## REPUBLIC OF NAMIBIA

# Second Biennial Update Report (BUR2) of the Republic of Namibia

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

**November 2016**

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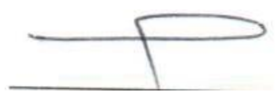
# Foreword

On behalf of the Government of the Republic of Namibia, it is an honour and privilege for me to present Namibia's Second Biennial Update Report (BUR 2) in fulfillment of its obligations as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC) in accordance with the enhanced reporting requirements adopted at the 16th and 17th Conference of the Parties (COP).

Namibia ratified the UNFCCC in 1995 and thus became obligated to prepare and submit national communications. Namibia was also one of the first countries to ratifie to the Paris Agreement. Thus far Namibia has prepared and submitted the Initial National Communication (INC) in 2002, the Second National Communication (SNC) in 2011, the first BUR in 2014, and the Third National Communication (TNC) in 2015. Furthermore, Namibia prepared and submitted its Intended Nationally Determined Contributions (INDC) in 2015. Namibia has also kick started the work to develop its Fourth National Communication (NC4) which will be submitted to the UNFCCC in 2019.

Namibia became the first Non-Annex I party to prepare and submit its first Biennial Update Report at COP 20. BUR 2 builds on and updates the information provided in the BUR 1 and TNC. The BUR updated information on the national Greenhouse Gas (GHG) inventory, mitigation actions and their effects, including the associated domestic Monitoring, Reporting and Verification (MRV), and needs and support received, and institutional arrangements. Namibia is one of the first countries to have gone through the first round of the International Consultation Analysis (ICA) process of its first BUR and has produced two stand-alone GHG Inventory Reports, covering a time series for the period 2000 to 2012.

At the national level, Namibia has made numerous strides to further engage itself to play its role in fighting climate change as outlined in the INDC. In 2014, the Cabinet of the Republic of Namibia approved the National Climate Change Strategy and Action Plan (NCCSAP). The NCCSAP, which is currently under implementation, aims at facilitating the realisation of the National Climate Change Policy (NCCP), which was passed in 2011. The strategy adopted in the document is cross-sectoral and will be implemented up to the year 2020 and it covers the thematic areas mitigation, adaptation and related cross cutting issues.



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**Hon. Pohamba Shifeta**

**Minister of Environment and Tourism**

# Acknowledgements

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- National Planning Commission
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- City councils and municipalities
- NamCor
- TransNamib Holdings Ltd
- Namibia Airports Company
- Petroleum products dealers
- Namport
- AGRA
- Electricity Control Board
- Meatco Namibia

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# Abbreviations and Acronyms

| Acronym | Definition |
|---|---|
| °C | Degree Celsius |
| AD | Activity Data |
| AFOLU | Agriculture, Forest and Other Land Use |
| AIDS | Acquired Immune Deficiency Syndrome |
| AGRA | Agriculture Namibia |
| ALU | Agriculture and Land Use |
| AR | Assessment Report |
| ARV | Antiretroviral |
| BAU | Business as usual |
| BCEF | Biomass Conversion and Expansion Factors |
| BGB | Below Ground Biomass |
| Bm | biomass |
| BRACE | Building Resilience Against Climate Effects |
| BUR | Biennial Update Report |
| C | carbon |
| CBNRM | Community Based Natural Resource Management |
| CBRLM | Community Based Rangeland and Livestock Management |
| CBS | Central Bureau of Statistics |
| CCCM | Canadian Climate Change |
| CCSAP | Climate Change Strategy and Action Plan |
| CCU | Climate Change Unit |
| CCVI | Climate Change Vulnerability Index |
| CCVI-NTS | Climate Change Vulnerability Index of the Namibian Tourism Sector |
| CDC | Centre for Disease Control |
| CDM | Clean development Mechanism |
| $CH_4$ | methane |
| CIAT | Centre International de l'Agriculture Tropicale |
| CNG | Compressed Natural Gas |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| $CO_2$-eq | carbon dioxide equivalent |
| COP | Conference of Parties |
| CS | Country specific |
| CSP | Concentrated Solar Power |
| CSIR | Council for Scientific and Industrial Research |
| CSU | Colorado State University |
| dbh | Diameter at breast height |
| DE | Digestible energy |

| Acronym | Definition |
|---|---|
| DEA | Department of Environmental Affairs |
| dm | dry matter |
| DoF | Directorate of Forestry |
| DRFN | Desert Research Foundation Namibia |
| DSM | Demand Side Management |
| ECB | Electricity Control Board |
| EDM | Electricidade de Moçambique |
| EEA | European Environment Agency |
| EF | Emission Factor |
| EIF | Environmental Investment Fund |
| EMEP | European Monitoring and Evaluation Program |
| ENP | Etosha National Park |
| ESA | Eastern and Southern Africa |
| EPZ | Export Processing Zone |
| ESKOM | Electricity Supply Commission |
| FANRPAN | Food, Agriculture and Natural Resources Policy Analysis Network |
| FAO | Food and Agricultural Organization |
| FOLU | Forestry and Other Land Use |
| GCF | Green Climate Fund |
| GCM | Global Circulation Model |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| Gg | Gigagram |
| GHG | GreenHouse Gas |
| GIS | Geographic Information System |
| GL | Guidelines |
| GNDI | Gross National Disposable Income |
| GNI | Gross National Income |
| GPG | Good Practice Guidance |
| GRN | Government of the Republic of Namibia |
| GVM | Gross Vehicle Mass |
| GWH | Gigawatt Hour |
| GWP | Global Warming Potential |
| ha | Hectare |
| HAC | High Activity Clay |
| HDI | Human Development Index |
| HFCs | hydrofluorocarbons |
| HIV | Human Immunodeficiency Virus |
| IEA | International Energy Agency |
| IMR | Infant Mortality Rate |

| Acronym | Definition |
|---|---|
| INC | Initial National Communication |
| INDC | Intended Nationally Determined Contribution |
| IPCC | Intergovernmental Panel on Climate Change |
| IPPC | International Plant Protection Convention |
| IPPU | Industrial Processes and Product Use |
| ITCZ | Inter-Tropical Convergence Zone |
| LED | Light emitting diode |
| lv | Growth rate |
| IWRM | Integrated Water Resources Management |
| KCA | Key Category Analysis |
| km | Kilometer |
| LAC | Low Activity Clay |
| LPG | Liquefied Petroleum Gas |
| LSU | Livestock Standard Unit |
| m | metre |
| m/s | Meter per second |
| Mamsl | Meter above mean sea level |
| MCA | Millennium Challenge Account |
| MCC | Millennium Challenge Corporation |
| MDG | Millennium Development Goals |
| MEA | Multilateral Environmental Agreement |
| M&E | Monitoring and Evaluation |
| MET | Ministry of Environment and Tourism |
| mm | Millimeter |
| $Mm^3/a$ | million metric cube per annum |
| MMS | Manure Management System |
| MODIS | Moderate Resolution Imaging Spectroradiometer |
| MRV | Measuring, Reporting and Verification |
| MS | Microsoft |
| MSW | Municipal Solid Waste |
| MTEF | Medium term expenditure framework |
| MW | Megawatt |
| MWG | Mitigation Working, Group |
| N$ | Namibian dollar |
| $N_2O$ | Nitrous oxide |
| NAB | Namibian Agronomic Board |
| NACSO | National Association of CBNRM Support Organization |
| NAFIN | National Alliance for Improved Nutrition |
| NAMA | Nationally Appropriate Mitigation Action |
| NAP | National Agricultural Policy |

| Acronym | Definition |
|---|---|
| NAP | National Agricultural Policy |
| NC | National Communication |
| NCCC | National Climate Change Committee |
| NCCP | National Climate Change Policy |
| NDA | National Designated Authority |
| NDHS | National Demographic and Household Survey |
| NDP | National Development Plan |
| NEI | Namibia Energy Institute |
| NFI | National Forest Inventory |
| NGO | Non-Governmental Organisation |
| NIE | National Implementing Entity |
| NHIES | Namibia Household Income & Expenditure Survey |
| NIIP | National Inventory Improvement Plan |
| NIR | National Inventory Report |
| NIRP | National Integrated Resource Plan |
| NMVOC | Non-Methane Volatile Organic Compound |
| NNFU | Namibian National Farmers Union |
| $NO_x$ | nitrogen oxides |
| NPC | National Planning Commission |
| NPHC | Namibia Population and Housing Census |
| NRMPS | National Rangeland Management Policy and Strategy |
| NSA | Namibia Statistics Agency |
| NTS | Namibian Tourism Sector |
| NVDCP | National Vector-Born Disease Control Program |
| ODS | Ozone Depleting Substances |
| OGEMP | Off-Grid Energisation Master Plan |
| PFCs | Perfluorocarbons |
| REFIT | Renewable Energy Feed in Tariff |
| QA | Quality Assurance |
| QC | Quality Control |
| RA | Reference approach |
| REDD | Reducing Emissions through Deforestation and Degradation |
| SA | Sectoral approach |
| SACU | Southern African Customs Union |
| SADC | Southern Africa Development Community |
| SAPP | South African Power Pool |
| SD | Sustainable Development |
| $SF_6$ | sulphur hexafluoride |
| SNC | Second National Communication |
| $SO_2$ | Sulphur dioxide |

| Acronym | Definition |
|---|---|
| t | Tonne |
| TCI | Tourism Climate Index |
| TJ | Terajoule |
| TNC | Third National Communication |
| TRD | Tropical Dry |
| TRMD | Tropical Montane Dry |
| UN | United Nations |
| UNDP | United Nations Development Program |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNICEF | United Nations International Children's Emergency Fund |
| Vol | Volume |
| VFR | Visiting Friends and Relatives |
| WDM | Water Demand Management |
| WET | Wet Mineral |
| WHO | World Health Organization |
| WMO | World Meteorological Organization |
| WTO | World Trade Organization |
| yr. | year |
| ZESA | Zimbabwe Electricity Supply Authority |
| ZESCO | Zambia Electricity Supply Corporation |

