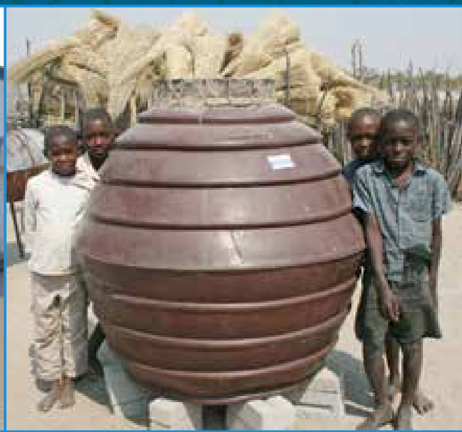
Republic of Namibia
Ministry of Environment & Tourism



FIRST BIENNIAL UPDATE REPORT

of the Republic of Namibia

under the United Nations Framework Convention on Climate Change (UNFCCC)

November 2014

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Foreword

As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), since 1995, Namibia is obligated to prepare and submit Biennial Update Reports (BUR) to the UNFCCC as per the recent decisions. Similar to National Communications (NCs), BUR comprises of a comprehensive national Greenhouse gas inventory covering, energy, waste, Industrial Process and Product Use (IPPU), and Agriculture Forest and other Land Use (AFOLU) sectors, information on mitigation measures and their effects and the monitoring reporting and verification system.

This is the first round of BURs to be submitted and Namibia will be one of the first few developing countries to prepare and submit its BUR on the agreed deadline of December 2014. This BUR builds on the work already done under the Initial National Communication which was compiled and submitted to UNFCCC in 2001, and the Second National Communication which was submitted in July 2011. All of these reports were and are coordinated by the Ministry of Environment and Tourism, with the National Climate Change Committee (NCCC) providing the overall oversight.

Apart from preparing and submitting NCs and BUR to the UNFCCC, Namibia has made considerable strides in addressing the issue of climate change. The Cabinet of the Republic of Namibia passed the National Policy on Climate Change Policy for Namibia in 2011. In order to implement the policy a comprehensive National Climate Change Strategy and Action Plan 2013 to 2020 was developed through a comprehensive consultation process with relevant stakeholders. Making Namibia one of the first few countries to have prepared a policy as well as a strategy and action plan to address climate change.

Hon. Uahekua Herunga
Minister of Environment and Tourism

Acknowledgements

This report has received contributions from various Ministries and Departments, and Private Institutions including social and community organizations of the Republic of Namibia. Their contributions are gratefully acknowledged. The main contributors are listed below. Namibia also acknowledges the financial contribution made by the Global Environment Facility through the UNDP country office as implementing Agency. Namibia also wishes to put on record the support provided by the Consultants of CLIMAGRIC Ltd for capacity building of the national experts and the compilation of the report.

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- NamPower
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Abbreviations And Acronyms

AD	Activity Data
AFOLU	Agriculture, Forest and Other Land Use
ALU	Agriculture and Land Use
BGB	Below Ground Biomass
Bm	Biomass
BUR	Biennial Update Report
CBEND	Combating Bush Encroachment for Namibia's Development
CCU	Climate Change Unit
CBNRM	Community-based natural resource management
CCU	Climate Change Unit
CH_4	Methane
CL	Cropland
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide equivalent
COP	Conference of the Parties
CSU	Colorado State University
dbh	diameter at breast height
DE	Digestible Energy
DEA	Department of Environmental Affairs
dm	dry matter
DoF	Directorate of Forestry
EE	Energy efficiency
ECB	Electricity Control Board
EF	Emission Factor
EMEP/EEA	European Monitoring and Evaluation Program/European Environment Agency
ESA	Eastern and Southern Africa
EFDB	Emission Factor Data Base
FL	Forest Land
FOLU	Forest and Other Land Use
GDP	Gross Domestic Product
GNDI	Gross National Domestic Income
GNI	Gross National Income
GEF	Global Environment Facility
Gg	Gigagram
GG	Grassland Grassland
GHG	Greenhouse Gas
GL	Grass Land
GWP	Global Warming Potential
GWh	Gigawatt hour
ha	hectare
HAC	High Activity Clay
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producers

IPPU	Industrial Processes and Product Use
ITCZ	Inter Tropical Convergence zone
km	Kilometre
KWh	Kilowatt hour
LAC	Low Activity Clay
LPG	Liquefied Petroleum Gas
FOLU	Forest and Other Land Use
mamsl	metres above mean sea level
m	metre
M&E	Monitoring and Evaluation
MCF	Methane Conversion Factor
MET	Ministry of Environment and Tourism
MMC	Mature Male castrate
MME	Ministry of Mines and Energy of Namibia
MMS	Manure Management System
MRV	Measure, Report and Verify
m/s	Metre per second for wind speed
MW	Mega Watt
MWh	Megawatt hour
MWT	Ministry of Works and Transport
NAMREP	Namibian Renewable Energy Programme
NAMCOR	National Petroleum Corporation of Namibia
NAMREP	Namibia Renewable Energy Programme
N	Nitrogen
Nadj	Nitrogen adjustment
NAMA	Nationally Appropriate Mitigation Action
NC	National Communications
NCCC	Namibia Climate Change Committee
NDP	National Development Plan
Nex	Nitrogen excretion factor
NH_3	Ammonia
NIIP	National Inventory Improvement Plan
NMS	National Meteorological Service
NMVOCs	Non-Methane Volatile Organic Compounds
NNFU	Namibia National Farmers Union
NO_x	Nitrogen Oxides
N_2O	Nitrous Oxide
N$	Namibian dollar
NSA	Namibia Statistics Agency
OFID	OPEC Fund for International Development
OGEMP	Off - Grid Energisation and Master Plan for Namibia
OL	Other Land
QA/QC	Quality assurance and Quality Control
PES	Payments for Environmental Services
PPAs	Power Purchase Agreement
PRP	Pasture Range and Paddock
RA	Reference Approach

REDD	Reducing Emissions from Deforestation and forest Degradation in Developing Countries
REP	Renewable Energy Policy
RET	Renewable Energy Technologies
REDMP	Rural Electrification Distribution Master Plan
S	Settlement
SADC	Southern African Development Community
SAN	Sandy Mineral
SA	Sectoral Approach
SADC	Southern African Development Community
SAPP	South African Power Pool
SADC	Southern African Development Community
SH	Shrubland
SO_2	Sulphur Dioxide
SWS	Solar Water System
SWH	Solar water heater
TJ	Tera joule
TNC	Third National Communication
TRD	Tropical Dry
TRMD	Tropical Montane Dry
TRW	Tropical Wet
toe	Tonnes of oil equivalent
TWh	Terawatt hour
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VS	Volatile Solid
WD	Woodland
WET	Wet mineral
WL	Wet Land
YF	Young Female
YIM	Young Intact Male
yr	Year

Excutive Summary:

National circumstances and institutional arrangements relevant to the preparation of the national communications and Biennial Update Reports on a continuous basis

Namibia's development is guided by its long term vision, Vision 2030, with the main objective of achieving a prosperous and industrialized Namibia, developed by its human resources, enjoying peace, harmony and political stability. Namibia ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 as a Non-Annex I Party, and as such, is obliged to submit information in accordance with Article 4, paragraph 1 of the Convention. Among these: (a) a national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHG) not controlled by the Montreal Protocol, using comparable methodologies; (b) a general description of steps taken or envisaged to implement the Convention and (c) any other information relevant to the achievement of the objective of the Convention.

With the adoption of the Cancun Agreements at COP 16 in 2011, the reporting by non-Annex I Parties in national communications, including national GHG inventories, should also include information on mitigation actions and their effects and support received, submit Biennial Update Reports (BURs). BURs, containing updates of national GHG inventories, an inventory report and information on mitigation actions, needs and support received and Institutional Arrangements, every two years with the first one due in December 2014.

The NCCC oversees the implementation of the climate change policy and the Ministry of Environment and Tourism (MET) is responsible for coordinating and implementing climate change activities, including the preparation of the National Communications and BUR. With the enhancement of the reporting requirements that came into force since the last few years and also the revised improved standards of the national communication and the newly introduced BUR, these past institutional arrangements have become outdated and need to be revisited.

Within the planned institutional arrangements, there will be a sharing of responsibilities with the coordinating body taking on most of the planning, preparation, quality control, archiving, evaluation and validation. The other stakeholders will concentrate on the preparation of the technical components, including data collection and validation, performing technical tasks like compilation of the GHG inventory, producing draft reports and documenting these.

Capacity building of the national experts started on the UNFCCC process within the BUR1 context and included reporting and other obligations of the country as a signatory Party. The next item was the compilation of GHG inventories as this is a major component of the first BUR and the latest decision being for the national experts to take over this activity that has been previously outsourced. Namibia has opted to meet the December 2014 deadline for submission of its first BUR, the time available for the preparation after accessing funds was only one year, making it difficult to develop and implement successfully the institutional arrangements. Other constraints include insufficient personnel within the coordinating body to sustainably oversee all the processes under it, lack of staff in the other institutions to devote the required time for the technical tasks and to meet deadlines for activities under their responsibility, staff movement resulting in loss of capacity especially when succession cannot be planned and implemented due to staff shortage

Namibia is situated in South-Western Africa, between latitude 17° and 29°S and longitude 11° and 26°E, and covers a land area of 825,418 km2. Namibia is one of the biggest and driest countries in sub-Saharan Africa, and is characterized by high climatic variability in the form of persistent droughts, unpredictable and variable rainfall patterns, variability in temperatures and scarcity of water. In spite of its very dry climate, Namibia holds a remarkable variety of species, habitats and ecosystems ranging from deserts to subtropical wetlands and savannas.

Agriculture plays a pivotal role in the socio-economic base of the country's population. It is one of the foundations of

Namibia's economy, as it is a vital source of livelihood for most rural families in term of food generation with approximately 48% of Namibia's rural households depending on subsistence agriculture (NDP4). Agriculture also generates substantial income for the country and when combined with forestry, it is presently the second highest primary industry contributor to GDP with 5.9 per cent. Additionally, these two sectors contribute significantly in the emissions and removals of the national GHGs balance, and as such offer mitigation potentials for curbing down emissions. Namibia has one of the most productive fishing grounds in the world and the fishing industry has grown to become one of the pillars of the Namibian economy.

Community conservation in Namibia covers over 159,755 km2 which is about 52.2% of all communal land, home to about 172,000 citizens. It is estimated that between 1991 and 2012, community conservation has contributed about N$2.9 billion to Namibia's net national income. At the end of 2014, there were 32 registered community forests in Namibia, an indication of the country's commitments to fully contribute to international targets of enhancing sink capacities of forests through better management.

Mining is the backbone of Namibia's national economy and contributes 11.5% to the country's Gross Domestic Product (GDP) in 2012. The manufacturing sector, a priority sector under the NDP4, is estimated to have recorded a constant growth of 1.2% in 2012 and 2011.

Regarding electricity, Namibia currently has three power stations. These include the hydroelectric Ruacana power station with the generation capacity of 240 MW; the Van Eck coal power station with a production capacity of 120 MW and the Paratus diesel plant with a capacity of 20 MW. The local supply (about 400 MW), which also includes a certain amount of solar energy that are not accounted for under these plants either as solar water heaters and off-grid photovoltaic systems, does not meet the national demand, currently at around 550 MW. Thus, Namibia imports this difference from South Africa and other Southern Africa Development Community (SADC) neighbouring member states.

Namibia's road network is regarded as one of the best on the continent with a total road network of more than 64,189 km, including 5,477 km of tarred roads which link the country to the neighbouring countries. The country has two ports handling imported and exported merchandise, and servicing the fishing industry. Passenger transport is mainly carried out by minibuses and sedans and is increasing in intensity. The railway network comprises 2,382 km of narrow gauge track.

Namibia is feeling the pressure of amounts of waste generated especially in the urban areas. Solid municipal waste are dumped in landfills or open dumps while almost all urban settlements are connected to reticulated waste water treatment systems. Management of the landfills and dumps are not at the highest standards and very often, the waste are burnt in the open dumps to reduce the volume or reduce health risks.

The domestic economy is estimated to have expanded by 5.0% during 2012, compared to 5.7% in 2011 (NSA, 2013). The primary and tertiary industries on the other hand recorded increases of 12.8% and 6.4% in value added, respectively.

According to the 2011 Namibia National Population and Housing census, the total population of Namibia was estimated at 2 113 077 people, with 14% of the population under 5 years, and 7% is 60 years and above. Nearly 57% of the population lives in rural areas. The urban population grew by nearly 50% between 2001 and 2011, illustrating the high rates of rural-urban migration. General life expectancy has not improved, partly because of the HIV/AIDS epidemic. Malnutrition levels in children under the age of five years are as high as 38% in some regions.

NATIONAL GREENHOUSE GAS INVENTORY

In line with Decisions adopted during COP16, Namibia is committed to provide updates to the national communications in BURs to be submitted every two years. The BUR should contain a full inventory for a year dating no more than 4 years from the date of submission of the BUR. The inventory presented in this report is at the national level and covers all the IPCC sectors subject to availability of activity data. The four sectors Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry, and Other Land Use (AFOLU) and Waste have been covered. The gases covered in this inventory are the direct gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and the indirect gases nitrogen oxides (NO_x), carbon monoxide (CO), non-methane organic volatile compounds (NMVOCs) and sulphur dioxide (SO_2).

The present national GHG inventory has been prepared in accordance with the IPCC 2006 Guidelines for National Greenhouse Gas Inventories and using the IPCC 2006 software for the compilations. As the IPCC 2006 Guidelines do not extensively cover all the GHGs, it has been supplemented with the European Monitoring and Evaluation Program/ European Environment Agency (EMEP/EEA) air pollutant and emission inventory guidebook for compiling estimates for nitrogen oxides (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2). All methodologies and tools recommended by IPCC within the inventory cycle have been used and followed to be in line with Good Practices.

Country-specific activity data (AD) are available within the existing statistical system whereby data pertaining to most of the socio-economic sectors are collected, verified and processed to produce official national statistics reports. Data gaps were filled through personal contacts and/or from results of surveys, scientific studies and by statistical modelling. Expert knowledge was resorted to as the last option. In a few isolated cases, due to the restricted timeframe and the inexistence of a declared national framework for data collection and archiving to meet the requirements for preparing GHG inventories, derived data and estimates were made to fill in the gaps.

For the FOLU sector, remote sensing technology was used whereby maps were produced from LandSat satellite imagery for two time steps, the years 2000 and 2010. These maps were then used to generate land use changes from the land covers obtained for these two time steps.

Country emission factors (EFs) were derived, for the tier 2 estimation of GHGs for a number of animal classes within the livestock sector and the FOLU sector where stock factors were derived to suit national circumstances. This is Good Practice towards enhancing the quality of the inventory and especially as these activity areas were major emitters of GHG. Additionally, default IPCC EFs for the remaining source categories were assessed for their appropriateness prior to use.

The findings showed that Namibia remained a net GHG sink in 2010 with the sink capacity increased compared to the year 2000 and 1994. The net removal of CO_2 reached 22 895.53 Gg in 2010 compared to 8542 Gg in the year 2000 and 3890 Gg in 1994.

In 2010, total methane (CH_4) emissions was 204.86 Gg, nitrous oxide (N_2O) stood at 6.81 Gg while the indirect GHGs nitrogen oxides (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide were at 35.07, 314.92, 34.05 and 3.76 Gg respectively.

The Agriculture, Forest and Other Land Use (AFOLU) sector was a net sink of 27 680.47 Gg CO_2 while the Energy sector emitted 2561.49 Gg, the Industrial Processes and Product Use (IPPU) sector 2220.98 Gg and the Waste sector 2.47 Gg. The AFOLU sector topped the different sectors for CH_4 with 194.79 Gg followed by the Waste sector with 6.89 Gg, the Energy sector with 3.11 Gg and IPPU with 0.07 Gg. The Agriculture, Forestry and Other Land Use sector emitted 95 % of the total 204.86 Gg of CH_4 followed by the Waste and Energy Sector. Regarding nitrous oxide emissions (N_2O), the AFOLU sector emitted 6.21 Gg, IPPU 0.36 Gg, Energy 0.13 and Waste 0.10 Gg. Emissions from the AFOLU sector accounted for 91 % of the total emissions. Among the indirect GHGs, AFOLU was the highest emitter for CO and Energy for NO_x and SO_2, and AFOLU for NMVOCs.

In 1994, total aggregated emissions for all gases for all sectors was 5685 Gg CO_2-eq and removals amounted to 5716

Gg CO_2 making the country a net sink of 31 Gg CO_2-eq. Of a total of 9123 Gg of CO_2-eq emitted in 2000, the largest contributor was methane (6758) and carbon dioxide (2024 Gg). When taking the removal of 10566 Gg CO_2 by the AFOLU sector, the net sink capacity increased to 1443 Gg CO_2-eq. In 2010, a similar situation is observed with a net sink of 16484 Gg CO_2-eq at national level. Therefore, the sink capacity of Namibia increased by 1413 and 15 041 Gg CO_2-eq for the period 1994 to 2000 and 2000 to 2010 respectively. The removal of CO_2 increased by 85% from 1994 to 2000 and by a further 162% in 2010.

On the other hand, CH_4 emission decreased by nearly 36%, i.e. from 6758 in 2000 to 4302 Gg CO_2-eq in 2010. Emissions of N_2O increased by nearly six-fold, from 341 Gg CO_2-eq in 2000 to 2110 Gg CO_2-eq in 2010.

Throughout the period 1994, 2000 and 2010, the Energy sector remained the highest emitting sector followed by IPPU while the waste sector contributed only a small portion of the GHG emissions. The AFOLU sector increased its sink potential and at the three time steps, this outweighed the emissions from all sectors to result in the country being a net sink.

Quality control and assurance (QC/QA) procedures, as defined in the IPCC 2006 Guidelines, have been implemented during the preparation of the inventory. Whenever there were inconsistencies or possible transcription errors, the responsible institution was queried and the problem discussed and solved. QC was implemented through (a) routine and consistent checks to ensure data integrity, reliability and completeness; (b) routine and consistent checks to identify errors and omissions; (c) accuracy checks on data acquisition and calculations; (d) The use of approved standardized procedures for emissions calculations; and (e) technical and scientific reviews of data used, methods adopted and results obtained. On the other hand, QA was undertaken by independent reviewers who were not involved with the preparation of the inventory in order to (a) confirm data quality and reliability; (b) review the AD and EFs adopted within each source category as a first step; (c) review and check the calculation steps in the software;

The uncertainty analysis has been performed using the tool available within the IPCC 2006 Software for the national inventory with and without Forest and Other Land Use (FOLU). For the national inventory, Uncertainty without FOLU was 7.1% while when FOLU was included it rose to 72.5%.

The Key Category Analysis also was performed using the tool in the IPCC 2006 Software when the compilation process was completed. There are six key categories, five of these from the AFOLU sector and the last one is Road Transportation from the Energy sector.

All raw data collected for the inventory have been stored in a database and in the 2006 software data base after being processed and formatted for making estimates of emissions and removals. All documentation on the data processing and formatting have been kept in soft copies in the excel sheets with the summaries reported in the BUR.

Based on the constraints and gaps and other challenges the following improvements have been identified and will be addressed during the preparation of Namibia's Third National Communications (NC3) and the second Biennial Update Report (BUR 2) inventories. These include (a) adequate and proper data capture, quality control, validation, storage and retrieval mechanism are required, (b) capacity building, to strengthen existing institutional framework, to provide improved coordinated action for reliable data collection and accessibility, (c) developing improved emission factors (EFs) more representative of the national context; (d) implementing fully the QA/QC system in order to reduce uncertainty and improve inventory quality; (e) establishment of a GHG inventory unit within DEA to be responsible for inventory compilation and coordination; (f) institutionalization of the archiving system; (g) collection of information on production technology used in the IPPU sector (h) starting data collection for categories not covered in the present exercise; (i) implementation of new forest inventories to supplement available data on the FOLU category; (j) reviewing and correcting inconsistencies existing for the recent land cover maps with additional overlays with previous maps and ground referencing; (k) production of new maps for 2005 to refine land use change data over 5 years; (l) refining data collection for determining country specific weights for dairy cows, sheep and goats; and (m) developing the digestible energy (DE) factor for livestock.

MITIGATION ACTIONS AND THEIR EFFECTS, INCLUDING ASSOCIATED METHODOLOGIES AND ASSUMPTIONS

Namibia has mainstreamed and integrated climate change, including mitigation, in its development plans. In order to pave the way to implementing mitigation and adaptation, Namibia established the NCCC in 2001. Other crucial milestones followed when Cabinet approved the first NPCC in 2011 and the NCCSAP in 2014, which set out the country direction towards addressing climate change mitigation. These two documents highlight the need for support to the country efforts in order for it to meet the national obligations and international commitments. Namibia has also to-date implemented a number of mitigation measures in various economic activities to curb down emissions such as increasing the share of renewable energy in the electricity generation, residential, manufacturing and commercial sectors amongst others while increasing sink capacity in the forest sector. However, these measures have mostly been implemented on a stand-alone basis as the country has not yet developed a mitigation plan and its NAMAs.

A list of the measures developed and implemented is provided in in this report along with information estimates of GHG emissions avoided or planned as well as other sustainable development benefits. It is estimated that the country is presently mitigation more than 1000 Gg of CO_2, excluding avoided emissions of the other direct gases. Short term plans aim at avoiding emissions of some 55 000 Gg CO_2, again not including CH_4 and N_2O. Concurrently, the country will be implementing its MRV system and this should enable it to widen the scope while enhancing the quality and quantitative assessment of these mitigation activities.

INFORMATION ON MRV OF DOMESTICALLY SUPPORTED NAMAS

Namibia has in place its own Monitoring and Evaluation (M&E) process to support its development agenda as laid out in the Fourth National Development Plan (NDP 4). Government has implemented a continuous M&E process through its National Planning Commission and the relevant sectors with a view to assessing progress on the various goals and strategies implemented under the NDP4, including those of the Ministry of Environment and Tourism which encompasses climate change. The concept of MRV being proposed now within the climate change framework is more demanding in terms of outputs and indicators which entail a reorganisation of the existing M&E system.

Namibia has not yet prepared or submitted any domestically supported NAMA to the UNFCCC registry. It has thus not developed and implemented an MRV system for these activities. Given the new enhanced reporting context in terms of frequency and the introduction of the BUR, the country has reviewed its stand on reporting and has decided to produce these reports in-house accompanied and supported by consultants to provide the necessary capacity building to the national experts over the coming years. In parallel, the collaboration of the institutions will be secured within the national institutional arrangements framework and the wider national M&E system for implementing the climate change policy, to support the development and implementation of the MRV system for the GHG inventory and mitigation including domestically supported NAMAs in the future.

The responsibility of implementing and running the MRV system will be under the CCU of the MET as the institution having under its mandate the overall coordination, compilation and submission of National Communications, BURs and national reporting. Changes are proposed to have the institutions to implement the system according to the new standards and requirements according to their capabilities while overcoming other constraints such as appropriate capacity and staff availability. The present formal arrangements will be kept and all the institutions will be able to embrace and adopt the new concept successfully on a continuous basis.

The GHG inventory remains as the baseline exercise within the MRV system for NAMAs and other mitigation actions. Namibia outsourced its two previous inventories and no system exists for producing GHG inventories. The country has embarked on the process to establish the appropriate framework to produce future GHG inventories in-house through a more active participation of the key stakeholders. In-depth discussions took place on what would be the best framework for establishing a structure that will work on a continuous basis for producing the inventories regularly for reporting in the NCs and BURs. All agreed on sharing the responsibilities for the compilation exercise between different departments of the key Ministries with MET overseeing the process. A first mapping of national institutions and organizations was completed to identify other stakeholders that would contribute in one way or the other for the inventory compilation.

In line with the Convention, Namibia will continue to adopt IPCC methods and tools. The recent decision is to move to the more user-friendly and less heavy IPCC 2006 Guidelines and software as it combines the Revised 1996 Guidelines and the GPGs of 2000 and 2003. In addition to the IPCC 2006 Guidelines, the country will attempt at using the ALU software, http://www.nrel.colostate.edu/projects/ALUsoftware/ which conforms to the IPCC reporting format to move to tier 2 for the AFOLU sector since the 2006 Guidelines compiles the inventory at tier 1 level only.

Namibia has yet to develop its NAMAS and as such has not felt the need to establish and implement a system to track their benefits in terms of emission reductions or sink enhancements as well as indirect returns within the wider context of sustainable development. The country will now devise the concept of MRV for NAMAs and mitigation more generally. The institutional arrangements will follow closely those described above for the GHG inventory, involving the same institutions but with somewhat different responsibilities within the system.

No special capacity building activities have been realized with respect to NAMAs. Training will be continuously provided to all stakeholders as the system is further developed, established and implemented. The institutional arrangements will be strengthened based on lessons learned through the development and establishment process as well as on constraints and challenges faced. CCU is already understaffed and meeting the challenges on the MRV in terms of coordination, follow-up of implementation, quality control, documentation and quality assurance will be very difficult.

Support will be required to address problems encountered with the institutional arrangements, namely to strengthen it to acquire enough robustness to meet the requirements to deliver efficiently and successfully. Lack of technical capacity for making appropriate measurements and data collection, their processing and reporting will have to be addressed urgently. As well, the national experts in the various departments will need capacity building for implementation, follow-up, quality control and reporting. Unless technical assistance is provided, the country will have to look for alternatives, such as outsourcing resource persons to provide for these capacity building needs. Financial resources are also lacking to implement the MRV system. Already, government budget is strained due to the numerous national priorities and it may prove difficult to allocate enough funds to cover all these expenses.

To-date no support specific to the development, establishment and implementation of the MRV system has been received directly. The country has pulled upon resources from other projects or from its BUR and TNC allocations to start the capacity building process for the production of its GHG inventories. While this will partially fulfill the purpose of the Measurement aspect, capacity still has to be acquired for the Reporting and Verification components. Technical assistance within the Eastern and Southern Africa capacity building project for GHG inventories of the UNFCCC has been tapped for starting the development and implementation of an inventory management system and its institutional arrangements as well as compilation of the GHG inventory for the AFOLU sector using the ALU software. In parallel, GEF funds from the NC3 have been invested to give a first training to sectoral experts for compiling GHG inventories.

CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS, INCLUDING A DESCRIPTION OF SUPPORT NEEDED AND RECEIVED

Numerous constraints and gaps exist for Namibia to report to the required standards and frequency to the UNFCCC as a result of improvements in the approach to inventories, but also through internal national re-organisation, e.g. the shift from outsourcing (external consultants) to in-house (use of national institutions and experts in line/sector and academic institutions) reporting. Constraint removal and filling of gaps are deemed possible in the medium and longer term with continuous sustained national efforts as it is presently planned. However, for this target to be met successfully, it will basically require urgent sustained support from bilateral and multilateral partners as technical assistance and the necessary resources from donor institutions to enable the country effectively transfer the much needed knowledge.

Implementation of mitigation actions is a major challenge in view of the multiple constraints and gaps that exist in various areas, namely at the institutional, organizational and individual levels. There is a need to create the enabling environment in Namibia. Barriers will have to be removed to speed up the process of implementation of mitigation while enhancing the identification of new mitigation measures and prepare project proposals for funding thereon.

For Namibia to meet its reporting obligations and implement the Convention requires substantial funding. The appropriate funding amounts and timing are important features to take into consideration when these actions, especially the implementation aspect, are aligned with the country's development strategy and agenda. Namibia as a developing country with its challenges to feed its population and provide the minimum requirements to it is not able to allocate the funding requirements to meet the climate change agenda. While it is recognized that the international community is providing support through the implementing agencies of the GEF, the amounts are insufficient and there are often problems in the timing for the release of the funds that prevents the country to meet the frequency of submission of the national reports. Implementation is even more difficult as a result of the significant amounts of funding required to develop and implement mitigation projects. Up to now, Namibia has not tapped much funding to support its mitigation strategy.

Mitigating climate change requires the latest technologies and its smooth transfer that demands for appropriate and sufficient capacity as well as funds. This exercise is being done piecemeal within the national communications framework, which does not provide adequate funding to conduct a comprehensive country wide TNA, and this approach is delaying both the exhaustive assessments on vulnerability and adaptation to and mitigation of climate change, and the associated cross-cutting issues. Thus the absence of adaptation and mitigation plans (NAMAS and NAPAs) to inform the private sector and public entities, including MTA and MoF, and other vital stakeholders (e.g. NAMPOWER, NAMWATER, Mining and Road infrastructural development, to mention just a few) and to develop a proper national implementation plan, that is owned and credible.

INFORMATION ON THE LEVEL OF SUPPORT RECEIVED TO ENABLE THE PREPARATION AND SUBMISSION OF BIENNIAL UPDATE REPORTS

The Global Environment Facility (GEF) through the UNDP as the GEF Implementing Agency, provided funds to the tune of USD 352 000 to support Namibia prepare its First Biennial Update Report (BUR1) for the fulfilment of its obligations under the UNFCCC. The government of the Republic of Namibia provided in kind support for the project to the value of USD 50 000 in order to realize this enabling activity. The line / sector Ministries, private sector including parastatals provided their generous in-kind support through the release of technical officials to work on the inventory as well as contribute through national workshops and technical working sessions.

Capacity to prepare the BUR is low in most Non-Annex I countries, including Namibia, due to the fact that the BUR is a new requirement and the guidelines on its preparation are not very explicit and capacity enhancement efforts need to be improved so that the teams involved can acquire skills and knowledge to for the future BURs and sustainability to prepare them. Namibia participated in a few capacity building initiatives directly and indirectly related to the preparation of its BUR1. It should however be stressed that substantial additional capacity building is required. This is mainly to ensure that there is a full institutionalization of the process, leading to ownership of the reported data and subsequent actions to realize national commitments.

ANY OTHER INFORMATION RELEVANT TO THE ACHIEVEMENT OF THE OBJECTIVE OF THE CONVENTION AND SUITABLE FOR INCLUSION IN ITS BUR

Namibia has not yet identified and worked on NAMAs except for current work on designing one NAMA on rural electrification using renewable energy in off-grid systems. The country is strengthening its mitigation assessment within the context of its NC3. Based on these results, Namibia will attempt at developing a mitigation plan in accordance with the national development strategies and plans.

Namibia is facing a severe problem of invader bush in its pastureland, thereby threatening its livestock industry, a major economic engine of the country. Invader bush can be exploited sustainably for producing electricity and heat and this activity will be further assessed for its development to reduce dependency on fossil fuels while rehabilitating the pastureland. Namibia is also enhancing its capacity to participate in the REDD+ programme.

As noted in the GHG Inventory chapter agriculture in particular, and AFOLU in general, is a key sector in Namibia, that need to be enhanced to fulfil its role as a carbon sink in the medium to the long-term frame. This will require a strategic approach that support small scale subsistence agricultural farmers, with means, technologies, tools and knowledge, to ensure that their agricultural land use practices that they undertake are improve the capacity of the agricultural landscapes to serve as sinks. Measures and best practices undertaken in Payment for Ecosystem Services, can be used to provide improved incentives to farmers so that they meet their immediate food and nutritional needs while improve ecosystem integrity.

Chapter 1:

National circumstances and institutional arrangements relevant to the preparation of the national communications on a continuous basis

1.1 INTRODUCTION

Namibia's development is guided by its long term vision, Vision 2030, and the current Fourth National Development Plan (NDP4). The objective of the vision is to have a prosperous and industrialized Namibia, developed by its human resources, enjoying peace, harmony and political stability. This section presents the national circumstances of Namibia, detailing the national development priorities, objectives and circumstances that serve as the basis for addressing issues relating to climate change.

1.2 CONVENTION OBLIGATIONS

Namibia ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 as a Non-Annex 1 Party, and as such, is obliged to report certain elements of information in accordance with Article 4, paragraph 1 of the Convention. These elements include:

a. **A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHG) not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties (COP);**
b. **A general description of steps taken or envisaged by the Party to implement the Convention; and**
c. **Any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends**

In order to meet its reporting obligations, Namibia has submitted two national communications (NCs); the initial national communication in 2002 and the second national communication in 2011 with support from the GEF through UNDP. With the adoption of the Cancun Agreements at the COP 16 in 2011, that stipulates the reporting by non-Annex I Parties in national communications, including national GHG inventories, be enhanced to include information on mitigation actions and their effects, and support received. As well, it was also decided that developing countries, consistent with their capabilities and the level of support provided for reporting, should submit Biennial Update Reports (BURs). BURs, containing updates of national GHG inventories, inventory report and information on mitigation actions, needs and support received and Institutional Arrangements are produced, every two years with the first one due in December 2014 as decided in COP 17. Reporting guidelines, also adopted during COP 17 for the UNFCCC biennial update reports for Parties not included in Annex I to the Convention, and contained in Annex III to decision 2/CP.17 is hereby adopted for this report.

The Ministry of Environment and Tourism (MET), through the Directorate of Environmental Affairs (DEA), Division of Multilateral Environmental Agreements is responsible for overseeing the coordination of Climate Change issues in Namibia, and thus the implementation of the BUR project, with the National Climate Change Committee (NCCC), chaired by MET, providing the overall oversight and advisory role.

