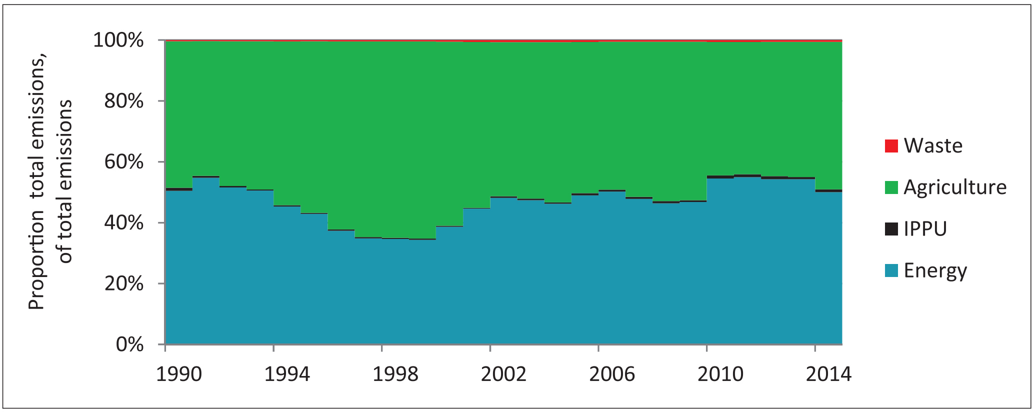

Figure 2-3: The contribution of sectors to Mongolia's total emissions for the period 1990-2014

2.2 Description and interpretation of emission trends sectors/categories

2.2.1 Energy

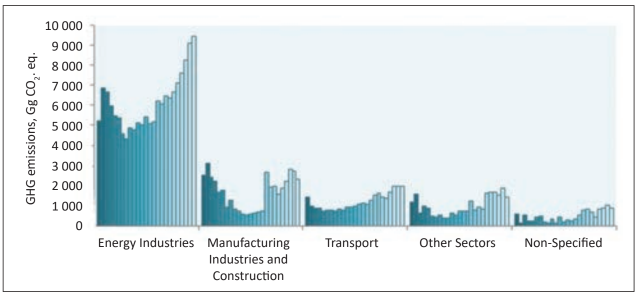

Figure 2-4: Trends in energy sector by categories, 1990-2014

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 the energy sector in 2014 increased by 55.69% compared to the base year 1990. A large part of emissions in the 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 of category, the energy efficiency of electricity and heat production should be improved (see Figure 2-4).

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

CHAPTER 2

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 an increasing number of domestic livestock which increased from 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 natural disaster.

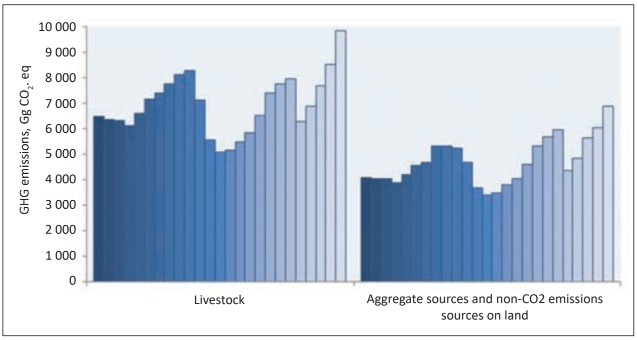

Figure 2-5: Trends in agriculture sector by categories, 1990-2014

2.2.3 Industrial Processes and Product Use (IPPU)

The Industrial Processes and Product Use (IPPU) sector contributes to 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 the total emissions. Cement and lime are important ingredients for building materials for production. The building material industry is growing in parallel with the population as well as the economy (see Figure 2-6).

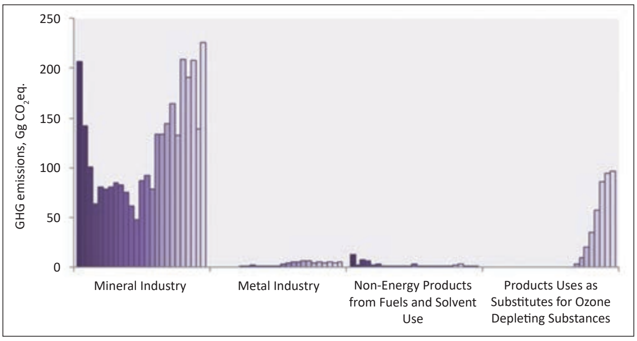

Figure 2-6: Trends in IPPU sector by categories, 1990-2014

2.2.4 Waste

The waste sector is an insignificant source of GHG emissions and contributes to only 0.46% of the 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

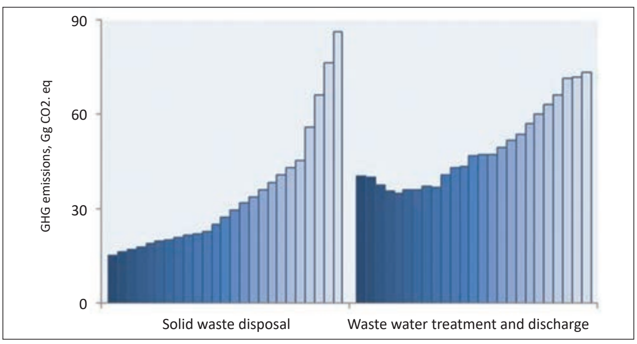

Figure 2-7: Trends in waste sector by categories, 1990-2014

sectors 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).

2.2.5 Land use, land use change and forestry

LULUCF is a net sink in Mongolia accounted approximately for 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).

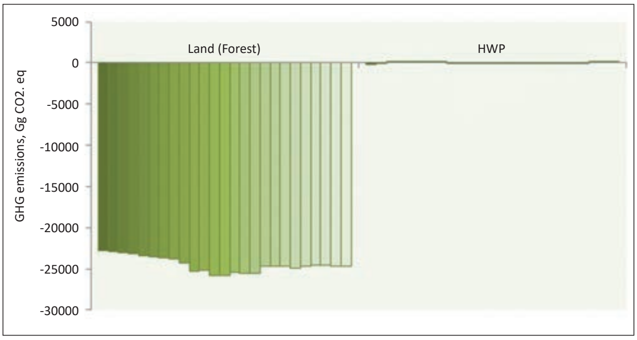

Figure 2-8: Trends in LULUCF sector by categories, 1990-2014

2.3 Description and interpretation of emission trends by gases

The most important GHG in Mongolia is carbon dioxide (CO_2) (without LULUCF) accounting for 46.41% of the 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 disposals contribute for 32.89% to the national total GHG emissions, and nitrous oxide (N_2O) from agricultural soils contributes for 20.42% to the national total, and HFCs from refrigeration, air conditioning, fire protection and foam blowing equipment usage contributes to 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 found 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.

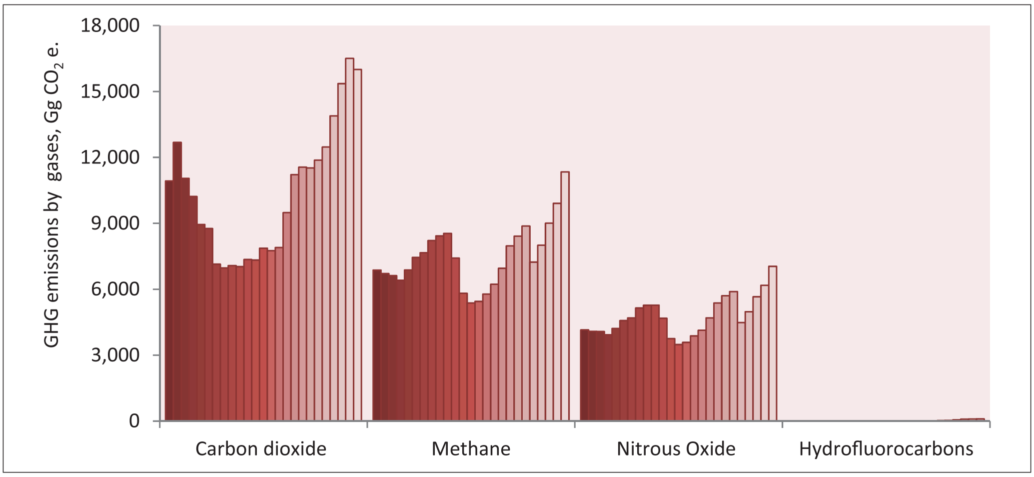

Figure 2-9: The trend of CO_2, CH_4 and N_2O emissions 1990-2014

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 sectors.

The main source of CO_2 emissions in Mongolia is 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 a 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 for CH_4 emission 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 (HFC_s)

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 HFC's emissions are directly related to the consumption of applications which include fluorinated substitutes, emissions are increasing with the growing consumption of applications. For the emissions estimation for HFCs Tier 1 method of IPCC 2006 was used which used 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 of 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 are caused by biomass burning in forest land which 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 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 (CRF 1)

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, it had 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.