# Executive Summary

## Introduction

Namibia's long term development is embedded in its Vision 2030 document which aims at high and sustained economic growth to create employment and move the country towards increased income equality. The current Fourth National Development Plan (NDP4) translates this vision into strategies and plans for implementation. 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.

## 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. 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. In line with decision 2/CP.17, Namibia submitted its BUR1 in 2014 and the present BUR2 will be submitted during the next COP meeting. As well, the INDC was presented in 2015.

## 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 Ministry of Environment and Tourism (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.

## Population profile

According to Namibia 2011 Population and Housing Census (NPHC, 2011), the total population of Namibia was estimated at 2 113 077 people. Women outnumbered men with 1 091 165, compared to 1 021 912. The age composition of the Namibia population indicates that, 14 % of the population was 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. In 2011, a total of 43 % of Namibia's population lived in urban areas, while 57 % of the population lived in rural areas. The intercensal population growth rate between 2001 and 2011 was 1.4 % compared to 2.6 % between 1991 –2001. The annual growth rate for urban areas was 4.0 %, which is much higher than the national rate. There was however, a negative growth rate (- 0.1 %) in rural areas due to high migration to urban areas. (NPHC, 2011).

## Geographic profile

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 $km^2$. It has a 1500 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.

Land cover and use is very diverse in Namibia. Apart from a substantial area being covered by the Namib Desert, there are vast expanses of Grasslands, itself sub-categorized into pure grassland, shrubland and savannahs. There are still forest areas sub-divided into Forestland and Woodland. The remainder of the territory is classified as Cropland, Wetlands and Settlement areas. The distribution and coverage by the different land cover and use as generated from satellite imagery is provided in Table 1.1.

Despite 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).

## Climate profile

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 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.

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 3800 mm per annum in the south to 2600 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.

## Economic profile

According to the National Accounts compiled by NSA for 2015, the domestic economy has slowed down in 2015 recording a growth of 5.3 % in real value as compared to 6.5 % in 2014. This decline was mainly attributable to the primary industries that recorded a contraction of 3.2 %. Furthermore, the secondary and tertiary industries recorded growth rates of 8.3 % and 5.4 % compared to 9.5 % and 7.7 % in 2014, respectively. The main contributor to national GDP was the tertiary industries (58.3 %) followed by the primary industries with 18.7 % and the secondary industries with 15.8 % (NSA, Annual National Accounts-2015). GDP at current prices amounted to N$ 146 619 million in 2015 compared to N$ 139 500 million in 2014.  At constant 2010 prices, the GDP was N$ 108 010million compared to N$ 102 578 million in 2014.

## Energy

The most dominant energy source in Namibia is liquid fuel which includes petrol and diesel and accounts for about 63 % of total net energy consumption which is mainly used in the transport sector, followed by

electricity with 17 % net consumption, coal with 5 % and the remaining 15 % from other sources of energy such as solar, wood and wind energy among others. Namibia does not produce or export any fossil fuel though it is planned to exploit natural gas from the recently discovered Kudu gas reserve.

Currently, Namibia's electricity demand stands at 597 MW, and grows at an annual energy consumption rate of 3 %. On the supply side, Namibia has currently only 3 major power generation stations, with an installed capacity of about 500 MW. The biggest one is the Ruacana Hydro Power station which generates about 332 MW of electricity, Van Eck Coal power station generates about 120 MW and the Paratus and Anixas diesel power stations at the coast with 24 MW and 22.5 MW respectively (Konrad *et al*., 2013). 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.

Studies have shown that energy consumption is related and a driver to economic growth and GDP production. The policy is thus geared towards increasing the amount of energy supply in Namibia through Sustained and improved energy infrastructure; Expanded energy research and development; Increased energy efficiency awareness; and Increased investment in energy sector.

The strategy aims at increasing the exploitation of local energy resources for electricity generation to reduce the country's dependence on foreign sources as well as for other purposes and also to increase the share of renewable energy in the future energy mix. Namibia intends to tap solar and wind energy resources in the future while concurrently exploiting efficiently the invasive bush as a biomass energy source since the latter is proving so detrimental to the livestock sector productivity and development.

## Transportation

Namibia's road network is regarded as one of the best on the continent with 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 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 3000 vessels each year and handles about 5 million tonnes of cargo.

The railway network comprises 2382 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.

## Manufacturing industry

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. It is one of the economic priorities of the Fourth National Development Plan (NDP4) currently running to 2016/17. Manufacturing activities in the country are concentrated in the subsectors of meat processing, fish processing, other food and beverages, and mineral value addition. However, it is considered that the rate of industrialization has been below expectations due to some of the barriers that have not been removed successfully and despite government incentives. Some of these barriers are a sub-optimal business environment for investors, inadequate quality infrastructure, shortage of specialized skills, lack of a protective framework for local products and, a lack of research and development activities. Manufacturing is estimated to have recorded a constant growth of 1.2 % and contributed 13.3 % of GDP in 2014 (Ann. Rep. NPC

2013/2014). Mining, including quarrying, remained one of the major contributor of Namibia's national economy with 13 % of the country's Gross Domestic Product (GDP) in 2014.

## 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 in 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 is 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.

## 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, excluding livestock, has seen its share of contribution among the primary industries to GDP gone down to 3.8 % in 2014 from slightly more than 5 % in 2010 and 2011. Approximately 48 % of Namibia's rural households depend on subsistence agriculture (NDP4). The main crops are maize, wheat, millet and sorghum, cultivated mainly for subsistence purposes under communal and commercial systems. Livestock rearing, a major activity and contributor to GDP comprises cattle as the leading livestock along with sheep and goats.

Forests play an important role in the livelihood of the Namibian. Most 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.

## Water Resources

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 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 neighbouring riparian states with an obligation for them to be managed and used in terms of the relevant rules of international water law.

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).

## 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. Since independence in 1990, the

fishing industry grew 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. However, due to declining stocks and other factors, this importance is declining. The fishery sector contributed only 2.8 % to GDP in 2014 compared to 4.6 % in 2009 and 3.7 % in 2010. The sector is a substantial export earner, with over 85 % of Namibia's fish output destined for international markets.

## 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 their combined direct and indirect impacts. In 2014, the tourism sector contributed 1.6 % of GDP. Total tourist arrivals dropped from some 570 000 in 2013 to about 490 000 in 2014 after consistent increases since 2010 as depicted in Figure 1.9.

## Health

The strategic objectives in the health sector are to reduce mortality and morbidity, reduce the level of malnutrition and ensure staff complement and fleet availability. These objectives are being attained through the programmes on Public Health, Clinical health care services, health system management and planning, disability prevention and rehabilitation and development of social welfare services. Infant and child mortality is comparatively low, but the maternal mortality ratio has increased, even though 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, diarrhoea, 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 incidence in 2010 were recorded as 10.4/1000 while in 2012 it decreased to 1.3/1000. Malaria morbidity and mortality has both declined by above 95 % from the mean baseline of 2002/3 (morbidity = 428 953; mortality = 1062).

Approximately 15 % of the total Namibian population aged 15-49 is living with HIV/AIDS, but the infection level appears to have stabilized. Seven per cent of all people living with HIV/AIDS are under the age of 15, and 60 % are women. Control of HIV/AIDS through various measures has led to a coverage of 87 % of the infected persons by antiretroviral therapy (ART) in 2014

The very high incidence of tuberculosis in Namibia is fuelled by the HIV/AIDS epidemic, which has reduced life expectancy from 62 years in 1991 to 49 years. This situation has reversed nowadays following implementation of remedial actions by government. The treatment success rate has increased consistently since 2002 to attain 85 % in 2012.