1.3 INSTITUTIONAL ARRANGEMENTS

The Cabinet of Namibia is the Government entity with the overall responsibility for the development of Climate Change

Policies. The NCCC, which comprises representatives of the various ministries and other stakeholders such as the private sector and NGOs amongst others, oversees the implementation of the climate change policy, including preparation of the reports for submission to the Convention and plays an advisory role to Government on climate change issues. The NCCC was established in 2001 by the MET to direct and oversee further obligations to the UNFCCC. The MET, the official government agency acting as national focal point of the Convention, is also responsible for coordinating and implementing climate change activities, including the preparation of both the National Communication and Biennial Update Reports to enable the country meets its reporting obligations. This is done through the Climate Change Unit (CCU) established within the DEA. Being a formalized and multi-sectoral committee, the NCCC provides the necessary support to the CCU by advising and guiding it for sector-specific and cross-sector implementation and coordination of climate change activities.

The NCCC is chaired by the MET and the deputy chair is the National Meteorological Service in the Ministry of Works and Transport. The NCCC reports to the Permanent Secretary of the MET via the head of the DEA. The NCCC has the powers to establish working groups and subcommittees as required for the follow-up and supervision of specific climate change activities. Such working groups have been active and very useful for overseeing the different thematic areas when preparing previous national communications. Since climate change has a bearing on all socio-economic sectors, therefore various Ministries, Organizations and Agencies actively implement climate change related issues either solely or in collaboration with other stakeholders as required. The CCU within the MET usually directly assists them with planning, development, implementation and coordination of the activities at the local, regional and national levels. The collaboration of existing local and regional structures is secured for supporting implementation and coordination at the level required.

These existing arrangements worked well for the preparation of the two submitted national communications. Preparation of national communications was on an ad-hoc basis and did not require a permanent set-up that would have proven too onerous for the country. Thus, reporting on the different thematic areas was outsourced and the CCU of MET catered for the whole process until the final report has been circulated, reviewed and approved by all stakeholders concerned for submission to the Cabinet for final clearance and submission to the COP. With the enhancement of the reporting requirements that came into force since the last few years and also the revised improved standards of the national communication and the newly introduced BUR, these past institutional arrangements have become outdated. Especially, since the national communication has to be prepared and submitted every four years and the BUR every two years. This situation demands for a permanent structure to enable the sustainable production of these reports while guaranteeing their quality. In addition, there is a need to develop and establish permanent systems for monitoring reporting and verifying mitigation actions and other activities related to the Convention for honouring the country's engagements on measuring, reporting and verification (MRV) on both the national and international fronts.

Conscious that the existing institutional arrangements are no longer appropriate and suitable under these new circumstances, the MET launched itself into a full exercise of reviewing the existing set-up towards developing and implementing new more robust institutional arrangements for meeting the enhanced and more frequent reporting obligations, namely the production of BURs.

One important decision was to shift from outsourcing the different elements of the Convention reports to having them produced in-house. The exercise started after the decision taken during COP 17 in 2012. While the NCCC and CCU were kept in place, an institutional mapping was done by the latter, which kept the responsibility of coordinating the production of the reports, to identify all stakeholders who would have a role and contribution to bring in the production of better quality NCs, the new BURs and eventual development of the MRV system. A round of one to one institutional consultation to engage stakeholders was made and this was followed by formalization through official letters inviting nominations of representatives. Nominees were then called for a brainstorming session to present them the new needs for meeting reporting standards, discuss the implications for the institutions and agree on their role, contribution and responsibilities, namely for the major GHG inventory component. It became evident during these consultations that there existed a serious lack of capacity. An agreement was reached to make an attempt at producing the BUR fully or at least partially, in-house with minimal outsourcing. Concurrently, this will serve in capacity building to enable the stakeholders assume their new responsibilities.

Within the planned institutional arrangements, there will be a sharing of responsibilities with the coordinating body taking on most of the planning, preparation, quality control, archiving, evaluation and validation and the other stakeholders concentrating on the preparation of the technical contents including data collection and validation, performing technical tasks like compilation of the GHG inventory, producing draft reports and documenting these.

During the exercise of strengthening of the existing institutional arrangements, numerous and very daunting challenges cropped up. The most urgent ones were insufficient capacity of the coordinating body as well as lack of institutional and technical skills within the different sectors, maintaining a motivated permanent coordinating body and/or personnel, staff availability in collaborating institutions due to their already overloaded schedules, absence of incentives and adequate funds to develop and maintain the system in place, and staff turn-over. It was also evident that the development and implementation of robust institutional arrangements will take considerable time before it becomes fully operational and runs smoothly. It is anticipated that this will take two to three rounds of BURs and NCs.

The adjusted institutional arrangements are presented below.

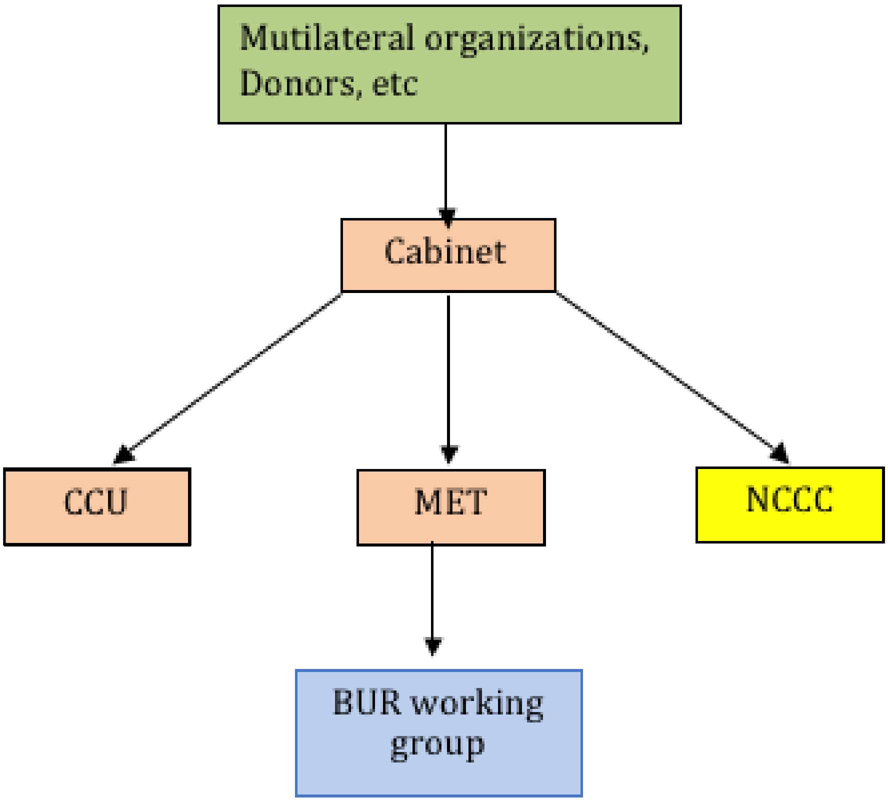


Figure 1.1. Institutional Arrangements for implementing climate change activities

Capacity building started on the UNFCCC process, including reporting and other obligations and followed with the compilation of the GHG inventory component of the first BUR. This took place in a single session due to insufficient resources and need to be further expanded with time as the stakeholders gain hands-on experience when applying the knowledge acquired. The national experts will need technical capacity building on the GHG inventory, mitigation assessment and MRV application. While training to improve coordination exists, it has to be extended on awareness raising of heads of key institutions that can only add to the development and successful implementation of robust institutional arrangements for the sustainable production of BURs and NCs.

There is a cost to maintain staff for the institutional arrangements to function smoothly and it is not easy for the departmental budgets to take over that additional load. Namibia faces numerous challenges in addition to climate change such as meeting the Millennium Development Goals and preserving the environmental balance of its territory.

The development and implementation of robust institutional arrangements remains a very difficult and sensible issue for the country. With Namibia moving from outsourcing to in-house production of reports for the Convention, the time factor is crucial as this exercise is a slow build-up linked with many other requirements. The country having opted to meet the December 2014 deadline for submission of its first BUR, the time available for the preparation after accessing funds was only one year. It was thus very difficult to develop and implement successfully the institutional arrangements. Other recurrent constraints were insufficient personnel within the coordinating body to sustainably oversee all the processes under it, lack of staff in the other institutions to devote the required time for the technical tasks and to meet deadlines for activities under their responsibility, staff movement resulting in loss of capacity especially when succession cannot be planned and implemented due to staff shortage. Their engagements in multiple tasks remain a major difficulty to bring together all required experts for work sessions. Another major gap was lack of knowledge of the nominated staff to deal with CC activities, more so that previous NCs was outsourced. It will take time to fill this gap as capacity building is implemented over the coming rounds of BURs. The existing needs are capacity building of the coordinating body and the technical experts, enough funds to recruit key personnel in the various institutions, technical assistance to support the setting-up of the institutional arrangements and its key features such as quality control, documentation and archiving amongst others. Funds received from the GEF may not be sufficient to cover all the expenditures linked with the maintenance of robust institutional arrangements for producing the BURs and NCs on a sustainable basis.

1.4 GEOGRAPHIPCAL CHARACTERISTICS

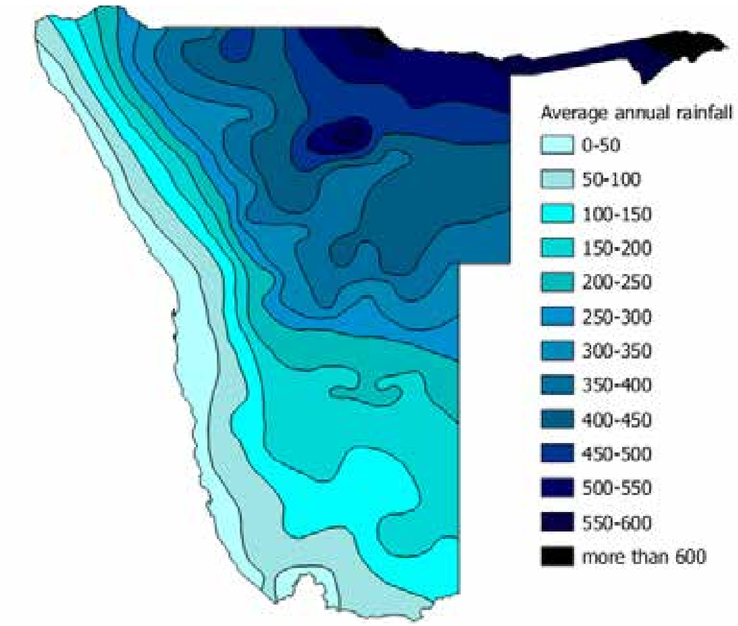
Namibia is situated in South-Western Africa, between latitude 17° and 29°S and longitude 11° and 26°E, and covers a land area of 825,418 km2. It has a 1 500 km long coastline on the South Atlantic Ocean. It is sandwiched between Angola to the North and South Africa to the South. Namibia also borders with Zambia to the far North, and Botswana to the East. The physical geographic context of Namibia is determined by its position at the border of the continental shelf of the Southern African subcontinent in the climatic sphere of influence of the Tropic of Capricorn and the cold Benguela Current. The land surface ascends from the Namib Desert to the mountains of the continental border range with peaks at 2 606 metres above mean sea level (mamsl). To the east and north the country then descends into the Kalahari basin with a mean altitude of 1 000 mamsl. Nearly half of the country's surface is exposed bedrock, while young surfacial deposits of the Kalahari and Namib deserts cover the remainder.

1.5 CLIMATE

Namibia is one of the biggest and driest countries in sub-Saharan Africa, and is characterized by high climatic variability in the form of persistent droughts, unpredictable and variable rainfall patterns, variability in temperatures and scarcity of water. Rainfall ranges from an average of 25 mm in the west to over 600 mm in the northeast. The climate of Namibia is a consequence of the country's location on the south-western side of the African continent, situated at the interface between different climate systems. The cold Benguela Current along the west coast and Namibia's position straddling the sub-tropical high-pressure belt determines the main features of the climate. The Benguela Current brings in cold water to its western shores. The climate of the northern part of the country is influenced by the Inter-Tropical Coverage Zone (ITCZ) and the Mid-Latitude High Pressure Zone, while the southern part of the country lies at the interface between the Mid-Latitude High Pressure Zone and the Temperate Zone. The different seasons experienced in Namibia are driven by the northward and southward movements of these zones, in response to the apparent movements of the sun.

The cold water from the western shores (Benguela current) is adverted from the south and is partly driven by a high-pressure system over the South Atlantic. The combination of cold water and high pressures leads to subsidence of cold dry air over much of the country which commonly suppresses rainfall. This situation is dominant during most of the year, except in summer when heating of the continent is greatest and the southerly position of the ITCZ draws moisture and rainfall from the tropics over northern and eastern Namibia. Therefore, the ITCZ and the Temperate Zone bring rainfall, while the Mid-Latitude High Pressure Zone brings drier conditions.

The movement of the ITCZ towards the south during the Namibian summer results in the rainfall season, normally starting in October and ending in April. In the far south, the Temperate Zone is moving northwards during the winter, resulting in the winter rains that occur in the far south-west of the country. Small variations in the timing of these movements result in the considerable differences in the weather experienced in Namibia from one year to another.



The mean annual rainfall ranges from just above 700 mm in the northeast to less than 25 mm in the southwest and west of the country see figure 1.1 left. The rainfall isohyets generally follow a gradient from the north-east to the southwest. There are exceptions from this general pattern, e.g. the maize triangle of Tsumeb, Grootberg and Otavi receives more rainfall than would be expected in that geographic location. The reason for this is the undulating topography, giving rise to orographic rainfall. On the other hand, the coastal zone receives almost no rainfall at all.

Figure 1.2: Distribution of average annual total rainfall in Namibia Source: Mendelsohn et al., 2012.

Most rain occurs in the summer months from November to April in the form of localized showers and thunderstorms. In the extreme southwest, winter rain and even snow can be expected from June to August. The inter-annual coefficient of variation of rainfall is very high, ranging from 25% in the northeast to >80% in the southwest. At some places in the southern parts of the country, winter rains account for up to 50% of annual rainfall. In the western part of the Namib Desert, coastal fog is an important source of water for the desert fauna and flora. Fog precipitation is five times greater than that of rain and is far more predictable.

Namibia is characterized by high temperatures (see figure 1.2 below left) Apart from the coastal zone, there is a marked seasonal temperature regime, with the highest temperatures occurring just before the wet season in the wetter areas or during the wet season in the drier areas.

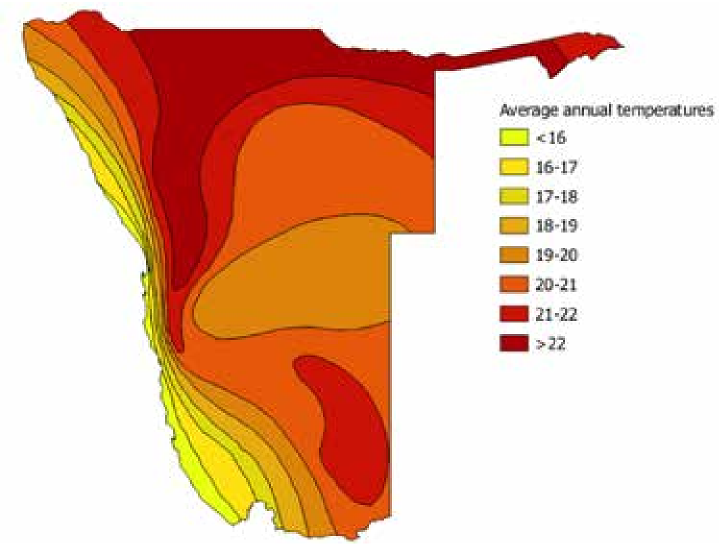


Figure 1.3. Average annual temperature in Namibia Source: Mendelsohn et al., 2012

The lowest temperatures occur during the dry season months of June to August. Mean monthly minimum temperatures do not, on average, fall below 0°C. However, several climate stations in the central and southern parts of Namibia have recorded individual years with negative mean minimum monthly temperatures, and individual days of frost occur widely.

From a hydrological point of view, Namibia is an arid, water deficit country. High solar radiation, low humidity and high temperature lead to very high evaporation rates, which vary between 3 800 mm per annum in the south to 2 600 mm per annum in the north. Over most of the country, potential evaporation is at least five times greater than average rainfall. In those areas where rainfall is at a minimum, evaporation is at a maximum. Surface water sources such as dams are subjected to high evaporation rates.

Wind speeds are generally low in Namibia, only at the coast do mean wind speeds exceed 3m/s, and it is only at isolated climate stations inland, e.g. Keetmanshoop, where the mean wind speeds exceed 2m/s. These winds, and the occasional stronger gusts, do not cause any real problems apart from some wind erosion in the drier parts of the country during the driest part of the year. Away from the coast, relative humidity averages between 25% and 70%. The humidity does change over the seasons with the dry season being less humid than the wet.

1.6 BIODIVERSITY

In spite of its very dry climate, Namibia holds a remarkable variety of species, habitats and ecosystems ranging from deserts to subtropical wetlands and savannas. Namibia is one of the very few countries in Africa with internationally-recognized "biodiversity hotspot". Namibia's most significant "biodiversity hotspot" is the Sperrgebiet, which is the restricted diamond mining area in the Succulent Karoo floral kingdom, shared with South Africa. The Succulent Karoo is the world's only arid hotspot. It constitutes a refuge for an exceptional level of succulent plant diversity, shaped by the winter rainfall and fog of the southern Namib Desert. A large portion of its plants is endemic (MET, 2001).

1.7 WATER RESOURCES

Namibia is the driest country in Southern Africa. Water is a scarce resource and one of the major primary limiting factors to development in Namibia. The effects of climate change, rapid population growth, and rural exodus pose additional challenges and threaten people's livelihoods as well as the balance of the ecosystem. Namibia's rainfall is skewed, with the northeast getting more that the west and south-western parts of the country. Namibia's international boundaries, both northern and southern are marked by the Kunene River in the northwest, the Okavango River in the Central north and the Zambezi and Kwando rivers in the northeast. The Orange River marks Namibia's southern border. It is only in these rivers that perennial surface water resources are found. These rivers are all shared with neighboring riparian states with an obligation for them to be managed and used in terms of the relevant rules of international water law.

Of the water that falls as rainfall in Namibia, it is estimated that only 2% of the rainfall ends up as surface run-off and a mere 1% becomes available to recharge groundwater. The balance of 97% is lost through evaporation (83%) and evapotranspiration (14%). Rainfall often evaporates before it reaches the ground. Another source of moisture comes from fog in the cooler coastal regions where it is an extremely valuable source of moisture to desert animals and plants. The primary sources of water supply are perennial rivers, surface and groundwater (alluvial) storage on ephemeral rivers, and groundwater aquifers in various parent rocks. Additionally, unconventional water sources have been adopted to augment the limited traditional sources. About 45% of Namibia's water comes from groundwater sources, 33% from the Border Rivers, mainly in the north, and about 22% from impoundments on ephemeral rivers (Christelis and Struckmeier, 2001).

1.8 AGRICULTURE AND FORESTRY

Agriculture in Namibia, like in most developing countries, plays a pivotal role in the economy base of the country. Agriculture is one of the foundations of Namibia's economy, as it is a vital source of livelihood for most families in term of food generation. In addition, it is an important sector as it is a predominant occupation for job creation, a major source of income and contributes highly to national foreign exchange earnings for the country. Agriculture and forestry is presently second highest primary industry contributor to GDP with 5.9 per cent, surpassing fishing and fish processing on board (3.6%), while the mining and quarrying industry still remains the highest, contributing 12.4% in 2007.

Approximately 48% of Namibia's rural households depend on subsistence agriculture (NDP4). The majority of rural communities (particularly in the higher rainfall areas of the north) depend directly on forest resources for use as fuel wood, building materials, fodder, food and medicine. It is necessary to ensure the systematic management and sustainability of forest resources.

1.9 FISHERIES

Namibia has one of the most productive fishing grounds in the world, primarily due to the presence of the Benguela current. The Up-welling caused by the current brings nutrient rich waters up from the depths that stimulate the growth of microscopic marine organisms. These in turn support rich populations of fish, which form the basis of the marine fisheries sector. As is the case in other up-welling systems, relatively few species dominate and their abundance can vary greatly in response to changing environmental conditions. Over 20 commercially important fish species are landed using various fishing methods. The off-shore commercial fishery represents the largest component of the fishing industry. Small pelagic (open-water) species (pilchard, anchovy and juvenile mackerel) and lobster are fished along the shallower onshore waters on the continental shelf. Large pelagic species including adult mackerel, demersal (bottom dwelling) hake and other deep- sea species, such as monkfish, sole and crab, are fished in the waters further offshore.

Since Independence in 1990, the fishing industry has grown to become one of the pillars of the Namibian economy. The commercial fishing and fish processing sectors significantly contribute to the economy in terms of employment, export earnings, and contribution to GDP. The fishery sector contributed 4.6% in 2009, compared to 3.7% contributed in 2010, representing a 20% reduction. The sector is a substantial export earner, with over 85% of Namibia's fish output destined for international markets.

1.10 TOURISM

Namibia's unique landscapes and biodiversity support a rapidly developing tourism sector. Travel and tourism's contribution to the Namibian economy is illustrated by the combined direct and indirect impact of the travel and tourism. In 2009, the direct impact of tourism contributed N$3.1 billion to GDP, equivalent to 3.8%, while the direct and indirect impact of tourism amounted to N$11.5 billion to GDP or 14% (NTB, 2011).

a. Communal-area conservancies

Community conservation in Namibia covers over 159,755 km^2 which is about 52.2% of all communal land with about 172,000 residents. Of this area, communal-area conservancies manage 158,247 km^2 which is about 19.2% of Namibia. Since 1991 until 2012, community conservation has contributed about N$2.9 billion to Namibia's net national income. During the year 2012 alone, community conservation generated over N$58.3 million for local communities. In the same year, community conservation facilitated 6,477 jobs in 2012 and 55 conservancies had a total of 99 enterprises based on natural resources (NACSO, 2012).

b. Community forests

At the end of 2012 there were 32 registered community forests in Namibia. The use of all indigenous plant resources is regulated by the Directorate of Forestry (DoF) within the Ministry of Agriculture, Water and Forestry. The Forestry Act of 2001 and the Forestry Amendment Act of 2005 enable the registration of community forests through a written agreement between the Directorate and a committee elected by a community with traditional rights over a defined area of land. The agreement is based on an approved management plan that outlines the use of resources. All residents of community forests have equal access to the forest and the use of its produce. Community forests have the right to control the use of all forest produce, as well as grazing, cropping and the building of infrastructure within the classified forest (NACSO, 2012).

1.11 MINING

Namibia is known world-wide for producing gem quality rough diamonds, uranium oxide, special high-grade zinc and acid-grade fluorspar, as well as a producer of gold bullion, blister copper, lead concentrate, salt and dimension stone. Mining is one of the major contributor of Namibia's national economy with 11.5% of the country's Gross Domestic Product (GDP) in 2012 from 8.2% in 2011.

1.12 MANUFACTURING

Namibian manufacturing is inhibited by a small domestic market, dependence on imported goods, limited supply of local capital, widely dispersed population, small skilled labour force and high relative wage rates, and subsidized competition from South Africa. The manufacturing sector, a priority sector under the NDP4, is estimated to have recorded a constant growth of 1.2% in both years 2012 and 2011. The growth in the sector can mainly be attributed to the sub-sector other food product and beverages that recorded an increase of 6.5%. Other manufacturing that recorded a positive growth in output was textiles, plastic products and diamond processing.

1.13 ENERGY

On the supply side, Namibia currently has three electricity power stations, these includes: the hydroelectric Ruacana power station with the generation capacity of 240 Mega Watts (MW), which depends on the in-flow of rainfall from the catchment areas in Angola; the Van Eck coal power station with a production capacity of 120 MW, with coal imports from South Africa; and the Paratus diesel plant with a capacity of 20 MW. This translates to 380 MW in total. The local supply does not meet the demand. Currently, Namibia imports most of this difference from South Africa and other Southern Africa Development Community (SADC) member states. A special arrangement between the Namibian power utility NamPower and Eskom, the South African Power utility, enables Namibia to buy and utilize the surplus energy from South Africa at affordable rates, with ZESCO in Zambia providing most of the remaining balance. NamPower also imports on a smaller scale from Zambia for supply to the Caprivi region and exports on a small scale to Angola and Botswana (Annual National Accounts, 2012).

1.14 TRANSPORT

Namibia's road network is regarded as one of the best on the continent withy road construction and maintenance being at international standards. Namibia has a total road network of more than 64,189 km, including 5,477 km of tarred roads which link the country to the neighbouring countries Angola, Botswana, South Africa, Zambia and Zimbabwe. The management and maintenance of the national road network is the responsibility of the Roads Authority under the Roads Authority Act, 1999 (Act 18 of 1999).

The country has two ports handling imported and exported merchandise, and servicing the fishing industry. The only deep-sea harbour is Walvis Bay in the Erongo Region. The other harbour is Luderitz in the Karas Region. The Port of Walvis Bay receives approximately 3,000 vessels each year and handles about 5 million tonnes of cargo.

Passenger transport is mainly carried out by minibuses and sedans and increasing in intensity. For business people and tourists, air travel has become a more important means of transport to bridge the long distances. As of December 2013, Namibia had a total of 300 045 vehicles, representing an increase of 66 405 more than in March 2007, when there were a total of 233 640. Out of the total number of vehicles 43.79% of them are light passenger motor vehicle (less than 12 persons), closely followed by light load vehicle (GVM 35000 kg or less), with 43.52%.

The railway network comprises 2,382 km of narrow gauge track with the main line running from the border with South Africa via Keetmanshoop to Windhoek, Okahandja, Swakopmund and Walvis Bay. Omaruru, Otjiwarongo, Otavi, Tsumeb and Grootfontein are connected to the northern branch of the railway network.

1.15 WASTE

Namibia, as a medium income country with a growing wealthy urban middle class, and significant urban drift is feeling the pressure of amounts of waste generated on its facilities throughout the country and more especially in the urban areas. Solid municipal waste are dumped in landfills or open dumps while almost all urban settlements are connected to reticulated waste water treatment systems. Management of the landfills and dumps are not at the highest standards and very often, the waste ate burnt in the open dumps to reduce the volume or reduce health risks. Additionally, in most areas there is no segregation of waste and no separate landfills or dumps implying that industrial waste is dumped along with municipal waste.

1.16 ECONOMIC GROWTH

According to the National Accounts estimates, compiled by NSA in 2013, the domestic economy is estimated to have expanded by 5.0% during 2012, compared to 5.7% in 2011. This decline was attributed to the secondary industry that recorded a slower growth of 3.9% in value added compared to 4.7% registered in 2011. The primary and tertiary industries on the other hand recorded increases of 12.8% and 6.4% in value added, respectively. The slow growth in the secondary industry was primarily owed to the construction that decelerated by recording growth of 12.5% in 2012 from the 19.3% growth registered in 2011.

Gross National Income (GNI) measures national income generated by Namibian factors of production, which are labour, land and capital, both inside and outside of Namibia. Between 2002 and 2012, Gross National Disposable Income (GNDI) has been higher than the GNI because of net inflows in current transfers that have been influenced mainly by high SACU receipts. GNI stood at NAD107 088 million in 2012 as compared to N$ 92 544 million recorded in 2011. GNDI improved to N$ 124 668 million in 2012 from N$ 104 304 million of the preceding year.

1.17 POPULATION

According to the 2011 Namibia National Population and Housing census, the total population of Namibia was estimated at 2 113 077 people. Woman outnumbered man with 1 091 165, compared to 1 021 912. The age composition of the Namibia population indicates that, 14% of the population is under 5 years, 23% between the ages of 5 and 14, 57% between the ages of 15 – 59 years, and only 7% is 60 years and above. A total of 43% of Namibia's population lived in urban areas, while 57% of the population lived in rural areas. The urban population grew by 49.7% between 2001 and 2011, while the rural population decreased by 1.4% over the same period. This trend illustrates the high rates of rural-urban migration in Namibia. The population density is low at 2.6 people per square kilometer in the Khomas Region, where the nation's capital is situated and has the highest population, followed by the northern regions. In Namibia 56% of households are headed by males and 44% by females.

1.18 HEALTH

Namibia's provision of health services is shared between the public and the private sector, the latter focusing on urban areas. Infant and child mortality is comparatively low, but the maternal mortality ratio has increased, despite the fact that over 70% of births are delivered in hospitals. General life expectancy has not improved, partly because of the HIV/AIDS epidemic. Malnutrition levels in children under the age of five years are as high as 38% in some regions. The five leading causes of inpatient deaths (all age groups) are HIV/AIDS, diarrhea, tuberculosis, pneumonia and malaria.

Malaria is one of the major health problems. However, year-on-year incidences of malaria are highly variable, and closely correlated with the prevailing temperature, rainfall and humidity. Malaria is endemic in parts of the north-central and north-eastern regions. In contrast, in north-western and parts of central Namibia, malaria transmission is seasonal and follows the onset of rains; these unstable occurrences increase the risk of malaria epidemics. Approximately 15% of the total Namibian population aged 15-49 is living with HIV/AIDS, but the infection level appears to have stabilized.

Chapter 2:

National Greenhouse Gas Inventory

2.1 INTRODUCTION

Under Article 4.1 (a) of the Convention, each party has to develop, periodically update, publish and make available to the Conference of the Parties (COPs), in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties. Namibia has so far complied to the Convention with regards to national inventories of greenhouse gases and has submitted two inventories so far as components of its first and second national communications. These inventories addressed emissions and sinks for the base years 1994 and 2000 respectively. In line with Decisions adopted during COP16, Namibia is committed now to also provide updates to the national communications in BURs to be submitted every two years. The BUR should contain a full inventory for a year dating no more than 4 years from the date of submission of the BUR. Within this context, Namibia has prepared its BUR including a GHG inventory for the year 2010. Previous inventories submitted in the initial and second national communications have not been updated but are presented and compar4e3d with the 2010 one.

The inventory is at the national level and covers all the IPCC sectors subject to availability of activity data. As per the IPCC 2006 Guidelines, emission estimates have been compiled for the four sectors Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry, and Other Land Use (AFOLU) and Waste. Namibia outsourced its two previous inventories and has decided to now produce its inventories in-house, starting with the one in the BUR1. The process of preparation of GHG inventories started but revealed itself to be a very laborious process due to severe lack of resources and human capacities. This situation has been compounded as funds to support the preparation of the BUR1 became available only last year thus allowing for only one year instead of two for completing this task. Implementation of the different steps of the inventory cycle was thus staged over a year (Figure 2.1) instead of two and this has resulted in some shortcomings in this first inventory prepared by the country.

The gases covered in this inventory are the direct gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and the indirect gases nitrogen oxides (NO_x), carbon monoxide (CO), non-methane organic volatile compounds (NMVOCs) and sulphur dioxide (SO_2).

2.2 METHODOLOGY

The present national GHG inventory has been prepared in accordance with the IPCC 2006 Guidelines for National Greenhouse Gas Inventories and using the IPCC 2006 software for the compilations. As the IPCC 2006 Guidelines do not extensively cover all the GHGs, it has been supplemented with the European Monitoring and Evaluation Program/ European Environment Agency (EMEP/EEA) air pollutant emission inventory guidebook for compiling estimates for nitrogen oxides (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2).