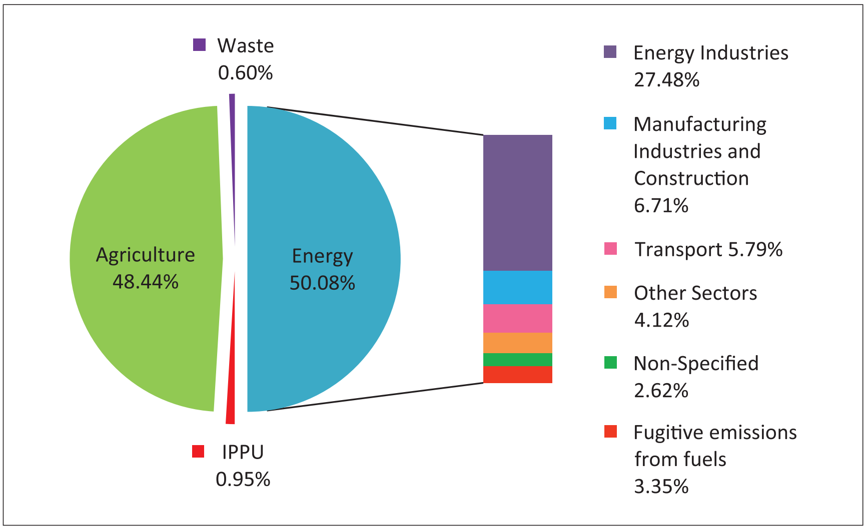

Figure 3-1: The share of each sector in total GHG emissions of Mongolia (excl. LULUCF), 2014

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 planned to the market economy in the late 90s. In addition to fuel combustion, 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 sectors 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.

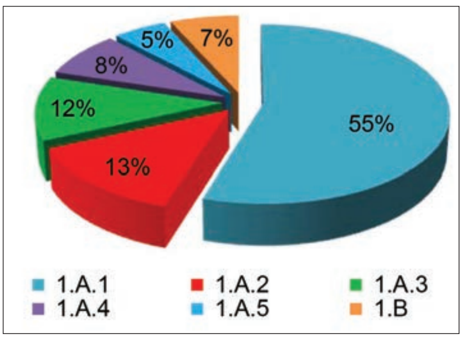

Figure 3-2: The share of aggregated GHG emissions by categories within energy sector in 2014

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

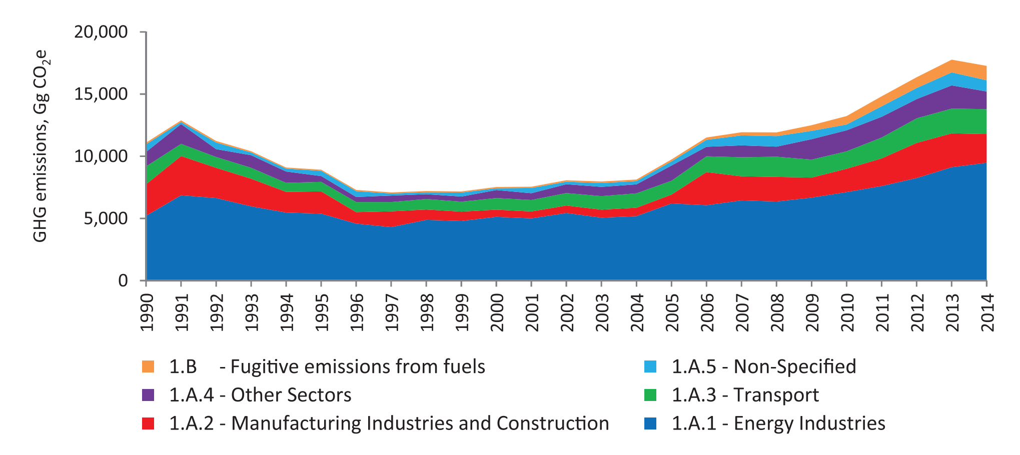

Figure 3-3: Trend in aggregated emissions by source categories within energy sector for the period 1990-2014 (in Gg CO_2e)

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% 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 the domestic aviation represents 2.04% (40.72 Gg CO_2e). The international aviation bunkers will not be 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 the 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

Year	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

Year	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)

CHAPTER 3

The Mongolia's climate is harsh continental with sharply defined four seasons, high annual and diurnal temperature fluctuations and low rainfall. Due to thishigh 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 as of 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 years (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 the 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 well developed, so the fuel consumption in manufacturing industries was not possible to disaggregate. Same case for transport sectors, the gasoline and diesel consumption for respective vehicle types were taken and imported to the 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 as 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 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 the 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 started from 1996 in Mongolia, 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.

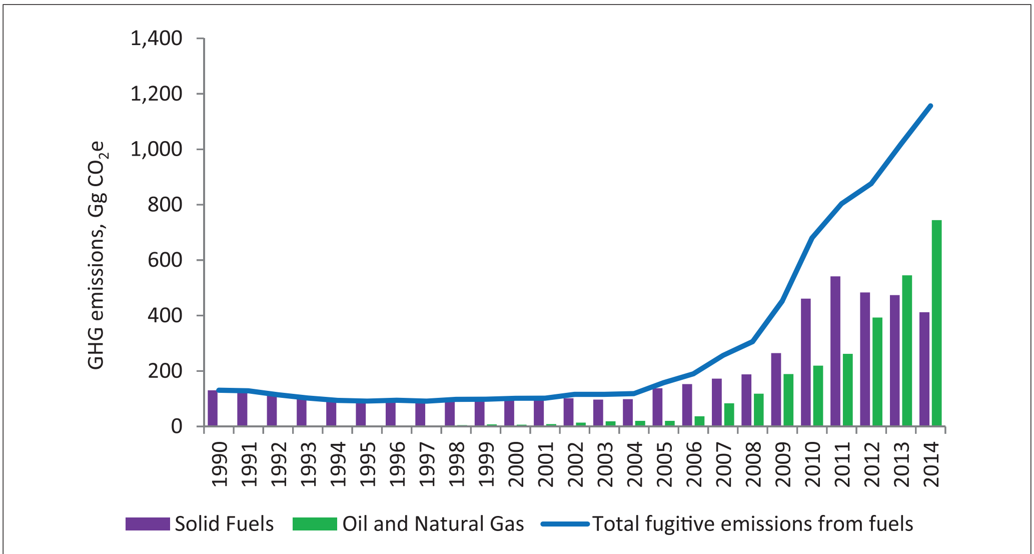

Figure 3-4: Total fugitive emissions from fuels for the period 1990-2014

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

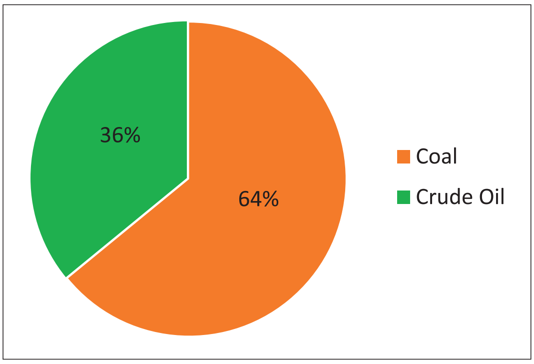

Figure 3-5: The share of coal and crude oil in the fugitive emissions from fuels over the years 1990-2014

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) has begun 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, Mongolia was able 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 the 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 international airport in Mongolia, but from 2013 a Mongolian-Japanese joint project to build a New Ulaanbaatar International Airport was started 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.

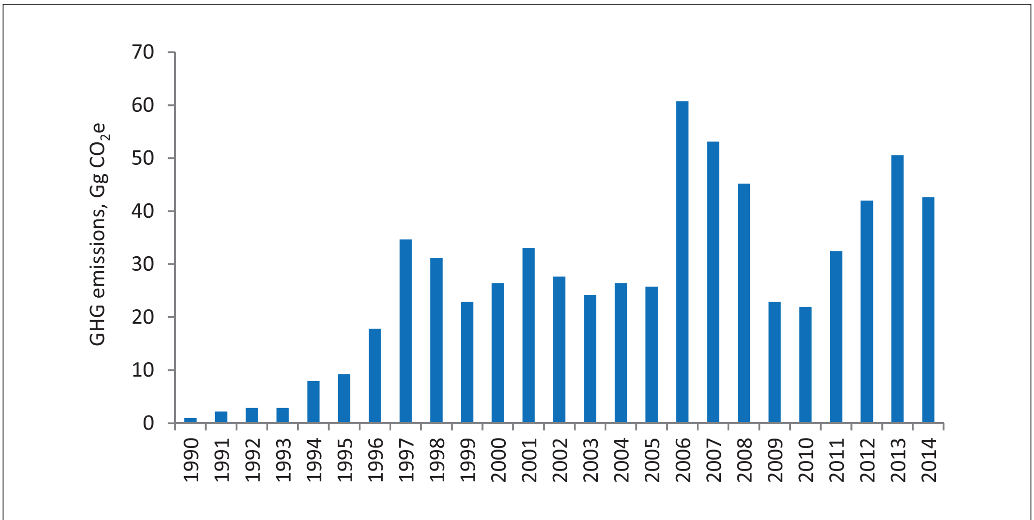

Figure 3-6: GHG emissions from international aviation bunkers for the period 1990-2014

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 in 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 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	GHG emissions			
	(kt)	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 efforts and data requirements (IPCC, 2006).

The RA is designed to calculate the emissions of CO_2 from fuel combustion, starting from high level of 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 of 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 the years and the average difference of CO_2 emissions between RA and SA is 2.29% over all the years.