## Priorities related to mitigation of climate change

The key sectors and areas identified for mitigation span over all development sectors of the economy and the four IPCC sectors. Emphasis is laid on those sectors and categories responsible for the highest emissions as well as sink potentials as per the key category analysis and development strategies of Namibia. However, other win-win situations such as mitigation in the waste sector which is expected to result in gains in the health of the population has not been neglected despite its low national emissions. Some of the areas earmarked for actions are provided below:

- Increasing the share of renewables in electricity production;
- Increase energy efficiency and other DSM activities;
- Improve passenger and freight transport to reduce fossil fuel use;
- Reduce emissions in industrial processes through the adoption of ESTs and other measures;

- Reduce deforestation rate;
- Reforestation and afforestation;
- Restoration of grasslands;
- Promote alternatives to reduce wood removals from forests and grasslands;
- Promote sylviculture and agro-forestry;
- Improve livestock husbandry practices;
- Enhance soil carbon storage through improved agricultural practices;
- Convert solid waste to energy; and
- Improve solid and liquid waste management.

## Adaptation

Namibia, as one of the driest countries in sub-Saharan Africa, is dependent on development sectors highly sensitive to climate. Primary economic sectors which are natural resource based such as agriculture, fisheries and mining account for about one third of the total GDP. More than half of the population depends on subsistence agriculture and in drought years, food shortages are a major problem in rural areas. Namibia is therefore potentially one of the most vulnerable countries to climate change. The predicted temperature rise and evaporation increase as well as higher rainfall variability will exacerbate the existing challenges that Namibia is facing. The potential effects of these climatic changes could prove catastrophic to the communities, population and economy at large. Thus, adaptation is of prime importance to the country and is high on government's agenda to guarantee the welfare of the people while reducing risks and building resilience. Adaptation is thus an obligation for the country to fulfil its role within the international context.

Broad avenues for adaptation to climate change in the future consist of:

- Improving technical capacity at the national and sub-national levels to develop a greater understanding of climate change and its impacts;
- Developing and implementing appropriate responses and adaptation strategies to reduce the impacts of floods, low rainfall and high temperatures on people, crops, livestock, ecosystems, infrastructure and services;
- Implementing soil and water conservation policies and practices;
- Improving ecosystem management, protection and conservation; and
- Developing common goals and facilitating better integration of different policies and practices in vulnerable sectors.

## GHG inventory

### Introduction

Namibia has so far complied with the Convention and submitted four national inventories as components of its first, second and third national communications and its first Biennial Update Report. More exhaustive information on the last inventory can be obtained by perusing the full NIR1 of the country that has also been submitted to the secretariat of the UNFCCC. These inventories have been compiled and submitted in line with Article 4.1 (a) of the Convention whereby 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. These inventories have been produced to the extent of the country's capabilities and using recommended methodologies of the IPCC which have been agreed upon by the Conference of the Parties. The NIR2 supersedes previous inventories and provides for the latest and best emissions estimates of the country in light of available data and information.

## Coverage (period and scope)

Namibia has compiled inventories for the period 2001 to 2009 also and is updating this time series with inventories for the years 2011 and 2012. The emissions and removals of the country are being made available in this present national inventory report. The inventory covered the full territory of the country and the results are presented at the national level. It addressed all the IPCC sectors and categories subject to Activity Data (AD) availability. The latest IPCC 2006 Guidelines have been used to estimate emissions for the four sectors, namely, Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry, and Other Land Use (AFOLU) and Waste.

## Institutional arrangements and GHG inventory system

Capacity building continued with the preparation of inventories to further improve, implement and consolidate the GHG inventory management system being implemented. The process of preparation of GHG inventories remained a very laborious exercise as resources and human capacities continued to be limiting factors. Implementation of the different steps of the inventory cycle was staged over less than a year instead of a longer period to fit the availability of funds for the compilation of this inventory. Due to this time constraint, it is obvious that there still exist shortcomings in this inventory, but the country is committed to strive to raise the quality of future GHG inventories through further strengthening of the GHG inventory system and human capacities.

The Climate Change Unit (CCU) of the Ministry of Environment and Tourism has the responsibility for overlooking the production of reports to the Convention, including the GHG inventories in its capacity as National Focal Point of the Convention. The framework with all stakeholders agreeing to pursue the sharing of responsibilities for the compilation exercise as for the TNC was maintained. Mapping of national institutions and organizations continued to identify additional stakeholders that would contribute in one way or the other for the inventory compilation. An international consultant was appointed to further capacity building, follow and guide the team until the production of the final output, which is the NIR2. Capacity building of all inventory team members continued on the different steps of the inventory cycle as well as on data management, running the 2006 IPCC software, analysing the outputs and reporting to the Convention.

## Methods

### Guidelines and software

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 computation of emissions. The IPCC 2006 Guidelines 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 ($SO_2$).

The Agriculture and Land Use Software of the Colorado State University (CSU) has also been adopted to facilitate derivation of national EFs and stock factors for improving estimates to be made at the Tier 2 level partially for the Livestock and Land sectors. Thus, the inventory has been compiled using a mix of Tiers 1 and 2. This is good practice and improved the accuracy of the emission estimates and reduced the uncertainty level accordingly.

### Gases

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 ($SO_2$). AD and important information required to allow on the choice of the EFs on the carbon fluorocarbons (CFCs), hydro-fluorocarbons (HFCs) and perfluorocarbons (PFCs) were lacking and thus estimates of emissions have not been made for these gases. As well, sulphur hexafluoride (SF6) has not been estimated since AD were not available.

### GWPs

Global Warming Potentials (GWP) as recommended by the IPCC have been used to convert GHGs other than $CO_2$ to the latter equivalent. Based on decision 17/CP.8, the values adopted were from the IPCC Second Assessment Report for the three direct GHGs, namely 1 for $CO_2$, 21 for $CH_4$ and 310 for $N_2O$.

## Activity data

Country-specific AD pertaining to most of the socio-economic sectors collected at national level from numerous public and private sector institutions, organizations and companies, and archived by the NSA, provided the basis and starting point for the compilation of the inventory. Additional and/or missing data, required to meet the level of disaggregation for higher than the Tier 1 level, were sourced from both public and private institutions by the inventory team members and coordinators through direct contacts. 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. For the Land sector, remote sensing technology was used whereby maps were produced from Landsat satellite imagery for 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 and then annualized for yearly values for the period 2000 and 2012.

## Emission factors

Country emission factors were derived for the Tier 2 estimation of GHGs for some animal classes for both enteric fermentation and manure management, and for the Land 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 based on previous inventory results. Additionally, default IPCC EFs for the remaining source categories were screened for their appropriateness before adoption, based on the situations under which they have been developed and the extent to which these were representative of national ones.

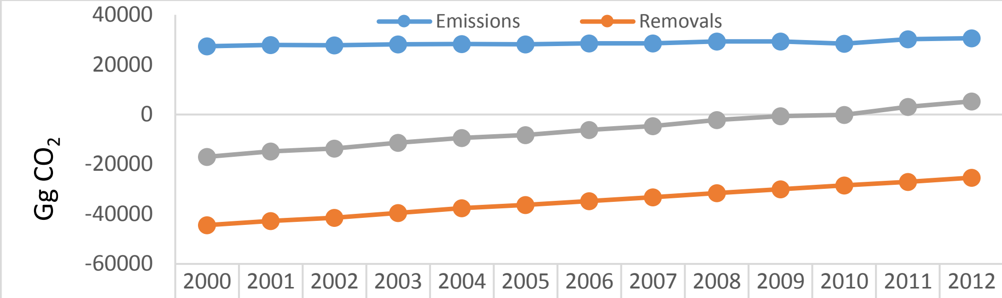
## Recalculations

The inventory for the years covered in the previous time series 2000 to 2010 was recalculated to bring them in line with the years 2011 and 2012 being added and to provide for a consistent series in this inventory report. This is essential as there have been changes in the methodologies with the upgrading of the IPCC software to the latest version 2.17 that was released in 2016 for the Waste sector. Following a new set of more detailed data on fertilizers, the full series have been recalculated. The scope of the inventory has also been widened to include cement production that started in 2011 in the IPPU sector.

## Inventory estimates

### Aggregated emissions

Namibia remained a net GHG sink over the period 2000 to 2010 because of the Land sector removals exceeding emissions. However, following the steady decrease of the removals, this situation changed as from 2011 when national emissions exceeded removals. The net removal of $CO_2$ thus declined from 17 070 Gg to only 121 Gg in 2010. In 2011 and 2012, the country recorded net emissions of 3088 Gg $CO_2$-eq and 5240 Gg $CO_2$-eq respectively. The trend for the period 2000 to 2012 indicates that the national GHG emissions increased from 27 389 Gg $CO_2$-eq in 2000 to 30 692 Gg $CO_2$-eq in 2012 while national removals decreased from 44 459 Gg $CO_2$-eq to 25 452 Gg $CO_2$-eq during this same period (Figure 1.1).