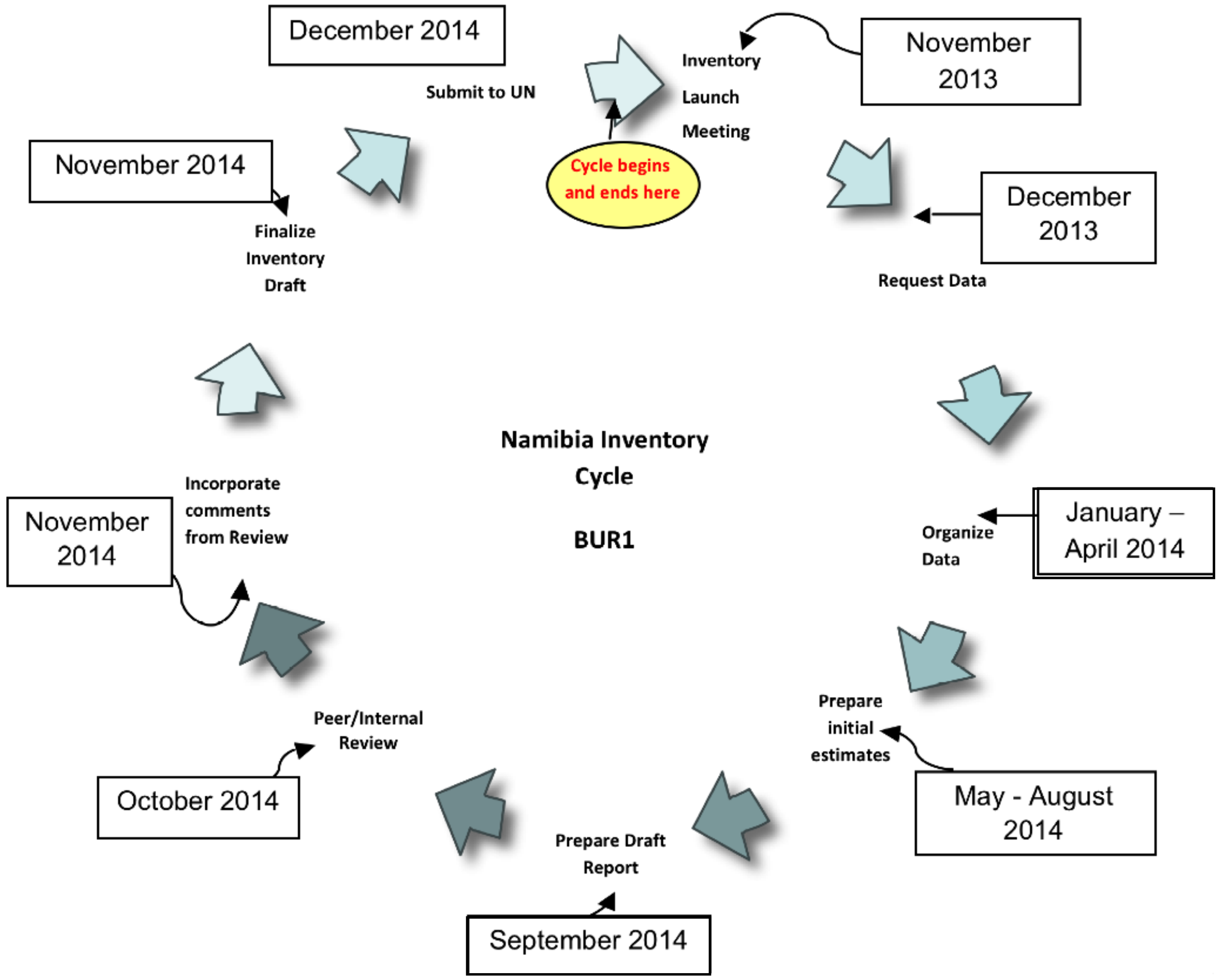


Figure 2.1. Inventory cycle of the BUR1

Generally, the method adopted to compute emissions involved multiplying activity data (AD) by the relevant appropriate emission factor (EF), as shown below:

Emissions (E) = Activity Data (AD) x Emission Factor (EF)

All the methodologies and tools recommended by IPCC within the inventory cycle have been used and followed to be in line with Good Practices.

As the IPCC 2006 Guidelines do not address compilations at the tier 2 level, the Agriculture and Land Use Software of the Colorado State University (CSU) has also been adopted to enable estimates to be made at the tier 2 level partially for the livestock and FOLU sectors. Thus the inventory has been compiled at a mix of tiers 1 and 2 as this is good practice and can improve the accuracy of the emission estimates, thus reducing uncertainties.

Global Warming Potentials (GWP) as recommended by the IPCC have been used to convert GHGs other than CO_2 to the latter equivalent. As per the requirements from decision 17/CP.8, the values adopted were those from the IPCC Second Assessment Report for the three main GHGs, namely:

- Carbon Dioxide 1
- Methane 21
- Nitrous Oxide 310

2.3 ACTIVITY DATA

Country-specific AD are available within the existing statistical system whereby data pertaining to most of the socio-economic sectors are collected, verified and processed to produce official national statistics reports. Thus data collected at national level from numerous public and private institutions, organizations and companies, and archived by the NSA provided the basis and starting point. Additional and/or missing data required to meet the level of disaggregation for higher than the Tier I level, were sourced directly from both public and private sector operators by the team members and coordinators. Data gaps were filled through personal contacts and/or from results of surveys, scientific studies and by statistical modelling. Expert knowledge was resorted to as the last option.

In a few isolated cases, due to the restricted timeframe and the inexistence of a declared national framework for data collection and archiving to meet the requirements for preparing GHG inventories, derived data and estimates were made to fill in the gaps. These were considered reliable and sound since they were based on scientific findings and other observations.

For the FOLU sector, remote sensing technology was used whereby maps were produced from LandSat satellite imagery for two time steps, the years 2000 and 2010. These maps were then used to generate land use changes from the land covers obtained for these two time steps.

Not all the AD required to compile an exhaustive GHG inventory could be collected due to the short timeframe or absence of a proper data collection and archiving system and some categories could not be assessed. Nevertheless, it is considered that the data collected and used to make estimates are of good quality.

2.4 EMISSION FACTORS

Country emission factors were derived for the tier 2 estimation of GHGs for some animal classes of the livestock sector where it was possible for both enteric fermentation and manure management. Similarly, the same exercise was performed for the FOLU sector where stock factors have been derived to suit national circumstances. This is Good Practice towards enhancing the quality of the inventory and especially as these activity areas were major emitters when the previous inventory results were considered. Additionally, default IPCC EFs for the remaining source categories were assessed for their appropriateness prior to being used; namely on the basis of the situations under which they have been developed and the extent to which these were representative of national ones. Details pertaining to the development of the country specific emission factors and the default ones used are given under the sectoral reports.

2.5 RESULTS

Namibia remained a net GHG sink in 2010. Even though the scope of the inventory has widened and the methodology in terms of software used has changed over time, the sink capacity increased compared to the year 2000 and 1994. The net removal of CO_2 reached 22 895.53 Gg. Total CH_4 emissions was 204.86 Gg, N_2O stood at 6.81 Gg while the indirect GHGs nitrogen oxides (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2) were at 35.07, 314.92, 34.05 and 3.76 Gg respectively. The emissions and removals by gas for the different IPCC sectors are presented in Table 2.1 below.

The Agriculture, Forest and Other Land Use (AFOLU) sector was a net sink of 27 680.47 Gg CO_2 while the Energy sector emitted 2561.49 Gg, the Industrial Processes and Product Use (IPPU) sector 2220.98 Gg and the Waste sector 2.47 Gg.

Table 2.1. National emissions and removals (Gg) in 2010

	Emissions (Gg)			Emissions (Gg)				
Categories	Net CO_2	CH_4	N_2O	Other halogenated gases without CO_2 equivalent conversion factors	NO_x	CO	NMVOCs	SO_2
Total National Emissions and Removals	-22895.53	204.86	6.81	NE	35.07	314.92	34.05	3.76
1 - Energy	2561.49	3.11	0.13	NE	20.80	88.63	14.58	3.61
2 - Industrial Processes and Product Use	2220.98	0.08	0.36	NE	0.89	2.85	0.01	0.14
3 - Agriculture, Forestry, and Other Land Use	-27680.47	194.79	6.21	NE	12.99	216.56	19.03	0
4 - Waste	2.47	6.89	0.10	NE	0.39	6.87	0.43	0.01
5 - Other	NA	NA	NA	NA	NA	NA	NA	NA

The AFOLU sector topped the different sectors for CH4 with 194.79 Gg followed by the Waste sector with 6.89 Gg, the Energy sector with 3.11 Gg and IPPU with 0.07 Gg. The Agriculture, Forestry and Other Land Use sector emitted 95 % of the total 204.86 Gg of CH4 as shown in Figure 2.2 followed by the Waste and Energy Sector.

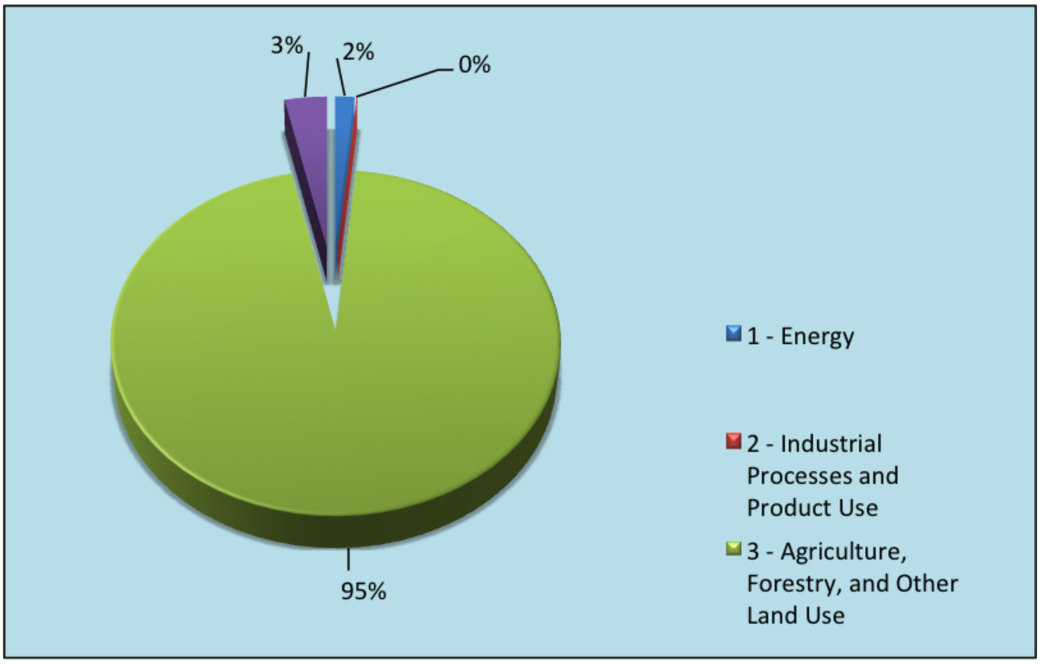


Figure 2.2 – Emissions of CH_4 by sector in 2010 (%)

Regarding N2O, the AFOLU sector emitted 6.21 Gg, IPPU 0.36 Gg, Energy 0.13 and Waste 0.10 Gg. Emissions from the AFOLU sector accounted for 91 % of the total emissions.

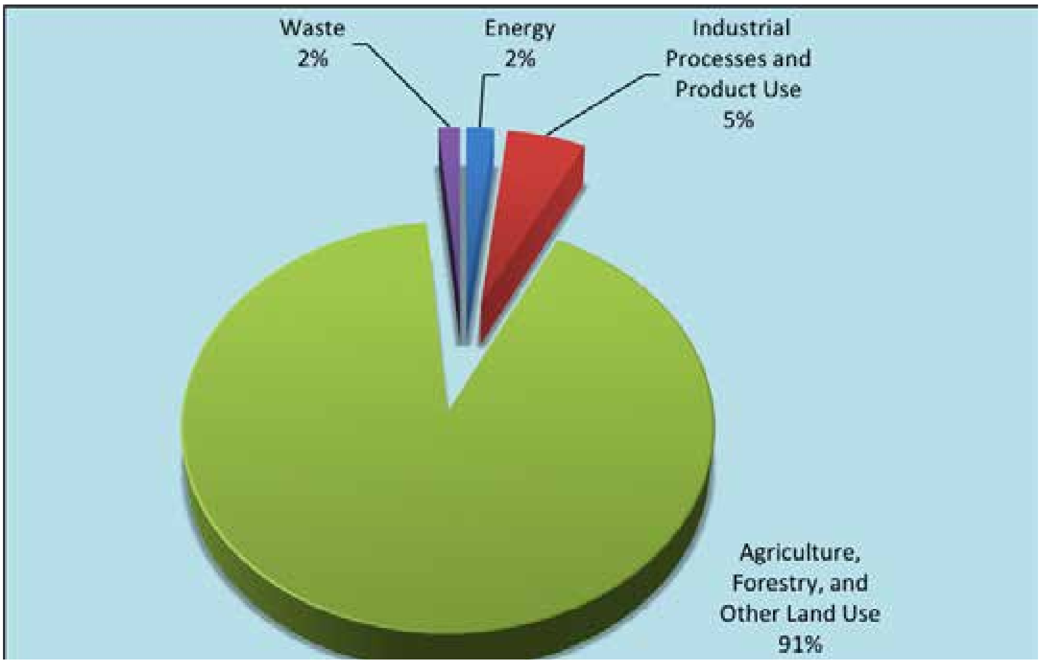


Figure 2.3 – Emissions of N_2O by sector in 2010 (%)

Among the indirect GHGs, AFOLU was the highest emitter for CO and Energy for NOx and SO2 and AFOLU for NMVOCs.

Aggregated emissions and removals for the AFOLU sector for 2010 expressed in CO2-eq for each category are summarized in Table 2.2. Methane accounted for emissions of 4302.1 Gg CO2-eq, CO2 for 4784.9 and N2O for 2109.9 Gg CO2-eq. The important sink (27 680.46 Gg) of CO2 that the sector AFOLU represents shifted the net balance to make Namibia a net sink of 16483.49 Gg CO2-eq for 2010.

Table 2.2 – Emission and removals by sector in Gg CO_2-eq. in 2010

Categories	CO_2	CH_4	N_2O	Total
Total National Emissions/ Removals	-22,895.53	4,302.08	2,109.86	-16,483.49
1 - Energy	2,561.49	65.33	39.68	2,666.57
2 - Industrial Processes and Product Use	2,220.98	1.41	112.84	2,335.37
3 - Agriculture, Forestry, and Other Land Use	-27,680.47	4,090.67	1,926.65	-21,663.16
4 - Waste	2.471	144.67	30.69	177.72
5 - Other	0	0	0	0.0

Table 2.3 – Summary of national emissions and removals in 2010

Categories	Emissions (Gg)			Emissions (Gg)			
	Net CO_2 (1)(2)	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
Total National Emissions and Removals	-22895.53	204.86	6.81	35.07	314.92	34.05	3.76
1 - Energy	2561.49	3.11	0.13	20.80	88.63	14.58	3.61
1.A - Fuel Combustion Activities	2561.49	3.11	0.13	20.80	88.63	14.58	3.61
1.A.1 - Energy Industries	35.53	0.00	1E-03	0.08	4E-03	4E-04	0.30
1.A.2 - Manufacturing Industries and Construction	322.82	0.03	4E-03	1.83	1.08	0.16	0.99
1.A.3 - Transport	1703.85	0.41	0.08	11.32	40.16	4.31	0.03
1.A.4 - Other Sectors	430.26	2.67	0.04	6.84	47.22	10.06	2.28
1.A.5 - Non-Specified	69.03	4E-03	4E-03	0.72	0.16	0.04	3E-04
1 - Industrial Processes and Product Use	2220.98	0.07	0.36	0.89	2.85	0.01	0.14
2.A - Mineral Industry	15.25	0	0	0	0	0	0
2.A.1 - Cement production	0			0	0	0	0
2.A.2 - Lime production	15.25			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	616.34	0	0.36	0.87	0.05	0	0
2.B.1 - Ammonia Production	616.34			0.46	0.05	0	0
2.B.2 - Nitric Acid Production			0.36	0.41	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
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0
2.C - Metal Industry	1561.93	0.07	0	0.02	2.81	0.01	0.14
2.C.1 - Iron and Steel Production	621.05	5E-03		0	0	0.01	0
2.C.2 - Ferroalloys Production	333.37	0.06		0	0	0	0
2.C.3 - Aluminium production	39.78			0.02	2.80	0	0.14
2.C.4 - Magnesium production	0			0	0	0	0
2.C.5 - Lead Production	12.55			0	0	0	0

Categories	Emissions (Gg)			Emissions (Gg)			
	Net CO_2 (1)(2)	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
2.C.7 - Other (please specify)	0	0	0	0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use	27.46	0	0	0	0	0	0
2.D.1 - Lubricant Use	8.19			0	0	0	0
2.D.2 - Paraffin Wax Use	19.27			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
3 - Agriculture, Forestry, and Other Land Use	-27680.47	194.79	6.21	12.99	216.56	19.03	0
3.A - Livestock	0	187.13	0.81	0	0	19.03	0
3.A.1 - Enteric Fermentation		181.20		0	0	0	0
3.A.2 - Manure Management		5.93	0.81	0	0	19.03	0
3.B - Land	-27680.47	0	0	0	0	0	0
3.B.1 - Forest land	-75926.29			0	0	0	0
3.B.2 - Cropland	-368.24			0	0	0	0
3.B.3 - Grassland	48614.07			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-CO_2 emissions sources on land	0	7.66	5.40	12.99	216.56	0	0
3.C.1 - Emissions from biomass burning		7.66	0.70	12.99	216.56	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 N_2O Emissions from managed soils			2.36	0	0	0	0
3.C.5 - Indirect N_2O Emissions from managed soils			1.60	0	0	0	0
3.C.6 - Indirect N2O Emissions from manure management			0.74	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	0	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	0			0	0	0	0
3.D.2 - Other (please specify)	0	0	0	0	0	0	0
4 - Waste	2.47	6.89	0.10	0.39	6.87	0.43	0.01
4.A - Solid Waste Disposal	0	3.40	0	0	0	0.28	0
4.B - Biological Treatment of Solid Waste	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	2.69	0.09	0	0	2E-03	0

Categories	Emissions (Gg)			Emissions (Gg)			
	Net CO_2 (1)(2)	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
5 - Other	0	0	0	0	0	0	0
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0
Memo Items (5)							
International Bunkers	247.72	0.01	0.01	4.11	0.74	0.26	0.98
1.A.3.a.i - International Aviation (International Bunkers)	96.38	1E-03	1E-03	0.41	0.03	0.02	0.03
1.A.3.d.i - International water-borne navigation (International bunkers)	151.34	0.01	4E-03	3.70	0.70	0.24	0.95
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0

EMISSION FOR 1994, 2000 AND 2010

Total GHG emissions, expressed in CO2-eq, for 1994, 2000 and 2010 are summarized in Table 2.4 for the four sectors Energy, IPPU, AFOLU and Waste.

Throughout this period, the Energy sector remained the highest emitting sector followed by IPPU while the waste sector contributed only a small portion of the GHG emissions. The AFOLU category increased its sink potential and at the three time steps outweighed the emissions from all sectors to result in the country being a net sink.

Table 2.4. Aggregated emissions and removals by sector (CO_2 eq) for 1994, 2000 and 2010

Year	1994	2000	2010
Energy	1,905	2,200	2,667
IPPU	5	Not Estimated	2,335
AFOLU	-2,004*	-3,829*	-21,663
Waste	63	180	177
TOTAL	-31	-1,443	-16,484

*- Agriculture and LULUCF combined

EMISSIONS BY GAS (TABLE 2.5)

In 1994, total aggregated emissions for all gases for all sectors was 5685 Gg CO2-eq and removals amounted to 5716 Gg CO2 making the country a net sink of 31 Gg CO2-eq. Of a total of 9123 Gg of CO2-eq emitted in 2000, the largest contributor was methane (6758) and carbon dioxide 2024 Gg. When taking the removal of 10566 Gg CO2 by the AFOLU sector, the net sink capacity increased to 1443 Gg CO2-eq. In 2010, a similar situation is observed with a net sink of 16484 Gg CO2-eq at national level. Thus the sink capacity of Namibia increased by 1412 and 15 041 Gg CO2-eq for the period 1994 to 2000 and 2000 to 2010 respectively.

Table 2.5. Aggregated emissions (Gg) and removals by gas for 1994, 2000 and 2010

	1994	2000	2010
CO_2	1,826	2,024	4,785
CH_4 (CO_2-eq)	3,549	6,758	4,302
N_2O (CO_2-eq)	310	341	2,110
Total GHG Emissions	5,685	9,123	11,197
Removals (CO_2)	-5,716	-10,566	-27,680
Net GHG Emissions	-31	-1,443	-16,484

The CO2 removals increased by 85 % from 1994 to 2000 and by a further 162% in 2010. On the other hand, CH4 emission decreased by nearly 36%, i.e. from 6758 in 2000 to 4302 Gg CO2-eq in 2010. Emissions of N2O increased by nearly six-fold, from 341 Gg CO2-eq in 2000 to 2110 Gg CO2-eq in 2010. It should be pointed out again that the methodologies are different as well as the scope of the inventory that increased with time while a new set of maps were used to implement the use of the IPCC 2006 Guidelines for the first time.

2.6 QA/QC

Namibia has its own system for quality control (QC) of data being collected within the different institutions. All data are quality controlled at different stages of the process until the final quality assurance (QA) is made by the National Statistics Department before archiving in national databases. The private sector also implements its own QC/QA within its data collection and archiving process. Thus the initial phases of the control system remains beyond the GHG inventory compiler and the process starts as from the time the AD are received.

QC and QA procedures, as defined in the IPCC 2006 Guidelines (IPCC, 2007) have been implemented during the preparation of the inventory. Whenever there were inconsistencies or possible transcription errors, the responsible institution was queried and the problem discussed and solved. QC was implemented through,

- Routine and consistent checks to ensure data integrity, reliability and completeness;
- Routine and consistent checks to identify errors and omissions;
- Accuracy checks on data acquisition and calculations;
- The use of approved standardized procedures for emissions calculations; and
- Technical and scientific reviews of data used, methods adopted and results obtained.

QA was undertaken by independent reviewers who were not involved with the preparation of the inventory, the objective being to

- Confirm data quality and reliability;
- Review the AD and EFs adopted within each source category as a first step;
- Review and check the calculation steps in the software;

Even if QA/QC procedures have been followed throughout the inventory process, systematic records as per the IPCC 2006 Guidelines have not been kept. This resulted from the lack of time, insufficient capacity and since the inventory management system was being implemented for the first time in the country.

2.7 COMPLETENESS

Prior to starting work on the 2010 GHG inventory, a source by source category analysis was conducted with a wide stakeholder group. The objective set was to be exhaustive and cover all categories as far as possible within permissible limits of time, capacity and availability of resources, namely AD and staffing. The scope of the inventory is provided in Table 2.5 below.

Table 2.6. Completeness of the 2010 inventory

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1.A - Fuel Combustion Activities							
1.A.1 - Energy Industries	X	X	X	X	X	X	X
1.A.2 - Manufacturing Industries and Construction	X	X	X	X	X	X	X
1.A.3 - Transport	X	X	X	X	X	X	X
1.A.4 - Other Sectors	X	X	X	X	X	X	X
1.A.5 - Non-Specified	X	X	X	X	X	X	X
1.B - Fugitive emissions from fuels							
1.B.1 - Solid Fuels	NO	NO	NO	NO	NO	NO	NO
1.B.2 - Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO
1.B.3 - Other emissions from Energy Production	NO	NO	NO	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage							
1.C.1 - Transport of CO_2	NO	NA	NA	NO	NO	NO	NO
1.C.2 - Injection and Storage	NO	NA	NA	NO	NO	NO	NO
1.C.3 - Other	NO	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use							
2.A - Mineral Industry							
2.A.1 - Cement production	NO	NO	NO	NO	NO	NO	NO
2.A.2 - Lime production	X	NA	NA	NA	NA	NA	NA
2.A.3 - Glass Production	NO	NO	NO	NO	NO	NO	NO
2.A.4 - Other Process Uses of Carbonates	NO	NO	NO	NO	NO	NO	NO
2.A.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.B - Chemical Industry							
2.B.1 - Ammonia Production	X	NA	NA	X	X	NA	NA
2.B.2 - Nitric Acid Production	NA	NA	X	X	NA	NA	NA
2.B.3 - Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	NO	NO	NO	NO	NO	NO	NO
2.B.5 - Carbide Production	NO	NO	NO	NO	NO	NO	NO
2.B.6 - Titanium Dioxide Production	NO	NO	NO	NO	NO	NO	NO
2.B.7 - Soda Ash Production	NO	NO	NO	NO	NO	NO	NO
2.B.8 - Petrochemical and Carbon Black Production	NO	NO	NO	NO	NO	NO	NO
2.B.9 - Fluorochemical Production	NO	NO	NO	NO	NO	NO	NO
2.B.10 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
2.C - Metal Industry							
2.C.1 - Iron and Steel Production	X	X	NA	NA	NA	X	NA
2.C.2 - Ferroalloys Production	X	NA	NA	NE	NE	NE	NE
2.C.3 - Aluminium production	X	NA	NA	X	X	NA	X
2.C.4 - Magnesium production	NO	NO	NO	NO	NO	NO	NO
2.C.5 - Lead Production	X	NA	NA	NA	NA	NA	NA
2.C.6 - Zinc Production	X	NA	NA	NA	NA	NA	NA
2.C.7 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use							
2.D.1 - Lubricant Use	X	NA	NA	NA	NA	NA	NA
2.D.2 - Paraffin Wax Use	X	NA	NA	NA	NA	NA	NA
2.D.3 - Solvent Use	NE	NE	NE	NE	NE	NE	NE
2.D.4 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.E - Electronics Industry							
2.E.1 - Integrated Circuit or Semiconductor	NO	NO	NO	NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display	NO	NO	NO	NO	NO	NO	NO
2.E.3 - Photovoltaics	NO	NO	NO	NO	NO	NO	NO
2.E.4 - Heat Transfer Fluid	NO	NO	NO	NO	NO	NO	NO
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances							
2.F.1 - Refrigeration and Air Conditioning	NO	NO	NO	NO	NO	NO	NO
2.F.2 - Foam Blowing Agents	NO	NO	NO	NO	NO	NO	NO
2.F.3 - Fire Protection	NO	NO	NO	NO	NO	NO	NO
2.F.4 - Aerosols	NO	NO	NO	NO	NO	NO	NO
2.F.5 - Solvents	NO	NO	NO	NO	NO	NO	NO
2.F.6 - Other Applications (please specify)	NO	NO	NO	NO	NO	NO	NO
2.G - Other Product Manufacture and Use							
2.G.1 - Electrical Equipment	NO	NO	NO	NO	NO	NO	NO
2.G.2 - SF_6 and PFCs from Other Product Uses	NO	NO	NO	NO	NO	NO	NO
2.G.3 - N_2O from Product Uses	NO	NO	NO	NO	NO	NO	NO
2.G.4 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO
2.H - Other							
2.H.1 - Pulp and Paper Industry	NO	NO	NO	NO	NO	NO	NO
2.H.2 - Food and Beverages Industry	NO	NO	NO	NO	NO	NO	NO
2.H.3 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use							
3.A - Livestock							
3.A.1 - Enteric Fermentation	NA	X	NA	NA	NA	NA	NA

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
3.A.2 - Manure Management	NA	X	X	NA	NA	X	NA
3.B - Land							
3.B.1 - Forest land	X	NA	NA	NA	NA	NA	NA
3.B.2 - Cropland	X	NA	NA	NA	NA	NA	NA
3.B.3 - Grassland	X	NA	NA	NA	NA	NA	NA
3.B.4 - Wetlands	NO	NO	NO	NO	NO	NO	NO
3.B.5 - Settlements	NO	NO	NO	NO	NO	NO	NO
3.B.6 - Other Land	NO	NO	NO	NO	NO	NO	NO
3.C - Aggregate sources and non-CO_2 emissions sources on land							
3.C.1 - Emissions from biomass burning	NA	X	X	X	X	NA	NA
3.C.2 - Liming	NO	NO	NO	NO	NO	NO	NO
3.C.3 - Urea application	NO	NO	NO	NO	NO	NO	NO
3.C.4 - Direct N_2O Emissions from managed soils	NA	NA	X	NA	NA	NA	NA
3.C.5 - Indirect N_2O Emissions from managed soils	NA	NA	X	NA	NA	NA	NA
3.C.6 - Indirect N_2O Emissions from manure management	NA	NA	X	NA	NA	NA	NA
3.C.7 - Rice cultivations	NO	NO	NO	NO	NO	NO	NO
3.C.8 - Other (please specify)	NA	NO	NO	NO	NO	NO	NO
3.D - Other							
3.D.1 - Harvested Wood Products	NE	NE	NE	NE	NE	NE	NE
3.D.2 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
4 - Waste							
4.A - Solid Waste Disposal	NA	X	NA	NA	NA	X	NA
4.B - Biological Treatment of Solid Waste	NO	NO	NO	NO	NO	NO	NO
4.C - Incineration and Open Burning of Waste	X	X	X	X	X	X	X
4.D - Wastewater Treatment and Discharge	NA	X	X	NA	NA	X	NA
4.E - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
5 - Other							
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NOx and NH_3	NO	NO	NO	NO	NO	NO	NO
5.B - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
Memo Items (5)							
International Bunkers							
1.A.3.a.i - International Aviation (International Bunkers)	X	X	X	X	X	X	X
1.A.3.d.i - International water-borne navigation (International bunkers)	X	X	X	X	X	X	X
1.A.5.c - Multilateral Operations	NO	NO	NO	NO	NO	NO	NO

X = Estimated, NA = Not Applicable, NO = Not Occurring, NE = Not Estimated, EE = Estimated Elsewhere

2.8 UNCERTAINTY ANALYSIS

The uncertainty analysis has been performed using the tool available within the IPCC 2006 Software for the national inventory with and without FOLU. For the national inventory, Uncertainty without FOLU was 7.1% while when FOLU was included it rose to 72.5%. This could be a problem with the software and is being looked into with the Technical Support Unit of IPCC.

2.9 KEY CATEGORY ANALYSIS

The Key Category Analysis also was performed using the tool in the IPCC 2006 Software when the compilation process was completed. The results are presented in Table 2.7 below. There are five key categories, four of these from the AFOLU sector, of which enteric fermentation and the last one is Road Transportation from the Energy sector.

Table 2.7. Key Category Analysis for 2010

Key Category Analysis - Approach 1 Level Assessment						
A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2010	|Ex,t| (Gg CO_2 Eq)	Lx,t	Cumulative Total of Column F
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-57963.35	57963.35	0.4259	0.4259
3.B.3.b	Land Converted to Grassland	CARBON DIOXIDE (CO2)	48614.07	48614.07	0.3572	0.7831
3.B.1.b	Land Converted to Forest land	CARBON DIOXIDE (CO2)	-17962.94	17962.94	0.1320	0.9151
3.A.1	Enteric Fermentation	METHANE (CH4)	3805.24	3805.24	0.0280	0.9431
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	1629.94	1629.937	0.0120	0.9551

2.10 ARCHIVING

All raw data collected for the inventory have been stored in a database and in the 2006 software data base after being processed and formatted for making estimates of emissions and removals. All documentation on the data processing and formatting have been kept in soft copies in the excel sheets with the summaries reported in the BUR1. These versions will be managed in electronic format in at least three copies, two at the Ministry of Environment and Tourism and a third copy at the National Statistics Agency.

2.11 CONSTRAINTS, GAPS AND NEEDS

Namibia as a developing country has its constraints and gaps that need to be addressed to produce better quality reports for reporting to the Convention. The following problems were encountered during the preparation of the national inventory of GHG emissions:

- Information required for the inventory had to be obtained from various sources as no institution has been endorsed with the responsibility for collection of specific activity data (AD) needed for the estimation of emissions according to UNFCCC;
- Almost all of the AD, including those from the NSA were not in the required format for feeding in the software to make the emission estimates;
- End-use consumption data for the different sectors and categories were not readily available and had to be

generated on the basis of other scientific and consumption parameters;

- Reliable biomass data such as timber, fuelwood, woody waste and charcoal consumed or produced were not available and had to be derived from statistical modelling.
- There were frequent inconsistencies when data were collected from different sources;
- Information on the technologies associated with production in the different industries were not available and this led to overestimation of emissions as technologies with highest EFs were chosen as good practice;
- Lack of solid waste characterization data, amount generated and wastewater generated from the industrial sector were not measured and had to be derived on the basis of production and demographic data amongst others;
- Lack of EFs to better represent national circumstances and provide for accurate estimates;
- Emissions for some categories have not been estimated due to lack of AD and time;
- Timing has been a major issue as funds were made available only about 12 months before the submission date, thus halving the preparation period; and
- Capacity of national experts to take over despite a round of training on running the IPCC 2006 software was not possible.

2.12 NATIONAL INVENTORY IMPROVEMENT PLAN (NIIP)

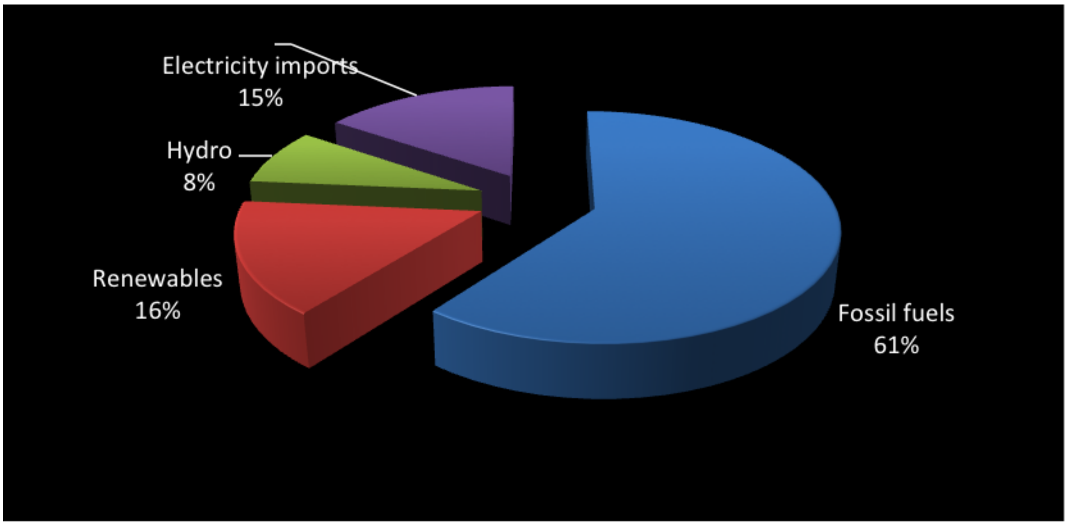
Based on the constraints and gaps and other challenges encountered during the preparation of the inventory, a list of the most urgent improvements have been identified. This is listed below and will be addressed during the preparation of the NC3 and the BUR2 inventories.