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

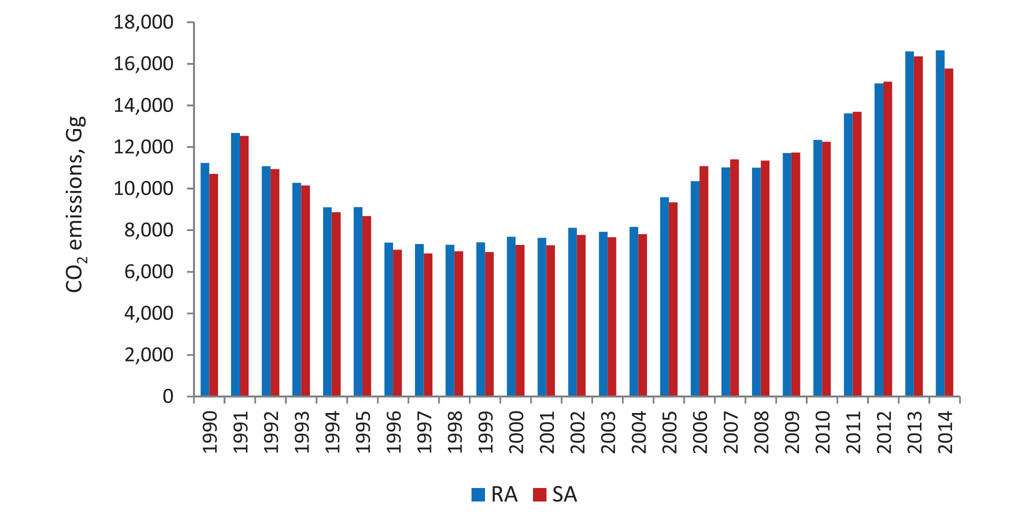

Figure 3-7: The difference of CO_2 emissions between RA and SA in 1990-2014

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

Year	TOTAL FUELS					
	Apparent Energy Consumption			CO_2 emissions		
	RA	SA	Difference	RA	SA	Difference
	(TJ)	(TJ)	%	CO_2 (Gg)	CO_2 (Gg)	%
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

Year	SOLID FUELS					
	Apparent Energy Consumption			CO_2 emissions		
	RA	SA	Difference	RA	SA	Difference
	(TJ)	(TJ)	%	CO_2 (Gg)	CO_2 (Gg)	%
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

Year	LIQUID FUELS					
	Apparent Energy Consumption			CO_2 emissions		
	RA	SA	Difference	RA	SA	Difference
	(TJ)	(TJ)	%	CO_2 (Gg)	CO_2 (Gg)	%
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 sectors.

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, and 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 of 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 types of coal in energy sector, EFs for some types 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 the waste sector in Mongolia. These country specific EFs were taken for GHG emission estimations of energy and waste sectors. NCVs for other liquid fuels were taken as default values from the IPCC 2006.

CHAPTER 3

Same as NCVs for some coal types, 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, the 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 the two methodologies differ slightly, namely the emissions from previous inventory which was calculated by using the revised IPCC 1996 are slightly higher than the emissions which was 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 the 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 calculations (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 the 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 the data from NSO. The data collected and published by NSO from the relevant government and private organizations/ institutions, in most cases differ from the data directly provided by those organizations/ institutions. The IPCC 2006 recommends if there are several sources of the activity data available, it is 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 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 is 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 is 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 (CRF 2)

CHAPTER 4

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 like 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 for 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 the use of fluorinated substitutes for ozone depleting substances (CRF 2.F) and represents around 29% (see Figure 4-1).

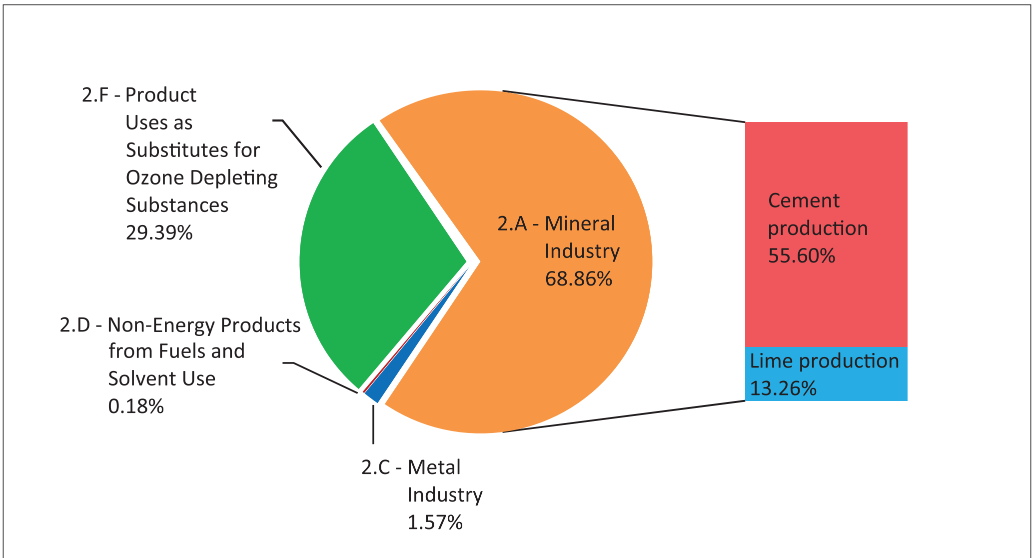

Figure 4-1: The share of each subsector in total GHG emissions of IPPU, 2014

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 introduction year. According to IPCC 2006, volume 3, part 2, if 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.

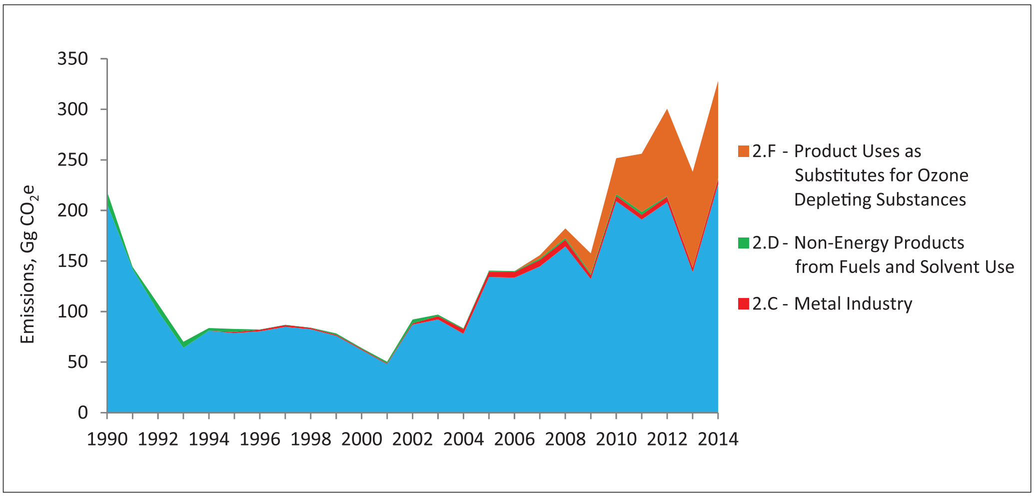

Figure 4-2: GHG emissions from IPPU sector by source categories, Gg CO_2e

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 a 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.

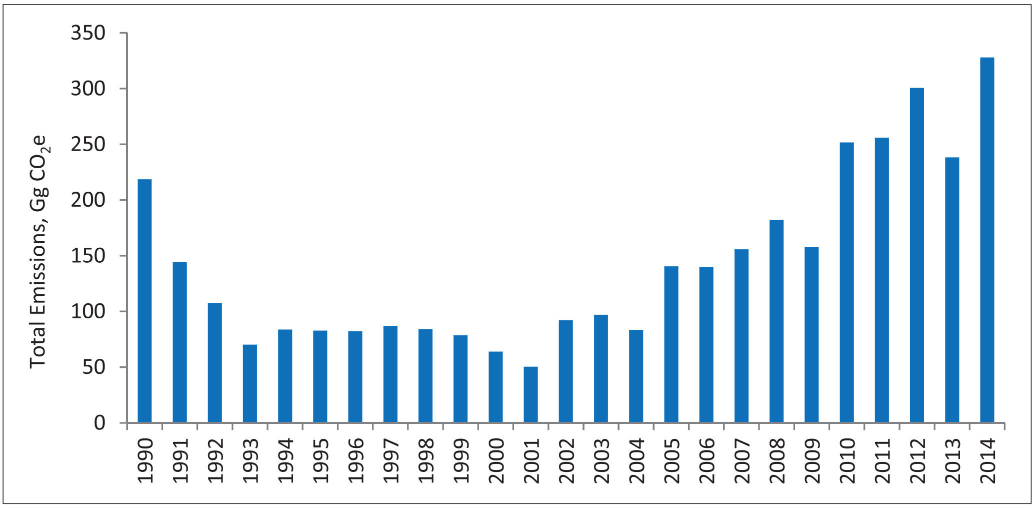

Figure 4-3: Total GHG emissions from IPPU sector over the years 1990-2014, Gg CO_2e

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

Year	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 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) have 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 a high temperature of about 1,450°C to form lime and CO_2 in a process known as calcination. Then 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 was 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.