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | 27389 | 27929 | 27772 | 28181 | 28336 | 28143 | 28532 | 28585 | 29394 | 29368 | 28414 | 30206 | 30692 |
| Removals | -4445 | -4273 | -4150 | -3953 | -3770 | -3640 | -3478 | -3326 | -3164 | -3007 | -2853 | -2711 | -2545 |
| Net removals | -1707 | -1481 | -1372 | -1135 | -9371 | -8258 | -6249 | -4679 | -2246 | -706 | -121 | 3088 | 5240 |

**Figure 1.1 - National emissions, removals and net removals (Gg $CO_2$-eq) (2000 – 2012)**

National and sectoral emissions are presented in Table 1.1 and Figure 1.2. Total national emissions increased by 12.1 % over these 13 years. The AFOLU sector remained the leading emitter throughout this period followed by Energy, Waste and IPPU for most of the years under review. Emissions from the AFOLU sector increased slightly from 25 274 Gg $CO_2$-eq in 2000 to 27 028 Gg $CO_2$-eq in 2012, representing a progression of 6.9 % from the 2000 level. In 2012, the share of GHG emissions from AFOLU amounted to 88.1 % of total national emissions.

Energy emissions increased from 1995 Gg $CO_2$-eq (7.3 %) of national emissions in 2000 to 2979 Gg $CO_2$-eq (9.7 %) in 2012. During the period 2000 to 2012, the average annual increase of GHG emissions in this sector was 4.1 %.

The contribution of the IPPU sector in total national emissions increased from 25 Gg $CO_2$-eq in 2000 to 523 Gg $CO_2$-eq in 2012. On average, the GHG emissions from the industrial processes sector increased by 166 % annually following the industrialization of the country.

Waste emissions on the other hand varied slightly over this period with the tendency being for a slight increase over time. Emissions from the Waste sector increased from the 2000 level of 96 Gg $CO_2$-eq to 162 Gg $CO_2$-eq in 2012, representing a 68.8 % increase.

**Table 1.1 - National GHG emissions (Gg, $CO_2$-eq) by sector (2000 – 2012)**

| Source Categories | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total emissions** | **27389** | **27772** | **28336** | **28532** | **29394** | **28414** | **30206** | **30692** |
| Energy | 1995 | 2269 | 2562 | 2795 | 2981 | 2904 | 2851 | 2979 |
| Industrial Processes | 25 | 26 | 235 | 255 | 291 | 302 | 421 | 523 |
| AFOLU | 25274 | 25378 | 25427 | 25359 | 25992 | 25062 | 26779 | 27028 |
| Waste | 96 | 99 | 113 | 123 | 130 | 145 | 155 | 162 |

**Emissions by gas**

The major gas emitted for all years remained $CO_2$ followed by $CH_4$ and $N_2O$ (Table 1.2). The amount of $CO_2$ increased slightly from 20 197 to 21 385 Gg. $CH_4$ and $N_2O$ increased from 4651 Gg $CO_2$-eq to 5756 Gg $CO_2$-eq and from 2541 Gg $CO_2$-eq to 3551 Gg $CO_2$-eq respectively for the period 2000 to 2012. $CO_2$ decreased from 74 % of total aggregated national emissions in the year 2000 to 70 % in 2012. The other two gases, $CH_4$ and $N_2O$, varied at around 17 % and 10 % respectively over this period of 13 year

**Table 1.2 - National GHG emissions and removals (Gg $CO_2$-eq) by gas (2000 – 2012)**

| GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total GHG emissions ($CO_2$-eq)** | **27389** | **27772** | **28336** | **28532** | **29394** | **28414** | **30206** | **30692** |
| **Removals ($CO_2$) ($CO_2$-eq)** | **-44459** | **-41501** | **-37707** | **-34781** | **-31641** | **-28534** | **27118** | **25452** |
| **Net removals ($CO_2$-eq)** | **-17070** | **-13729** | **-9371** | **-6249** | **-2246** | **-121** | **3088** | **5240** |
| $CO_2$ | 20197 | 20470 | 20965 | 21214 | 21432.0 | 21366 | 21435 | 21385 |
| $CH_4$ ($CO_2$-eq) | 4651 | 4505 | 4545 | 4504 | 4928 | 4336 | 5427 | 5756 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $N_2O$ ($CO_2$-eq) | 2541 | 2796 | 2827 | 2814 | 3034 | 2712 | 3345 | 3551 |

Among the GHG precursors (Table 1.3), CO largely exceeded the others in emissions with an increase of 10 Gg from 365 to 369 Gg from 2000 to 2012 after peaking at 376 Gg in 2008. NMVOCs varied between 19.5 and 21.6 Gg while $SO_2$ dwindled between 2.2 and 4.2 Gg and $NO_X$ increased from 31.5 Gg to 36.3 Gg over this same period.

**Table 1.3 - Emissions (Gg) of GHG precursors and $SO_2$ (2000 – 2012)**

| Gases | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| $NO_X$ | 31.5 | 34.7 | 36.0 | 35.2 | 34.6 | 35.2 | 36.0 | 36.3 |
| CO | 364.9 | 366.9 | 371.6 | 373.8 | 375.6 | 375.3 | 367.5 | 369.2 |
| NMVOC | 19.5 | 20.5 | 21.2 | 21.8 | 22.9 | 22.0 | 21.5 | 21.6 |
| $SO_2$ | 2.2 | 2.8 | 3.6 | 4.2 | 4.2 | 2.8 | 3.3 | 2.9 |

**Findings for the year 2012**

The following findings are based on the 2012 compilations:

(i) Most $CO_2$ were emitted in the AFOLU sector with some 18 000 Gg. Concurrently, this sector acted as a sink of about 25 500 Gg, to be a net sink of about 7500 Gg for the year 2012. The Energy sector came next with 2869 Gg.

(ii) $CH_4$ emanated mainly from the AFOLU sector followed by the Waste sector. Emissions were 265 Gg and 6 Gg for the year 2012 for these two sectors respectively. The Energy sector was responsible for 3 Gg of $CH_4$ emissions in 2012.

(iii) $N_2O$ emissions, 11.2 Gg, were associated with the AFOLU sector primarily which contributed more than 98 % of national emissions of this gas.

(iv) Among the indirect GHGs, the AFOLU sector was the highest emitter of CO at 76 % of national emissions with 282 Gg, followed by Energy with 79 Gg and Waste with 8 Gg. Energy emitted 61 % of national $NO_X$ emissions with 22 Gg and AFOLU was responsible for 14 Gg. The Energy and AFOLU sectors contributed 49 % and 46 % of national emissions of NMVOCs which stood at around 22 Gg.

(v) $SO_2$ emissions of 2.9 Gg emanated from the Energy sector and represented more than 99 % of national emissions.

## QA/QC

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 and 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 main objectives being to:

- Confirm data quality and reliability from different sources wherever possible;
- Compare AD with those available on international websites such as FAO and IEA;
- Review the AD and EFs adopted within each source category as a first step; and

- Review and check the calculation steps in the software to ensure accuracy.

## Completeness

A source-by-source category analysis was conducted before the preparation of this inventory and it was updated by adding the latest activity category, namely cement production. A few categories of the IPPU sector on the HFCs and PFCs have not been included due to lack of disaggregated data, the information on them being as blends without the content of the different components.

## Uncertainty Analysis

For this Inventory, a Tier 1 uncertainty analysis of the aggregated figures as required by the IPCC 2006 Guidelines, Vol. 1 (IPCC, 2007) was performed. Based on the quality of the data and whether the EFs used were defaults or nationally derived, uncertainty levels were assigned for the two parameters and the combined uncertainty calculated. The uncertainty analysis has been performed using the tool available within the IPCC 2006 Software and an Excel worksheet based on the equations from the IPCC 2006 GL because of serious overestimation which occurred when the Land sector was included in the software. The uncertainty in total emissions obtained using the IPCC tool (excluding emissions and removals from the Land sector) is in the range 5.6 to 6.4 %. When emissions and removals from the Land sector are included, the uncertainty levels shoot up to give results considered unrealistic. This situation is being further investigated.

## Key category analysis

The Key Category Analysis also was performed using the tool available within the IPCC 2006 Software for both level and trend assessment. There are eight key categories in the level assessment, six of these from the AFOLU sector, of which enteric fermentation from Agriculture, Forest Land remaining Forest Land, Land converted to Grassland, Land converted to Forestland, Direct and Indirect $N_2O$ emissions from FOLU and the remaining two are Road Transportation and Other Sectors-Liquid fuels from the Energy sector. The results change slightly when considering the trend assessment. There are only six key categories that are common in the level assessment also.