- Adequate and proper data capture, QC, validation, storage and retrieval mechanism are required and need to be established to facilitate the compilation of future inventories;
- There is a necessity to build capacity and to strengthen the existing institutional framework that are well equipped to provide improved coordinated action for reliable data collection and accessibility.
- Develop improved emission factors (EFs) more representative of the national context;
- Implement fully the QA/QC system in order to reduce uncertainty and improve inventory quality;
- Establish a GHG inventory unit within DEA to be responsible for inventory compilation and coordination;
- Institutionalize the archiving system;
- Collect information on production technology used in the IPPU sector;
- Start data collection for categories not covered in this exercise;
- Implement new forest inventories to supplement available data on the FOLU category;
- Review and correct inconsistencies existing for the recent land cover maps with additional overlays with previous maps and ground referencing;
- Produce new maps for 2005 to refine land use change data over 5 years as opposed to the decadal one available now;
- Refine data collection for determining country specific weights for dairy cows, sheep and goats;
- To develop the digestible energy (DE) factor for livestock as country specific data is better than the default IPCC value to address this key category fully at tier 2.

2.13 ENERGY

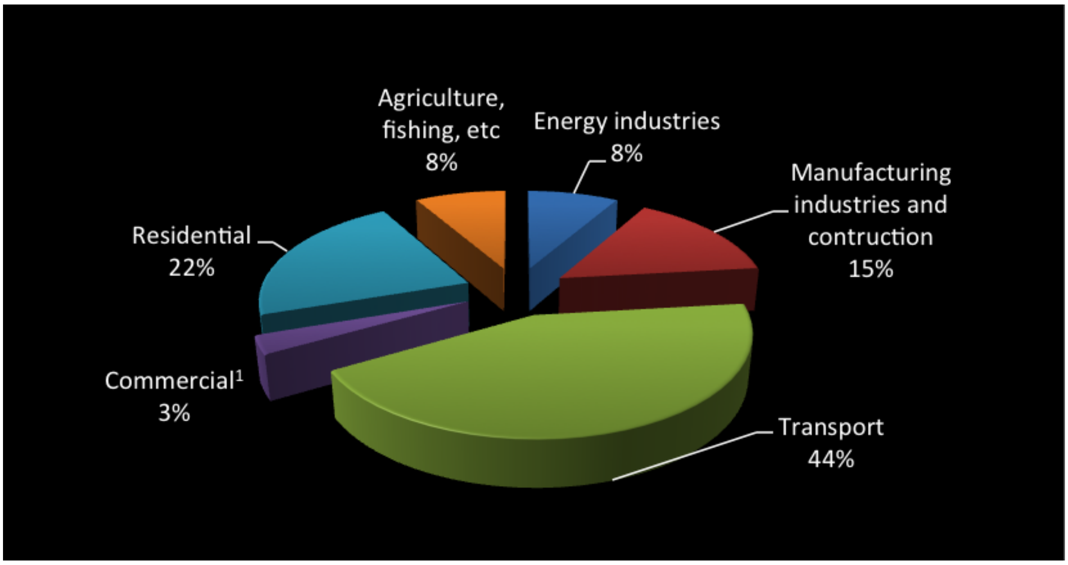
Namibia is not a producer of fossil fuels on its own and does not refine or process any fuel. Therefore, only fossil fuel consumed and combusted in the country has been used to estimate emissions in the energy sector under Fuel Combustion Activities. All IPCC source categories have been covered. However, due to unavailability of disaggregated data to enable a well demarcated consumption in the different source categories, some fuels may have been burned in another category but finally the emissions have been captured within the sector. In line with IPCC Good Practice, both the reference and sectoral approaches have been adopted for compiling emissions as recommended. As well both international aviation and water-borne navigation bunkering have been covered. The energy requirements of the country for 2010 are presented by source of fuel in figure 2.4 below. Fossil fuels constituted the major share of the energy requirements of the country in 2010 followed by renewable sources comprising biomass, solar and wind. Electricity imports had a share of 15% and hydro 8%.

Figure 2.4. Energy requirements for year 2010



Energy use by economic sector is given in figure 2.5. The transport sector is by far the highest consumer of energy followed by the residential, and manufacturing industries and construction sectors. These sectors stood at 44%, 22% and 15% of the national energy used in 2010. Energy industries that include electricity generation had a share of only 8%, with Agriculture and fishing combined using a similar amount.

Figure 2.5. Energy use by sector for the year 2010



2.13.1 Description of energy sector

For the Energy sector, GHG emissions have been estimated for the following IPCC source categories:

1. Energy Sector
1.A. Fuel Combustion Activities
1.A.1. Energy Industries
1.A.2. Manufacturing Industries and Constructions
1.A.3. Transport (Civil Aviation, Road Transport, Railways, Navigation, Pipeline Transport)
1.A.4. Other Sectors (Commercial/Institutional, Residential, Agricultural/Forestry/Fishing)
1.A.5. Other

Memo items (International bunkers and CO_2 emissions from biomass)

More details on these source categories are provided below.

1.A.1 - Energy Industries

This sub-category is confined to the production of electricity from a mix of liquid and solid fossil fuels. The amount used is however minimal in the energy balance since the country generates a high proportion of its needs from hydro and electricity is imported from neighbouring countries. Approximately 50% of Namibia's electrical energy is imported from South Africa, the South African Power Pool (SAPP) and Zimbabwe to meet the current demand, which reached a peak of 534 MW in 2012 (http://africa-energy-forum.com/webfm_send/201).

All solid, liquid and gaseous fossil fuels, including petrol, diesel, heavy fuel oil, jet fuel, liquid petroleum gas and coal are imported, mainly from South Africa. Namibia's total installed electricity generation capacity in 2010 was about 384 MW for a peak demand of some 500 MW. Hydro contributes for about 240 MW in this Namibia is thus highly dependent on energy imports. The fossil fuel generation plants are mainly used to supplement these during peak demand time. Solar and wind potential exists but are tapped only marginally at the moment. Plans, within the energy policy, are for these two renewable sources along with biomass from the invader bush to be used in the future.

1.A.2 - Manufacturing Industries and Construction

Fossil fuel inputs are primarily used for generating process heat within the mining sector but not extensively as the two major companies imported electricity directly from the neighbouring countries. The construction industry is highly diversified and detailed information was not available.

1.A.3 – Transport

The transport sector comprised domestic aviation, road transportation, railways and domestic water-borne navigation. All four sub-categories have been covered in the inventory as well as fuel combusted for international bunkering.

1.A.4 - Other Sectors

Sub-categories covered under other sectors included Residential and Fishing as AD were not available for Commercial/ Institutional, Stationary combustion and Off-road vehicles and other machinery within the Agriculture and Forestry sectors.

The main sources of energy used within the residential sector by households for cooking purposes are wood/charcoal (54%) and electricity (33%), the remainder being LPG and cow dung. The main sources of energy used for lighting purposes are paraffin and waxes (50%) and electricity (43%). Nearly 50% of households utilize wood/charcoal for heating purposes and 30% have recourse to electricity.

Fishing is an important activity in Namibia, with a fleet of 160 fishing vessels (Ministry of Works and Transport, Maritime Affairs, 2010) operating out of a total of 208 registered ships. Thus special attention was given to this sub-category to collect AD and make estimates of emissions.

Memo items

International bunkers cover international aviation and navigation according to the IPCC Guidelines. Both activity areas were covered as they consume significant amounts of fossil fuel imported in the country and the emissions have been compiled and reported in this inventory.

2.13.2 Methodology

It is Good Practice to estimate emissions by the Reference and Sectoral approaches. During this exercise, estimates were compiled using both approaches. The top down Reference approach was carried out using import-export, production and stock change data for making the energy balance of the country. The Sectoral Approach is a bottom up one and generally involves determining fuel consumption from end use data by the different sector source categories and using the IPCC conversion and emission factors to determine GHG emissions. The following IPCC source categories were covered in the Sectoral approach:

- Energy industries;
- Manufacturing Industries and Construction;
- Transport;
- Other sectors (commercial/institutional,residential);
- Agriculture, fishing and forestry sector); and
- Other sectors (not specified).

Emissions were compiled using the IPCC 2006 software based on the IPCC 2006 Guidelines and the tier 1 approach was adopted.

The basic equations used to estimate GHG emissions are given below:

(i) CO_2 emissions = (Fuel Consumption j • Conversion Factor (TJ/unit) • Carbon Emission Factor j (t C/TJ) – Carbon Stored • Oxidation Fraction j • 44/12).

(ii) Non-CO_2 emissions= (Fuel Consumption j • Emission Factor j)
where: j – type of fuel.

2.13.3 Activity Data

Activity data (AD) were collected from a vast group of stakeholders concerned with the combustion of fossil fuels. Basically, AD for working out the reference approach was obtained from the energy database of the NSA on imports and exports of energy products. For the bottom up sectoral approach, AD were sourced from the end-users of fossil fuels within the different IPCC categories. Data on biomass used was either collected from the Forest department or derived from amount consumed by households. Data on consumption of different fuels by households are collected in the censuses conducted by the NSA. The same approach was used to determine the amount of cow dung burned and charcoal used. The key stakeholders for provision of AD were NSA, the different petroleum distribution companies, the Ministry of Mines and Energy (MME), Nampower, the government entity that generates electricity, Electricity Control Board that regulates the electricity sector and the National Petroleum Corporation of Namibia (NAMCOR). The data collection covered all solid, liquid and gaseous fossil fuels, fuelwood, charcoal and cow dung.

AD were not readily available and in the format required as well as at the level of disaggregation needed. Gaps were filled using statistical methods such as trend analysis and extrapolation as appropriate. In some cases, fuels had to be allocated or determined according to the activity area such as amount of fuel used in the fishing sector being directly related to fishing vessel campaigns. Fuel use for sectors like agriculture, forestry and institutional amongst others could not be traced and even generated. Thus fuels from these sectors were eventually allocated in different sectors based on distributed and consumed amounts.

2.13.4 Emission factors

In the absence of national emission factors the greenhouse gas emissions were computed on the basis of IPCC default emission factors (table 2.8).

Table 2.8. List of emission factors used in the Energy sector

	Emission Factor			Source		
Fuel	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Motor gasoline	69300	3.0	0.6	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
“”	“”	3.3	3.2	Vol. 2, table 2.2	Vol. 2, table 2.2.3	Vol. 2, table 2.2.3
“”	“”	10.0	0.6	Vol. 2, table 3.5.2	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3
Aviation gasoline	69300	0.5	2.0	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
Jet kerosene	71500	0.5	2.0	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
Other kerosene	71900	10.0	0.6	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
Gas/Diesel oil	74100	3.0	0.6	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
“”	“”	3.9	3.9	Vol. 2, table 3.2.2	Vol. 2, table 2.2.3	Vol. 2, table 2.2.3
“”	“”	7.0	2.0	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3
“”	“”	10.0	0.6	Vol. 2, table 3.5.2	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3
Residual fuel oil	77400	3.0	0.6	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
Liquefied petroleum gases	63100	5.0	0.1	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
Paraffin waxes	73300	10.0	0.6	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
Other bituminous coal	94600	1.0	1.5	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
“”	“”	10.0	1.5	Vol. 2, table 2.2	Vol. 2, table 3.4.1	Vol. 2, table 3.4.1

Fuel	Emission Factor			Source		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Wood	112000	300.0	4.0	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2
Charcoal	112000	200.0	1.0	Vol. 2, table 2.2	Vol. 2, table 2.2	Vol. 2, table 2.2

2.13.5 Results

Reference approach

Comparison of the sectoral approach (SA) with the reference approach (RA)
Emissions of CO2 with the reference approach amounted to 2504.5 Gg compared to 2561.5 Gg for the sectoral approach (table 2.9). The difference between the two approaches stands at 57 Gg representing 2.3%. The results are thus very consistent with the two approaches.

In 1994, the Reference Approach estimates were 1 760 Gg of CO2, while the Sectoral Approach derived an estimate of 1 821 Gg of CO2. These estimates differed by less than 4%. In the year 2000, the estimates of CO2 by the Reference Approach were 1540 Gg as opposed to 2018 Gg by the Sectoral Approach giving a difference of 478 Gg which represented 31%. This difference is significant and may be due to lower quality AD, especially for the year 2000. The drastic reduction in difference by the two approaches in the year 2010 is indicative of better quality AD.

Table 2.9. Comparison of the reference and sectoral approaches for 2010 (Gg)

Approach	CO_2 emissions (Gg)
Reference approach	2504.5
Sectoral approach	2561.5

Sectoral approach

The estimates of the three major GHGs CO2, CH4 and N2O and the total aggregated emissions in CO2-eq is given in table 2.10 below for the five IPCC source categories for the year 2010. Total emissions resulting from Fuel Combustion Activities amounted to 2561.49 Gg CO2, 3.11 Gg CH4 and 0.13 Gg N2O, making an aggregate of 2666.50 Gg CO2-eq. In 2010, the main GHG in Namibia in the energy sector was carbon dioxide (CO2), accounting for 96% of the total aggregated GHG emissions.

Table 2.10. Emission estimates for Fuel Combustion Activities (Gg) for 2010.

Categories	Emissions (year 2010) Gg			
	CO_2	CH_4	N_2O	CO_2-eq.
1.A - Fuel Combustion Activities	2,561.490	3.111	0.128	2666.501
1.A.1 - Energy Industries	35.535	0.000	0.001	35.845
1.A.2 - Manufacturing Industries and Construction	322.818	0.027	0.004	324.625
1.A.3 - Transport	1,703.846	0.411	0.082	1737.897
1.A.4 - Other Sectors	430.257	2.669	0.038	498.086
1.A.5 - Non-Specified	69.033	0.004	0.004	70.357

Carbon dioxide (CO_2)

The total emission of CO2 for 2010 is 2561.49 Gg, partitioned as follows: transportation (1703.85 Gg) accounting for nearly 66.5% of all emissions, 17% from other sectors which include commercial, institutional, residential, agriculture, forestry, fishing and fish farms, 13% from the manufacturing industries and construction sector and 1% from energy industries. The transport sector topped the source categories with 1703.85 Gg CO2-eq making up for 66.5 % of the aggregated emissions of this category.

Methane (CH_4)

A total of 3.11 Gg of methane (CH4) was emitted in 2010, of which 2.67 Gg stemmed from other sectors which comprised the residential and fishing source categories. Road transportation accounted for 0.41 Gg.

Nitrous oxide (N_2O)

A total of 0.13 Gg of N2O was emitted in 2010, the distribution being 0.08 Gg from transport, 0.038 Gg from other sectors, 0.004 Gg, both from manufacturing industries and construction and the non-specified sub-category.

Table 2.11. Energy Sector emissions

	Emissions (Gg)						
Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
1 - Energy	2561.49	3.11	0.13	20.80	88.63	14.58	3.61
1.A - Fuel Combustion Activities	2561.49	3.11	0.13	20.80	88.63	14.58	3.61
1.A.1 - Energy Industries	35.53	5E-04	5E-04	0.08	4E-03	4E-04	0.30
1.A.1.a - Main Activity Electricity and Heat Production	35.53	5E-04	5E-04	0.08	4E-03	4E-04	0.30
1.A.1.a.i - Electricity Generation	35.53	5E-04	5E-04	0.08	4E-03	4E-04	0.30
1.A.1.a.ii - Combined Heat and Power Generation (CHP)				0	0	0	0
1.A.1.a.iii - Heat Plants				0	0	0	0
1.A.1.b - Petroleum Refining				0	0	0	0
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries				0	0	0	0
1.A.1.c.i - Manufacture of Solid Fuels				0	0	0	0
1.A.1.c.ii - Other Energy Industries				0	0	0	0
1.A.2 - Manufacturing Industries and Construction	322.82	0.03	4E-03	1.83	1.08	0.16	0.99
1.A.2.a - Iron and Steel				0	0	0	0
1.A.2.b - Non-Ferrous Metals				0	0	0	0
1.A.2.c - Chemicals				0	0	0	0
1.A.2.d - Pulp, Paper and Print				0	0	0	0
1.A.2.e - Food Processing, Beverages and Tobacco				0	0	0	0
1.A.2.f - Non-Metallic Minerals				0	0	0	0

Categories	Emissions (Gg)						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
1.A.2.h - Machinery				0	0	0	0
1.A.2.i - Mining (excluding fuels) and Quarrying	320.65	0.03	4E-03	1.82	1.08	0.16	0.99
1.A.2.j - Wood and wood products				0	0	0	0
1.A.2.k - Construction				0	0	0	0
1.A.2.l - Textile and Leather				0	0	0	0
1.A.2.m - Non-specified Industry	2.17	9E-05	2E-05	0.02	2E-03	1E-03	1E-03
1.A.3 - Transport	1703.85	0.41	0.08	11.32	40.16	4.31	0.03
1.A.3.a - Civil Aviation	21.74	2E-04	6E-04	0.05	4.53	0.07	7E-03
1.A.3.a.i - International Aviation (International Bunkers) (1)							
1.A.3.a.ii - Domestic Aviation	21.74	2E-04	6E-04	0.05	4.53	0.07	7E-03
1.A.3.b - Road Transportation	1629.94	0.41	0.08	10.43	35.46	4.17	0.02
1.A.3.b.i - Cars	335.20	0.14	0.02	1.06	8.13	1.22	0.01
1.A.3.b.i.1 - Passenger cars with 3-way catalysts	167.60	0.07	0.01	0.53	4.07	0.61	4E-03
1.A.3.b.i.2 - Passenger cars without 3-way catalysts	167.60	0.07	0.01	0.53	4.07	0.61	4E-03
1.A.3.b.ii - Light-duty trucks	705.44	0.24	0.034	3.23	25.38	2.49	0.01
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts	352.72	0.12	0.02	1.61	12.69	1.25	7E-03
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts	352.72	0.12	0.02	1.61	12.69	1.25	7E-03
1.A.3.b.iii - Heavy-duty trucks and buses	587.39	0.03	0.03	6.14	1.62	0.37	3E-03
1.A.3.b.iv - Motorcycles	1.92	9E-04	9E-05	4E-03	0.33	0.09	1E-04
1.A.3.b.v - Evaporative emissions from vehicles				0	0	0	0
1.A.3.b.vi - Urea-based catalysts	0			0	0	0	0
1.A.3.c - Railways	52.17	2E-03	4E-04	0.84	0.17	0.07	2E-05
1.A.3.d - Water-borne Navigation				0	0	0	0
1.A.3.d.i - International water-borne navigation (International bunkers) (1)							
1.A.3.d.ii - Domestic Water-borne Navigation				0	0	0	0
1.A.3.e - Other Transportation				0	0	0	0
1.A.3.e.i - Pipeline Transport				0	0	0	0
1.A.3.e.ii - Off-road				0	0	0	0
1.A.4 - Other Sectors	430.26	2.67	0.04	6.84	47.22	10.06	2.28
1.A.4.a - Commercial/ Institutional				0	0	0	0
1.A.4.b - Residential	103.77	2.62	0.035	0.66	29.44	4.41	0.18

Categories	Emissions (Gg)						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
1.A.4.c.i - Stationary				0	0	0	0
1.A.4.c.ii - Off-road Vehicles and Other Machinery				0	0	0	0
1.A.4.c.iii - Fishing (mobile combustion)	326.49	0.045	3E-03	6.18	17.77	5.65	2.10
1.A.5 - Non-Specified	69.03	4E-03	4E-03	0.72	0.16	0.04	3E-04
1.A.5.a - Stationary				0	0	0	0
1.A.5.b - Mobile	69.03	4E-03	4E-03	0.72	0.16	0.04	3E-04
1.A.5.b.i - Mobile (aviation component)				0	0	0	0
1.A.5.b.ii - Mobile (water-borne component)				0	0	0	0
1.A.5.b.iii - Mobile (Other)	69.03	4E-03	4E-03	0.72	0.16	0.04	3E-04
1.A.5.c - Multilateral Operations (1)(2)							
1.B.2 - Oil and Natural Gas	0	0		0	0	0	0
1.B.2.a - Oil	0	0		0	0	0	0
1.B.2.a.i - Venting	0	0		0	0	0	0
1.B.2.a.ii - Flaring	0	0		0	0	0	0
1.B.2.a.iii - All Other	0	0		0	0	0	0
1.B.2.a.iii.1 - Exploration	0	0		0	0	0	0
1.B.2.a.iii.2 - Production and Upgrading				0	0	0	0
1.B.2.a.iii.3 - Transport	0	0		0	0	0	0
1.B.2.a.iii.4 - Refining	0	0		0	0	0	0
1.B.2.a.iii.5 - Distribution of oil products	0	0		0	0	0	0
1.B.2.a.iii.6 - Other	0	0		0	0	0	0
1.B.2.b - Natural Gas				0	0	0	0
1.B.2.b.i - Venting				0	0	0	0
1.B.2.b.ii - Flaring				0	0	0	0
1.B.2.b.iii - All Other				0	0	0	0
1.B.2.b.iii.1 - Exploration				0	0	0	0
1.B.2.b.iii.2 - Production				0	0	0	0
1.B.2.b.iii.3 - Processing				0	0	0	0
1.B.2.b.iii.4 - Transmission and Storage				0	0	0	0
1.B.2.b.iii.5 - Distribution				0	0	0	0
1.B.2.b.iii.6 - Other				0	0	0	0
1.B.3 - Other emissions from Energy Production				0	0	0	0
Memo Items (3)							
International Bunkers	247.72	0.01	7E-03	4.11	0.74	0.26	0.98
1.A.3.a.i - International Aviation (International Bunkers) (1)	96.38	7E-04	3E-03	0.41	0.03	0.02	0.03

Categories	Emissions (Gg)						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
1.A.5.c - Multilateral Operations (1) (2)				0	0	0	0
Information Items							
CO2 from Biomass Combustion for Energy Production	985.69						

Emissions for 1994, 2000 and 2010

Emissions for the three main gases (CO2, CH4 and N2O) for the years 1994, 2000 and 2010 are summarized in table 2.12 below and Figure 2.6 as per data availability from the previous inventories published in the first and second national communications. Total CO2 emission for the Fuel combustion sector increased from 1821 Gg in 1994 to 2018 in 2000 and 2561 in 2010. CH4 emissions on the other hand increased from 4.0 Gg in 1994 to 5.7 Gg in 2000 but regressed to 3.5 Gg in 2010. N2O was not estimated in 1994, but remained constant at 0.1 Gg for both the years 2000 and 2010.

CO2 emissions from the energy industries category increased from 217 Gg in 1994, to 239 Gg in 2000 and dropped drastically to some 35 Gg in 2010 due to a lower amount of coal burned in that year. For the manufacturing industries and construction category, CO2 emission decreased from 207 Gg in 1994 to 99 Gg in 2000 and then increased to 322.8 Gg in 2010 while for non-specified industries, a steady decrease from 117 to 97 and eventually 69 Gg in 2010 is observed. In contrast, CO2 emission from transport increased drastically from 900 Gg in 1994, to 1025 Gg in 2000 and reached a peak of 1703.8 Gg in 2010.

Table 2.12. Emissions of CO_2, CH_4 and N_2O for 1994, 2000 and 2010 (Gg)

Category	CO_2			CH_4			N_2O		
	1994	2000	2010	1994	2000	2010	1994	2000	2010
1.A Fuel Combustion	1821.0	2018.0	2561.5	4.0	5.7	3.1	NA	0.1	0.12
1.A.1 Energy Industries	217.0	239.0	35.5	NA	NA	0.0	NA	NA	0.0
1.A.2 Manu. Ind & Cons.	207.0	99.0	322.8	NA	NA	0.03	NA	NA	0.0
1.A.3 Transport	900.0	1025.0	1703.8		0.2	0.4	NA	NA	0.08
1.A.4 Other sectors	380.0	558.0	430.3	4.0	5.5	2.7	NA	0.1	0.04
1.A.5 Non-specified	117.0	97.0	69.0	NA	NA	0.0	NA	NA	0.0

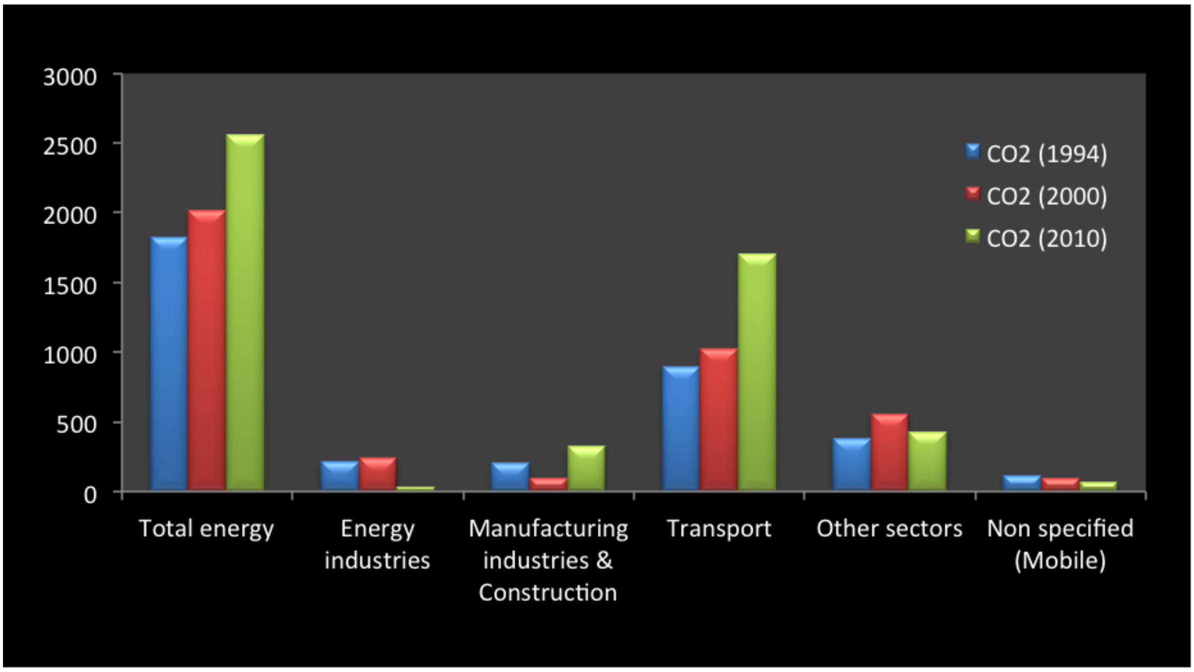


Figure 2.6. CO_2 emissions (Gg) from different categories for 1994, 2000 and 2010.

CH_4 emission for 1994, 2000 to 2010

Emission of CH4, in general, has increased by 40% for the period 1994 to 2000, from 4 Gg to 5.7 Gg and afterward reverted back to 3.1 Gg in 2010. In contrast the transport sub-category has recorded a 100% increase in CH4 emission from 2000 to 2010, i.e. from 0.2 Gg to 0.4 Gg.

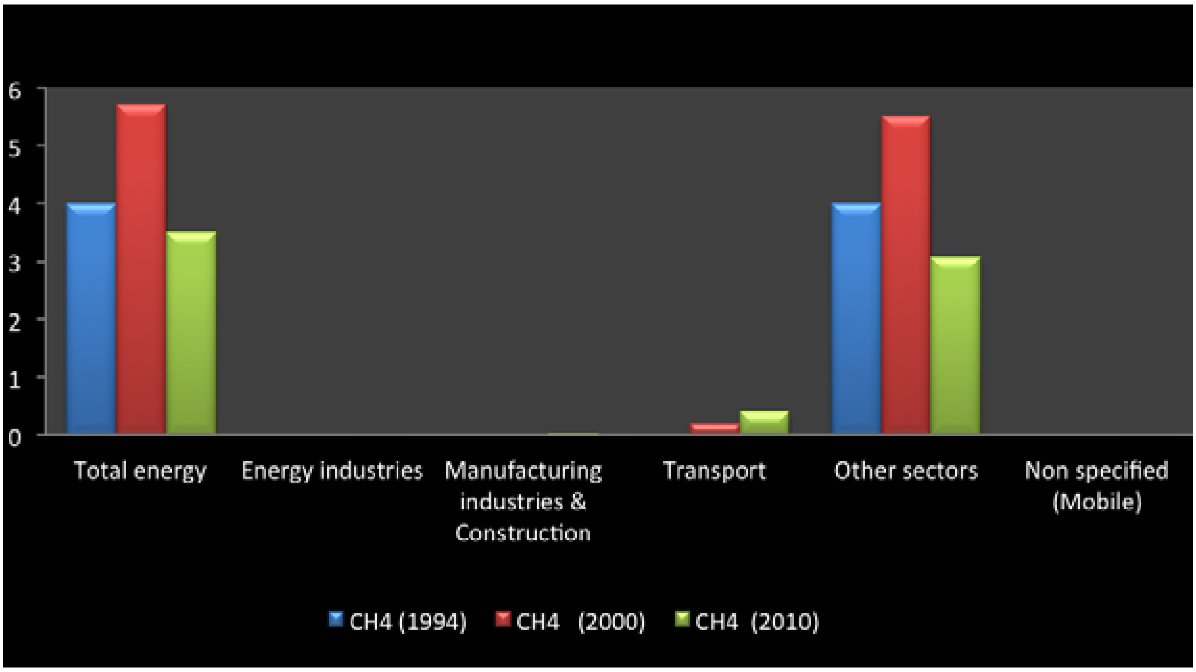


Figure 2.7. CH4 emissions (Gg) from different categories for 1994, 2000 and 2010

N_2O emission across years 1994, 2000 to 2010

No data was available for emissions of N2O in 1994. The emission of N2O did not almost change for the period 2000 to 2010, remaining at 0.12 Gg. The transport sub-category contributed mostly to this 0.08 Gg N2O in 2010.

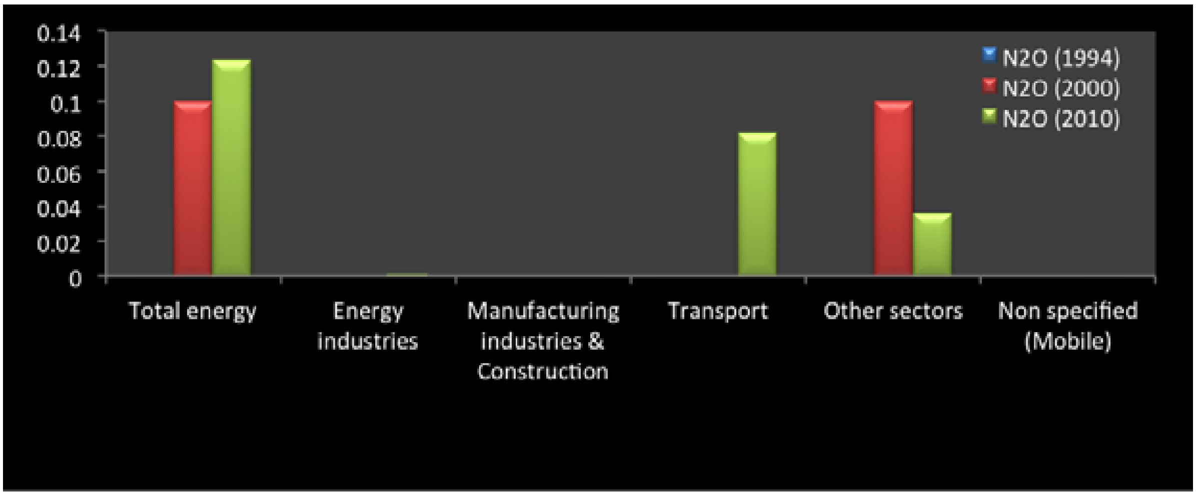


Figure 2.8. N_2O emissions (Gg) from different categories for 1994, 2000 and 2010

Aggregated emissions (Gg CO_2-eq) for 1994, 2000 and 2010

Total aggregated emissions of the three greenhouse gases, CO2, CH4 and N2O, (Table 2.13) in the Fuel Combustion sector increased from 1862.8 Gg CO2 -eq. in 1994 to 2027.8 Gg in 2000 and reached 2666.5 Gg CO2-eq. in 2010. Total emission increased by 9% during the period 1994 to 2000, and increased by a further 31% from 2000 to 2010. In general, over the period 1994 to 2010, the GHG emissions increased by 43.1% (Figure 2.9), i.e. a yearly increase of 2.7%.

Table 2.13. GHG emissions (CO_2-eq) for the Energy sector for 1994, 2000 and 2010.

Category	CO_2 equivalent (Gg)		
	1994	2000	2010
1.A - Fuel Combustion Activities	1,862.8	2,027.8	2,666.5
1.A.1 - Energy Industries	217.0	239.0	35.8
1.A.2 - Manufacturing Industries and Construction	207.0	99.0	324.6
1.A.3 - Transport	900.0	1,029.2	1,737.9
1.A.4 - Other Sectors	421.8	563.6	498.0
1.A.5 - Non-Specified	117.0	97.0	70.3

When expressed on a CO2 equivalent basis, there is a clear drastic increase in emission from the transport sub-category across the period 1994 to 2010, ranging from 900 Gg to 1738 Gg, i.e. nearly a 95% increase in emission, followed by the manufacturing industries and construction sub-category, with nearly a 60% increase in emission and the other sectors sub-category.