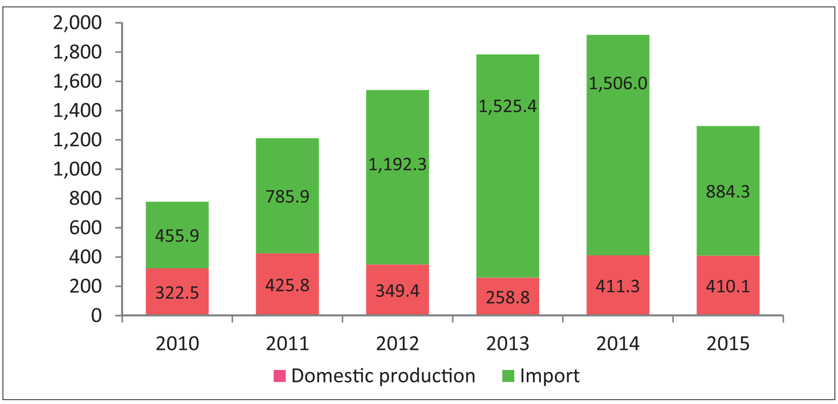

Figure 4-4: Cement consumption in thousand tons

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 limestone extraction, clinker and cement production data from producers 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, 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 and not from an 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[1] and steel bloom[2]) were obtained from the National statistics 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 the metal industry. The iron and steel production contributes to the total emissions from IPPU sector at around 2% (see Figure 4-1, Table 4-4).

[1] *Cast steel = Ган цувимал*

[2] *Steel bloom = Ган бэлдэц*

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	-	-	-	-	-	1.25	1.54	1.82	1.30	1.05	1.04	0.80	1.27
TOTAL	-	-	-	-	-	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, categories have been included only of GHG emissions from lubricant use in industrial and transport applications. Mongolia imports 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 is consumed in machinery and in vehicles which is actually combusted and emitted as CO_2 emissions. Therefore, it has been assumed that all amount of imported lubricants consumed as motor and industrial oils. The assumption is that all amount of l imported lubricant 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;
- 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 all the above mentioned applications. The emissions from the fluorinated substitutes for ODS were estimated from the 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 HFC-23		Chemicals				
		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					
Fire Protection				x		

Note: x = exist

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).

CHAPTER 4

The activity data for the estimation of HFCs emissions were available only from 2012 to 2014. Therefore the emissions have been estimated only for the 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).

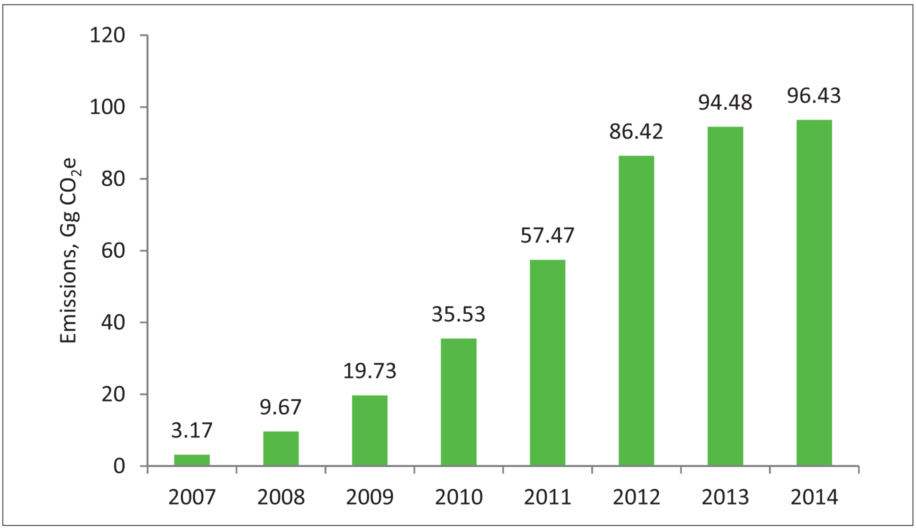

Figure 4-5: Emissions from product uses as substitutes for ozone depleting substances (HFCs), 2007-2014, Gg CO_2e

4.3 Emission factors and global warming potentials used

Emission factors (EFs) used in GHG emissions estimations of IPPU sector was taken by 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

CHAPTER 4

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"3 (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.*

[3] *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.*

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 at 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 differ from the data directly provided by those organizations/institutions. The IPCC 2006 recommends if there is availability of several sources of the activity data. Generally, it's a good practice to follow the data from national statistics.

4.6 Sector specific planned improvements

Some significant improvements in IPPU sector in the short and medium term are required. 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 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)

CHAPTER 5

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 occasionally due to severe, cold winter. 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. The second harsh winter within GHG inventory period of 1990-2014 happened in 2009-2010, and over 11 million livestock lost and decreased by circa 26% from previous year's total. As a result, methane and nitrous oxide emissions from domestic livestock 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).

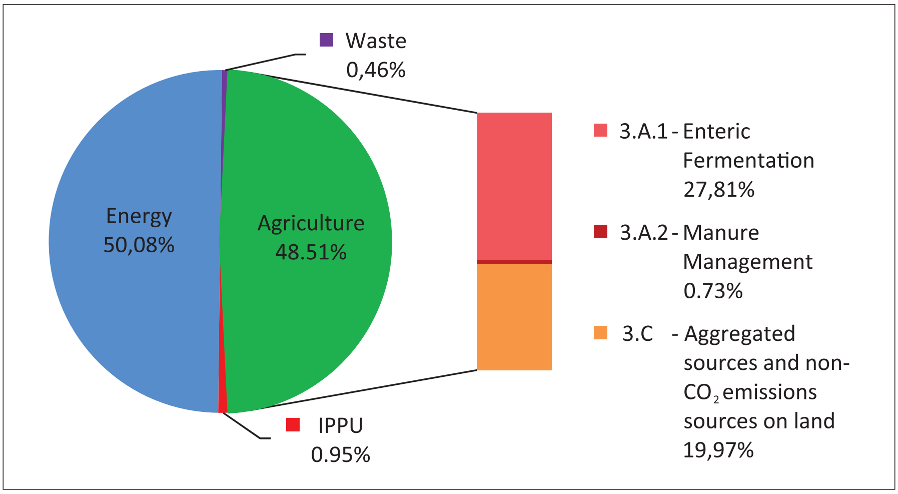

Figure 5-1: CO_2e emissions from the agriculture sector compared to the total GHG emissions (excl. LULUCF) in Mongolia in 2014

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 number of domestic livestock which increased 25,856.9 million to 51,982.7 million in 1990-2014. However, animal numbers 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%

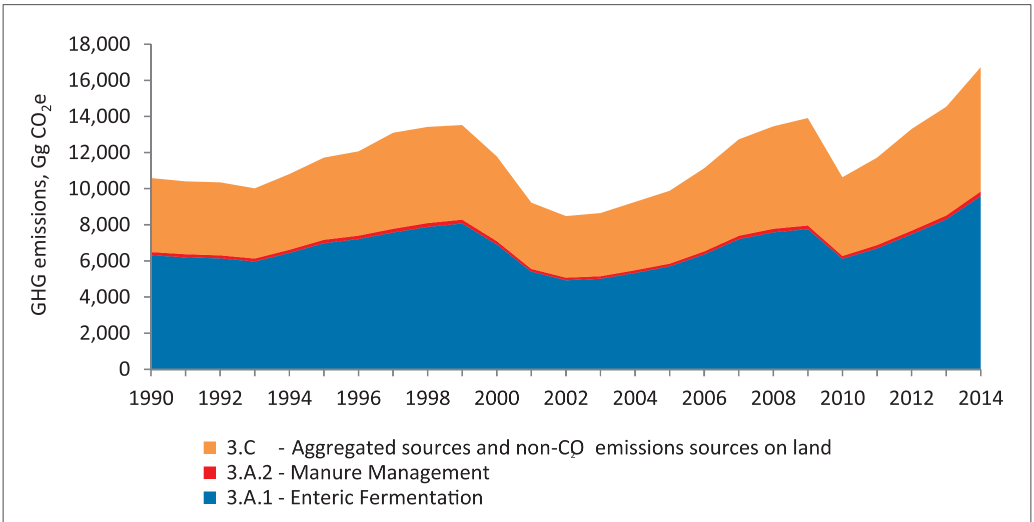

Figure 5-2: Trend in aggregated emissions by subcategories within agriculture sector for the period 1990-2014, Gg CO_2e

5.1.1 Key Categories

The results of key category analysis (including LULUCF) are shown in Table 5-4. Emissions from enteric fermentation, direct N_2O emissions from managed soils were included in both levels 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 the 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 was 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 2001 and 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.

CHAPTER 5

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 sized compared to the 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 a clarification of 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 were not used due to high uncertainty of the input parameters used. At present planning a reassessment with updated raw data of livestock survey is 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 below in 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 a 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 the next following years (Figure 5-3).