## Archiving

All raw data, collected for the inventory, have been stored in the IPCC 2006 software database 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 NIR. These versions will be managed in electronic format in at least three copies, two stored at the Ministry of Environment and Tourism and a third copy at the National Statistics Agency.

## Constraints, gaps and needs

Namibia, as a developing country, has its constraints and gaps that need to be addressed to improve the quality of the inventory for reporting to the Convention. Major problems encountered were related to availability of AD, appropriateness of EFs, background information on technologies associated with production and national stock factors for the estimation exercise. Additionally, lack of resources - both technical and financial - coupled to insufficient capacity of national experts to take over the compilation of the full inventory remained a major issue of concern.

## 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 priority improvements have been identified. The main issues are listed below.

- Adequate and proper data capture, QC, validation, storage and retrieval mechanism need to be improved to facilitate the compilation of future inventories;
- Capacity building and strengthening of the existing institutional framework to provide improved coordinated action for reliable data collection and accessibility is a priority undertaking in the future;

- Improve the existing QA/QC system to reduce uncertainty and improve inventory quality;
- Find the necessary resources to establish a GHG inventory unit within DEA to be responsible for inventory compilation and coordination;
- Conduct new forest inventories to supplement available data on the Land sector;
- Produce new maps for 1990 to 2015 to refine land use change data over 5 years periods as opposed to the decadal one available now which is proving inadequate;
- 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.

## Mitigation actions and their effects

### Context

Namibia has made efforts as a signatory Party to implement the Convention according to its capabilities and is geared towards a progressive decoupling of carbon emissions from economic growth to match the low carbon pathway embedded in its policies and strategies. Mitigation measures have been piecemeal due to lack of resources. However, the outcomes of COP21 and Namibia's commitment, have created the impetus for a more structured and focused mitigation effort. The country has committed to reducing its emissions under the UNFCCC. Namibia submitted its Intended Nationally Determined Contribution (INDC) that includes a willingness to contribute to the global effort to mitigate GHG emissions, aiming at a reduction of about 89% of its GHG emissions at the 2030-time horizon compared to the BAU scenario. The projected GHG emissions to be avoided in 2030 is of the order of 20 000 Gg $CO_2$-eq inclusive of sequestration in the AFOLU sector and compared to the BAU scenario (Republic of Namibia 2015b). The contribution will be economy-wide and addresses the Intergovernmental Panel on Climate Change (IPCC) sectors Energy, Industrial Process and Product Use (IPPU), Agriculture Forestry and Land Use (AFOLU) and Waste. The INDC envisaged mitigation in all sectors with the primary reductions anticipated in the AFOLU sector.

Namibia has developed its first Nationally Appropriate Mitigation Action (NAMA) and it has been deposited into the UNFCCC NAMA registry. The NAMA represents an opportunity for sustainable development for Namibia, and at the same time an opportunity for mitigation. The overall target of the NAMA is to support Namibia in achieving the goal defined in the Off-Grid Energisation Master Plan (OGEMP), namely to provide access to appropriate energy technologies to everyone living or working in off-grid areas. More specifically, the NAMA aims at giving access to electricity for regions, households and companies which are currently without access to electricity, as well as improving the share of renewable energies (mainly using solar energy). The NAMA will reduce GHG emissions through the replacement of fossil fuels with renewable energies and will provide the conditions for income generation and new business opportunities.

### Mitigation actions implemented and planned

As noted in Nambia's INDC, reductions of the order of 162 Gg $CO_2$-eq were achieved in 2010 (unconditionally through government funding) and this was estimated to exceed 216 Gg $CO_2$-eq in 2015. Namibia has prioritised mitigation actions based on those activities contributing most to GHG emissions (IPCC key categories) as well as areas such as waste management that has a direct bearing on the quality of the environment and can provide multiple side benefits.

### Key mitigation actions

Namibia's INDC identified key mitigation actions funded by the Namibian government as being the Solar Revolving Fund, the commissioned hydro generation plant of Ruacana and other demand side management (DSM) measures. Few measures in the AFOLU section had been reported on previously. However, the AFOLU sector is a key category and among the highest emitters. Emissions come from the use of fuelwood, production of charcoal and wood removals for construction and other purposes,

especially in the rural areas. Mitigation actions therefore target reductions in these sources. The livestock industry is also a major contributor through mainly enteric fermentation but offers restricted mitigation avenues because the extensive production system.

Actions in the AFOLU are largely planned or in early stages of development. No AFOLU options were reported on in BUR1 and the addition is driven largely by Namibia's INDC. Key actions include:

- Using cattle feedlots to reducing methane emissions while creating; opportunities for local farmers and improving manure management;
- Reducing emissions from soil degradation;
- Afforestation and measures to reduce deforestation; and
- Restoring grassland.

The only information available on GHG reductions is based on potentials included in the INDC. There is no information on the GHG emission reduction achieved to date. The greatest potential for emission reductions is associated with a reduction in deforestation.

Mitigation actions in the energy sector focus on the shift from fossil fuels to renewable energy sources, improved energy efficiency through various DSM measures and reduced fossil fuel consumption through a series of measures in the road transportation sector. Actions in the energy sector include:

- Driving energy efficiency through providing audits (implementation of identified savings has not been measured), distributing free LED lightbulbs, and capacity building;
- Establishing commercial net metering (feeding back into the grid) which has facilitated private investment in rooftop solar PV;
- Establishing National Renewable Energy Policy, a Renewable Energy Feed in Tariff (REFIT) programme and a draft Independent Power Producer Framework to stimulate investments into renewable technologies. Under the REFIT, 14 IPPS, each generating 5 MW are expected to save in the region of 180 000 t $CO_2$-eq per year
- Currently developing a solar thermal technology roadmap and implementing a Concentrated Solar Power (CSP) technology transfer programme with the support of the GEF through UNDP;
- NamPower has conducted a feasibility to consider CSP implementation options (through or central receiver with storage) of between 50 and 200 MW;
- Part of the Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) and supported various Solar Water Heater demonstration projects (included in the SOLTRAIN initiative);
- Exploring projects to generate electricity from invader bush (biomass-to-electricity power station);
- Supporting the use of solar technologies in the residential sector;
- Developing a sustainable urban transport master plan for Windhoek including the mass transport, cars and freight pooling
- Considering options related to gas and hydro power to generate electricity (including the 332 MW Ruacana hydro project, the proposed 880 MW Kudu power plant and the proposed 300 MW Baines hydropower plant both of which are still under consideration)
- Submission of a NAMA to the UNFCCC NAMA Registry to support A) Minigrids and B) Energy Zones (intended to contribute toward achieving the goal defined in the Off-Grid Energisation Master Plan); and
- Using biomass (from de-bushing) to generate electricity

Namibia is not a highly industrialized country and thus mitigation potential from the IPPU sector is limited. However, there exists a cement production unit with clinker production integrated. Namibia is

focusing on opportunities related to clinker replacement with both extenders and substitute materials with hydraulic properties.

Namibia's has a small population (2.113 million in 2011) and therefore has limited potential to reduce GHG emissions from the waste sector. Actions targeted in this sector include waste to energy projects with multiple benefits. There are relatively fewer interventions to prevent GHG emissions associated with the transport, handling, management and decomposition of waste streams. Namibia has developed emissions reduction projects in the waste sector under the Clean Development Mechanism (CDM). These relate to capturing landfill gas and biogas from waste water treatment works. Additionally, the large municipalities are exploring opportunities to generate electricity from Municipal Solid Waste (MSW).

## Barriers to mitigation and lessons learned

Namibia faces several challenges in planning and implementing mitigation actions: lack of financial support and capacity being the most significant of these. In addition, each IPCC sector faces different barriers and opportunities to mitigate GHG emissions.

### AFOLU

- Implementing mitigation actions in the AFOLU sector is challenging given a lack of data and complexities associated with multiple stakeholders at multiple scales.

### Energy

- Namibia has significant renewable energy potential and has taken steps to direct investment and creating an enabling environment for private sector investment in renewables.
- Namibia's transport is dominated by the road component for both passengers and goods. Taking into consideration the extended geographic nature of the country with low population densities outside its urban areas, there is little prospect for the transport landscape to change in the short or medium term. There is no other means of transport which can replace the existing modes in the present context of the country's development and bring a significant change in its total energy demand profile and reduce its heavy reliance on imported fuel. In view of its rather small fleet of vehicles and therefore small volume of consumption of petroleum products, there is no economic incentive for these fuels to be replaced by alternative energy sources (TNC).