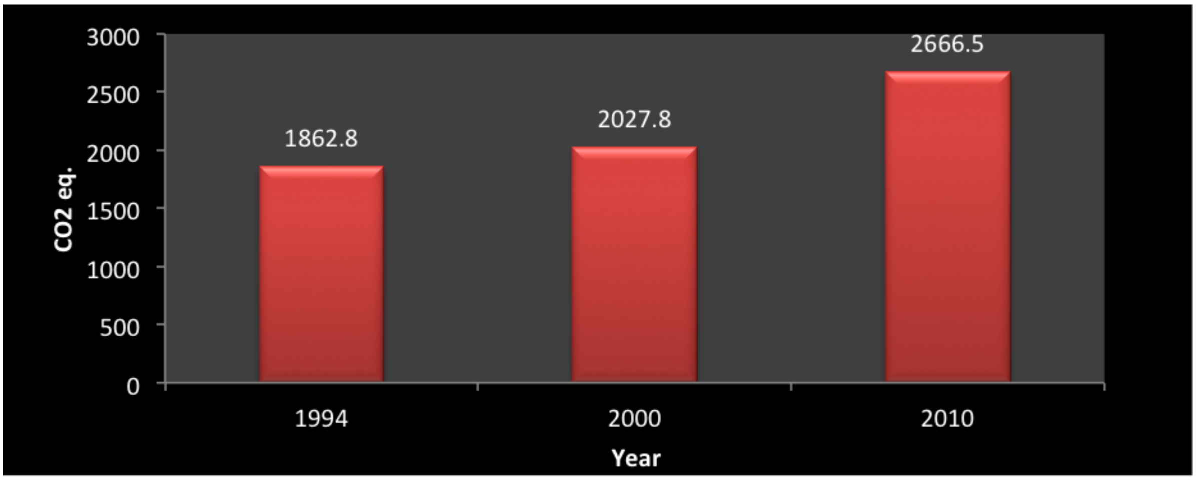


Figure 2.9: GHG emissions in CO_2-eq for the energy sector

2.14 INDUSTRIAL PROCESSES AND PRODUCT USE

2.14.1 Description of IPPU sector

Greenhouse gas emissions are produced from a wide variety of industrial activities. Emissions arise mainly from industrial processes during the chemical or physical transformation of materials (for example, in the blast furnace in the iron and steel industry, ammonia and other chemical products manufactured from fossil fuels used as chemical feedstock and the cement industry are notable examples of industrial processes that release a significant amount of CO_2). During these processes, many different greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), can be produced; (IPCC 2006 Guidelines V3_1, Ch 1). Other gases are also emitted in different sub categories including SF_6 and NMVOC.

Activities occurred in four out of the eight categories regrouped under the IPPU sector and emissions were estimated for these four source categories, namely lime production under mineral industry, ammonia and nitric acid production under chemical industry, iron and steel, ferroalloys, aluminium, lead and zinc production under metal industry, and lubricants and paraffin wax use under non-energy products from fuel and solvents use.

Quite a number of activity areas have not been included as activity data were not available to calculate the estimates. These sources are enumerated below.

- Product used as substitutes for ozone depleting substances
  - Refrigeration and air conditioning
  - Fire protection
  - Aerosols
  - Solvents
- Other products manufacture and use
  - Disposal of electric equipment
  - SF_6 in military applications
  - N_2O from medical applications and propellant for pressure and aerosol products.
- Food and beverage industry
  - Beer manufacture
  - Bread production
  - Fishmeal production

2.14.2 Methods

The method adopted is from the IPCC 2006 Guidelines at the Tier 1 level due to unavailability of reliable information on the technologies used in the production processes. Only the three main GHGs CO_2, CH_4 and N_2O were estimated as per the IPCC 2006 software that does not cover the other GHGs.
Output data from industries and input data from import and export were available from the NSA. Default values were used where required.

2.14.3 Activity Data

Activity data for the IPPU sector were obtained mainly from the NSA. Both the outputs from the production units and annual report of the Chamber of Mines were used to supplement the import and export data AD from the NSA. All AD from the different sources were compared and quality controlled to identify the most reliable sets which were used in the software for generating emissions. AD for lubricants use and paraffin wax use were derived from the mass balance of imports and exports data.

2.14.4 Emission factors

In the absence of information on technology used, all EFs used were IPCC defaults, with those giving the highest emissions adopted as per Good Practice. When the choice was linked to the country development, the factor attached with developing countries was adopted. The EFs used for the different source categories are listed in table 2.14 below.

Table 2.14. EFs for the IPPU sector

Category	IPPC Guideline volume	Table and page
Liming	V3_2_Ch2 Mineral Industry	Table 2.4 Page 2.22
Ammonia	V3_3_Ch3 Chemical Industry	Table 3.1 Page 3.15
Nitric acid	V3_3_Ch3 Chemical Industry	Table 3.3 Page 3.23
Iron and steel	V3_4_Ch4 Metal Industry	Table 4.1 Page 4.25
Ferroalloys	V3_4_Ch4 Metal Industry	Table 4.5 Page 4.37
Aluminum	V3_4_Ch4 Metal Industry	Table 4.10 Page 4.47
Lead	V3_4_Ch4 Metal Industry	Table 4.21 Page 4.73
Zinc	V3_4_Ch4 Metal Industry	Table 4.24 Page 4.80
Lubricant	V3_5_Ch5 Non Energy Products	Table 5.2 Page 5.9
Paraffin wax	V3_5_Ch5 Non Energy Products	Chapter 5.3.2.2 Page 5.12

2.14.5 Results

The IPPU sector emitted 2220.98 Gg of CO_2, 0.07 Gg of CH_4 and 0.36 Gg of N_2O in 2010. The highest emissions were from the Metal Industry sub-sector followed by Chemical Industry, Fuel and Solvent Use and the Mineral Industry. Aggregated emissions for the IPPU sector amounted to 2330 Gg CO2 eq. The metal industry category accounted for

67 % of the total emissions with the three main contributors being iron and steel, zinc and ferroalloy production with emissions estimated at 621, 555 and 333 Gg of CO_2-eq respectively. The chemical industry emitted 31 % in this sector with

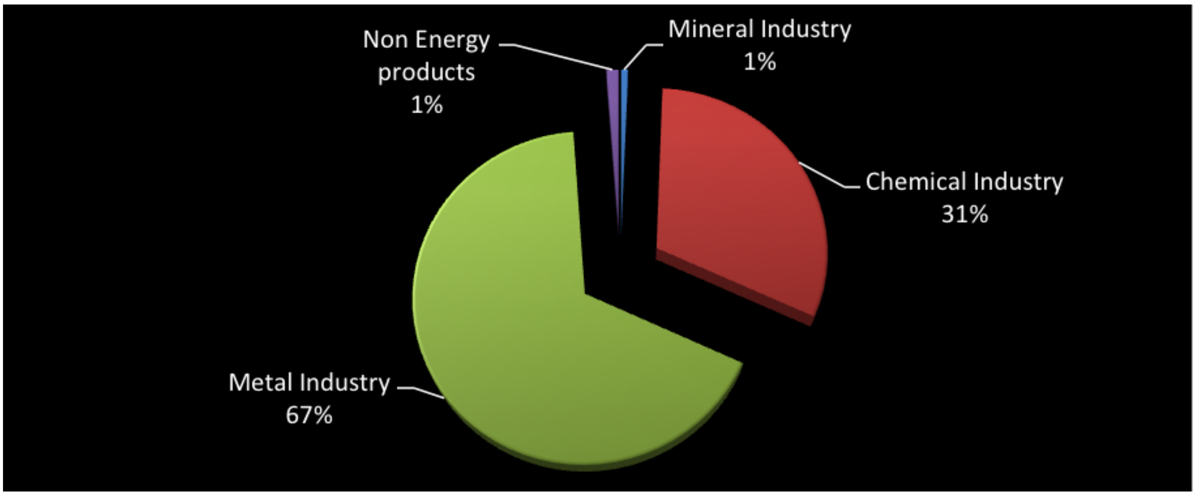


Figure 2.10. Aggregated emissions by IPPU source categories (CO_2-eq)

ammonia production responsible for 616 Gg CO_2 and nitric acid production for 108 Gg CO_2-eq. Emissions from the mineral industry and solvent use accounted for the remaining 2 % of the total aggregated emissions of the IPPU sector.

Emissions in IPPU sector for 1994, 2000 and 2010

In the 1994 inventory, estimates in the IPPU sector were done only for cement production and in the year 2000, it was not covered except for NMVOC on bitumen use. Hence, only aggregated emissions are presented in this report even if they are not strictly comparable as the scope of the two previous inventories were restricted. The emissions compiled are nevertheless provided in table 2.16.

Table 2.15. Aggregated emissions in IPPU sector for 1994. 2000 and 2010

1994	2000	2010
5	4*	2330

NMVOC estimate in Gg

Table 2.16. IPPU Sector emissions

Categories	Gg			Gg				
	CO_2	CH_4	N_2O	Other halogenated gases without CO_2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO_2
2 - Industrial Processes and Product Use	2220.98	0.08	0.36	0	0.89	2.85	0.01	0.14
2.A - Mineral Industry	15.25	0	0	0	0	0	0	0
2.A.1 - Cement production	0				0	0	0	0
2.A.2 - Lime production	15.25				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	0	0	0
2.A.4.a - Ceramics	0				0	0	0	0
2.A.4.b - Other Uses of Soda Ash	0				0	0	0	0
2.A.4.c - Non Metallurgical Magnesia Production	0				0	0	0	0
2.A.4.d - Other (please specify) (3)	0				0	0	0	0
2.A.5 - Other (please specify) (3)					0	0	0	0
2.B - Chemical Industry	616.34	0	0.36	0	0.87	0.05	0	0
2.B.1 - Ammonia Production	616.34				0.46	0.05	0	0
2.B.2 - Nitric Acid Production			0.36		0.41	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

Categories	Gg				Gg			
	CO_2	CH_4	N_2O	Other halogenated gases without CO_2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO_2
2.B.8.a - Methanol	0	0			0	0	0	0
2.B.8.b - Ethylene	0	0			0	0	0	0
2.B.8.c - Ethylene Dichloride and Vinyl Chloride Monomer	0	0			0	0	0	0
2.B.8.d - Ethylene Oxide	0	0			0	0	0	0
2.B.8.e - Acrylonitrile	0	0			0	0	0	0
2.B.8.f - Carbon Black	0	0			0	0	0	0
2.B.9 - Fluorochemical Production	0	0	0	0	0	0	0	0
2.B.9.a - By-product emissions (4)					0	0	0	0
2.B.9.b - Fugitive Emissions (4)					0	0	0	0
2.B.10 - Other (Please specify) (3)					0	0	0	0
2.C - Metal Industry	1561.93	0.07	0	0	0.023	2.81	0.006	0.140
2.C.1 - Iron and Steel Production	621.05	0.005			0	0	0.006	0
2.C.2 - Ferroalloys Production	333.37	0.06			0	0	0	0
2.C.3 - Aluminium production	39.78				0.023	2.81	0	0.140
2.C.4 - Magnesium production (5)	0				0	0	0	0
2.C.5 - Lead Production	12.55				0	0	0	0
2.C.6 - Zinc Production	555.18				0	0	0	0
2.C.7 - Other (please specify) (3)					0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use (6)	27.46	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	8.19				0	0	0	0
2.D.2 - Paraffin Wax Use	19.27				0	0	0	0

Categories	Gg			Gg				
	CO_2	CH_4	N_2O	Other halogenated gases without CO_2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO_2
2.D.4 - Other (please specify) (3), (8)					0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor (9)				0	0	0	0	0
2.E.2 - TFT Flat Panel Display (9)				0	0	0	0	0
2.E.3 - Photovoltaics (9)					0	0	0	0
2.E.4 - Heat Transfer Fluid (10)					0	0	0	0
2.E.5 - Other (please specify) (3)					0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning	0	0	0	0	0	0	0	0
2.F.1.a - Refrigeration and Stationary Air Conditioning					0	0	0	0
2.F.1.b - Mobile Air Conditioning					0	0	0	0
2.F.2 - Foam Blowing Agents				0	0	0	0	0
2.F.3 - Fire Protection					0	0	0	0
2.F.4 - Aerosols				0	0	0	0	0
2.F.5 - Solvents				0	0	0	0	0
2.F.6 - Other Applications (please specify) (3)				0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment	0	0	0	0	0	0	0	0
2.G.1.a - Manufacture of Electrical Equipment					0	0	0	0

Categories	Gg			Gg				
	CO_2	CH_4	N_2O	Other halogenated gases without CO_2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO_2
2.G.1.c - Disposal of Electrical Equipment					0	0	0	0
2.G.2 - SF6 and PFCs from Other Product Uses	0	0	0	0	0	0	0	0
2.G.2.a - Military Applications					0	0	0	0
2.G.2.b - Accelerators					0	0	0	0
2.G.2.c - Other (please specify) (3)					0	0	0	0
2.G.3 - N_2O from Product Uses	0	0	0	0	0	0	0	0
2.G.3.a - Medical Applications			0		0	0	0	0
2.G.3.b - Propellant for pressure and aerosol products			0		0	0	0	0
2.G.3.c - Other (Please specify) (3)			0		0	0	0	0
2.G.4 - Other (Please specify) (3)					0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry					0	0	0	0
2.H.2 - Food and Beverages Industry					0	0	0	0
2.H.3 - Other (please specify) (3)					0	0	0	0

2.15 AGRICULTURE, FOREST AND OTHER LAND USE (AFOLU) SECTOR

2.15.1 Description of sector

The AFOLU sector includes four categories and except for Harvested Wood products, the remaining three enumerated below were covered in this inventory.

3 – Agriculture, Forestry, and Other Land Use
3.A – Livestock
3.B – Land
3. C – Aggregate sources and non-CO2 emissions sources on land

All activity areas falling under these categories have been addressed. Additionally, special efforts have been devoted to treat the livestock and Land categories at the tier 2 level except for some stock factors where the IPCC defaults have been adopted.

The methodologies are based on the IPCC 2006 Guidelines and the IPCC 2006 software was used to estimate emissions and removals. Since the IPCC 2006 Guidelines do not estimate emissions at the tier 2 level, the Agriculture and Land Use software has been partially used as a supplement for the Livestock category. Otherwise, it was a very difficult exercise to accommodate higher than tier 1 with the IPCC 2006 Guidelines and significant work had to be accomplished in Excel worksheets and then used in the software. Some detailed information on management systems of certain land classes could not be assigned in the IPCC 2006 software.

Detailed reporting will follow under each category with the full sectoral summary table at the end of the AFOLU section. This approach has been adopted for presenting this sector in view of facilitating reader's comprehension.

2.15.2 Livestock

Methods

Enteric fermentation and manure management emissions are both estimated by using the IPCC 2006 Guidelines and IPCC 2006 software. Tier level 2 has been adopted for cattle and dairy cows for both enteric fermentation and manure management. Tier 1 has been applied for all remaining animal groups as there is no software providing for estimates to be made at a tier 2 level. Country specific data on live weight, pregnancy and other parameters were available or generated as described in the emission factor section below. The calculation of the methane emission factors has been conducted with the ALU software while the computation of nitrogen excretion rates for the different animal groups has been done using Excel spreadsheet using the formula provided in the IPCC 2006 Guidelines.

Activity Data

Good quality data were available for beef cattle (non-dairy) and dairy cows from the NSA and the surveys done annually by the Ministry of Agriculture. These two sources of statistics provided the necessary background information for the different IPCC livestock groups reared under Communal and Commercial conditions for the year 2010 and these were used for compiling estimates. Cattle have been subdivided in non-dairy and dairy groups. The number of dairy cows was taken as 1500 according to communications from the single dairy farm (Namibia Super Dairies) of Namibia. Communal non-dairy cattle has been sub-divided into mature bulls, mature females, mature male castrates, young intact males and young females following a split of respectively 36%, 4%, 16%, 20% and 24% based on information from a study on farming practices (NNFU 2006). Due to lack of data on gender and age for commercial cattle, it has been assumed that it follows the same split as communal. The livestock categories and sub-categories together with the population (head) are shown in Table 2.17.

Table 2.17. Animal population by sub-category

Sub-category	Population (No. of heads)
Dairy commercial cows	1 500
Non Dairy commercial mature bulls	30 923
Non Dairy commercial mature females	260 253
Non Dairy commercial mature male castrated (MMC)	120 080
Non Dairy commercial young intact male (YIM)	144 892
Non Dairy commercial young female (YF)	172 401

Sub-category	Population (No. of heads)
Non Dairy communal mature bulls	70 452
Non Dairy communal mature females	592 930
Non Dairy communal mature male castrates (MMC)	273 577
Non Dairy communal young intact male (YIM)	330 105
Non Dairy communal young female (YM)	392 777
Commercial swine	25 487
Communal swine	38 011
Goat	1 690 467
Sheep	1 378 861
Poultry	778 855
Horses	49 852
Mules and asses	141 588
Camels	43

Average live weights for the non-dairy cattle sub-categories have been derived from slaughterhouse data of Meatco and live weights of auctioned animals by group. The live weight for dairy cow has been assumed the same as for cows being slaughtered. Daily weight gain has been derived from the live weight of the different animal groups and is provided in Table 2.18 below.

Table 2.18. Country specific values for live weights and weight gain for cattle (kg)

	Communal		Commercial	
Animal	Avg Live weight	Daily weight gain	Avg Live weight	Daily weight gain
Diary cows		0,00	541,5	0,00
Cows	399,1	0,00	541,5	0,00
Bulls	596,7	0,00	624,5	0,00
Oxen	422,7	0,00	506,0	0,00
Growing male cattle	184,5	0,38	468,75	0,70
Growing female cattle	201,5	0,41	468,75	0,70

For tier 2 estimations it is necessary to also assign a typical mature weight for each animal group and these values for commercial and communal animal groups were again derived from the weight of animals being slaughtered or sold by auction. For dairy and non-dairy commercial cattle a mature animal weight of 464 kg/head and for communal cattle, a typical mature weight of 451 kg was adopted.

Emission factors

The management of the animals includes the feeding system, daily work, lactation and pregnancy, feeding situation and management of the manure. These factors have an influence on both the enteric fermentation and manure management emission factors. The emissions for cattle are calculated following a tier 2 approach as specified by IPCC methodologies adopted in the ALU software. For all the other animals a default factor (1996 IPCC GL, Table 4-3 to 4-5, p. 4.10 -4.12, developing countries) has been used to calculate the emission factors for enteric and methane emissions.

The emissions for tier 2 have been calculated following the equations (beef cattle and dairy cows):

Enteric CH_4 emissions = EF(enteric)$_{CH4}$ x POP)/1000

Manure CH_4 emissions = POP x (%MMS/100) x EF(manure)$_{CH4}$ /1000

Manure direct N_2O emissions = Nm x EF (tier 2)

The emission factors for enteric and manure CH_4 have been derived with the use of the ALU software while manure N_2O was obtained using the live weights and default nitrogen excretion rates in the IPCC 2006 software. Country specific values are provided in Tables 2.19 and 2.20.

The emission factor for enteric CH_4 is calculated using the following equation:

EF(enteric)$_{CH4}$ = GE_c (MJ.(head.day)$^{-1}$) x Y_m with GE, the daily gross energy intake and Y_m, the rate converted to CH_4 (fraction).

Gross energy (GE) is the sum of energy for maintenance, the energy for activity, lactation, work, pregnancy and growth. Live and mature weight (kg/head), feeding system (% stall, pasture or grazing), milk production (kg/head/day), fat content of milk, average daily work (%), pregnancy (%), average daily weight gain (kg/head/day) and the digestible energy (DE) (%) are necessary parameters to calculate the energy requirements of animals.

The emission factor for manure CH4 is calculated with following equation:

EF (manure)$_{CH4}$ = VS x 365 days/year x B0 X 0.67 (kg/m3 CH_4) x MCF with VS the volatile solid excretion rate (kg dry solid/ (head.day)$^{-1}$), B0, the maximum methane producing capacity (m^3/kg dry solid) and MCF, the methane conversion fraction (fraction)

VS is the sum of GE intake multiplied by DE and ash of manure (%).

The missing emission factors were taken as default for all animals (source: 2000 IPCC GPG, Table 4.13, p. 4.44). The Nm (amount of managed N) for direct N_2O is calculated with following equation:

Nm = POP x Nex x Nadj x (%MMS/100) with Nex (the N excretion rate0, Nadj (adjustment factor) and MMS (the manure management system).

Table 2.19. Methane producing capacity (B0) for estimation of manure methane for cattle (IPCC 2006)

Maximum methane producing capacity	
Animal	B0 (m^3 CH_4/ kg VS)
Dairy cattle	0,13
Non Dairy cattle	0,1

Table 2.20. Tier 2 parameters for manure and enteric CH_4 emission factors for cattle

Sub-category	Feeding situation[1]	MMS[2]	Lactation	milk production (l/ day)	pregnant (%)	DE%
Commercial Dairy Cow	100% S	LS	20%	32	60%	75%
Communal Cows	100% LAG	50% PRP/ 49% SS / 1% CON		0	60%	55%
Communal Bulls	100% LAG	50% PRP/ 49% SS / 1% CON				55%
Communal MMC[3]	100% LAG	50% PRP/ 49% SS / 1% CON				55%
Communal YIM[4]	100% LAG	50% PRP/ 49% SS / 1% CON				60%
Communal YF[5]	100% LAG	50% PRP/ 49% SS / 1% CON				60%
Commercial Cows	100% LAG	50% PRP/ 49% SS / 1% CON	20%	0	60%	55%
Commercial Bulls	100% LAG	50% PRP/ 49% SS / 1% CON				55%
Commercial MMC	100% LAG	50% PRP/ 49% SS / 1% CON				55%
Commercial YIM	100% LAG	50% PRP/ 49% SS / 1% CON				60%
Commercial YF	100% LAG	50% PRP/ 49% SS / 1% CON				60%

The feeding situation is based on information available from the census and surveys while MMS for cattle are based on country expert judgment and on information in the farming system guide (NNFU, 2006). The MMS for swine is liquid slurry. For poultry, manure with bedding (60%) and manure without bedding (40%) was adopted and PRP for remaining manure.

Pregnancy is based on the number of young females and intact males population as a percentage of the cows population assuming that the young animals are sold annually as there exists no carrying capacity above a critical total number of heads of livestock and also the number of young animals sold and slaughtered annually.

The lactation period of dairy cows is assumed to be over a period of 4 months after birth, based on expert judgment. Therefore lactation was taken as the number of animals pregnant divided by 3 to bring it in line with the animal population. The DE is taken from IPCC 2006, chapter 10 annex table 10A2 for animals in large grazing areas and based on feed characteristics supplied by Feed Master Ltd, the company producing feeds in the country for dairy cows.

The average daily work for commercial and communal cattle has been assumed as 6 hours/day for the whole year, based on expert judgment of Namibia GHG inventory team, for mature male castrates only as the other animal groups do not perform any work.

Footnotes

1. Large area grazing (LAG), pasture (P), stall (S)
2. Liquid Slurry (LS), pasture range paddock (PRP), Solid Storage (SS), Construction (CON)
3. Mature Male Castrates
4. Young Intact Males
5. Young Females

Results

The livestock category emitted 187.13 Gg CH4 and 0.81 Gg N2O in 2010 (Table 2.21) The major part of the methane came from enteric fermentation with 181.2 Gg (97%) and the remaining 5.9 Gg (3%) came from manure. In both cases, the cattle category accounted for the major fraction of the methane and as well the nitrous oxide on account of the large number of heads and higher body mass.

Table 2.21. Livestock category emissions

Categories	(Gg)				
	Emissions				
	CH_4	N_2O	NOx	CO	NMVOCs
3.A - Livestock	187.131	0.811	0	0	0
3.A.1 - Enteric Fermentation	181.202	0	0	0	0
3.A.1.a - Cattle	163.477	0	0	0	0
3.A.1.a.i - Dairy Cows	0.128		0	0	0
3.A.1.a.ii - Other Cattle	163.349		0	0	0
3.A.1.b - Buffalo	0		0	0	0
3.A.1.c - Sheep	6.894		0	0	0
3.A.1.d - Goats	8.452		0	0	0
3.A.1.e - Camels	0.002		0	0	0
3.A.1.f - Horses	0.897		0	0	0
3.A.1.g - Mules and Asses	1.416		0	0	0
3.A.1.h - Swine	0.063		0	0	0
3.A.1.j - Other (please specify)	0		0	0	0
3.A.2 - Manure Management (1)	5.929	0.811	0	0	0
3.A.2.a - Cattle	4.846	0.811	0	0	0
3.A.2.a.i - Dairy cows	0.101	0.001	0	0	0
3.A.2.a.ii - Other cattle	4.745	0.810	0	0	0
3.A.2.b - Buffalo	0	0	0	0	0
3.A.2.c - Sheep	0.290	0	0	0	0
3.A.2.d - Goats	0.372	0	0	0	0
3.A.2.e - Camels	0.000	0	0	0	0
3.A.2.f - Horses	0.109	0	0	0	0
3.A.2.g - Mules and Asses	0.170	0	0	0	0
3.A.2.h - Swine	0.127	0	0	0	0
3.A.2.i - Poultry	0.016	0	0	0	0
3.A.2.j - Other (please specify)	0	0	0	0	0

Aggregated emissions from the livestock category amounted to 4181.5 Gg CO_2-eq out of which enteric fermentation contributed 3804.9 GG CO_2-eq and manure management 376.6 Gg CO_2-eq. Out of this same total, methane had a share of 94% (3930.5 Gg CO_2-eq) and nitrous oxide 6% (251.4 Gg CO_2-eq)

<u>Emissions for 1994, 2000 and 2010</u>

Methane emissions from enteric fermentation decreased from 250.4 Gg in 2000 to 181.2 Gg in 2010 which represents 28% less. In CO_2-eq, the decrease is also 28% from 5258.4 to 3804.9. This could be due to the more precise estimates made at the tier 2 level in 2010 as opposed to tier 1 in the year 2000. The emissions for manure management cannot be compared as this activity area was not covered in the year 2000.

Table 2.22. Emissions for livestock by gas in Gg and CO_2-eq. for 1994, 2000 and 2010

	Gg			CO_2 eq			
	1994	2000	2010	1994		2000	2010
Manure CH_4	3	NA	5.96	63		NA	125.16
Manure N_2O	NA	NA	0.81	NA		NA	251.41
Enteric CH_4	112	250.40	181.19	2352		5,258.40	3,804.95
TOTAL				2415		5,258.40	4,181.52

2.15.3 FOLU

The FOLU sub-sector covers emissions and removals within the six IPCC land classes and between the classes when there is a change in land use within the inventory year. All lands within the Namibian territory has been treated in this inventory as managed land and thus accounted for in the compilation of emissions and removals. Land use has been derived from the land covers attributed on the maps generated from satellite images.

The categories covered in this inventory under FOLU are:

- 3.B.1 Forestland
- 3.B.2 Cropland
- 3.B.3 Grassland
- 3.B.4 Wetlands
- 3.B.5 Settlements
- 3.B.6 Other land

Methods

The estimation of the emissions by source and removals by sink for the FOLU sector has been done on the basis of the IPCC 2006 Guidelines and using the IPCC 2006 software. Approach 2 was adopted with a mix of tier 1 and tier 2 levels, the latter being applied for the categories falling under FOLU as some of these were among the highest emitters or sinks in the last inventory. Most of the stock factors have been derived from forest inventories and other available in-country resources. More detailed descriptions of these are provided further in this report under activity data and emission factors.

Activity Data

The activity data used for FOLU are summarized in this chapter together with assumptions and sources of information. Activity data for the FOLU categories have been generated on the basis of geospatial maps produced for two time steps, the years 2000 and 2010. A paragraph is dedicated to the description of the activity data generated and used.

Land representation

Geospatial data have been used to determine the land cover of Namibia. Two maps were generated from LandSat satellite imagery 30m resolution for the years 2000 and 2010. Both maps provide for the area divided by country specific sub-classes within the six main IPCC land classes. The combination of the two maps allowed for a land representation under approach 2 and enabled calculation ofland use changes between the sub-classes. Climate and soil maps of the country have been aligned to the IPCC classification and overlaid on the land cover land use maps to generate the combined Climate-Soil-Land classifications.

The data contained two climates and four soil types that are IPCC default climates and soils:

- Tropical Dry (TRD) and Tropical Montane Dry (TRMD)
- High Activity Clay (HAC), Low Activity Clay (LAC), Sandy Mineral (SAN) and Wet Mineral (WET)

More details on the sub classification of the six IPCC land classes are provided further below.

Deriving land use from land cover maps using the remote sensing technology has been a major challenge. Some land use changes between classes were not obvious at all such settlements being converted to Forestland or still Cropland. As these did not reflect the reality, adjustments had to be made to cater for these inconsistencies. Moreover, some of the areas allocated to some classes did not match with existing data from previous mapping exercises and land surveys. These are still being looked into. This exercise is thus still on-going to further refine land representation from these maps with the objective of raising the quality of future inventories. It is also planned to generate maps for 2005 to evaluate and calculate land use changes over shorter timespans to further improve accuracy of the inventory as now land use has been derived over a period of 10 years and then annualized. The initial areas from the maps have been adjusted to be in line with other resources and to remove inconsistencies mentioned previously. The adjusted areas that have been used to estimate emissions and removals are given in Table 2.23.

Table 2.23. Total land use adjusted area

Category	Area adjusted (ha)	Sub-category	Area adjusted (ha)
3.B.1 Forestland	7,267,850.78	Forest	6,387,411.68
		Woodland	880,439.10
3.B.2 Cropland	567,578.16	Crops	263,874.55
		Set aside	303,703.61
3.B.3 Grassland	62604,423.72	Grassland	17,932,224.60
		Savannah Grassland	30,327,444.81
		Shrubland	14,344,754.31
3.B.4 Wetland	657,612.99	Wetland	657,612.99
3.B.5 Settlements	31,162.59	Settlements	31,162.59
3.B.6 Other land	11,432,153.92	Other Land	11,432,153.92
TOTAL	???		82,560,782.16

Land use changes

The data from the two land cover maps for the years 2000 and 2010 allow the determination of land use changes between each sub-class by climate and soil type (6 combinations) at an approach 2 level. The land use change matrices generated from these maps for each climate and soil category are provided in Table 2.24 below.

Table 2.24. Land use matrices for the different climate soil type combinations

Climate Soil	TRDHAC						
	C	F	G	O	S	W	Total
C	209161.35	5292.27	99827.64	0	0	0	314281.26
F	2714.22	5418887.36	233469.27	0	0	0	5655070.85
G	155526.3	713786.85	30546991.26	0	0	0	31416304.41
O	0	0	0	10512604.21	0	0	10512604.21
S	0	0	0	0	19550.07	0	19550.07
W	0	0	0	0	0	625424.31	625424.31
Total	367401.87	6137966.48	30880288.17	10512604.21	19550.07	625424.31	48543235.11
Climate Soil	TRDLAC						
	C	F	G	O	W	Total	
C	360.99	4.14	109.53	0		474.66	

F	46.26	8532.36	11860.56	0		20439.18	
G	1308.33	16873.92	51268.59	0	0	69450.84	
W			0		2.7	2.7	
Total	1715.58	25410.42	63238.68	0	2.7	90367.38	
ClimateSoil	TRDSAN						
	C	F	G	O	S	W	Total
C	123995.16	8261.1	117285.21	0	0	0	249541.47
F	7354.26	702434.97	882001.89	0	0	0	1591791.12
G	184432.23	2011143.69	27118942.29	0	0	0	29314518.2
O	0	0	0	915390.9	0	0	915390.9
S	0	0	0	0	2987.91	0	2987.91
W	0	0	0	0	0	30859.02	30859.02
Total	315781.65	2721839.76	28118229.39	915390.9	2987.91	30859.02	32105088.6
ClimateSoil	TRDWET						
	C	F	G	W	Total		
F		87.57	234.27		321.84		
G	0.18	133.02	614.07	0	747.27		
Total	0.18	220.59	848.34	0	1069.11		
ClimateSoil	TRMDHAC						
	C	F	G	O	S	W	Total
C	3037.23			0		0	3037.23
F			49.77	0			49.77
G		493.74	1567980.63	0	0	0	1568474.37
O			0	3742.02	0	0	3742.02
S			0	0	8624.61		8624.61
W		0	0	0		1222.02	1222.02
Total	3037.23	493.74	1568030.4	3742.02	8624.61	1222.02	1585150.02
ClimateSoil	TRMDSAN						
	C	F	G	O	W	Total	

C	243.54			0		243.54	
F			178.02			178.02	
G		1045.08	233883.54	0	0	234928.62	
O			0	416.79		416.79	
W		0	0		104.94	104.94	
Total	243.54	1045.08	234061.56	416.79	104.94	235871.91	

Deforestation

The deforestation rate from the initial maps reached some 275 703 ha annually and such a rate will result in no more forest existing in the country within a decade or even less when considering the use made of forests by the communities. After the adjustments were made to the initial maps, the deforestation rate fell to 161,912.53 ha/year which is more realistic. Compared to FRA 2010, this rate is still relatively high (Table 2.25). However, since this rate can ensure for a sustainable use of forest resources, it has been adopted for this inventory until all the problems linked to the maps are fixed.