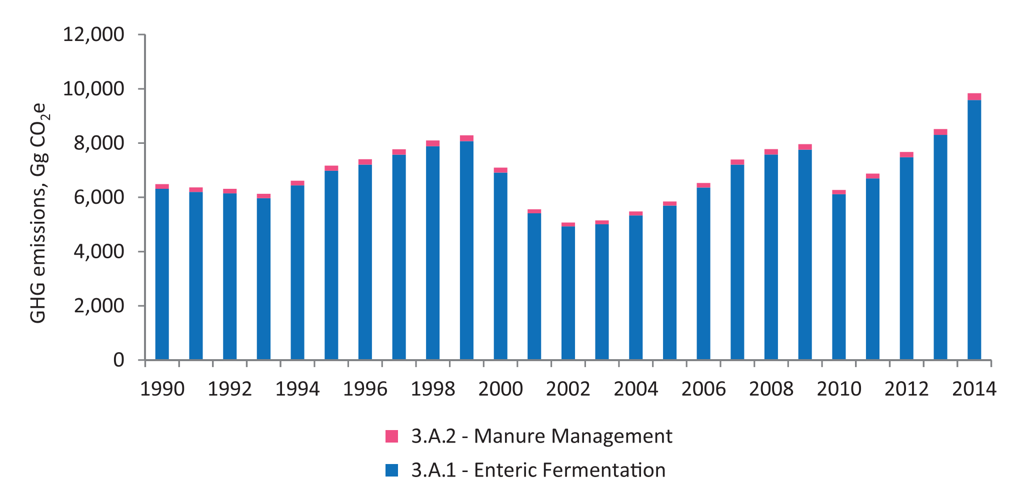

Figure 5-3: Emissions trend from livestock

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

CHAPTER 5

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 natural disasters (see in overview of the agricultural sector). The Figure 5-4 shows that total methane emissions from enteric fermentation by livestock type.

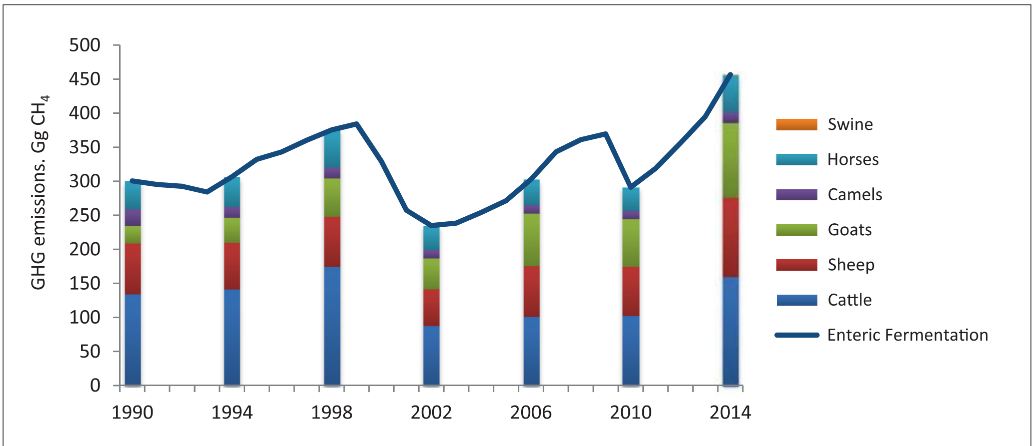

Figure 5-4: Total emission trend from enteric fermentation of livestock

In 1990, cattle contributed 45% of the total emissions from enteric fermentation (Figure

CHAPTER 5

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%).

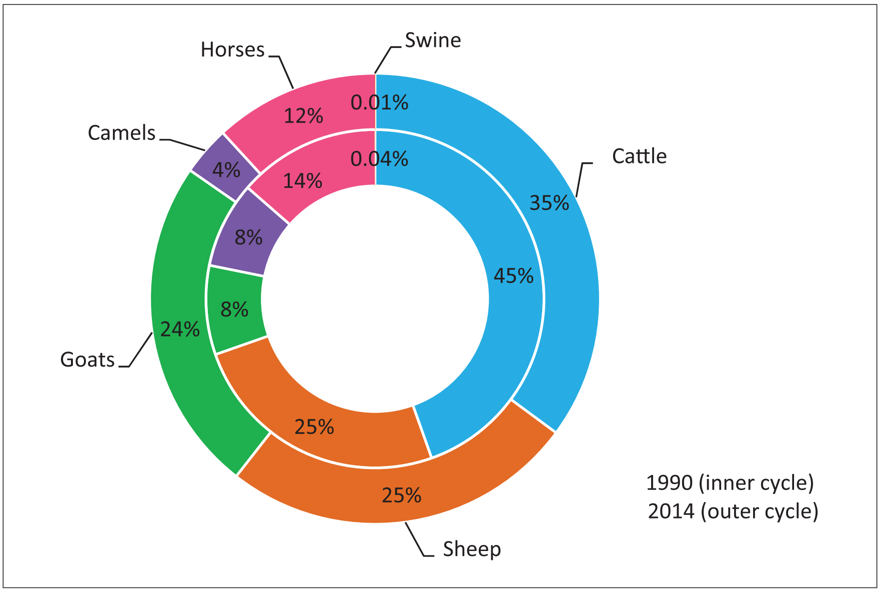

Figure 5-5: Each livestock contribution to the enteric fermentation emission in 1990 and 2014

Over the period under review, emission trend from each livestock category showed different patterns of change compared 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:

$$\text{Emission} = A * EF$$

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 consists of methane (CH_4) and nitrous oxide (N_2O) gases from aerobic and anaerobic manure decomposition processes. The term 'manure' is used here collectively and includes 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 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 natural disasters (See in overview of the Agricultural sector). The Figure 5-6 shows that total methane emissions from manure management by livestock type.

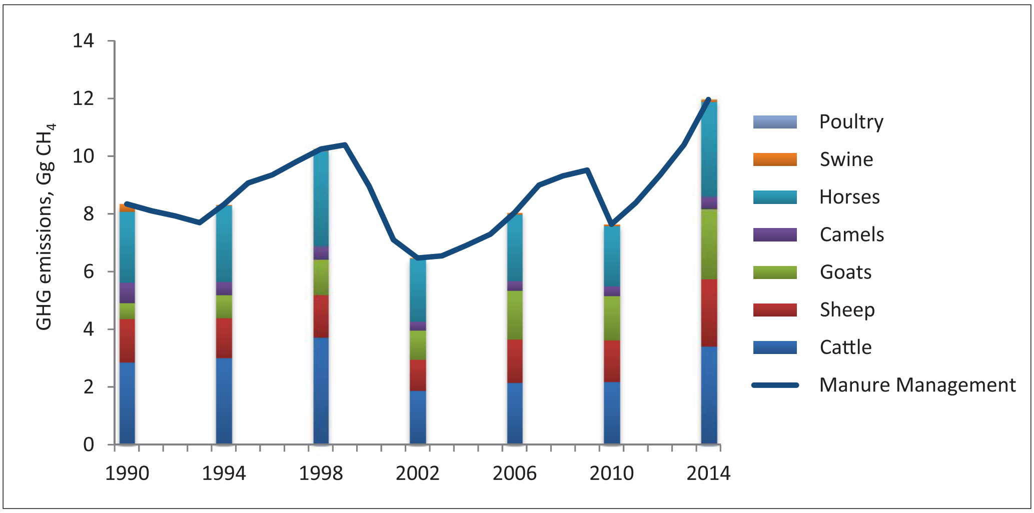

Figure 5-6: Total emission trend from manure management of livestock

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%).

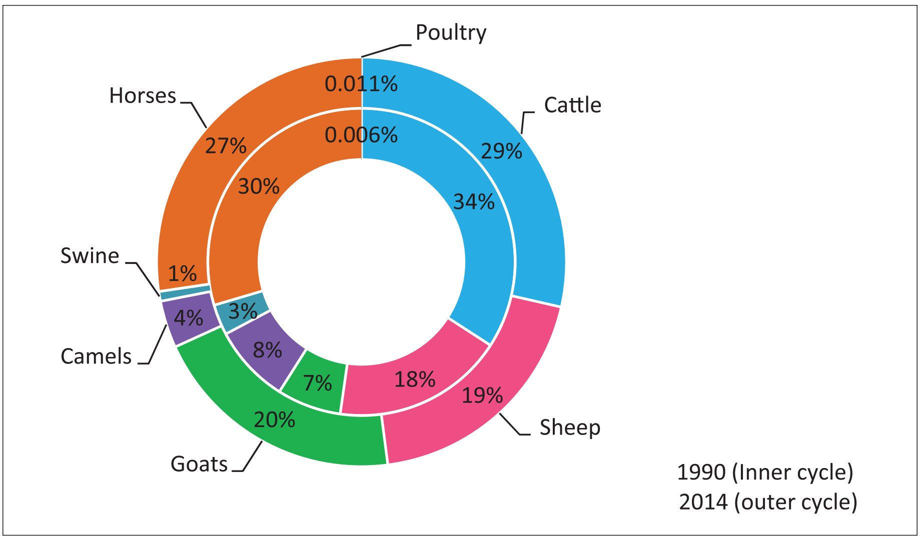

Figure 5-7: Each livestock contribution to the manure management emission in 1990 and 2014

Over the period under review, emission trend from each livestock category showed different patterns 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:

$$\text{Emission} = A * EF$$

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

CHAPTER 5

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 (≤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-CO2 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 increased 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%

CHAPTER 5

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.