### IPPU

- Use of extenders and other materials to replace GHG-intensive clinker is a way of reducing the GHG intensity of cementitious products. The challenge is that the long-term properties of these products is not known. This makes it difficult to find an appropriate "properties" metric to use as the denominator.
- There is a risk that a metric based only on clinker content could incentivise extending at the expense of quality. This could, in the longer term, require more cement which would have GHG emission implications. Alternatively cement companies could shift the non-hydraulic extender blending process from the downstream value chain to within its direct operational boundary. This would change the emissions profile of the country but would not impact emissions of the final products used (there is an argument that emissions could increase as centralised blending may not be optimal relative to decentralised needs).

### Waste

- Limited waste is generated in Namibia (due to a small population). There are long distances between the municipalities making it expensive to transport waste. And there is a Lack of waste characterization.

- Waste industries are not incentivised to reduce or prevent waste. Disposals costs (the gate fees) are not high enough to incentivise alternatives such as waste use in energy generation. Viable waste to energy projects require access to reliable and suitable feedstock which, given the current system, presents a potential barrier.
- Finally, administrative and technical capacity requirements tend to be quite high

## Information on domestic Measurement Reporting and Verification

Prior to the publication of BUR1 Namibia did not have a system to track mitigation benefits in terms of emission reductions or sink enhancements as well as indirect returns within the wider context of sustainable development. However, efforts have been made to develop systems and build capacity domestically to sustainably assess and report mitigation actions within the framework of the UNFCCC. Progress has been made but there remain challenges relating to:

- Availability of data and resources required to gather and manage relevant data
- Capacity to undertake mitigation assessments; and
- Formalised roles and responsibilities to which institutions and individuals are held accountable

Given the outcomes of COP21, a sustainable, capacitated system is required to meet the ongoing reporting requirements. Additionally, Namibia needs to generate evidence to inform domestic investment in mitigation, motivate for access to climate finance and other support and equip the country to engage more effectively around what represents a fair contribution to the global climate change mitigation effort.

### Overall coordination of MRV

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 (Republic of Namibia 2014).

Namibia is experiencing challenges integrating climate change MRV into the NPC's M&E system. The NPC is responsible for M&E of National Development and serves on the NCCC but systems for integrating climate change MRV elements within the national M&E process still need to be formalised.

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.

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 analysed 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.

The CCU is considering establishing a Memorandum of Understanding (MOU) with the NSA. This would facilitate better data collection from the Ministries as the NSA has a legal framework to require data. A challenge is that the NSA has capacity and staff turnover challenges which would need to be overcome if such a system were to be established.

The establishment of the QA/QC system remain in progress. 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.

### Building a sustainable domestic MRV system

The BUR1 noted that Namibia has decided to produce UNFCCC 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 terms of reference for the consultancies explicitly included the need for local capacity building to enable the transition to a sustainable system managed and delivered by Namibian public and private sector institutions.

### GHG Inventory System

The GHG Inventory System is described in the Inventory chapter of this report.

### Mitigation Actions (including NAMAs)

Namibia continues to build and improve its system for measuring, reporting and verifying mitigation actions and their effects. The institutional arrangements follow closely those described above for the GHG inventory, involving the same institutions but with somewhat different responsibilities within the system. A Mitigation Working Group (MWG) has been established with representatives responsible for collecting and reporting data related to mitigation actions according to the IPCC sectors of AFOLU, Energy, IPPU and Waste.

Although established, formalising the reporting of relevant data by the members of the group remains a challenge. If no progress is made in establishing an MOU with the NSA then the CCU may need to consider MOUs with each Ministry to ensure that climate change MRV receives adequate priority.

Responsibility for MRV of individual mitigation policies, programmes and projects rests with the relevant MWG member depending on the relevant IPCC sector. MWG members can delegate data collection and reporting responsibilities to the managing institutions. For example, project implementers could be required to report according to an M&E plan established at the beginning of project implementation.

Data reporting templates have been created. The following information on mitigation actions is gathered, to the extent possible:

- Mitigation action description: name, main objective, description, coverage (sector and gases) and type (policy, programme or project);

- Implementation information: status (planned, ongoing, implemented), implementing agency and progress indicators;
- Methodology (including assumptions)
- Effects: outcomes achieved, co-benefits (non-GHG impacts) and estimated GHG emission reductions
- Costs and support
- Other: barriers and opportunities for mitigation.

### Improving the capacity of the Mitigation Working Group

The mitigation and MRV workshop served to build the capacity of the MWG to measure and report on mitigation actions. A Namibian consultancy with support from an international climate change mitigation and MRV expert facilitated the workshop to develop an understanding within the MWG of why and what Namibia is required to implement and report on; to improve the capacity of the MWG to assess mitigation and report on MRV requirements; and to collectively determine key interventions for improving the MRV system. The workshop focused on different types of mitigation actions and key methodologies for measuring GHG emissions and non-GHG impacts of mitigation actions. Following the workshop, recommendations were made and will inform the process of improving the MRV system going forward.

### Measurement and Monitoring of Sustainable Development Benefits

In addition to GHG emissions, the MRV system will monitor the impact of the key mitigation actions on selected Sustainable Development (SD) indicators or mitigation co-benefits. The selection of the SD indicators will be done on a project by project basis and will align with priority indicators relevant to the achievement of Vision 2030. Initially the intention is to focus on a small number of projects to test potential methods understand the potential value associated with measuring and reporting of SD co-benefits. This acknowledges the challenges in reporting on SD co-benefits and Namibia's limited capacity in this regard. Efforts will be made to improve the reporting of SD co-benefits over time. As an example, the capacity building workshop undertaken as part of reporting on mitigation actions in the BUR2 included a focus on SD co-benefits.

### NAMAs

Namibia has submitted its first NAMA to the UNFCCCC NAMA registry to seek financial, capacity-building and technology support. The NAMA includes the following proposed MRV system (UNDP 2015). Implementation of the NAMA will be led by the Ministry of Environment as the NAMA Coordinating Authority (NCA). The Ministry of Environment has already been appointed as NAMA Approver/Focal Point to the UNFCCC and as the National Designated Authority (NDA) to the Green Climate Fund (GCF). The Environmental Investment Fund (EIF) will take on the role of NAMA Implementing Entity (NIE) and will be supported in technical issues by the Namibia Energy Institute (NEI). The Namibia Climate Change Committee (NCCC) will act as the supervisory board for the NAMA.

The main responsibility for the MRV system lies with the managing institution, which may delegate some of the tasks to the project implementers (PPPs, grid operators, equipment suppliers). The process should unfold in the following sequence.

- The Executing Entities collect data according to the monitoring plan (as part of their approved application) and ensure they fulfil all related requirements such as record keeping and quality control.
- The Executing Entities report the monitoring results to the NIE in an annual report.
- The NIE collects all monitoring reports, combines them in a central monitoring database and summarizes the results in a NAMA monitoring report.

- This report contains information on GHG emission reductions, progress in the sustainable development (SD) indicators, and the financial performance of the NAMA activities.
- The NCA checks and approves the annual monitoring report.
- The NIE arranges for an external verification entity to verify the annual monitoring report.
- The final monitoring report together with the verification report of the external verifier is submitted to the NAMA donor(s).

The NCA is charged with creating reporting form templates. These forms will include at a minimum the information on Details about the venture; ESP contact details; Description of the measuring system; Data parameters measured; Default values applied; Sampling plan details; and Calculations of emission reductions. The reporting form template will be provided by the NAMA Coordinating Authority to the NEEs. The completed forms will be submitted annually to the NCA by the NEEs.

The goal of verification is to have an independent third party auditor ensure that the NAMA is operating as planned and that the measuring and reporting system is being implemented as planned. The verification also ensures that emissions reductions and SD benefits are real and measurable. Auditors should be accredited entities. They can be entities accredited under the CDM or under another accreditation system acceptable to the Government of Namibia and the NAMA donor(s).

Verification should occur every one or two years. The verification will consist of desk review of documents; site visits/interviews of key stakeholders; drafting of the verification report; provision of feedback on the report by the NAMA Coordinating Authority; and finalization of verification report.

### Support

Responsibility for support required lies with the members of the MWG responsible for implementing planned mitigation actions and is overseen by the CCU of the MET. This data is gathered via the data collection template described above as well as through ad hoc, bilateral engagements between the CCU and the various members of the MWG. Information on support received is provided by the NPC and the Ministry of Finance.