Table 2.25. Deforestation and total forest area of Namibia and compared to FRA data

	Deforestation (ha/10 year)	Deforestation (ha/year)	Reforestation (ha/year)	Net deforestation (ha/year)	Total Area Forest (ha)
FRA 2010				74,000.00	7,290,000.00
Area	2,757,033.81	275,703.38	113,790.85	161,912.53	7,267,850.78

Forest land stratification

The Forest definitions adopted for the interpretation of the maps are provided below.

The forests were divided in two sub-categories:

- Forests (FL): with a tree height of 5 m and a canopy cover of more than 20%
- Woodlands (WD): with tree height of 5 m and a canopy cover between 10% and 20%

Age classes

The area is further subdivided in age classes using non-spatial datasets. It was calculated that 45% of the trees are <20 years and 55% are >20 years for forests from the forest inventories. These age classes have been derived on the basis of the diameter at breast height (dbh) of the most abundant species (Mendelson and Obeid, Forests and woodlands of Namibia, 2007). Based on this, the area forestland was subdivided into 45% less than 20 years and the remainder more than 20 years.

In Namibia fuel wood is harvested in forestland and grassland. Living biomass and deadwood are collected for fuel wood. For the inventory it was assumed that 20% of the total fuelwood is collected deadwood (expert knowledge). Deadwood has not been accounted for in this inventory estimates because only emissions from the living biomass pool are considered whereas deadwood harvest is a change in carbon in the litter pool. For the remaining 80% fuel wood, 80% removal has been attributed to shrublands and 20% to woodlands. Fuelwood collection is assumed to occur only in the climate and soil combinations TRDHAC and TRDSAN where the communities usually have recourse to this activity. The 80% attributed to grassland has been accounted for in land classes converted to forestland, because the IPCC 2006 software did not allow to account for it in grassland remaining grassland. The density of fuelwood is taken approximate as 0.91 t dm/m^3 and BCEF defaults provided in the IPCC table (Vol 4, chaq 04, p 4.51) has been used, namely 0.89 for growing stock level of 41-60 m^3, 2.11 for 21-40 m^3 and 5.55 for 10-20 m^3.

Fuelwood including charcoal and timber removals have been calculated on the basis of censuses made by NSA and other reports. The volume of fuelwood was based on the amount used by households in the rural and urban areas (NHIES main report 2009-2010 from NSA) and fuelwood production (woodchips in Namibia). Volume of poles representing timber harvested was based on the report on low cost dwellings in Namibia (Iteaa M,(2010) to calculate use per household and frequency as well as the amount used for kraals in relation to the number of households from the NHIES report.

Timber is harvested especially in the North of the country in forest and woodland areas. Collection of timber is assumed to only occur in forests aged more than 20 years in the ratio 75:25 in the climate and soil combinations TRD HAC and TRD SAN since it is associated with the rural population in the north, mainly where TRD HAC occurs.
Table 2.25 gives an overview of the final volumes extracted from woody land in relation to climate and soil combination, and age.

Table 2.26. Volume of timber and fuelwood extracted from forestland and grassland

	TIMBER (m^3)	FUELWOOD (m^3)
TRDHAC WD <20year (remaining)	-	36,839.29
TRDHAC WD >20year (remaining)	255,877.25	36,839.29
TRDSAN WD <20year (remaining)	-	36,839.29
TRDSAN WD >20year (remaining)	85,292.42	36,839.29
TRDHAC F converted to SH	-	294,714.28
TRDSAN F converted to SH	-	294,714.28
TOTAL	341,169.66	736,785.71

Cropland stratification

Cropland areas were not stratified and all were considered as Annual Cropland since perennial crops cover a marginal area of total cropland, about 0.001% only. The annual crop management systems considered are wheat, millet, sorghum, and maize grown under commercial and communal set-ups. Estimations for Stock factors for annual cropland are based on management practices of the individual crops under these two conditions.

Area

Cropland area was overestimated from the maps when compared to annual surveys undertaken for food security purposes and thus the latter areas were adopted for the inventory along with the information on the specific crop cultivated. The annual crop survey revealed that 54% of the area attributed to cropland is not cultivated. Therefore, this area is accounted as set aside in the inventory. The total cropland area of 567,578.16 ha was sub-divided in 263,874.55 ha annual cropland and 268 548.93 ha set-aside. It has been assumed that most of the managed annual cropland are located in the soil climate-combinations HAC and SAN under TRW and TRD as it is known that these are the regions where agricultural activity takes place. Therefore 50% of the cropland area has been assigned to each stratum.

Grassland stratifications

Grassland is divided into 3 sub-categories:

- Savannah Grassland (SG): area with shrubs and bushes with most trees 5m and above a canopy cover of 5%
- Shrubland (SH): area where shrubs (less 5m in height) dominate the landscape, with greater than 2% woody biomass cover, and there are few trees
- Grassland (GG): area with predominant grass cover with less than 2% woody biomass cover

Age classes for woody savanna

The age class for woody biomass in grassland is taken by default as no country specific data is available.

Area

The total area of grassland estimated initially from the maps as 56,614,422.51 ha was adjusted to 62,604,423.72 ha to accommodate inconsistencies on land use changes as reported previously. It is sub-divided into 17,932,224.60 ha of grassland, 30,327,444.81 ha savannah grassland and 14,344,754.31 ha of shrub land on the basis of expert knowledge.

Wetlands stratification

The wetlands have not been further subdivided. The total adjusted wetland area is 657,612.99 ha.

Settlements stratification

This land also has not been further subdivided. The total settlements area is 31,162.59 ha.

Other land stratification

This land was further subdivided into bare land, rock outcrops and desert sand. For the purpose of this inventory, these sub-classes were not taken into consideration as there is no activity leading to emissions or removals there. The total adjusted area of other land is 11,432,153.31.

Emission factors

This section resumes how emission and other stock factors have been analyzed, screened, adopted and generated so as to be representative of circumstances of Namibia. Where an emission factor is not country specific, the most appropriate default values contained in the IPCC 2006 software has been used.

Above ground biomass stock and growth

<u>Forestland</u>

The above ground biomass stock (Bm) (t dm/ha) and annual growth rate (Iv) (m3/ha/year) in forests was estimated for:

- Forests younger than 20 years
- Forests older than 20 years
- Woodland younger than 20 years
- Woodland older than 20 years

No below ground biomass (BGB) has been derived, and the default ratios between Bm and BGB has been taken from IPCC 2006 Guidelines.

Namibia conducted an extensive assessment of its woody biomass resources towards sustainable use of biomass by the country during the period 2000 to 2006. The 13 regions of the country were covered and inventories of woody biomass made. The method was the one usually adopted for making National Forest Inventories whereby all trees with a dbh exceeding 5cm are accounted for as woody biomass. All the trees were inventoried, by species and whether live or dead. The dbh of each tree for all species and number of trees were used to derive volume in the inventoried area and then brought to a per hectare basis.

Two regions, Okongo and Oshikoto were also characterized for their landcover under sub-classes Forest, Closed Woodlands, Open Woodlands, Thicket, closed Shrubland and Bushland. Taking into consideration the results of these two inventories primarily and the fact that woodlands are not subdivided into closed and open woodlands in the recent maps used in this inventory, it was assumed that Forestland and Woodland growing stocks stood at 50 and 30 m3/ha respectively based on expert judgement. Above ground biomass (equation below) was then derived by multiplying the growing stock volume by the weighted average density of all species calculated from data from the NFI of Okongo forest as the dominating species are not very different in the country. Wood density was obtained from the Global Wood Density Database of Zanne et al. (2009) and the density of Acacia flechii was taken from the African wood density database (Local data for wood density ref No. 16a. http://cdm.unfccc.int/filestorage/. (ICRAF species switchboard). The average density has been taken as 0.7 t dm/ha.

Bm (t dm/ha) = Growing Stock (m3/ha) x Density (t dm/m3)

Then, the above ground biomass for each age class was calculated by using a default ratio of BM>20 years/Bm<20 years of 70/30, taken from table 4.8 tropical dry forest plantation ratio for young and aged trees and the distribution of species by dbh class. It was calculated that 45% of the trees are <20 years and 55% are >20 years. The Bm for forest with age <20 year was estimated at 21.44 t dm/ha and Bm for forest with age >20 year at 50.03 t dm/ha (including saplings). The above ground biomass excludes herbaceous biomass. The age classes have been derived from the dbh distribution (Mendelsohn, 2007).

The biomass growth rate was estimated on the basis of the individual above ground biomasses divided by the average

age for each class. These were then adjusted to account for woody biomass increase from the Grassland class. For sapling biomass an estimation of 2 t dm/ha has been taken.

A summary of Bm and Iv used for forests and woodlands in the inventory is given in Table 2.27.

Table 2.27. Above ground biomass and growth rate by tree age classes

Sub-category	Above ground Biomass (t dm/ha)	Iv (t dm/ha/year)	Adjusted Iv (t dm/ha/year)
Forest <20y	21.44	2.14	3.26
Forest >20y	50.03	0.90	2.26
Woodlands <20	12.97	2.16	3.16
Woodlands >20	42.08	1.41	2.29
Saplings	2.00	NA	NA
Herbaceous biomass	2.30	NA	NA

Cropland

Since there are only annual crops, no woody biomass growth factors have been assigned.

Grassland

The above ground biomass stock (t dm/ha) differ between grassland, shrubland and grassland savanna. In shrubland a total Bm for woody biomass of 8 t dm/ha has been calculated on the basis of the study on wood chip production in shrublands where the invader bush is found. (wood chip production technology and costs for Fuel in Namibia) and data from the forest inventories of Okongo and Oshikoto mentioned previously.

The Bm for woody biomass from grassland Savanna is 4.3 and has been taken from IPCC 1996 guidelines, reference manual, p. 4.76 table 4.14. The woody biomass of grassland has been accounted for under forest land remaining forest land using the IPCC 2006 software, because of tier 1 limitations whereby woody biomass accumulation is not possible under the class Grassland remaining Grassland. The total Bm was calculated for the total area of Grassland Savanna and Grassland Shrubland. This amount was then redistributed on to forests of tree age below 20 years and above 20 years at the rate of 1.36 t dm/ha and 1.12 t dm/ha for all soil and climate combinations except TRMD climate. A value of 1.17 t dm/ha has been used to adjust for the above to below ground biomass ratio.

Herbaceous biomass is taken 2.3 t dm / ha, which is the IPCC default for grasslands.

The Bm after conversion for the same year has been assumed different from the IPCC default, that is 0 t dm/ha. After conversion woody biomass is 1 t dm/ ha and herbaceous biomass is 2.3 t dm/ ha.

Table 2.28. Above ground biomass for grassland (t dm/ha)

	Shrubland	Grassland savanna	Grassland
Bm woody	8	4.3	0
Bm herbaceous	2.3	2.3	2.3
Bm woody after conversion	1	1	0
Bm herbaceous after conversion	2	2.3	2.3

Similarly as for woody biomass stocks, annual increments cannot be accounted in the IPCC 2006 software under Grassland remaining Grassland. All trees and woody biomass in grasslands are assumed to be between 8 and 30 years old. Annual growth of woody biomass in grasslands is derived by dividing the standing stock by the average age derived from the forest inventory. The annual growth of shrubland was based on an annual average age of 15 years because of the regular harvest for making charcoal and fuelwood. For grassland savannah an average of 36 years, obtained from the forest inventories, has been taken. Using the same reasoning and approach as for standing aboveground biomass stocks, an amount was added to the forest biomass growth rates, namely 0.53 t dm/ha/yr and 0.12 t/dm/ha/yr for forests aged less than 20years and more than 20 years respectively.

<u>Disturbances</u>

In the category forest land remaining forest land, a total of 3% of the land is burned through disturbance every year with a fraction of biomass loss of 10% lost based on documents published by the department of forest on burnt areas determined from scars from MODIS data. This means that every year 183 898 ha from a total forest of 6 129 942 ha is burned with a fraction loss of biomass of 0.1.

No disturbance has been accounted for on grassland and cropland.

<u>Management factors</u>

For forestland, no management has been accounted for. Therefore, the land use management and input stock factors are taken as 1.

The grassland stock factors have been taken respectively as 1 and 0.67 to reflect the national circumstances
For croplands, the land use stock factor is 0.58 and the management and input factor is 1 for annual crops. For set aside, other factors have been taken, respectively 0.93 and 1.17 for the land use and management and input.

Results

In 2010, the FOLU sector acted as a net sink, with a total net removal of -27 680.46 Gg of CO_2. Forestland acted as a sink for 75 926.29 Gg CO_2 with Forest Land remaining Forest Land accounting for 57 963.35 Gg out of this. The conversions of other classes to Forest Land brough the remaining sink. Cropland accounted for a removal of 368.28 Gg CO_2 while Grassland emitted 48 614 Gg of CO_2. This includes the emissions and removals from land use management and land use conversions. A major source of emission is the conversion of forest land to grassland. A significant part of removals comes from woody biomass C in grasslands (bush encroachment).

Table 2.29. Emissions and removals from the land category for 2010

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NOx	CO	NMVOCs
3.B - Land	-27680.466	0	0	0	0	0
3.B.1 - Forest land	-75926.291	0	0	0	0	0
3.B.1.a - Forest land Remaining Forest land	-57963.354			0	0	0
3.B.1.b - Land Converted to Forest land	-17962.936	0	0	0	0	0
3.B.1.b.i - Cropland converted to Forest Land	-156.887			0	0	0
3.B.1.b.ii - Grassland converted to Forest Land	-17806.050			0	0	0
3.B.1.b.iii - Wetlands converted to Forest Land	0			0	0	0
3.B.1.b.iv - Settlements converted to Forest Land	0			0	0	0
3.B.1.b.v - Other Land converted to Forest Land	0			0	0	0
3.B.2 - Cropland	-368.247	0	0	0	0	0
3.B.2.a - Cropland Remaining Cropland	-174.680			0	0	0
3.B.2.b - Land Converted to Cropland	-193.567	0	0	0	0	0
3.B.2.b.i - Forest Land converted to Cropland	189.151			0	0	0
3.B.2.b.ii - Grassland converted to Cropland	-382.718			0	0	0
3.B.2.b.iii - Wetlands converted to Cropland	0			0	0	0
3.B.2.b.iv - Settlements converted to Cropland	0			0	0	0
3.B.3.a - Grassland Remaining Grassland	0			0	0	0
3.B.3.b - Land Converted to Grassland	48614.072	0	0	0	0	0
3.B.3.b.i - Forest Land converted to Grassland	48895.554			0	0	0
3.B.3.b.ii - Cropland converted to Grassland	-281.483			0	0	0

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NOx	CO	NMVOCs
3.B.3.b.iii - Wetlands converted to Grassland	0			0	0	0
3.B.3.b.iv - Settlements converted to Grassland	0			0	0	0
3.B.3.b.v - Other Land converted to Grassland	0			0	0	0
3.B.4 - Wetlands	0	0	0	0	0	0
3.B.4.a - Wetlands Remaining Wetlands	0	0	0	0	0	0
3.B.4.a.i - Peatlands remaining peatlands	0		0	0	0	0
3.B.4.a.ii - Flooded land remaining flooded land				0	0	0
3.B.4.b - Land Converted to Wetlands	0	0	0	0	0	0
3.B.4.b.i - Land converted for peat extraction			0	0	0	0
3.B.4.b.ii - Land converted to flooded land	0			0	0	0
3.B.4.b.iii - Land converted to other wetlands				0	0	0
3.B.5 - Settlements	0	0	0	0	0	0
3.B.5.a - Settlements Remaining Settlements	0			0	0	0
3.B.5.b - Land Converted to Settlements	0	0	0	0	0	0
3.B.5.b.i - Forest Land converted to Settlements	0			0	0	0
3.B.5.b.ii - Cropland converted to Settlements	0			0	0	0
3.B.5.b.iii - Grassland converted to Settlements	0			0	0	0
3.B.6 - Other Land	0	0	0	0	0	0
3.B.6.a - Other land Remaining Other land				0	0	0
3.B.6.b - Land Converted to Other land	0	0	0	0	0	0
3.B.6.b.i - Forest Land converted to Other Land	0			0	0	0

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NOx	CO	NMVOCs
3.B.6.b.ii - Cropland converted to Other Land	0			0	0	0
3.B.6.b.iii - Grassland converted to Other Land	0			0	0	0
3.B.6.b.iv - Wetlands converted to Other Land	0			0	0	0
3.B.6.b.v - Settlements converted to Other Land	0			0	0	0

Table 2.29 gives a comparison of CO_2 removals for the years 1994, 2000 and 2010 for FOLU. For 1994 and 2000 these emissions were accounted under Changes in Forest and Other Woody Biomass (5A), Forest and Grassland Conversion – CO_2 from Biomass (5B), Non-CO_2 Trace Gases Released by On-site Burning of Biomass , Abandonment of Managed Lands (5C), Soil Carbon, Organic Soils and Liming (5D) because the 1996 IPCC Guidelines have been used. For the sake of this comparison, the net balance has been made and provided. The total estimation on land is a removal of 27 680.5 Gg CO_2 compared to 10566.0 in 2000 and 5716.0 in 1994.

Table 2.30. CO_2 removals from the FOLU category for 1994, 2000, 2010

3.B Land	CO_2 (Gg)
1994	- 5,716.00
2000	- 10,566.00
2010	- 27,680.47

2.15.3 Aggregated sources and non-CO_2 emission sources on land

Description of category

Aggregated sources and non-CO_2 emissions on land in Namibia covered all the IPCC categories, namely

- 3.C.1 biomass burning
- 3.C.4 direct emissions from managed soils
- 3.C.5 indirect emissions from managed soils
- 3.C.6 indirect emissions from manure management

Methods

All emission factors are defaults from IPCC 2006. The activity data from fertilizer is country specific. Methods are according to the IPCC 2006 Guidelines and the 2006 IPCC Software has been used.

Activity data

The activity data is the area expressed under land for biomass burning in forest land and grassland. It was assumed that 3 % of all forest land and grassland land is burned, and burning occurs only on herbaceous biomass as the woody biomass has already been accounted for under disturbances within the forest remaining forest activity area.

Herbaceous biomass burning has been accounted for on grassland and forestland with a Mass of Fuel of respectively 2.3 t dm/ha and 2 t dm/ha.

Emission factor

For direct emissions of managed soil a total amount of N applied for fertilizer is 96 630 000 kg N/yr. A total amount of N applied from animal manure is 55 503 619 kg N/yr. The default emission factor for N_2O for managed soil has been used (0.01 kg N2O/kg N/yr).

The indirect N_2O emissions applied on soils is the fraction of the N from fertilizer, manure, compost, sewage, and urine that volatilizes and deposits back on the managed land. The Fraction of volatilized fertilizer is taken as a default 0.1 kg NH_3-N+NOx-N/(kg N) and the fraction for volatilized urine is taken as a default 0.2. The emission factor of the total volatilized N deposited on the managed soil is taken 0.01 kg N_2O-N / kg NH_3-N+NO_x-N. Another source of indirect emissions is from leaching and runoff from managed lands. The fraction of N applied to managed land lost through leaching and run-off is 0.3 kg N / kg added. The emission factor for run-off and leaching is rather low, with 0.0075 kg N_2O-N/(kg N leaching/runoff). These are all default factors from the IPCC 2006 Guidelines.

The indirect emissions from manure management are calculated on the basis of the management system applied. The fraction volatilized is respectively for burned fuel, LS, poultry manure with litter and without litter and SS 1, 0.4, 0.48 and 0.45. The emission factor has been taken 0.01 kg N_2O-N/kg NH_3-N+NOx-N (same as indirect N_2O for managed soils) for all deposits.

Results

The total emissions from biomass burning, direct and indirect emissions from managed soils and indirect emissions from N_2O are presented in Table 2.31 below.

Of the direct GHGs, methane emissions accounted for 7.66 Gg and nitrous oxide for 5.4 Gg. Carbon monoxide is the major indirect GHG with 216.56 Gg and nitrogen oxides contributing to 12.99 Gg. Grassland burning was responsible for the major emissions of methane at 7.14 Gg representing 93%. As for nitrous oxides, the use of fertilizers contributed the most with 43% (2.36 Gg) as direct emission whereas its indirect emissions amounted to 1.6 GG (30%). Again, both indirect gases emanated mostly from grassland burning with 12.11 Gg NO_x and 201.83 Gg CO representing % and % respectively.

Table 2.31. Emissions from Aggregate sources and non-CO_2 emissions on land

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NO_x	CO	NMVOCs
3.C - Aggregate sources and non-CO2 emissions sources on land (2)	0	7.663	5.404	12.994	216.564	0
3.C.1 - Emissions from biomass burning	0	7.663	0.700	12.994	216.564	0
3.C.1.a - Biomass burning in forest lands		0.521	0.048	0.884	14.738	0
3.C.1.b - Biomass burning in croplands		0	0	0	0	0
3.C.1.c - Biomass burning in grasslands		7.142	0.652	12.110	201.826	0
3.C.1.d - Biomass burning in all other land		0	0	0	0	0
3.C.2 - Liming	0			0	0	0
3.C.3 - Urea application	0			0	0	0
3.C.4 - Direct N_2O Emissions from managed soils (3)			2.359	0	0	0
3.C.5 - Indirect N_2O Emissions from managed soils			1.601	0	0	0
3.C.6 - Indirect N_2O Emissions from manure management			0.744	0	0	0
3.C.7 - Rice cultivations		0		0	0	0
3.C.8 - Other (please specify)				0	0	0

The total emission in CO_2-eq. was 1836. GG CO_2-eq for 2010 for this category and the breakdown by activity area is presented in Table 2.32 below.

On account of its much higher GWP, nitrous oxide emissions vastly exceed that of methane with 1675.1 Gg compared to 160.9 for methane. N_2O contributed 91% of the emissions of this category.

Table 2.32. Emissions from Aggregate sources and non-CO_2 emissions on land (CO_2-eq)

Categories	CH_4	N_2O	Total
3.C - Aggregate sources and non-CO_2 emissions sources on land (2)	160.92	1,675.09	1,836.01
3.C.1 - Emissions from biomass burning	160.92	216.90	377.82
3.C.1.a - Biomass burning in forest lands	10.95	14.76	25.71
3.C.1.c - Biomass burning in grasslands	149.97	202.14	352.11
3.C.4 - Direct N_2O Emissions from managed soils (3)		731.37	731.37
3.C.5 - Indirect N_2O Emissions from managed soils		496.33	496.33
3.C.6 - Indirect N_2O Emissions from manure management		230.49	230.49

Table 2.33. AFOLU Sector emissions for 2010

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NO_x	CO	NMVOCs
3 - Agriculture, Forestry, and Other Land Use	-27680.466	194.794	6.215	12.994	216.564	0
3.A - Livestock	0	187.131	0.811	0	0	0
3.A.1 - Enteric Fermentation	0	181.202	0	0	0	0
3.A.1.a - Cattle	0	163.477	0	0	0	0
3.A.1.a.i - Dairy Cows		0.128		0	0	0
3.A.1.a.ii - Other Cattle		163.349		0	0	0
3.A.1.b - Buffalo		0		0	0	0
3.A.1.c - Sheep		6.894		0	0	0
3.A.1.d - Goats		8.452		0	0	0
3.A.1.e - Camels		0.002		0	0	0
3.A.1.f - Horses		0.897		0	0	0
3.A.1.g - Mules and Asses		1.416		0	0	0
3.A.1.h - Swine		0.063		0	0	0
3.A.1.j - Other (please specify)		0		0	0	0
3.A.2 - Manure Management (1)	0	5.929	0.811	0	0	0
3.A.2.a - Cattle	0	4.846	0.811	0	0	0
3.A.2.a.i - Dairy cows		0.101	0.001	0	0	0
3.A.2.a.ii - Other cattle		4.745	0.810	0	0	0
3.A.2.b - Buffalo		0	0	0	0	0
3.A.2.c - Sheep		0.290	0	0	0	0
3.A.2.d - Goats		0.372	0	0	0	0
3.A.2.e - Camels		0.000	0	0	0	0
3.A.2.f - Horses		0.109	0	0	0	0
3.A.2.g - Mules and Asses		0.170	0	0	0	0
3.A.2.h - Swine		0.127	0	0	0	0
3.A.2.i - Poultry		0.016	0	0	0	0
3.A.2.j - Other (please specify)		0	0	0	0	0
3.B - Land	-27680.466	0	0	0	0	0
3.B.1 - Forest land	-75926.291	0	0	0	0	0

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NO_x	CO	NMVOCs
3.B.1.b.i - Cropland converted to Forest Land	-156.887			0	0	0
3.B.1.b.ii - Grassland converted to Forest Land	-17806.050			0	0	0
3.B.1.b.iii - Wetlands converted to Forest Land	0			0	0	0
3.B.1.b.iv - Settlements converted to Forest Land	0			0	0	0
3.B.1.b.v - Other Land converted to Forest Land	0			0	0	0
3.B.2 - Cropland	-368.247	0	0	0	0	0
3.B.2.a - Cropland Remaining Cropland	-174.680			0	0	0
3.B.2.b - Land Converted to Cropland	-193.567	0	0	0	0	0
3.B.2.b.i - Forest Land converted to Cropland	189.151			0	0	0
3.B.2.b.ii - Grassland converted to Cropland	-382.718			0	0	0
3.B.2.b.iii - Wetlands converted to Cropland	0			0	0	0
3.B.2.b.iv - Settlements converted to Cropland	0			0	0	0
3.B.2.b.v - Other Land converted to Cropland	0			0	0	0
3.B.3 - Grassland	48614.072	0	0	0	0	0
3.B.3.a - Grassland Remaining Grassland	0			0	0	0
3.B.3.b - Land Converted to Grassland	48614.072	0	0	0	0	0
3.B.3.b.i - Forest Land converted to Grassland	48895.554			0	0	0
3.B.3.b.ii - Cropland converted to Grassland	-281.483			0	0	0
3.B.3.b.iii - Wetlands converted to Grassland	0			0	0	0
3.B.3.b.iv - Settlements converted to Grassland	0			0	0	0
3.B.3.b.v - Other Land converted to Grassland	0			0	0	0

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NO_x	CO	NMVOCs
3.B.4.a.i - Peatlands remaining peatlands	0		0	0	0	0
3.B.4.a.ii - Flooded land remaining flooded land				0	0	0
3.B.4.b - Land Converted to Wetlands	0	0	0	0	0	0
3.B.4.b.i - Land converted for peat extraction			0	0	0	0
3.B.4.b.ii - Land converted to flooded land	0			0	0	0
3.B.4.b.iii - Land converted to other wetlands				0	0	0
3.B.5 - Settlements	0	0	0	0	0	0
3.B.5.a - Settlements Remaining Settlements	0			0	0	0
3.B.5.b - Land Converted to Settlements	0	0	0	0	0	0
3.B.5.b.i - Forest Land converted to Settlements	0			0	0	0
3.B.5.b.ii - Cropland converted to Settlements	0			0	0	0
3.B.5.b.iii - Grassland converted to Settlements	0			0	0	0
3.B.5.b.iv - Wetlands converted to Settlements	0			0	0	0
3.B.5.b.v - Other Land converted to Settlements	0			0	0	0
3.B.6 - Other Land	0	0	0	0	0	0
3.B.6.a - Other land Remaining Other land				0	0	0
3.B.6.b - Land Converted to Other land	0	0	0	0	0	0
3.B.6.b.i - Forest Land converted to Other Land	0			0	0	0
3.B.6.b.ii - Cropland converted to Other Land	0			0	0	0
3.B.6.b.iii - Grassland converted to Other Land	0			0	0	0
3.B.6.b.iv - Wetlands converted to Other Land	0			0	0	0

Categories	(Gg)					
	Net CO_2 emissions / removals	Emissions				
		CH_4	N_2O	NO_x	CO	NMVOCs
3.C.1 - Emissions from biomass burning	0	7.663	0.700	12.994	216.564	0
3.C.1.a - Biomass burning in forest lands		0.521	0.048	0.884	14.738	0
3.C.1.b - Biomass burning in croplands		0	0	0	0	0
3.C.1.c - Biomass burning in grasslands		7.142	0.652	12.110	201.826	0
3.C.1.d - Biomass burning in all other land		0	0	0	0	0
3.C.2 - Liming	0			0	0	0
3.C.3 - Urea application	0			0	0	0
3.C.4 - Direct N_2O Emissions from managed soils (3)			2.359	0	0	0
3.C.5 - Indirect N_2O Emissions from managed soils			1.601	0	0	0
3.C.6 - Indirect N_2O Emissions from manure management			0.744	0	0	0
3.C.7 - Rice cultivations		0		0	0	0
3.C.8 - Other (please specify)				0	0	0
3.D - Other	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	0			0	0	0
3.D.2 - Other (please specify)				0	0	0

2.16 WASTE SECTOR

2.16.1 Description of Sector

In Namibia, solid waste is generated by domestic, industrial, commercial and agricultural activities whereas waste water is generated mostly through domestic, industrial and commercial activities. As in other countries, waste generation is directly related to population growth, the industrialization rate and the urbanization trend, the latter being an important impacting factor. Greenhouse gas emission in the waste sector is also affected by the type of disposal mechanisms as well as the level of management exercised.

In this inventory the waste source categories covered included only those listed below as no data was available on waste incineration while Biological treatment of Solid waste does not occur in the country.

4.A.3 - Uncategorised Waste Disposal Sites
4.C.2 - Open Burning of Waste

4.D.1 - Domestic Wastewaster Treatment and Discharge
4.D.2 - Industrial Wastewater Treatment and Discharge

Uncategorised Waste Disposal Sites and Open Burning of Waste

According to the NPHC 2011 (Namibia 2011 Population and Housing Census), 37.8 % of the solid waste of the country is disposed of through burning, 37.2 % is regularly collected, 19.8 % is disposed of in rubbish pits or dumped on roadside while the remaining 1.4 % is disposed of through other means (figure 2.11).

The solid waste from 70% of urban households is collected on a regular basis while two thirds of rural households burn their waste. A regular waste collection service is provided to only about 5 % of rural households.

There are three landfill sites in the country, one at Kupferberg in the Khomas region for the disposal of general and hazardous waste generated within the City of Windhoek area of jurisdiction, and two in the region of Erongo which receive waste from Swakopmund and Walvis Bay. The remaining collected solid waste is disposed of in open dump sites

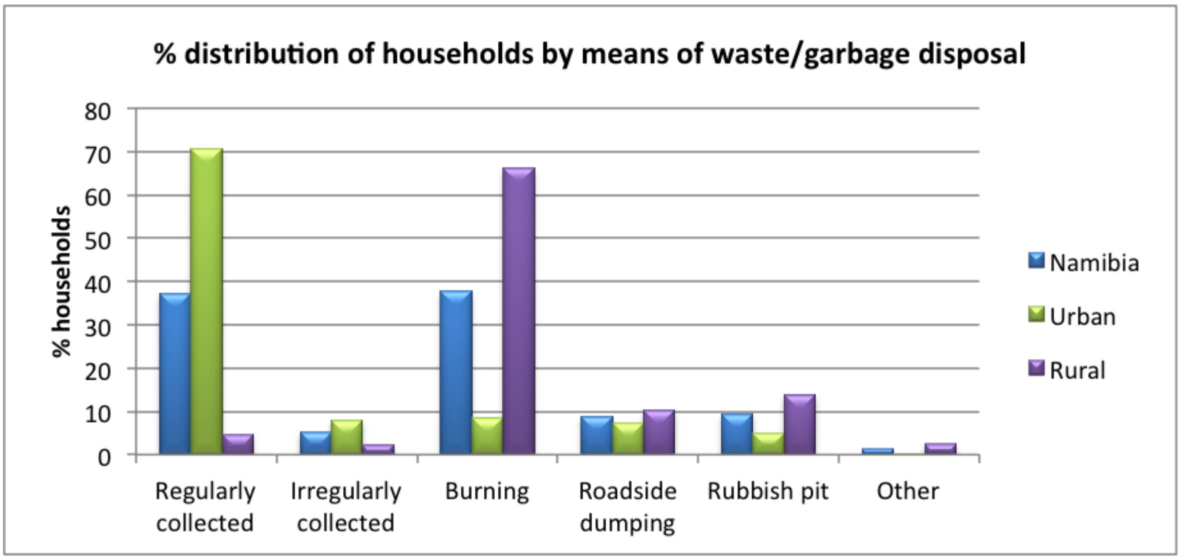


Figure 2.11: % distribution of households by means of waste/garbage disposal

Domestic Wastewater Treatment and Discharge

At the country level, a notable fact is that 48.6 % of the population does not have any toilet facility. All regions confounded, 36.5 % of the population is connected to a sewer system, 3 % dispose of waste water via septic tanks/ cesspool systems and 9.3 % use pit latrines.