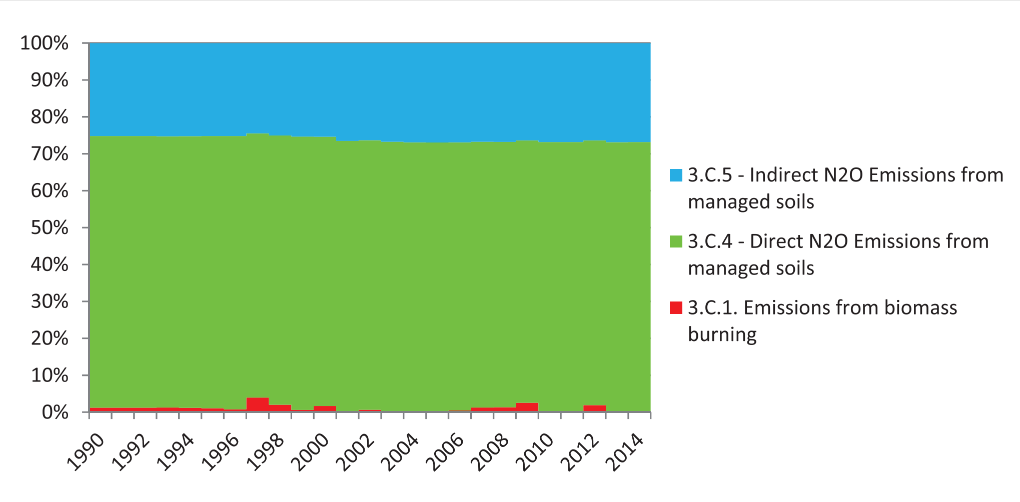

Figure 5-8: Each subcategory contribution to the 'aggregated sources and non-CO_2 emission sources on land' category

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 occurrences of certain years (Figure 5-9).

CHAPTER 5

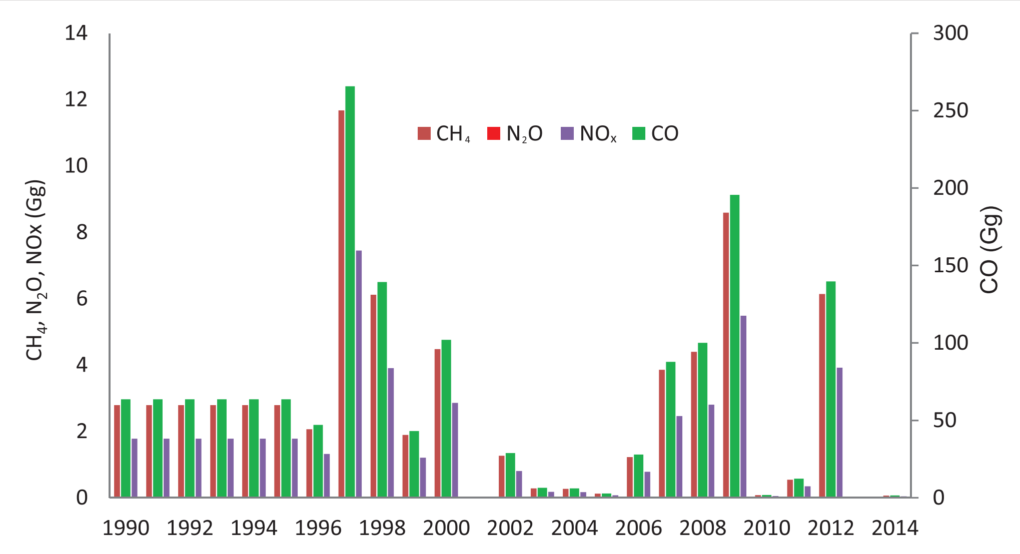

Figure 5-9: GHG emission of biomass burning, Gg

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:

$$Emission = A * \mathrm{MB} * \mathrm{Cf} * EF$$

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. Increase 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, the percentage share of 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.

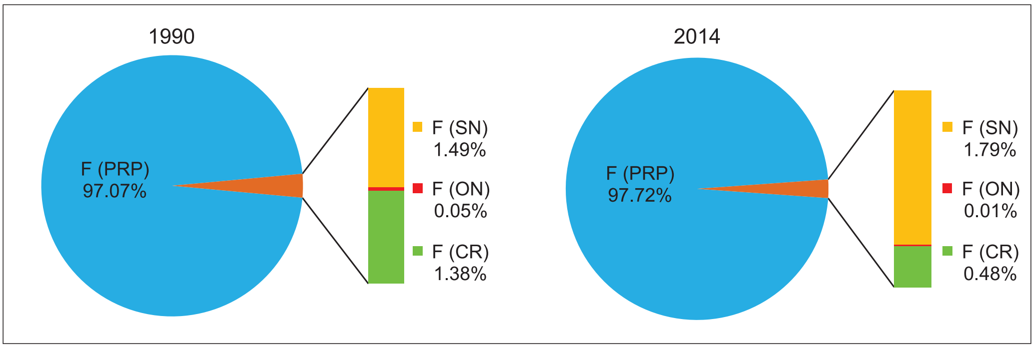

Figure 5-10: Direct N_2O emissions by source category in 1990

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:

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

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 5-18). 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%

CHAPTER 5

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 have 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 was documented and archived both in hard and electronic copies. 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 on 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 of 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 be overestimated or underestimated and further improvements 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 covered all over the Mongolian 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 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 consists 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.

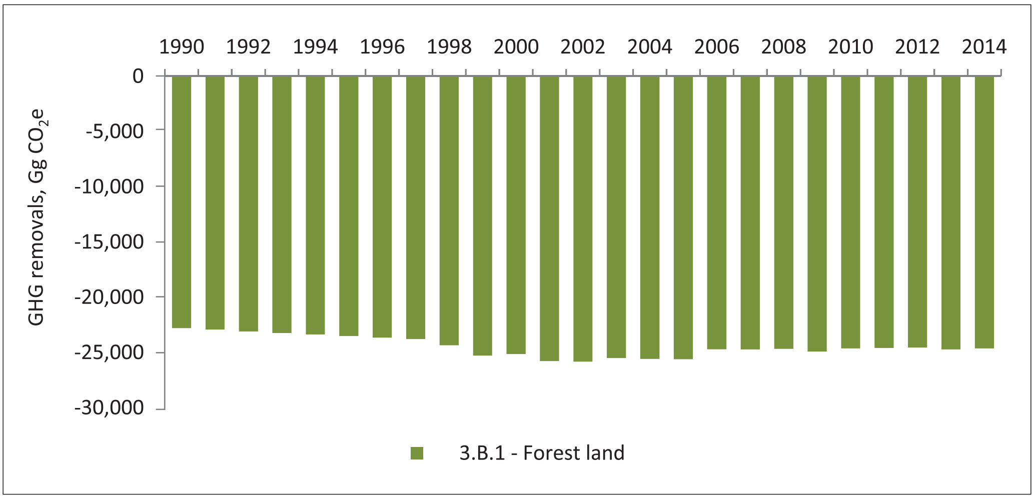

Figure 6-1: GHG removal trend in Land source category for the period 1990-2014, Gg CO_2e

The forest resources which cover about 10% of the country and 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 also influence 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 emitting 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.

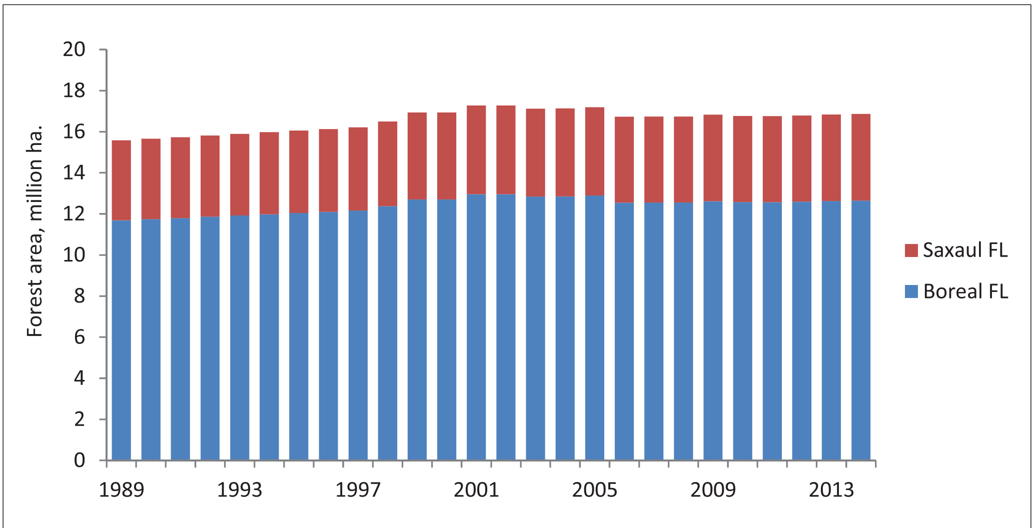

Figure 6-2: Total forest area by two sub-categories

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 shown in 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, 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 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 emissions and removals trend from the HWP category is given in 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 as 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/)[1] . To prevent 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, conversion factors are used in an aggregated way. For this submission no country specific values for the disaggregation of sub-commodities,

[1] 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.

CHAPTER 6

nor conversion factors, or half-live times have been applied[2]. 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)

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

CHAPTER 7

Waste (CRF 5)

7.1 Overview of the sector

This Chapter includes information on the GHG emissions from the waste sector. The categories and activities for estimation of methane (CH_4) and nitrous oxide (N_2O) emissions are described in detail. The GHG inventory of the waste sector is based on the 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.

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).