### Major data / information gaps

A lack of data on the GHG emission reductions and the SD benefits of mitigation actions represents a general challenge. There is a lack of financial resources to support the comprehensive MRV of mitigation actions required by the UNFCCC. Additionally, there is a lack of capacity to conduct assessments. The process of reporting on mitigation actions and their effects in the BUR2 also included an emphasis on capacity building. This was principally achieved through workshops and further capacity building is needed to ensure a sustainable domestic MRV system that meets the ongoing UNFCCCC reporting requirements. Institutional arrangements also need to be formalised to ensure ongoing and sustainable domestic MRV

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

### Reporting

Namibia is still facing serious challenges and encountering constraints and gaps to report to the required standards and frequency to the UNFCCC. Despite notable progress on the shift from outsourcing to in-house reporting, the country is not ready to complete this exercise on a stand-alone basis. Thus, further strengthening of the capacity of national experts was undertaken during the preparation of the BUR2 report to enable them overcome the constraints and gaps. This process will continue with the preparation of future reports, namely the NC4 and it is expected that constraint removal and filling of gaps will progress more rapidly in the medium and longer terms. To achieve this, national investments will continue, the institutional arrangements will be further enhanced but sustained support will be needed from the bilateral and multilateral partners, and donor institutions to hasten the process.

## Implementation

Implementation of mitigation actions remains a major challenge for the country when taking stock of the multiple barriers and difficulties being confronted to in various areas. Weaknesses exist at the institutional, organizational and individual levels over and above financial and technology transfers needs, especially at a time when the country is being seriously affected by a drought running into its fourth consecutive year. There is a need to create the enabling environment in the country. Barriers must be removed to speed up the process of implementation of mitigation projects while enhancing further work on new mitigation measures and preparation of project proposals thereon for funding. Namibia has high expectations on the ratification of the Paris Agreement and sincerely hopes that the pledges will become reality soon and needs will be fulfilled by the Annex I Parties for it to start implementing the identified mitigation and adaptation projects.

## Technical and capacity building needs

In the absence of tangible support as requested in the BUR1, Namibia is at a standstill and has not progressed significantly on furthering technical and capacity building. Conscious of this situation, the country invested in capacity building of national experts for reporting to the Convention within the grant availed by the GEF. However, this is only marginal and for reporting only while enhancing of technical and capacity building for implementation of mitigation projects remain a void that should be filled urgently. An updated list of the technical and capacity building needs is provided in Table 5.1.

## Financial Needs

Substantial funding is required to enable Namibia meet its reporting obligations and implement the Convention. 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, faces serious difficult challenges to feed its population and provide it with the minimum requirements for a decent livelihood. As such, the country will not be able to allocate adequate funding to meet the climate change agenda, even if this is of prime importance to it.

Reporting has become more stringent and regular timewise. It has to be supported by a full array of 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 some support through the implementing agencies of the GEF, these amounts are insufficient and there are often problems in the timing for the release of the funds that impacts on the quality of the national reports.

Implementation is even a more gigantic task because 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. Pledges by Annex I Parties did not become a reality and Namibia is suffering from the impacts of climate change, experiencing now a drought running in its fourth year.

## 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 for both mitigation and adaptation to climate change. This exercise is being done piecemeal within the national communications framework when identifying potential mitigation and adaptation activities, 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 national adaptation and mitigation strategies to inform the stakeholders and to develop proper implementation plans.

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

### Financial

The Global Environment Facility (GEF), through the UNDP country office, the implementing agency, provided funds to the tune of USD 352 000 to support Namibia prepare its first and second Biennial Update Reports (BUR1 and BUR2) 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 to realize these two projects.

### Technical

Capacity to prepare the BUR is low in most Non-Annex I Parties including Namibia since 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.

### 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 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 time steps, 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 using 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. Several 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.

### Africa workshop on GHG inventory management systems

This workshop was organised by the UNFCCC in collaboration with the IPCC and the GEF implementing agencies UNEP and UNDP and took place from the27 to the 29 October 2016 in Windhoek, Namibia. The workshop covered institutional arrangements based on the US-EPA template workbook on developing a national GHG inventory system, the different steps to compute a comprehensive good quality GHG inventory using the IPCC 2006 Guidelines and the QA/QC process for the AFOLU sector. Hands-on training on the IPCC 2006 software was also provided to participants. The workshop was attended by some national experts along with other experts from the African region to build capacity on these issues towards the production of good quality GHG inventories.

# 1. National Circumstances

## 1.1. Introduction

Namibia's long term development is embedded in its Vision 2030 document which aims at high and sustained economic growth to create employment and move the country towards increased income equality. The current Fourth National Development Plan (NDP4) translates this vision into strategies and plans for implementation.

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

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. The adoption of the Cancun Agreements at the COP 16 in 2011, stipulated that 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 submitted 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 that was adopted for the BUR1 is also used 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 BUR2 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 NC1 and NC2 as preparation 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 and 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 must 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. Additionally, there will be all the tracking work of implementation of the INDC post 2020.

One important decision was to shift from outsourcing the different elements of the Convention reports to having them produced in-house. In addition to the NCCC and the CCU which continued to play the same roles, nominees from wide stakeholder groups from the public and private sectors were then called for a brainstorming session to present them the new requirements for meeting reporting standards and Convention implementation, discuss their implications and agree on their role, contribution and responsibilities.

During the implementation of the new institutional arrangements for the preparation of the BUR1, TNC and BUR2, notable progress has been achieved but insufficient for the national team to fully take over the preparation of the BUR2. Lack of capacity of the coordinating body as well as inadequate institutional and technical skills within the different sectors, maintenance of 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 were recurrent barriers. Thus, the support of an international consultant was resorted to and capacity building continued. It became evident that the development and implementation of robust institutional arrangements will take more time than anticipated before it becomes fully operational and runs smoothly. It is anticipated that this will take another two to three rounds of BURs and NCs.

The latest institutional arrangements for the preparation of national reports to the Convention are presented in Figure 1.1.

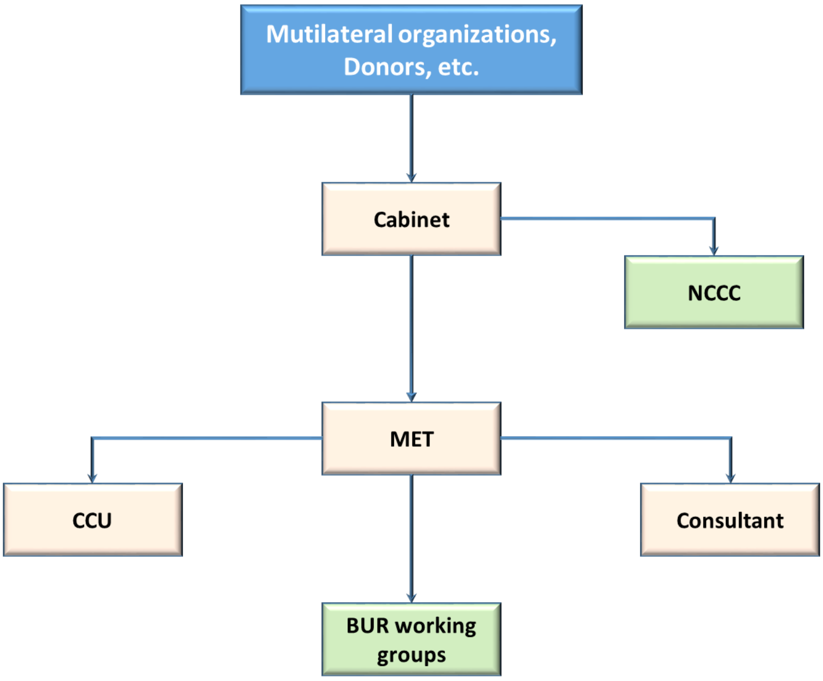
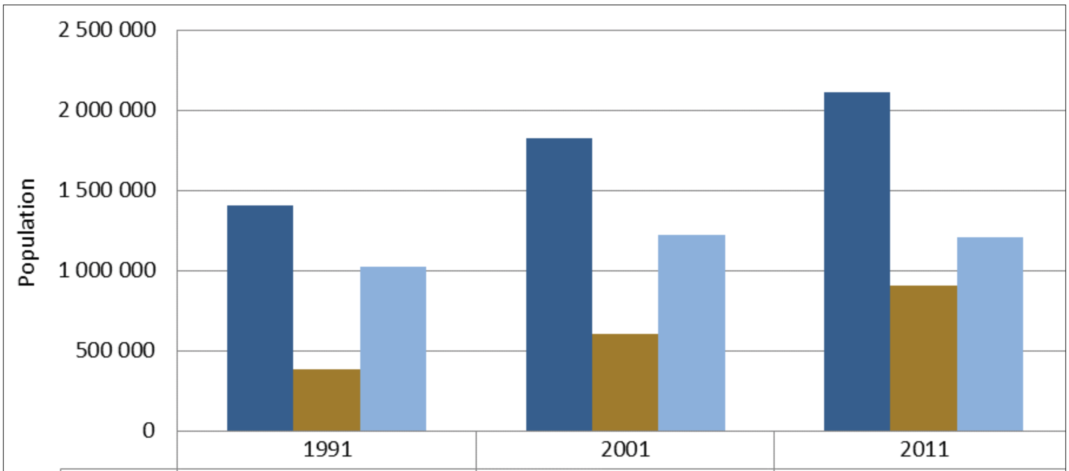