Table 2.34. Households and population by main type of toilet facility (%)

Region	Namibia	Urban	Rural
Private Flush Connected to Sewer	24.8	44.4	5.8
Shared Flush Connected to Sewer	11.7	21.2	2.5
Private Flush Connected to Septic/Cesspool	1.6	1.4	1.9
Shared Flush Connected to Septic/Cesspool	1.4	1.7	1.1
Pit Latrine with Ventilation Pipe	4.3	3.6	4.9
Covered Pit Latrine without Ventilation Pipe	3.2	2.2	4.2
Uncovered Pit Latrine without Ventilation Pipe	1.8	1.4	2.2
Bucket Toilet	1.8	1.3	2.3
No Toilet Facility	48.6	22.4	74.0
Other	0.7	0.4	1.0
Households	464,839	228,955	235,884
Population	2,064,489	872,448	1,192,041
Source: Namibia 2011 Population and Housing Census			

Industrial Wastewater Treatment and Discharge

Industrial waste water of relevance to greenhouse gas emissions originates mainly from such activities as fish processing, slaughter houses, meat conditioning, tanneries and breweries. On account of unavailable data, only the meat sector is covered in this inventory.

2.16.2 Methodology

GHG emissions originating from the Waste Sector were estimated following a Tier 1 methodological approach as per the IPCC 2006 Guidelines for National Greenhouse Gas Inventories and compiled using the IPCC 2006 software.

Wastes and waste management are important challenges to Namibia. Development trends show a clear urbanization trend and the rate doubled over the decade 2000 to 2010 compared to the previous decade (urban population: 1990=22.7 %, 2000 = 32.5 %, 2010 = 43.0%) and with this, the amount of waste generated is increasing at higher rates. However, the management of wastes has not been following the same pace as evidenced by the fact that such aspects as waste to energy and recycling are still relatively insignificant in the country.

2.16.3 Activity Data

Solid waste

Data from municipal councils coupled with population census statistics were first used to estimate solid waste generation for “high-income” urban and “low-income” urban regions for 2010. The need for this categorization has been prompted by the sustained and significant population migration from rural to urban regions with the emergence of fast expanding suburbs to the main cities where the dwellers lifestyle is of the urban type with a relatively lower purchasing power.

Estimates of solid waste generation for rural regions for 2010 were subsequently worked out by discounting solid wastes which are typically generated by urban dwellers from the landfills data available on waste characterization. These solid waste generation potentials were also compared with those in the 2006 IPCC Guidelines (Volume 5: Waste, Page 2.5, Table 2.1).

Using the 2010 baseline, population census data (interpolated for non-census years) and adjusted for socio-economic factors, estimates for solid waste generation were then made for the period 1990 to 2009.
The process of calculating solid waste generation was not straightforward because of the lack of data. Furthermore, no official data was available on waste categorization which would have enabled more accurate calculation of GHG emissions.

The fraction of solid waste which is open burnt was calculated by multiplying the total solid waste estimated by the percentage of the population whose wastes are so treated as evidenced from the NPHC 2011 statistics.
The amount of sludge generated per capita for 2010 was estimated using that year's data for Windhoek City Council. Using this factor and urban population, the amount of sludge generated for the period 1990 to 2009 was then estimated for the other urban areas.

Wastewater

The actual amount of domestic wastewater generated was not available at country level. However, the different types and usage levels of treatment or discharge as per the NPHC 2011 census report were used as well as the respective IPCC 2006 Guidelines (Vol 5.3 Ch 3 Table 3.1) default MCFs.

Exploitable data on industrial waste water production were available only for the meat sector. The total meat industry product and the amount of waste water as provided by local authorities were used in conjunction with the respective IPCC 2006 Guidelines (Vol 5.3 Ch 3 Table 3.1) defaults for calculation of emissions.

Emission factors

In the absence of country specific emission factors, the default values provided within the IPCC 2006 software and IPCC 2006 Guidelines ((Vol 5.3 Ch 3 Table 3.3) were used for estimating GHG emissions.

2.16.4 Results

Methane tops the emissions in the waste sector with 6.89 Gg followed by CO_2 with 2.47 Gg and N_2O with 0.10 Gg. Methane emanates from the Solid waste disposal (3.40 Gg) , Open Burning of Waste (0.80 Gg) and both Domestic (2.57 Gg) and Industrial (0.12 Gg) Waste Water Treatment and Discharge. CO_2 is emitted during Open Burning of Waste at 2.47 Gg, N_2O is from Domestic Waste Water Treatment with 0.088 Gg and Open Burning of Waste at 0.01 Gg.

Table 2.35 Waste Sector emissions for 2010

Categories	Emissions [Gg]						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
4 - Waste	2.471	6.889	0.099	0.391	6.871	0.430	0.014
4.A - Solid Waste Disposal	0	3.401	0	0	0	0.277	0
4.A.1 - Managed Waste Disposal Sites				0	0	0	0
4.A.2 - Unmanaged Waste Disposal Sites				0	0	0	0
4.A.3 - Uncategorised Waste Disposal Sites				0	0	0.277	0
4.B - Biological Treatment of Solid Waste		0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	2.471	0.800	0.011	0.391	6.871	0.151	0.014
4.C.1 - Waste Incineration	0	0	0	0	0	0	0
4.C.2 - Open Burning of Waste	2.471	0.800	0.011	0.391	6.871	0.151	0.014
4.D - Wastewater Treatment and Discharge	0	2.688	0.088	0	0	0.002	0
4.D.1 - Domestic Wastewater Treatment and Discharge		2.565	0.088	0	0	0.002	0
4.D.2 - Industrial Wastewater Treatment and Discharge 0.122				0	0	0.0001	0
4.E - Other (please specify)				0	0	0	0

In 2010, the waste sector emitted a total of 174.02 Gg CO_2-eq of GHG with 144.27 Gg coming from the methane component, 27.28 Gg from N_2O and 2.47 Gg from CO_2 (Table 2.36). The two highest contributing categories are Solid Waste Disposal at 70.98 Gg CO_2-eq and Domestic Wastewater Treatment at 53.97 Gg CO_2-eq of CH_4.

Table 2.36. Aggregated emissions for waste sector (Gg CO_2-eq)

Categories		Emissions [Gg CO_2-eq]/Year						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
4	Waste	2.47	144.27	27.28	0	0	0	0
4.A	Solid Waste Disposal	0	70.98	0	0	0	0	0
4.C.2	Open Burning of Waste	2.47	16.8	0	0	0	0	0
4.D.1	Domestic Wastewater Treatment and Discharge	0	53.97	27.28	0	0	0	0
4.D.2	Industrial Wastewater Treatment and Discharge	0	2.52	0	0	0	0	0

Emissions for 1994, 2000 and 2010

Total aggregated emissions increased from 63 in 1994 to 180 in 2000 and decreased to 174 in 2010. These estimates have to be taken with caution since the results are not strictly comparable. This is explained by the scope of the inventories and the methodological approach used being different between the years under review. All solid waste was landfilled which was not the case and the previous approach also inflated the waste amount generated compared to the data of 2010. No waste was burned as is the case in the rural areas in the year 2000 inventory. Table 2.37 below shows the GHG emissions for 1994, 2000 and 2010

Table 2.37. Emissions for 1994, 2000 and 2010, aggregated in Gg CO_2-eq and Gg by gas

Source	Base Year	Emissions [Gg]/Year				
		Total CO_2 eq		CO_2	CH_4	N_2O
NC1	1994	63		0	3	0
NC2	2000	180		0	5.6	0.2
BUR1	2010	174		2.47	6.06	0.09

Chapter 3:

Mitigation actions and their effects, including associated methodologies and assumptions

Namibia has made efforts as a signatory Party to implement the Convention according to its capabilities. In order to pave the way to implementing mitigation and adaptation, Namibia established the NCCC in 2001. Other crucial milestones followed when Cabinet approved the first NPCC in 2011 and the NCCSAP in 2014, which set out the country direction towards addressing climate change mitigation. These two documents highlight the need for support to the country efforts in order for it to meet the national obligations and international commitments. The country has mainstreamed and integrated climate change, including mitigation, in its development plans and has to-date implemented numerous mitigation measures in various economic activities to curb down emissions. Additionally, the country has also promoted removals through various measures adopted in the AFOLU sector. However, these measures have mostly been implemented on a stand-alone basis as the country has not yet developed a mitigation plan and its NAMAs.

A list of the measures developed and implemented is provided in Table 3.1. Information on the estimates of GHG emissions avoided or planned as well as other sustainable development benefits are included. It is estimated that the country is presently mitigation more than 1000 Gg of CO_2, excluding avoided emissions of the other direct gases. Short term plans aim at avoiding emissions of some 55 000 Gg CO_2, again not including CH_4 and N_2O.

It is worth pointing out that this list is not exhaustive due to the short timeframe available to prepare the BUR1. Work is continuing within the framework of the NC3 to collect and analyze further data for reporting to the UNFCCC. Concurrently, the country will be implementing its MRV system and this should enable it to widen the scope while enhancing the quality and quantitative assessment of these mitigation activities.

Table 3.1 Mitigation measures implemented with progress and achievements

Name of the action	Coverage	Quantitative goals/ Objectives	Progress indicators	Methodologies/ assumptions	Steps taken/ envisaged	Outcomes achieved	Outcomes achieved Estimated emission reductions
Increase renewable energy share in national energy balance (policy program)	Residential, industrial and commercial sectors and CO_2	Increase the share of electricity generation from renewable energy sources	Renewable energy programme commissioned,	Assessment of changes in emissions done on a project basis using IPCC methodologies and Guidelines	Feed in tariffs partly worked out; Barrier removal studies completed; Technicians trained on installation and maintenance of RE systems, 19 independent power producer (IPP) licenses delivered by regulator	The share of RE has increased with commissioning of hydro, biomass, wind and solar plants	GHG reduction will be presented on a project basis further down
Barrier removal to RE program in 2005	Energy (Residential) sector; CO_2	Identify barriers to penetration of solar technologies;	No of regions visited, surveys/ interviews conducted	Survey on adoption rates and penetration in the rural communities	Install solar home systems, solar water heaters and solar water pumps in 5 villages; Provide solar rechargeable batteries and electrical installations to 148 households	12 regions visited, surveyed and interviews conducted; The 5 villages and 148 households covered	Adoption and penetration is timid due to low purchasing power of villagers mainly

Assessment of investment and financial flows to mitigate climate change in the energy sector	Energy sector, CO_2	Quantify the investment and financial flows required to mitigate in the energy sector UNDP project 2011	Mitigation measures modeled included increased solar use, 42 MW wind, 20% more efficiency in energy use, and fuel switching to LPG in the transport sector	Modeling approach used and estimates of emissions reduction based on GHG inventory of INC ; Fuel switching to LPG will be adopted by car owners	Subsidy to be provided on the LPG kits	1.13 billion US$ for electricity generation plants, and 69 million US$ for fuel switching	1.2 M t CO_2 eq of emission reduction by 2030
Off grid energization master plan	Energy (Residential) sector; CO_2	Electrify remote rural areas	Master plan approved by cabinet in 2007	Transmission to the remote rural areas are onerous and not economical, improved quality of life	Approved by cabinet; Barrier removal study completed for solar energy	No of villages and households provided with electricity and other energy linked usage	Not available
Solar water heating in all government and parastatal building by cabinet in 2007	Energy (Institutional) sector; CO_2	Replace electric water heaters by solar water heaters	No of electric water heaters replaced	IPCC, solar water heaters installed in all new buildings	Legislation for all new institutional buildings to be serviced by solar water heaters	Not available	Not available
Feed in Tariff by ECB 2013	Energy (residential) sector, CO_2	Increase share of solar energy	No of public producers sending electricity to the grid	Tariff is attractive to the public, calculation of emissions using IPCC 2006 software based on no of kW produced	Discussions ongoing with stakeholders to calculate tariff	Tariff not yet agreed	Not available

Gam off-grid solar system	Energy (residential) sector; Avoiding CO_2 emissions from fossil fuel use	Provide electricity to 2000 inhabitants through an off-grid system	Solar power plant commissioned	IPCC GL, Decrease in fuelwood consumption, increased welfare of community with access to more utilities and equipments, etc	Rural electricity distribution master plan imp-lemented	2000 inhabitants provided with electricity in their household, improved quality of life, job creation	300 t CO_2 annually
Tsumkwe solar energy project	Energy (residential) sector; Avoiding CO_2 emissions from fossil fuel use	Provide electricity to 1000 persons in a rural settlement	When commissioned and operational	IPCC GL, quality of life raised, job creation, lower dependency on fuelwood	Rural electricity distribution master plan imp-lemented	Plant commissioned in 2010 and operational 2011, all households (1000 people) connected, improved quality of life, job creation	250 t CO_2 annually
Usab solar energy project	Energy (residential) sector; Avoiding CO_2 emissions from fossil fuel use	Provide electricity to rural school and community garden	Plant commissioned since June 2014 and supplying electricity	IPCC GL, Better education, higher welfare, contributing to food security	Rural electricity distribution master plan imp-lemented	School and the community garden connected and using electricity, improved quality of life	
Solar PV grid tied system at Spar	Energy (commercial) sector; Avoiding CO_2 emissions from	Increase the share of RE	Supply power to the commercial institution with excess sent to the grid	IPCC GL, Excess supplied to the grid is paid for to the institution	Feed in tariff put in place by Erongo Red	PV system installed, Feed in tariff implemented and working	300 t CO_2 annually
Solar PV grid tied system at Nampower	Energy sector; Avoiding CO_2 emissions from	Increase the share of RE	Supply power to the commercial institution with excess sent to the grid	IPCC GL, Excess supplied to the grid	Grid tied system	2 PV systems installed, Excess sent to grid	200 t CO_2 annually

Replace incandescent lamps with compact fluorescent lamps	Energy (residential) sector; Avoiding CO_2 emissions from fossil fuel	reduce energy consumption	No. of bulbs replaced	IPCC GL, Lamps used over a period of 12 hours daily on average,	Awareness campaigns, free distribution to launch the lamps and encourage community to adopt	900 000 bulbs distributed, public aware of benefits,	6600 t CO_2 annually
Replace all electric water heaters by solar ones over 10 years	Energy sector; Avoiding CO_2 emissions from fossil fuel	Reduce energy consumption of fossil origin	No. of solar water heaters installed over time	IPCC GL, Community accepts the technology, financial barriers are removed	Sensitization done, Loan system, incentives	808 installed 2004, improved quality of life	5000 t CO_2 annually in 2004
Energy audits in commercial and industrial sectors	Energy sector; Avoiding CO_2 emissions from fossil fuel	increase energy efficiency through 60 audits	No. of audits undertaken	IPCC GL, Stakeholders collaborate and then take over for making the regular audits, Enough auditors to do audits	Sensitization, Incentive possibly to start with free audits	Programme not yet started	17000 t CO_2 when fully implemented
Solar home systems	Energy (residential) sector, CO_2	Reduce use of fuelwood and fossil fuel	No. of systems installed	IPCC GL, Barriers to technology adoption removed, Cost is not prohibitive,	Sensitization campaign done, Loan incentive, Incentives offered by Govt	1145 installed by 2004, improved quality of life, generation of income	Minimum of 100 t CO_2 annually since 2004
Solar cookers	Energy sector, CO_2	Reduce use of fuelwood	No. of cookers installed	Barriers to technology adoption removed, Cost is not prohibitive	Barriers to technology adoption removed, Cost is not prohibitive	562 in 2004, improved quality of life	Minimum of 80 t CO_2 annually since 2004

Ruacana hydro project 4th turbine	Energy sector, CO_2	Reduce dependency on import of electricity and energy production from fossil fuels	Commissioning of turbine	IPCC GL, dependency on electricity imports reduced, improve GDP, electricity security	Additional electricity needs existent, grid can support output and transmit to users,	Turbine installed in 2012, improved quality of life, income generation, job creation	150 000 t CO_2 annually since 2012
CBEND biomass electricity generation plant	Energy sector, CO_2	Supply electricity to remote community through off-grid system, Use of biomass from invader bush to produce electricity,	Performance of plant	IPCC GL, Biomass supply for long term operation, Technology mastered	Small grid built to supply electricity produced, Community connected	Plant Commissioned but not started operating up to now, technical problem	300 t CO_2 annually
Photovoltaic water pumps	Energy sector, CO_2	Reduce energy consumption from the grid, increase water availability to communities and growers	No of pumps installed, people reached and farmers	IPCC GL, Water is available, cost not prohibitive, technology is user-friendly	Government incentive, Bank loans at low interest,	659 by 2004, improved quality of life	800 000 t CO_2 annually
Solar (Energy) shops	Energy sector, CO_2	Avail electricity to shops in remote rural areas, 156 over 20 years	No of solar systems installed	IPCC GL, Community have the purchasing power, improved quality of life,	Barrier removal done, sensitization of villagers, loans	Improved quality of life	Difficult to assess
Biogas Fish river small CDM (unfccc 2012) from landfill and water treatment plants	Energy and Waste sector, CH_4	Convert waste to energy	CDM proposal submitted for approval	IPCC GL, Improved quality of life of communities	CDM approved to kick start project implementation	Not available	Not available

Windhoek CDM from Gammams water treatment plant (245 kW)	Energy and Waste sectors, CH_4	Convert waste to energy	CDM proposal submitted for approval	IPCC GL, Improved quality of life of city dwellers	CDM approved to kick start project implementation	Not available	7869 t CO2 eq
Kupferberg CDM from landfill gas UNFCCC 2012	Energy and Waste sectors, CH_4	Convert waste to energy	CDM proposal submitted for approval	IPCC GL, Improved quality of life of city dwellers	CDM approved to kick start project implementation	Not available	Not available
Ohorongo cement using wood chips to replace coal	Energy (manufacturing) sector, CO_2	Control bush encroachment and reduce fossil fuel use	Data being collected from producer	IPCC GL, wood chips production will remain cost-effective	Measures adopted for burning wood chips instead of coal	Job creation, preserving the environment, improved quality of life	Not available
Erongo wind farm	Energy, CO_2	Increase share of renewable energy	Stage of implementation	IPCC GL, market exists for additional electricity	PPA made with Nampower	Farm site identified, EIA under way, Licence granted by regulator	250 000 t CO2 annually when operational
44 MW windfarm in Luderitz	Energy, CO_2	Increase share of renewable energy	Stage of implementation	IPCC GL, market exists for additional electricity	PPA made with Nampower	Farm site identified, Licence granted by regulator	50 M t CO_2 annually when operational

The activities implemented and planned that are reported above represent a potential annual reduction of some 52 Gg in CO_2 emissions achievable in the short time. Namibia is concurrently also prepare its NAMA where more important projects with significantly higher GHG savings will be met.

Chapter 4:

Information on domestic MRV of Domestically supported NAMAs

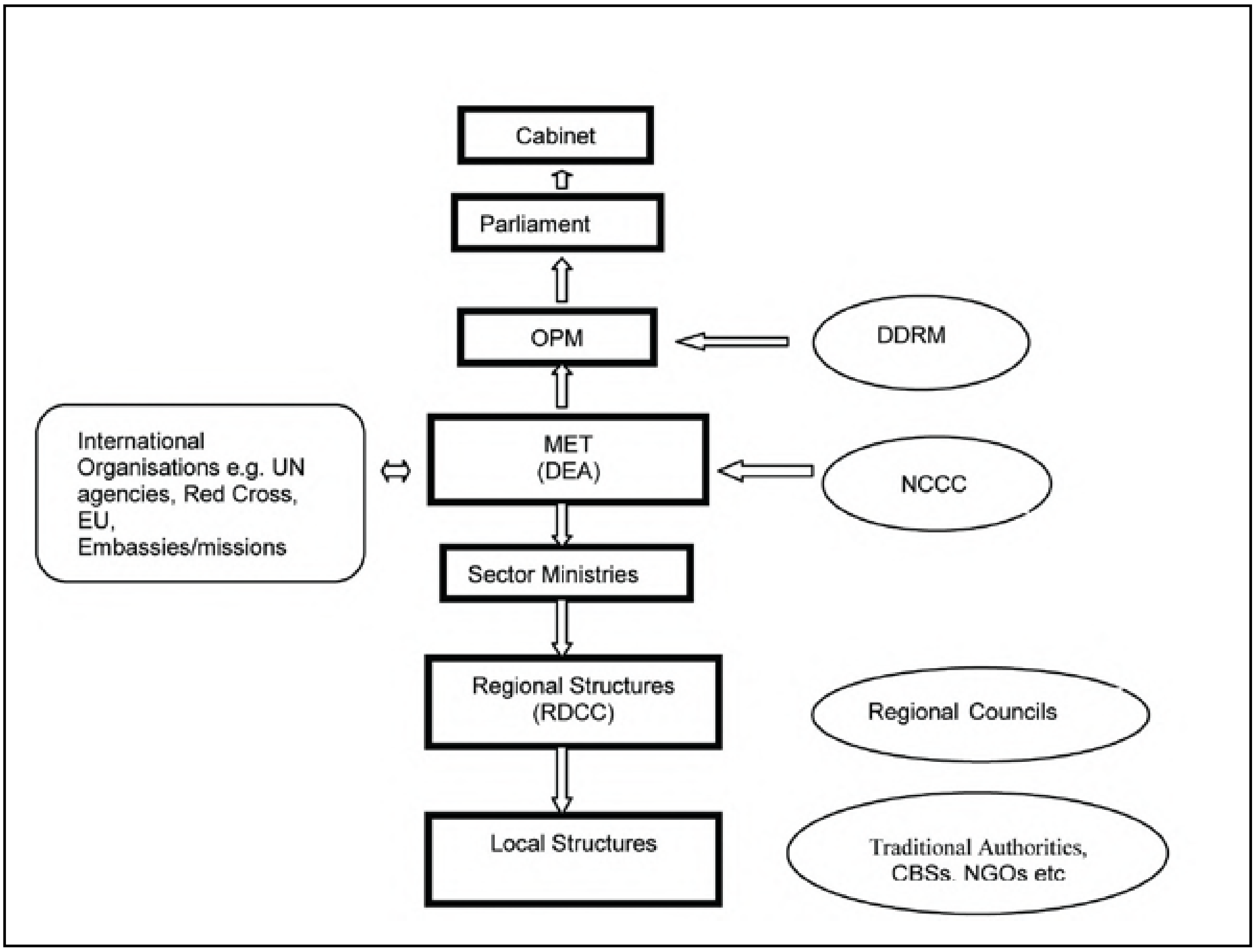
4.1 OVERALL COORDINATION OF MRV

Outright from the start it should be said that Namibia has in place its own Monitoring and Evaluation (M&E) process to support its development agenda as laid out in the Fourth National Development Plan. Government has implemented a continuous M&E process through its National Planning Commission and the relevant sectors with a view to assessing progress on the various goals and strategies implemented under the NDP4, including those of the Ministry of Environment and Tourism which encompasses climate change. The Ministries are required to report regularly to the National Planning Commission on the physical and financial execution rates in addition to analyzing the impact of the various activities on sectoral targets and overall national development goals. Furthermore, the reports include an analysis of factors that contribute to the successful implementation of programmes and projects and to achieving targets, as well as those factors that prevent such success. The MET through its DEA and CCU reports on the climate change activities including reporting to the Convention within this context of M&E. The concept of MRV being proposed now within the climate change framework is more demanding in terms of outputs and indicators which entail a reorganization of the existing M&E system to be able to meet the new agenda of the UNFCCC.

Presently, government departments and the private sector organizations regularly measure, collect and verify data on their activities to track performance, productivity, quality assurance and to conform to legislations amongst others. These data are then analyzed and reported to the parent ministries for transmission to the National Planning Commission and administrative entities to inform them of the progress and achievements for sustainable decision-making and for guiding policies and planning. Most of these data are then stored in private databases and/or centralized within the NSA. The latter has been established to ensure improvement in the national statistics system and to provide quality data for supporting the M&E. The NSA also regularly undertakes surveys and censuses to supplement usual data collection, especially in areas not covered under regular organizational activities. However even if this system functions well and has been able to deliver for ensuring sustainable development of the country, this has been achieved according to the capabilities of government and the institutions, taking into consideration the financial, technical and technological capacities, including availability of funds, level of knowledge required, availability of appropriate staff and technologies such as the necessary hardware and software. Unfortunately, data for compiling GHG inventories have not been part of the system and this is being addressed now.

Additionally, Namibia being a developing country State has its own national priorities for sustainable development as laid out in its Vision 2030. Its development is already constrained by a harsh climate and highly fragile and delicate land resource base. Despite these constraints, the country has adhered to the international agenda and working according to its capabilities to contribute to it. In this endeavour, Namibia has produced a National Policy on Climate Change in 2011 and a National Climate Change Strategy and Action Plan for the period 2013-2020 that paves the way to be adopted for coping with climate change challenges while contributing to the international agenda to meet COP decisions.

The Cabinet of Namibia is the Government entity responsible for approving policies. The Parliamentary Standing Committee on Economics, Natural Resources and Public Administration advises the Cabinet on relevant policy matters and the MET is responsible for all environmental issues in the country, including climate change. MET is the National Focal Point to the Convention and is the coordinating body for all climate change activities through its CCU of the DEA. The CCU is supported directly by a formalized multi-sectoral National Climate Change Committee (NCCC) for the implementation and coordination of sector-specific and cross-sectoral activities while also providing advice and guidance on climate change issues. Since climate change affects directly or indirectly all socio-economic development sectors, therefore all Ministries through their various departments, Organisations and Agencies actively collaborate and contribute in the implementation of climate change activities at local, regional and national levels. The existing local and regional structures are also used for implementation at their levels within their areas of jurisdiction.



(Source: Namibia National Policy on Climate Change; 2011)

Figure 4.1. Institutional structure for implementation of the National Climate Change Policy

Namibia outsourced the GHG inventory components of its first and second national communications and has not yet submitted any domestically supported NAMA to the UNFCCC registry. It has thus not developed and implemented an MRV system for these activities. Given the new enhanced reporting context in terms of frequency and the introduction of the BUR, the country has reviewed its stand on reporting and has decided to produce these reports in-house accompanied and supported by consultants to provide the necessary capacity building to the national experts over the coming years. In parallel, the collaboration of the institutions will be secured within the national institutional arrangements framework and the wider national M&E system for implementing the climate change policy, to support the development and implementation of the MRV system for the GHG inventory and mitigation including domestically supported NAMAs in the future.

The responsibility of implementing and running the MRV system will be under the CCU of the MET as the institution having under its mandate the overall coordination, compilation and submission of National Communications, BURs and national reporting. The same institutions forming part of the NCCC will be requested to contribute to the measurement component and partly to the reporting one. The verification component will rest with the CCU of MET. Changes will be proposed to have the institutions to implement the system according to the new standards and requirements according to their capabilities while overcoming other constraints such as appropriate capacity and staff availability. The present formal arrangements will be kept and hopefully all the institutions will be able to embrace and adopt the new concept successfully on a continuous basis. Quality control will be shared between the primary institutions implementing the activity and the CCU. Quality assurance will be under the responsibility of the CCU as a major component of the verification component. In case, the capacity does not exist, then other institutions of the NCCC will be resorted to and eventually calling upon consultants until enough capacity has been imparted to the personnel of the CCU and other institutions to fully complete this task. Documentation will be the prime responsibility of the institution responsible for implementing the activity jointly with the CCU. Raw data will be archived by the appropriate institution with a copy at the NSA while the CCU at MET will be responsible for archiving all compilations relating to national communications and BURs reports submitted to the UNFCCC.

The GHG inventory remains as the baseline exercise within the MRV system for NAMAs and other mitigation actions. More information on these two elements is provided in the following sections.

4.2 GHG INVENTORY SYSTEM

It is essential to recall here that Namibia outsourced its two previous inventories available in the initial and second national communications submitted to the UNFCCC. As such, no system existed for producing GHG inventories and the country has embarked on the process to establish the appropriate framework to produce future GHG inventories in-house through a more active participation of the key stakeholders. The CCU of MET has been the responsible entity for overlooking the production of past GHG inventories and will continue to assume this responsibility. This exercise of reframing the whole set-up for the production of inventories started soon after the COP's decision for enhanced and more frequent reports from Non-Annex I countries. Due to the previous outsourcing of the inventories, capacity was inexistent in all institutions also and this had to be remedied.

So the challenge was to firstly develop and implement an inventory management system, including robust institutional arrangements and in the second phase, introduce and train the national experts of the various institutions to take over the production of the GHG inventory with the support of consultants and resource persons within ongoing capacity building projects. Further to the feeling that most institutions were not sufficiently aware of the challenges of climate change and their past limited commitment and participation in the reporting process, the key stakeholders were visited and briefed on the Convention and more deeply on their role within the new framework under development to enable set up a sustainable system for the country to meet its obligations to the UNFCCC. This one to one interaction proved very successful to obtain the higher commitment of the institutions and secure their collaboration through appropriate nominations.

The second phase consisted in getting all the stakeholders over a common work session with the objective of raising their awareness on the climate change process and the Convention, informing them of the reporting obligations and buying in their contribution on this cross-sectoral issue which is climate change. The nominees from the different institutions were provided with a deep insight of the climate change process, the elements of the national communication and the BUR.

More in depth discussions took place between the stakeholders towards agreeing on the way forward for enhanced collaboration altogether with clear roles and responsibilities. It also came out that all the nominees did not have the necessary capacity to compile GHG inventories including also a clear understanding of what is an inventory and the reason behind its compilation as well as the obligation for the country to report on this to the Convention. While this was explained during the work session, training on the compilation of GHG inventories and the use of available software to meet IPCC standards was identified as a most urgent issue. This had to be organized in the shortest possible delay.
In-depth discussions took place on what would be the best framework for establishing a structure that will work on a continuous basis for producing the inventories regularly for reporting in the NCs and BURs. All agreed on sharing the responsibilities for the compilation exercise between different departments of the key Ministries with MET overseeing the process. A first mapping of national institutions and organizations was completed to identify other stakeholders that would contribute in one way or the other for the inventory compilation. Thus data providers and possible institutions and organizations to support derivation of emission factors to suit national circumstances and enable moving to tier 2 were

identified. It was also decided that the existing collaboration streams be used and that there was no other official formal engagements such as MOUs needed. All present during this work session viewed the first compilation of the inventory for the first BUR as a big and difficult challenge but volunteered to give it a try after the training session on the software and the compilation process.

The responsibilities arrived at within the institutional arrangements were:

- The CCU of Ministry of Environment and Tourism for inventory coordination, compilation and submission;
- Ministry of Mines and Energy for the Energy sector;
- Ministry of Trade, Industry for the Industrial and Production and Product Use sector;
- Ministry of Agriculture Water Affairs and Forestry for Agriculture, Forest and Other Land Use sector;
- City Council of Windhoek for the Waste sector;
- Namibia National Statistics Agency for Archiving including provision of quality controlled activity data;
- The CCU of Ministry of Environment and Tourism for coordinating QA/QC;
- External consultant for QA;
- Uncertainty Analysis coordinator yet to be decided if it cannot be done by the sectoral teams; and
- The CCU of Ministry of Environment and Tourism to act as GHG inventory specialist to track capacity building needs, the IPCC process and COP decisions for application.

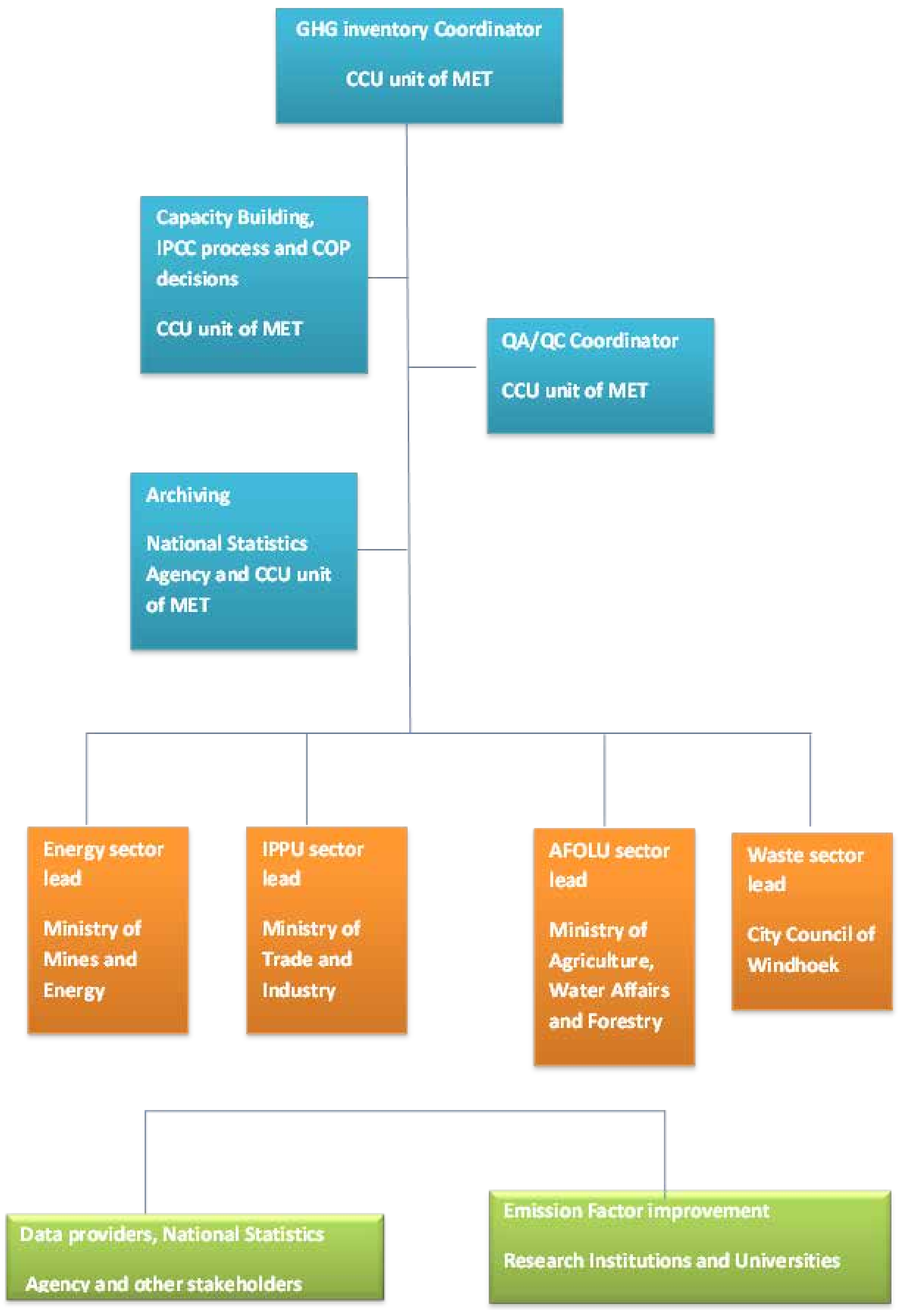


Figure 4.2. Institutional Arrangements

The other institutions to collaborate with the sector lead institutions from the first mapping exercise will be reviewed when the work will be ongoing to bring in contributors that were missed during this exercise. Documentation will be the responsibility of the sector team leads to be centralized eventually with the CCU of MET and copies archived in NSA.