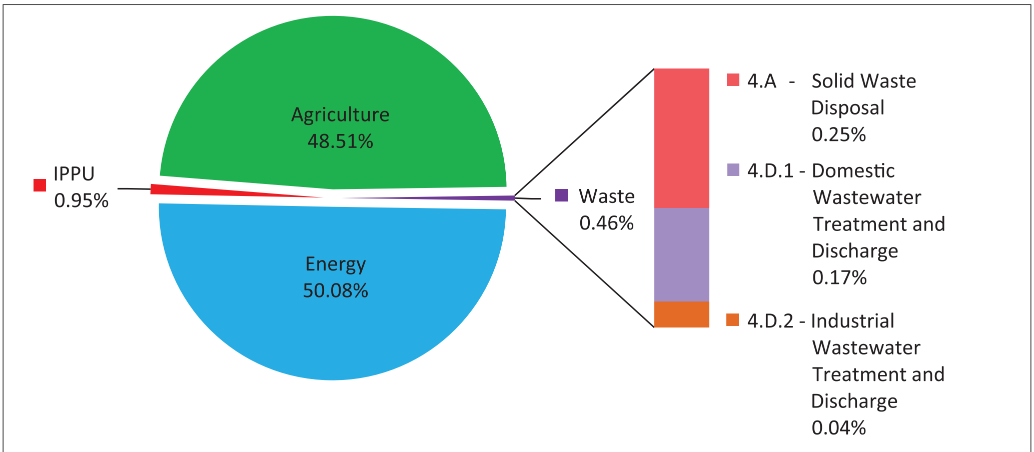

Figure 7-1: CO_2 equivalent emissions from the waste sector compared to the total GHG emissions (excl. LULUCF) in Mongolia in 2014

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 by 463.35% and the methane emission from industrial wastewater treatment and discharge has increased by 89.48%, methane and nitrous oxide emissions from domestic wastewater treatment and discharge have increased by 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.

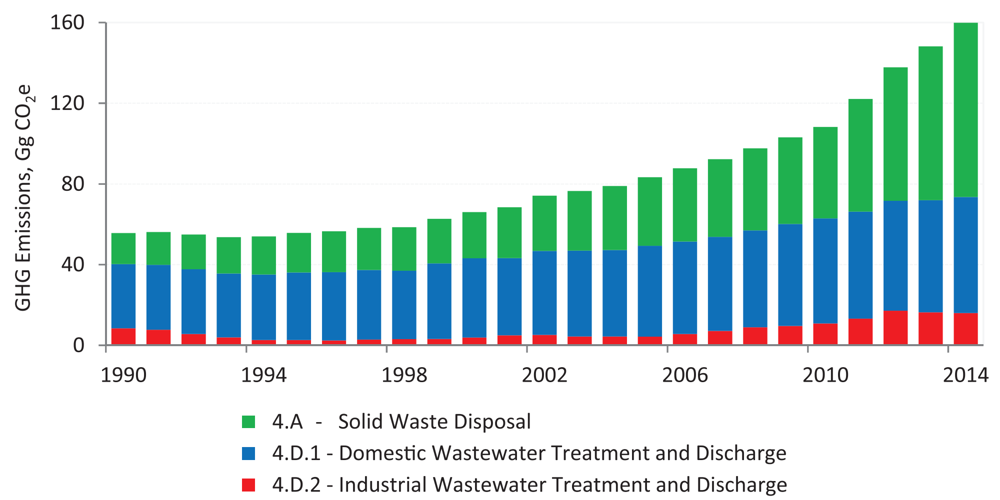

Figure 7-2: Trend of GHG emissions in the waste sector by source categories in 1990-2014, Gg CO_2e

The emissions from solid waste disposal sites (SWDS) contribute to 54.02%, domestic wastewater treatment and discharge to 35.96% and industrial wastewater treatment and discharge to 10.02% of 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 the last five years due to waste disposed into 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 to only 0.46% of the national total. The SWDS and domestic wastewater treatment and discharge are 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 the methodology used in emission estimations, derived from IPCC 2006 and detailed uncertainty values used in uncertainty assessment are presented under source of 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% of total emissions from the 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 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 and electronic copies.

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 (Gg)	5.19	5.29	5.71	5.90	5.90	6.05	6.19	6.38	6.57
iBUR		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 sectors in the BUR are lower than the results included into 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.

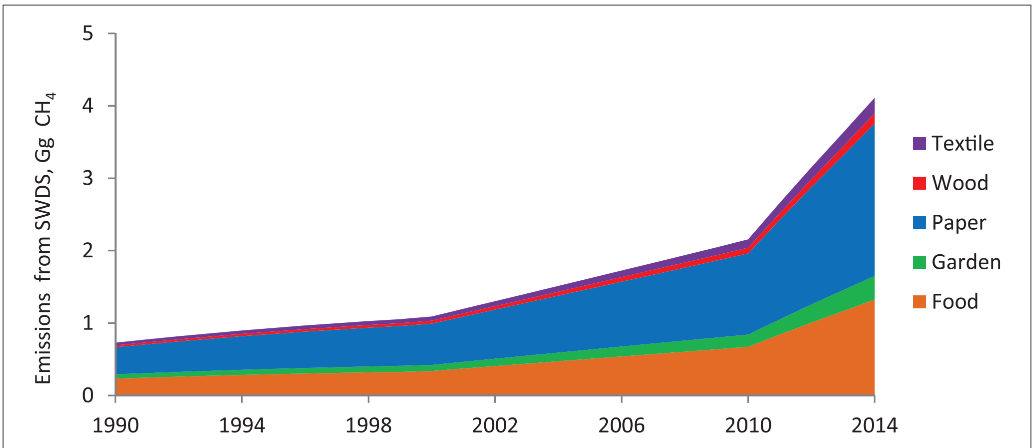

Figure 7-3: Quantities of CH_4 emission from biodegradable solid waste disposed in landfills 1990–2014, Gg

As seen from the Figure 7-3, the quantities of emitted methane from solid waste disposal (SWD) is at an increasing trend, and it depends on the population growth, especially in urban areas. Methane emissions have rapidly increased for the 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 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 CH4 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 account of 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 papers 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 of 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 per capita waste generation rates with the number of urban population. Data on urban population was 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[1],
- 2000-2009: 0.6 kg/cap/day[2],
- 2010-2014: 0.84 kg/cap/day[3]

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

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

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

[1] *Report WMO, Cal Recovery, 2003*

[2] *What a waste, World bank*

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

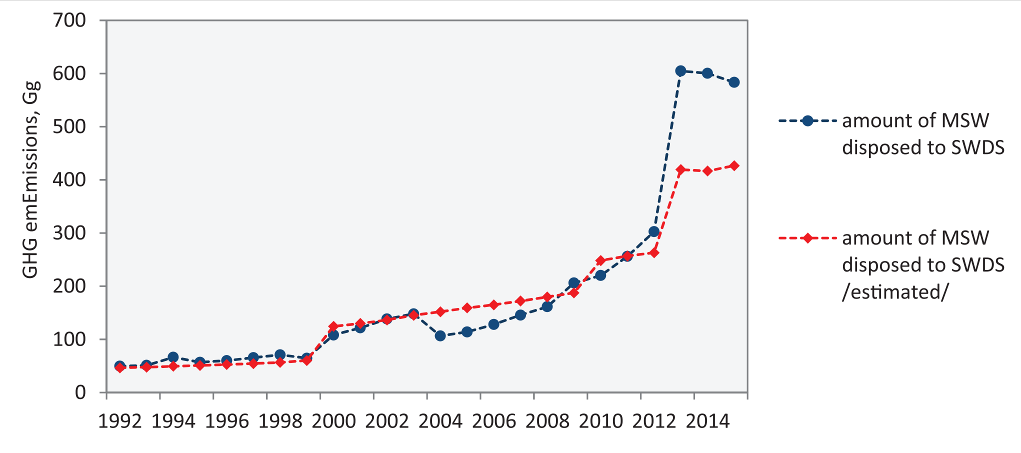

Figure 7-4: Amount of MSW disposed to SWDS in Ulaanbaatar city

As seen from the Figure 7-4, the observed MSW in the last 5 years was bigger than estimated amount due to illegal disposed wastes that 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 the entire period of 1990 – 2014.

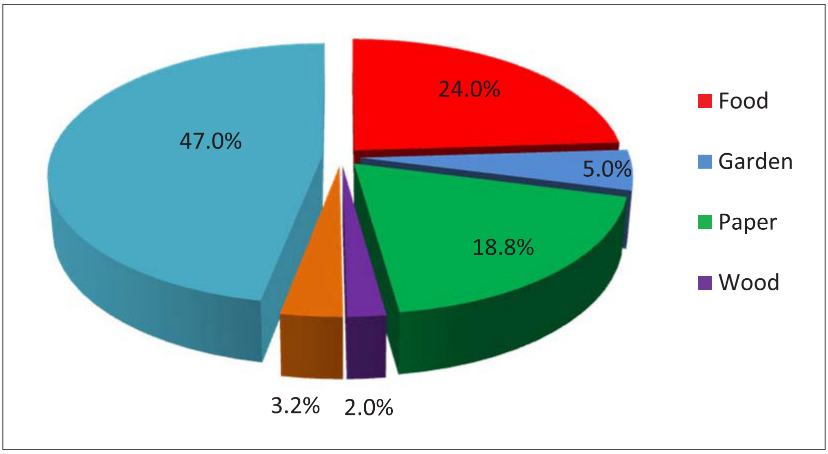

Figure 7-5: Composition of waste

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 generated 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 1970s (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 of soil cover. Landfill technology started to get used 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 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 a default value for emission estimation between 1970 and 2009. Then in the later period of the 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 papers 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 were checked for its 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 (Gg)	1.86	1.90	2.14	2.14	2.19	2.24	2.29	2.38	2.43
iBUR		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 a 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