Table 4.3. Energy team stakeholders

Institution	Role and contribution
CCU unit of MET	Overall coordination
Ministry of Mines and Energy	Sector lead compiler
NamPower	Data provider
Ministry of Works and Transport	Data provider
Namibia Roads Authority - NATIS	Data provider
Electricity Control Board	Data provider
NAMCOR	Data provider
PUMA Energy	Data provider
TransNamib	Data provider
Namibia Airports Company	Data provider
Roads Authority	Data provider

Table 4.4. IPPU team stakeholders

Institution	Role and contribution
CCU unit of MET	Overall coordination
Ministry of Trade and Industry	Sector lead compiler
Namibia Statistics Agency	Data provider
Namibia Chamber of Commerce and Industry	Data provider

Table 4.5. AFOLU team stakeholders

Institution	Role and contribution
CCU unit of MET	Overall coordination
Ministry of Agriculture, Water affairs and Forestry	Sector lead compiler
Department of Forestry	Data provider
Agra	Data provider
Namibia Statistics Agency	Data provider
Feed Masters	Data provider
Namibia Agronomic Board	Data provider
Regional Centre for Mapping of Resources for Development (RCMRD)	Data provider
Independent Consultants	Data provider

Table 4.6. Waste team stakeholders

Institution	Role and contribution
CCU unit of MET	Overall coordination
City Council of Windhoek	Sector lead compiler
Meatco Namibia	Data provider
Municipality of Walvis Bay	Data provider
Ministry of Agriculture, Water Affairs and Forestry	Data provider

In line with the Convention, Namibia will continue to adopt IPCC methods and tools. The recent decision is to move to the more user-friendly and less heavy IPCC 2006 Guidelines and software as it combines the Revised 1996 Guidelines and the GPGs of 2000 and 2003. In addition to the IPCC 2006 Guidelines, the country will attempt at using the ALU software which conforms to the IPCC reporting format to move to tier 2 for the AFOLU sector since the 2006 Guidelines compiles the inventory at tier 1 level only. Thus, in order to start the process of in-house production of the GHG inventory for the first BUR and the Third National Communication, a three day training session was held with the lead sector and other representatives on the 2006 Guidelines and software.

It should be said however that the exercise of taking over turned out to be very difficult and that the country had to once more resort to a consultant for doing the compilation while continuing with the hands-on training of the national experts. Further capacity building will be required to make the process of producing good quality inventories regularly and on a sustainable basis smooth. Collaboration between the institutions have worked but not with the smoothness anticipated. This indicates that it is very difficult to develop and implement robust institutional arrangements within a relatively short lapse of time. This process will continue and may take a few rounds of BURs and NCs preparation before it becomes fluent to all concerned. The inventory cycle adopted spans over two years and should enable fulfillment of the country's obligations for reporting both on the BURs and NCs.

4.3 MITIGATION ACTIONS (INCLUDING NAMAS)

Namibia has yet to develop its NAMAs and as such has not felt the need to establish and implement a system to track their benefits in terms of emission reductions or sink enhancements as well as indirect returns within the wider context of sustainable development. The country will now devise the concept of MRV for NAMAs and mitigation more generally. The institutional arrangements will follow closely those described above for the GHG inventory, involving the same institutions but with somewhat different responsibilities within the system. The responsibility will be more entrusted to the department under the supervision of the parent Ministry implementing the NAMA activity in close collaboration with the focal point agency, MET. The implementing institution will be responsible for the quality control of measurements and data collected as well as during processing within the IPCC 2006 software to evaluate emission

Figure 4.7. Inventory Cycle

reductions and removals. MET will also perform a QC on the report submitted and eventually apply quality assurance through its staff independently.

The MRV approach will be thus two-pronged, being geared for project-based and national NAMAs. Thus if a project is within a department of the Ministry of Mines and Energy such as NATIS, the latter will be responsible for the implementation, measurements and data collection pertaining to the implementation and follow-up over time. These data will then be fed into the IPCC 2006 software to calculate emission reductions on a project basis for MRV purposes. In cases where it is difficult to have direct reliable measurements or data on the impacts, such as consumption of fuelwood or penetration of energy efficient domestic appliances, then efforts will be deployed to track emission reduction or absorption within the GHG inventory process for making estimates for the source category. More details on the MRV system including the institutions and their role where more than one will be concerned with the implementation will be laid down in the NAMA project. These individual MRV plans will be validated and approved when developing the project. Reporting on the NAMAs will be the sole responsibility of the CCU of MET based on monitoring and reporting by the parent Ministry after verification by the CCU. All documentation and other materials on the NAMAS will be archived at the CCU of the MET and available for verification by any other body or entity.

No further formal agreements will be set up and it is anticipated that the system to be established and implemented will be permanent and sustainable. As the measurements and data collection on the NAMAS will be concurrently done with activity data collection for the GHG inventories. As these will be produced on a continuous basis at least every two years for the BUR with NC in between sometimes, it is expected that this alignment will render the process smooth.

No special capacity building activities have been realized with respect to NAMAs. The recent and forthcoming training on the GHG inventory preparation will lay down the baseline for the measurement component of the MRV and partly also for the reporting on emission reductions and removals. As spelled out previously, training will be continuously provided to all stakeholders as the system is further developed, established and implemented. If there is need, the institutional arrangements will be strengthened based on lessons learned through the development and establishment process as well as on constraints and challenges faced. CCU is already understaffed and meeting the challenges on the MRV in terms of coordination, follow-up of implementation, quality control, documentation and quality assurance will be very difficult. The structure of this unit may have to be reviewed and strengthened to enable it meet its future responsibilities within the context of reporting including maintaining and servicing MRV.

4.4 SUPPORT REQUIRED

Namibia as a Non-Annex I country with limited resources will need substantial support to develop, establish and implement the MRV system for domestically supported NAMAs. The coordination body, namely the CCU of MET staff will need training, more so that it will most probably have to recruit additional personnel. Support will be required to address problems encountered with the institutional arrangements, namely to strengthen it to acquire enough robustness to meet the requirements to deliver efficiently and successfully. Lack of technical capacity for making appropriate measurements and data collection, their processing and reporting will have to be addressed urgently. As well, the national experts in the various departments will need capacity building for implementation, follow-up, quality control and reporting. New recruits to perform independent validation and verification will have to be trained. Unless technical assistance is provided, the country will have to look for alternatives, such as outsourcing resource persons to provide for these capacity building needs.

Financial resources are also lacking to implement the MRV system. Already, government budget is strained due to the numerous national priorities and it may prove difficult to allocate enough funds to cover all these expenses. It is hoped that funds will be made available through the multilateral organizations like the Global Environment Facility to support activities, including the very urgent capacity building needs, to enable Namibia to develop, establish and implement a permanent sustainable MRV system to support its domestic NAMAs within the framework of the Convention.

4.4 SUPPORT RECEIVED

To-date no support specific to the development, establishment and implementation of the MRV system has been received directly. The country has pulled upon resources from other projects or from its BUR and TNC allocations to start the capacity building process for the production of its GHG inventories. While this will partially the purpose of the Measurement aspect, capacity still has to be acquired for the Reporting and Verification components. Technical assistance within the Eastern and Southern Africa capacity building project for GHG inventories of the UNFCCC has been tapped for starting the development and implementation of an inventory management system and its institutional arrangements as well as compilation of the GHG inventory for the AFOLU sector using the ALU software. In parallel, GEF funds from the TNC have been invested to give a first training to sectoral experts for compiling GHG inventories.

Chapter 5:

Constraints and gaps, and related financial, technical and capacity needs, including a description of support needed and received

5.1 REPORTING

Numerous constraints and gaps exist for Namibia to report to the required standards and frequency to the UNFCCC as a result of the shift from outsourcing to in-house reporting. Constraint removal and filling of gaps will be possible in the medium and longer term with continuous national efforts as planned but will require urgent sustained support from the bilateral and multilateral partners and donor institutions.

5.2 IMPLEMENTATION

Implementation of mitigation actions is a major challenge for the country in view of the multiple constraints and gaps that exist in various areas, namely at the institutional, organizational and individual levels. There is a need to create the enabling environment in the country. Barriers will have to be removed to speed up the process of implementation of mitigation while enhancing the identification of new mitigation measures and prepare project proposals for funding thereon.

5.3 TECHNICAL AND CAPACITY BUILDING NEEDS

One of the most urgent and toughest challenges that Namibia faces presently to report to the Convention and to implement it is inadequate technical capacity as laid down briefly in the preceding paragraphs. A list of the technical and capacity building needs is provided below.

Table 5.1. Technical and capacity building needs including support received and additional requirements

Activity	Status	Support needed	Support received	Additional support needed
Preparation of BUR (Strengthen existing institutional arrangements)	Ongoing	Technical assistance from partners and resource persons or consultants	Technical assistance under the UNFCCC GHG inventory capacity building project, Consultants under the BUR GEF funds	Further technical assistance and or resource persons to be contracted with future GEF allocations for the next BUR preparation
Preparation of BUR (enhance coordination)	Ongoing	Technical assistance from partners and resource persons or consultants	Consultant with the BUR GEF funds	Further technical assistance and or resource persons to be contracted with future GEF allocations for the next BUR preparation

Activity	Status	Support needed	Support received	Additional support needed
Preparation of BUR (compile GHG inventories)	Ongoing	Technical assistance from partners and resource persons or consultants	Technical assistance under the UNFCCC GHG inventory capacity building project, Consultant with the BUR GEF funds	Further technical assistance and or resource persons to be contracted with future GEF allocations for the next BUR preparation
Preparation of BUR and NCs (Prepare maps for refining the FOLU component)	Ongoing	Technical assistance from partners and resource persons or consultants	Technical assistance under the UNFCCC GHG inventory capacity building project	Further technical assistance and or resource persons to be contracted with future GEF allocations for the next BUR preparation
Preparation of BUR (develop and implement MRV)	Planned	Technical assistance from partners and resource persons or consultants	None	Further technical assistance and or resource persons to be contracted with future GEF allocations for the next BUR preparation
Preparation of BUR (assess outcomes of mitigation actions)	Ongoing and planned	Technical assistance from partners and resource persons or consultants	Consultant with the BUR GEF funds	Further technical assistance and or resource persons to be contracted with future GEF allocations for the next BUR preparation
Improve knowledge of market mechanisms linked to mitigation	Planned	Technical assistance from partners and resource persons or consultants	None	
Improve capacity for resource mobilization (funds)	Planned	Technical assistance from partners and resource persons or consultants	None	
Natural gas to electricity (Kudu project)	Planned			
Fuel switching to LPG for motor vehicles	Ongoing	Capacity building for installation of LPG kits	None	Not applicable
Solar home systems	Ongoing	Capacity building for installation and maintenance of solar home systems and assessment of impact	None	Not applicable

Activity	Status	Support needed	Support received	Additional support needed
Solar water heaters	Ongoing	Capacity building for installation and maintenance of solar home systems and assessment of impact	None	Not applicable
Photovoltaic pumps	Ongoing	Capacity building for installation and maintenance of solar home systems and assessment of impact	None	Not applicable
Solar cookers	Ongoing	Technical assistance for promoting penetration and adoption and assessment of impact	None	Not applicable
Low emissions bulbs	Ongoing	Capacity building to assess impact	None	Not applicable
Solar street lighting	Ongoing	Capacity building to assess impact	None	Not applicable
Establishment of the Renewable Energy and Energy Efficiency Institute (REEEI)	Ongoing	Technical capacity to enhance capacity of Institute	None	Not applicable
Improve energy efficiency in buildings	Ongoing	Capacity building of architects and engineers to integrate energy efficiency in buildings	None	Not applicable
Reduce distribution losses	Planned	Capacity building of engineers to assess and implement reduction	None	Not applicable
Energy audits in industries	Planned	Technical assistance to train engineers in performing energy audits	None	Not applicable
Reduce deforestation	Ongoing	Technical assistance	Some support received from German Development Bank (KfW) through GIZ	Technical assistance to further enhance capacity of foresters
Promote reforestation and afforestation	Ongoing	Technical assistance on transplanting techniques		Technical assistance to further enhance capacity of foresters
Promote community forest management	Ongoing	Technical assistance for awareness raising		Technical assistance to further enhance capacity of foresters

Activity	Status	Support needed	Support received	Additional support needed
Use alternatives to poles for construction	Ongoing	Technical assistance to evaluate impact of alternative materials	None	Not applicable
Improve livestock feed quality to reduce enteric fermentation	Ongoing	Technical assistance to evaluate impact	None	Not applicable
Switch from Fuelwood/charcoal to solar/LPG	Ongoing	Technical assistance to evaluate impact	None	Not applicable
Promote waste sorting and recycling	Ongoing	Technical assistance to evaluate impact	None	Not applicable
Reduce waste generation	Ongoing	Technical assistance to evaluate impact	None	Not applicable
Convert waste to energy	Planned	Technical assistance to prepare more CDM projects	None	Not applicable
Composting of abattoir sludge	Ongoing	Technical assistance to evaluate impact	None	Not applicable
Promote composting of domestic waste	Ongoing	Technical assistance to promote technology absorption	None	Not applicable
Switch to improved water treatment technologies	Ongoing	Technical assistance to evaluate impact	None	Not applicable

5.4 FINANCIAL NEEDS

For the country to meet its reporting obligations and implement the Convention requires substantial funding. The appropriate funding amounts and timing are important features to take into consideration when these actions, especially the implementation aspect, are aligned with the country's development strategy and agenda. Namibia as a developing country with its challenges to feed its population and provide the minimum requirements to it is not able to allocate the funding requirements to meet the climate change agenda.

Reporting has become more stringent and has to be supported by sufficient background studies to reflect the status of the country and its efforts in implementing activities to meet the objectives of the Convention. While it is recognized that the international community is providing support through the implementing agencies of the GEF, the amounts are insufficient and there are often problems in the timing for the release of the funds that prevents the country to meet the frequency of submission of the national reports.

Implementation is even more difficult as a result of the significant amounts of funding required to develop and implement mitigation projects. Up to now, Namibia has not tapped much funding to support its mitigation strategy. There is need for these shortcomings to be corrected and a list of actions requiring funding is provided in Table 5.2.

Table 5.2. Financial needs including support received and additional requirements

Activity	Status	Support needed	Support received	Additional support needed
Preparation and submission of BUR1	Ongoing	Enhanced funding	USD 352 000 from GEF	Will be calculated and submitted with BUR2 proposal to cover additional capacity building and implement activities to generate quality AD and improve EFs
Natural gas to electricity (Kudu project MW)	Planned	Financial needs being worked out	None	Will be provided in NC3 or BUR2
Wind power electricity generation plan	Ongoing	Financial needs being worked out	None	Will be provided in NC3 or BUR2
Plan for photovoltaics for generating electricity for the grid	Ongoing	Financial needs being worked out	None	Will be provided in NC3 or BUR2
Energy efficient bulbs	Ongoing	USD 1 000 000	USD 150 0000 from government funds	USD 100 000 annually over next 10 years to complete full programme
Fuel switching to reduce fuelwood consumption	Ongoing	Financial needs being worked out	None	Will be provided in NC3 or BUR2
Off grid energization master plan	Ongoing	Financial needs being worked out	None	Will be provided in NC3 or BUR2
Barrier removal to RE program in 2005	Completed	USD 100 000	USD 100 000 from government	Will be provided in NC3 or BUR2
Assessment of investment and financial flows to mitigate climate change in the energy sector	Completed for road transport sector	Provided under UNDP Global Project	Not estimated	None
Replace 1M incandescent lamps with compact fluorescent lamps	Completed	USD 150 000	Government funds USD 150 000	USD 100 000 annually over next 5 years to continue programme
Replace all electric water heaters by solar ones over 10 years	Ongoing	USD 10 000 000 annually over a period of 10 years	None	USD 3 000 000 annually over next 10 years to provide incentive at 30% of cost

Activity	Status	Support needed	Support received	Additional support needed
Solar home systems phase 1	Ongoing	USD 200 000	Government funds USD 50 000	USD 150 000 within next 2 years
Ruacana hydro project 4th turbine	Completed	Information not available	Information not available	None
CBEND biomass electricity generation plant	Ongoing	USD 1 200 000	USD 900 000 as grant	None
Photovoltaic water pumps phase 1	Ongoing	USD 200 000	Government funds USD 50 000	USD 150 000 within next 2 years
Biogas Fish river small CDM project from landfill and water treatment plants	Ongoing	Financial needs being updated	None	Will be provided in NC3 or BUR2
Windhoek CDM from Gammams water treatment plant	Ongoing	Financial needs being updated	None	Will be provided in NC3 or BUR2
Kupferberg CDM project from landfill gas	Ongoing	Financial needs being updated	None	Will be provided in NC3 or BUR2
Ohorongo cement using wood chips to replace coal	Ongoing	Financial needs being worked out	None	Will be provided in NC3 or BUR2
Erongo wind farm (220 kW)	Planned short term	Financial needs being worked out	None	Will be provided in NC3 or BUR2
Several 1 kW mini hydro for water pumping	Planned short term	Financial needs being worked out	None	Will be provided in NC3 or BUR2
44 MW windfarm in Luderitz	Planned short term	Financial needs being worked out	None	Will be provided in NC3 or BUR2

5.5 TECHNOLOGY NEEDS ASSESSMENT AND TECHNOLOGY TRANSFER NEEDS

Mitigating climate change requires the latest technologies and its smooth transfer that demands for appropriate and sufficient capacity as well as funds. Namibia has yet to complete a full extensive study on its technology needs and transfer. This exercise is being done piecemeal within the national communications framework and this is delaying both the exhaustive assessments on vulnerability and adaptation to and mitigation of climate change, and the associated cross-cutting issues. Thus the absence of adaptation and mitigation plans to inform the stakeholders and to develop a proper implementation plan. A list of the most urgent needs related to technology, soft and hard, assessment and transfer is given in Table 5.3 below.

Table 5.3. Technology Needs Assessment and Technology Transfer needs

Activity	Status	Support needed	Support received	Additional support needed
In-depth Technology Needs Assessments for mitigation	Planned	USD 300 000	Small amounts of funds from GEF allocation for NC3	USD 300 000
Barrier removal for RE technology transfer	Planned	USD 100 000 annually over next 5 years	None	USD 500 000
Natural gas to electricity (Kudu project)	Planned	Costing under way	None	Will be provided in NC3 or BUR2
Wind power electricity generation plan	Planned	Costing under way	None	Will be provided in NC3 or BUR2
Plan for photovoltaics for generating electricity for the grid	Planned	Costing under way	None	Will be provided in NC3 or BUR2
Off grid electricity generation	Ongoing	Costing under way	None	Will be provided in NC3 or BUR2
Photovoltaic pumps	Ongoing	Costing under way	None	Will be provided in NC3 or BUR2
Energy efficient bulbs	Ongoing	Costing under way	None	Will be provided in NC3 or BUR2
Fuel switching to reduce fuelwood consumption	Ongoing	Costing under way	None	Will be provided in NC3 or BUR2

Chapter 6:

Information on the level of support received to enable the preparation and submission of biennial update reports

6.1 FINANCIAL

The Global Environment Facility (GEF) through the UNDP country office, the implementing urgency, provided funds to the tune of USD 352 000 to support Namibia prepare its first Biennial Update Report (BUR1) for the fulfilment of its obligations under the United Nations Framework Convention on Climate Change (UNFCCC). The government of the Republic of Namibia through its Ministry of Environment and Tourism (MET) Department of Environmental Affairs, Division of Multilateral Environmental Agreement (MEA) provided in kind support for the project to the value of USD 50 000 in order to realize this enabling activity.

6.2 TECHNICAL

Capacity to prepare the BUR is low in most Non-Annex I Parties including Namibia due to the fact that the BUR is a new requirement and the guidelines on its preparation are not very explicit. There was therefore a need for capacity building and some initiatives, directly or indirectly have partially addressed this shortcoming. These initiatives are described further down in this chapter.

Peer to peer review for the African Region on BUR

Namibia was among the countries that benefited from the "*peer-to-peer initiative for the African Region on BUR reports of the International Partnership on mitigation and MRV*" provided and funded by GIZ. The initiative started with a workshop in South Africa in May 2013 on the invitation of the Government of South Africa, where policy-makers from eight African countries (Egypt, Ethiopia, Ghana, Kenya, Mali, Tunisia, South Africa and Zambia) had discussions on their respective strengths and challenges in their national reporting systems and shared their experiences within the regional group. This forum equipped the African countries with a unique opportunity to benefit from the knowledge base of the International Partnership on Mitigation and MRV by sharing experiences and expert inputs on the preparation of BURs, knowledgeable information on mitigation and MRV.

In October 2014 the International Partnership on mitigation and MRV together with the Ghanaian Environmental Protection Agency organized a peer to peer information sharing on BUR, mitigation and MRV with the financial support from the GIZ. Namibia was invited for the first time and is now part of the group and will continue to participate in future activities. The countries shared their experiences and lessons learned on accessing funding and the preparation of the BUR. Namibia is among those countries that are well in the process with the submission of its BUR1 in December this year. GIZ shared a template covering the elements to be provided in the BUR report.

Eastern and Southern Africa GHG inventory capacity building project

Namibia participated in the UNFCCC Capacity Building Project for Sustainable National Greenhouse Gas Inventory Management Systems in Eastern and Southern Africa (ESA) over 4 years from 2011 to 2014. The objective was to develop capacity in the participating countries to develop and implement inventory management systems to enable them compile and submit good quality GHG inventories as part of their NC and BURs on a sustainable basis to meet their reporting obligations. The project also had as components technical capacity building for compiling the inventory on the Agriculture, Land Use and Land use Change and Forest sectors as they are major emitters or sinks in the participating countries. Additionally they are among the difficult sectors to compile the inventory for mapping land cover and land use had been identified as a major drawback to producing good quality inventories for the AFOLU sector. Remote sensing technology was adopted and maps were produced as from LandSat imagery for two timesteps, 2000 and 2010, to generate land use change, The land use changes were then fed in the software for making emission estimates resulting from land use change to conform to IPCC requirements. The project also aimed at enhancing the capabilities of national experts to move from tier 1 to tier 2 for the AFOLU sector through the use of the Agriculture and Land Use software of the Colorado State University. Through the ESA project, Namibia benefited in developing the inventory management system and strengthening its institutional arrangements for compiling the GHG inventory. A number of Namibian experts from the different sectors received training on the use of IPCC methods and tools as well as compiling estimates at the tier 2 level with the ALU software.

Global training workshop on the preparation of Biennial Update Reports

The training was organized by the Consultative Group of Experts on national communications from Parties not included in Annex I to the convention (CGE), in Bonn, Germany in September 2013. As a part of the provision of technical assistance to non-Annex I Parties, the CGE decided to develop supplementary training materials to facilitate the preparation of BURs, by improving the existing CGE training materials developed to assist non-Annex I Parties in preparing their national communications, to incorporate other elements within the scope of the BUR guidelines (Annex III of 2/CP.17), in particular, the following:

- Institutional arrangements for the preparation of national communications and BURs on a continuous basis;
- Mitigation actions and their effects, including associated methodologies and assumptions;
- Constraints and gaps, and related financial, technical and capacity needs, including a description of support needed and received; and information on the level of support received to enable the preparation and submission of biennial update reports.

Namibia benefited in participating in the meeting relative to actions being undertaken and progress achieved that the country could implement when preparing its BUR1.

IPCC Expert Meeting to collect Emission Factors Database (EFDB) and software users' feedback

Organized by the IPCC through its Task Force on Inventories, the meeting was held in Hayama, Japan, in October 2014. The meeting aimed at helping inventory compilers to move from the revised 1996 guidelines to the IPCC 2006 ones and to encourage the use of the IPCC 2006 software, and the Emissions Factor DataBase (EFDB). At the meeting, the IPCC 2006 guidelines and software were presented. National experts also received hands-on training on running the software after which experiences were shared.

Chapter 7:

Any other information relevant to the achievement of the objective of the Convention and suitable for inclusion in its Biennial Update Report

Namibia has not yet identified and worked on NAMAs except for current work on designing one NAMA on rural electrification using renewable energy in off-grid systems. The country is strengthening its mitigation assessment within the context of its NC3. Based on these results, Namibia will attempt at developing a mitigation plan in accordance with the national development strategies and plans. The most promising and feasible projects will be identified and NAMA projects developed on these for implementation. Key source categories, based on the GHG inventory results, will be prioritized.

Namibia is facing a severe problem of invader bush in its pastureland, thereby threatening its livestock industry, a major economic engine of the country. Invader bush can be exploited sustainably for producing electricity and heat and this activity will be further assessed for its development to reduce dependency on fossil fuels while rehabilitating the pastureland.

Namibia is also enhancing its capacity to participate in the REDD+ programme. Among the key preparatory activities to participate in REDD is the development of systems to measure, report and verify (MRV) changes in forest cover and related carbon emissions. The REDD+ capacity building project for the SADC region aims at enhancing the mitigation capacity of its members and contributes to providing the basis for emission reductions. Furthermore, the project supports the implementation of the Protocol on Forestry and the achievement of sustainable forest management in the SADC region. The main objective is that SADC as a region has a standard MRV system that is compliant with the recommendations of the IPCC as well as enhanced capabilities to measure changes to forest areas, and loss of carbon stocks from deforestation and forest degradation.

References

Africa Energy Yearbook. (2013).

De Klerk, JN (2004). Bush Encroachment. Report on Phase 1 of the Bush Encroachment Research, Monitoring and Management Project, Ministry of environment and Tourism, Windhoek. Available at: http://www.met.gov.na/programmes/napcod/encroachment.htm.

Directorate of Forestry. (2000). Inventory Report on the Woody resources in the Omusati region. Namibian Finland Forestry Programme, Ministry of environment and Tourism, Windhoek, June 2000.

Directorate of Forestry. (2000). Inventory Report on the Woody Resources in the Okongo Community Forest. Namibian Finland Forestry Programme, Ministry of environment and Tourism, Windhoek, October 2000.

Directorate of Forestry (2007). Inventory report on the Woody Resources in the Proposed Ozonahi Community Forest. Namibian Finland Forestry Programme, Ministry of environment and Tourism, Windhoek, December 2007.

Directorate of Agricultural Planning (2009). Agricultural Statistic Bulletin (1996-2003), Ministry of Agriculture, Water and Forestry, Windhoek.

Duplessis, P. (1999). First greenhouse gas inventory: A report on sources and sinks of greenhouse gases in Namibia in 1994 (Namibia's country study on climate change). DRFN.

Heleen de Coninck, T. Mikunda, B. Cuamba, R. Schultz and P Zhou. (2010). CCS in Southern Africa: An assessment of the rationale, possibilities and capacity needs to enable CO_2 capture and storage in Botswana, Mozambique and Namibia.

http://www.laurea.fi/en/connect/results/Documents/Namibia%20Country%20Report.pdf

http://www.unfccc.int/resource/docs/natc/namnc2.pdf), Namibia SNC to UNFCCC (2011)

http://www.mme.gov.na/pdf/energy_policy_whitepaper.pdf, White Paper on Energy Policy (1998).

http://www.nbc.na/news_article.php?id=10517&title. The situation of power supply in Namibia remains critical.

http://www.worldbank.org/en/country/namibia/overview, downloaded September 2014, last updated 7 April 2014.

http://africa-energy-forum.com/webfm_send/2011. Energy efficiency: the case for renewables.

http://www.ipcc-nggip.iges.or.jp/public/gl/invs4,5,6.html.

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

Hager, C., Schultz, R. & von Oertzen, D. 2008, Turning Namibian Invader Bush into Electricity: The CBEND Project. DRFN, Windhoek.

IPCC (1996). Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: The Reporting Instructions (Volume 1). http://www.ipcc-nggip.iges.or.jp/public/gl/invs4.html.

IPCC (1996). Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3). http://www.ipcc-nggip.iges.or.jp/public/gl/invs6.html.

IPCC (1997). Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Houghton J.T., Meira. Filho L.G., Lim B., Treaton K., Mamaty I., Bonduky Y., Giggs D.J., Callander B.A. (Eds.) Intergovernmental panel on Climate Change (IPCC), IPCC/OECD/IEA, Paris, France.

IPCC (2000). Good Practice Guidance and Uncertainty Management in Nationalk \greenhouse Gas Inventories.

IPCC (2003). IPCC, Good Practice Guidance for land use, land-use change and forestry.

IPCC (2007). 2006 Guidelines for national National greenhouse Gas Inventories.

Jones, B.T.B. and J.I. Barnes (2009). Preparing for REDD in dryland forests: Investigating the options and potential synergy for REDD payments in the miombo eco-region (Namibia country study). International Institute for Environment and Development (IIED), London, UK.

Leinonen, A. (2007). Woodchips Production Technology and Costs for Fuel in Namibia, Available from: http://www.vtt.fi/publications/index.jsp

Mendelsohn, J and S. El Obeid (2007). Forests and Woodlands of Namibia, Windhoek.

Miika Rämä, Esa Pursiheimo, Tomi Lindroos, Kati Koponen, (2013). Development of Namibian energy sector. Research Report VTT-R-07599-13. Energy Policy, Regulatory Framework and Energy Future of Namibia 69 pp.

Muteyauli et al. (2011). Assessment of Investment and Financial Flows for mitigation in the energy sector in Namibia. Republic of Namibia & UNDP.

Namibia. (2002) Initial National Communication to the United Nations Framework Convention on Climate Change. Ministry of Environment and Tourism, July 2002.

Namibia (2011). Second National Communication to the United Nations Framework Convention on Climate Change. Ministry of Environment and Tourism, July 2011.

Namibia 2011 Population and Housing Census Main Report. (2012). Republic of Namibia, Windhoek, 2012.

Namibia's Fourth National Development Plan (NDP4). (2012). Republic of Namibia, Windhoek, May 2012.

Namibia Vision 2030 (2004). Office of the President, Private Bag 13356, Windhoek, Namibia.

NAMREP (2005). Ministry of Mines and Energy. Barrier removal to Namibian Renewable Energy Programme (NAMREP). final report: assessment of feasibility for the replacement of electrical water heaters with solar water heaters.

National Policy on Climate Changefor Namibia (2011). Ministry of Environment and Tourism.

NNFU (J. Mendelsohn, S. EL Obeid(2006). Farming systems in Namibia, Namibia National Farmers Union (NNFU).
Hartz, C and C. Smith (2008). Namibia's GHG Inventory for 2000, Directorate of Environmental affairs.
OGEMP (2007). Off – Grid Energisation Master Plan for Namibia (OGEMP). http://www.mme.gov.na/pdf/undp-reports/off-grid-masterplan.pdf (downloaded 23 September 2014),

OPEC Fund for International Development (OFID) (2010). OFID PAMPHLET SERIES 39, Vienna, Austria, October 2010 ENERGY POVERTY, IN AFRICA, Proceedings of a Workshop held by OFID in Abuja, Nigeria, June 8 –10, 2008, uniting against poverty.

Profile of Namibia (2013). National statistics Agency, Windhoek, 2013.

Republic of Namibia (2007). Namibia Energy Review for the UNFCCC. Ministry of Environment and Tourism.

RCMRD-SEVIR AFRICA (2013). Report of Namibia Ancillary data collection workshop held in February 2013, Windhoek Namibia.

SADC (2014). http://www.sadc.int/sadc-secretariat/directorates/office-deputy-executive-secretary-regional-integration/food-agriculture-natural-resources/redd/. The REDD+ Project in the SADC Region.

Von Oertzen, D. (2010). Namibian National Issues Report on the key sector of energy with a focus on mitigation. UNDP.

Zanne, A.E., Lopez-Gonzalez, G., Coomes, D.A., Ilic, J., Jansen, S., Lewis, S.L., Miller, R.B., Swenson, N.G., Wiemann,

M.C., and Chave, J. (2009). Global wood density database. Dryad. Identifier: http://hdl.handle.net/10255/dryad.235.

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