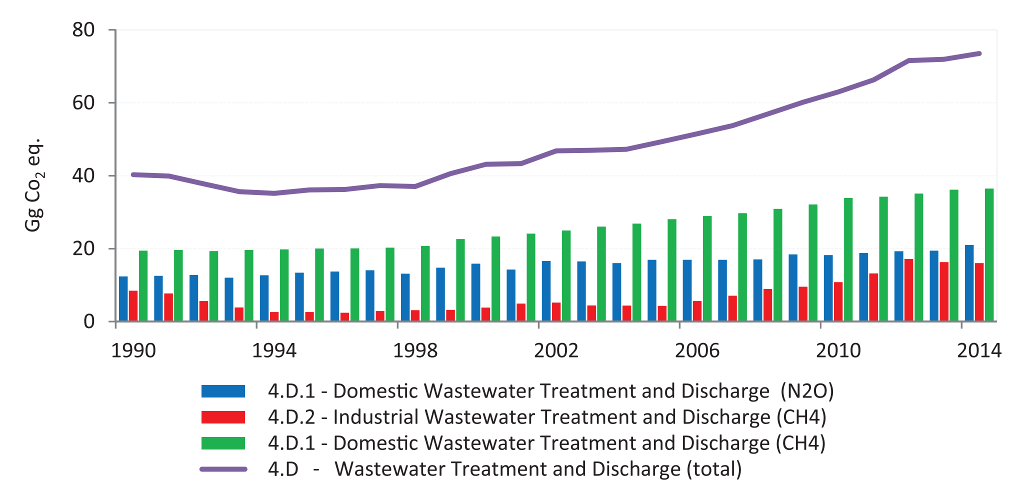

Figure 7-6: Emissions of methane and nitrous oxide from wastewater treatment by source categories

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.

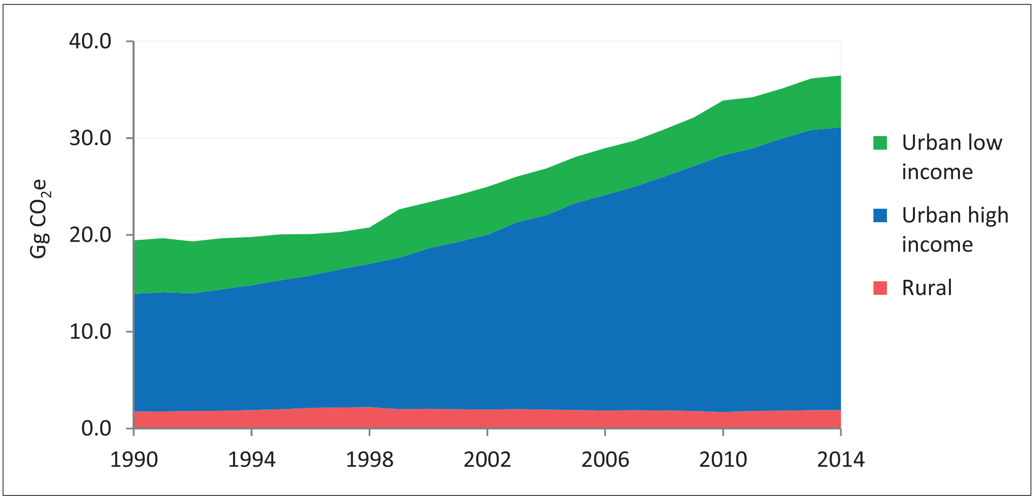

Figure 7-7: CH_4 emissions from domestic wastewater treatment, by income groups

CHAPTER 7

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 a good practice to treat the three categories: rural population, urban-high income population, and urban-low income population separately.

Mongolia administratively is divided into the capital Ulaanbaatar, 21 provinces called aimag, and aimags into soums. Therefore, population of Ulaanbaatar city was considered as an 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 as 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[3]
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

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[4] 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 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.

[4] 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.*

CHAPTER 7

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[5]. 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 of 0.3 was used for emission calculations.

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

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 the case of Mongolian, even in the capital city and other main cities, wastewater treatment facilities do not have an 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[6].

Therefore, for amount of methane recovered default IPCC value of 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 1990 and 8.14% increase from 2013.

[5] *Green Development Strategic Action Plan for Ulaanbaatar 2020.*

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

As seen from the Figure 7-4, the quantities of emitted nitrous oxide from domestic wastewater sources is at an increasing trend which 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.

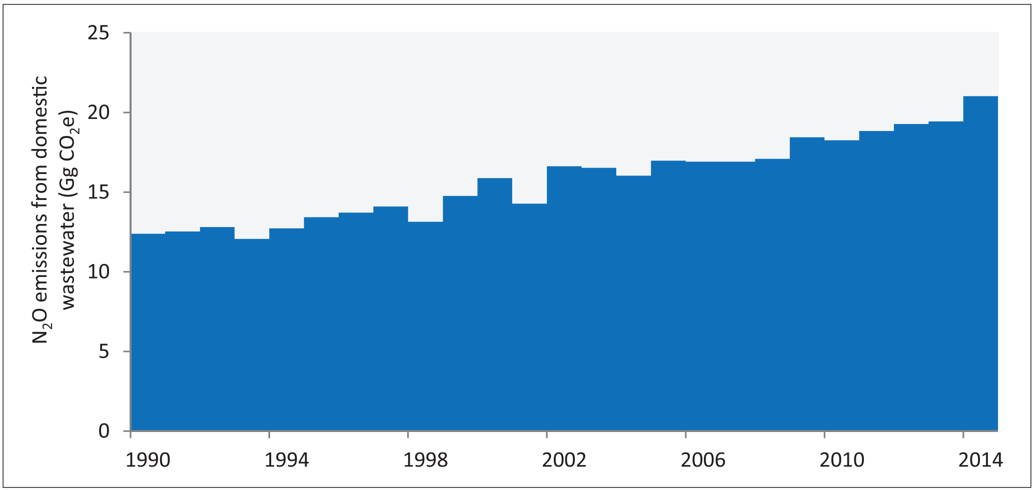

Figure 7-8: N_2O emissions from wastewater domestic sources

7.3.2.3 Activity data and emission factors

Annual number of country population has been obtained from NSO. Approximately 25.19% of the 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 of 1990 and 1991, average value for the years of 1992-1994 have been applied for the years, where data are missing. 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 by 1.84% compared to 2013, due to a decrease in alcohol production. CH_4 emissions from industrial wastewater treatment for the period of 1990-2014 are shown in Figure 3.5-10.

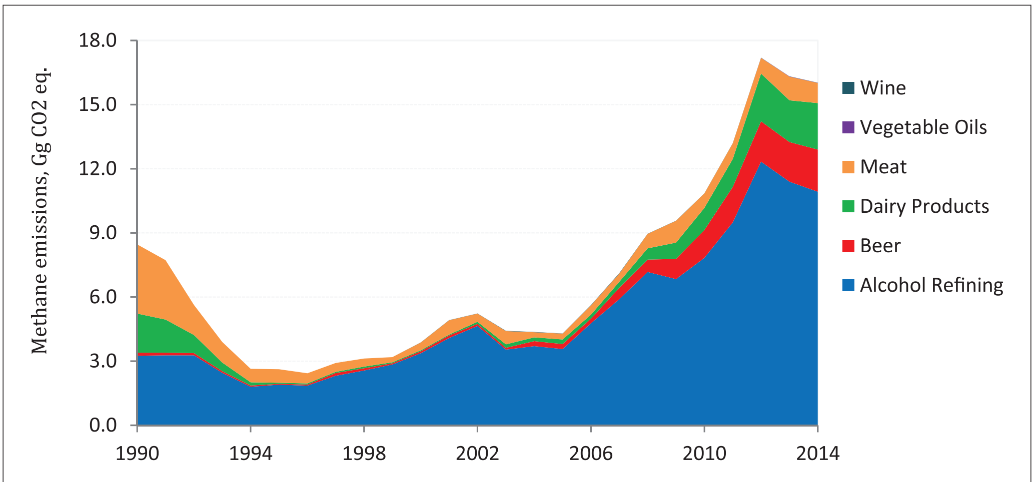

Figure 79: CH_4 emissions from industrial wastewater treatment, by industrial outputs

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 the 90s. Since 2012, emissions have been reduced due to 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 the 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 of 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 Table 7-17, which was used for the entire period of 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.*

CHAPTER 7

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 calculations 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 in 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 the source for 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 its 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	±50%
COD/unit wastewater	
Emission factor	
Methane correction factor (MCF)	±30%;
Maximum Methane Producing Capacity (Bo)	±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	%	-51.00	-67.00	-64.00	-63.00	-61.00	-62.00	-62.00	-61.00	-60.00

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 the 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 becomes available, will be considered to use them in the calculation of the emissions.

ANNEX

ANNEX

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

ANNEX

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

ANNEX

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 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	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

ANNEX

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 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

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

ANNEX

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

ANNEX

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		

ANNEX

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	Railways	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	Railways	N_2O	26.38	28.31	0.006	0.001	0.997
4.D	Wastewater 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

ANNEX

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	Railways	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	Railways	N_2O	26.38	28.31	0.001	0.002	0.963
4.D	Wastewater 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	Wastewater 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	Railways	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 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							
			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

ANNEX

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

ANNEX

ANNEX

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												

ANNEX

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