**Figure 1.1. Institutional Arrangements for implementing climate change activities**

## 1.4. Population profile

According to Namibia 2011 Population and Housing Census (Main Report) (NPHC, 2011), 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 was 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. In 2011, a total of 43 % of Namibia's population lived in urban areas, while 57 % of the population lived in rural areas. The intercensal population growth rate between 2001 and 2011 was 1.4 % compared to 2.6 % between 1991 –2001. The annual growth rate for urban areas was 4.0 %, which is much higher than the national rate. There was however, a negative growth rate (- 0.1 %) in rural areas due to high migration to urban areas as depicted in Figure 1.2. (NPHC, 2011).




| | 1991 | 2001 | 2011 |
|---|---|---|---|
| Namibia | 1 409 920 | 1 830 330 | 2 113 077 |
| Urban | 382 680 | 603 612 | 903 434 |
| Rural | 1 027 240 | 1 226 718 | 1 209 643 |

**Figure 1.2. Population growth and distribution as enumerated in 3 censuses**

(Source (NPHC, 2011)

As a result of the growth of the population, the population density of Namibia has increased from 1.7 in 1991 to 2.2 in 2001 and to 2.6 inhabitants per square kilometre in 2011. The most densely populated regions are Ohangwena and Oshana the with 22.9 and 20.4 people per square kilometres, respectively, and, the least densely populated region is Karas with a density of 0.5 people per square kilometre followed by Hardap at 0.7 and both Kunene and Omaheke at 0.8. The population density by region is given in Figure 1.3. (NPHC, 2011).

A general improvement in human development occurred between 1991 and 2011; life expectancy fluctuated but increased, access to knowledge was expanded and income increased overall. In 2011, the national HDI stood at an estimated 0.666, with 0.752 and 0.577 for urban and rural areas respectively. The HDI is highest in Khomas at 0.811 and lowest in Kavango at 0.483 (National Planning Commission, Annual Report 2014/2015).

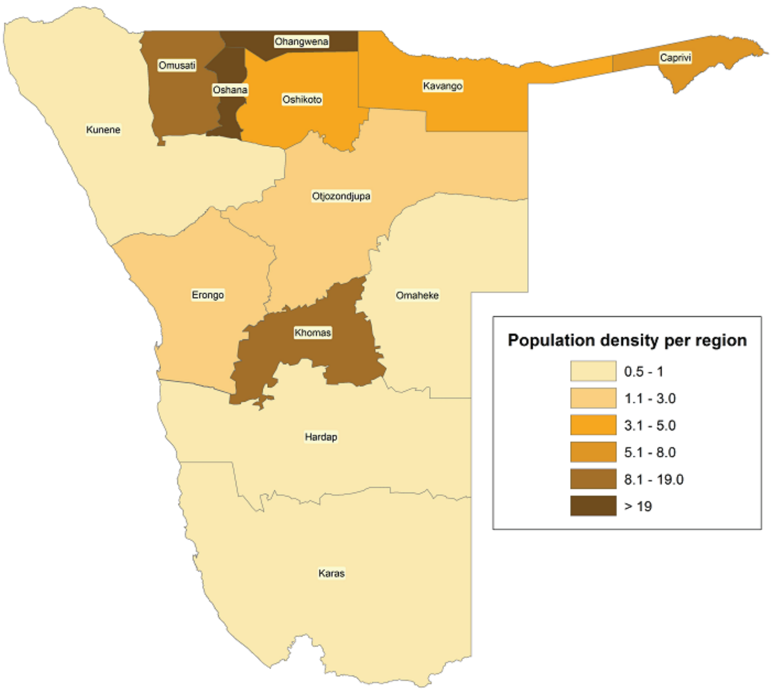



**Figure 1.3. Population density of Namibia by region in 2011**

## 1.5. Geographic profile

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 km$^2$. It has a 1500 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 2606 metres above mean sea level (mamsl) to the east and north the country then descends into the Kalahari Basin with a mean altitude of 1000 mamsl. Nearly half of the country's surface is exposed bedrock, while young surface deposits of the Kalahari and Namib Deserts cover the remainder.

Land cover and use is very diverse in Namibia. Apart from a substantial area being covered by the Namib Desert, there are vast expanses of Grasslands, itself sub-categorized into pure grassland, shrubland and savannahs. There are still forest areas sub-divided into Forestland and Woodland. The remainder of the territory is classified as Cropland, Wetlands and Settlement areas. The distribution and coverage by the different land cover and use as generated from satellite imagery is provided in Table 1.1.

Despite 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).

**Table 1.1. Land use for the years 2000 and 2010 in Namibia**

| Land Type category | Area (ha) | |
|---|---|---|
| | Year 2000 | Year 2011 |
| Forestland | 8 404 206 | 6 629 983 |
| Cropland | 403 178 | 271 882 |
| Grassland | 60 731 438 | 62 636 957 |
| Wetlands | 657 613 | 657 613 |
| Settlements | 31 163 | 31 163 |
| Other land (desert and bedrock) | 11 682 154 | 11 682 154 |

## 1.6. Climate profile

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 Convergence 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 (Figure 1.4). 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.

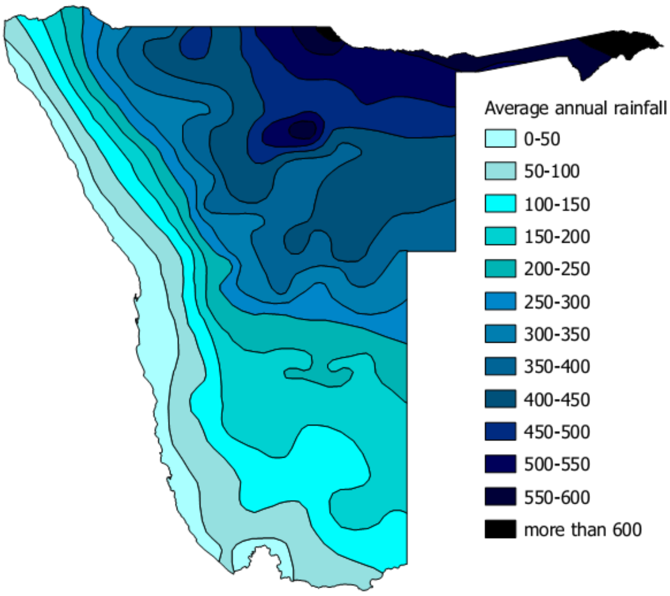



**Figure 1.4. Distribution of average annual total rainfall in Namibia**

(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 (Figure 1.5). 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.

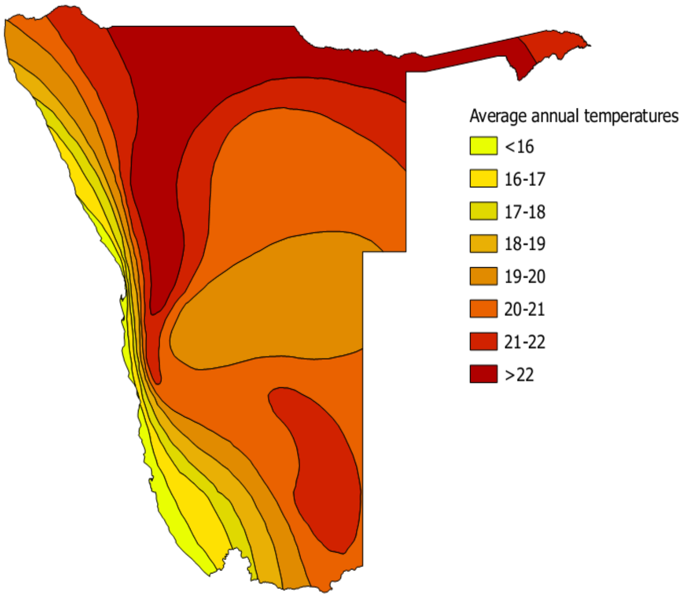



**Figure 1.5. Average annual temperature in Namibia**

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 3800 mm per annum in the south to 2600 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 3 m/s, and it is only at isolated climate stations inland, e.g. Keetmanshoop, where the mean wind speeds exceed 2 m/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.

## 1.7. Economic profile

According to the National Accounts compiled by NSA for 2015, the domestic economy has slowed down in 2015 recording a growth of 5.3 % in real value as compared to 6.5 % in 2014 % %This decline was mainly attributable to the primary industries that recorded a contraction of 3.2 %. Furthermore, the secondary and tertiary industries recorded growth rates of 8.3 % and 5.4 % compared to 9.5 % and 7.7 % in 2014, respectively. The main contributor to national GDP was the tertiary industries (58.3 %) followed by the primary industries with 18.7 % and the secondary industries with 15.8 % (NSA, Annual National Accounts-2015).

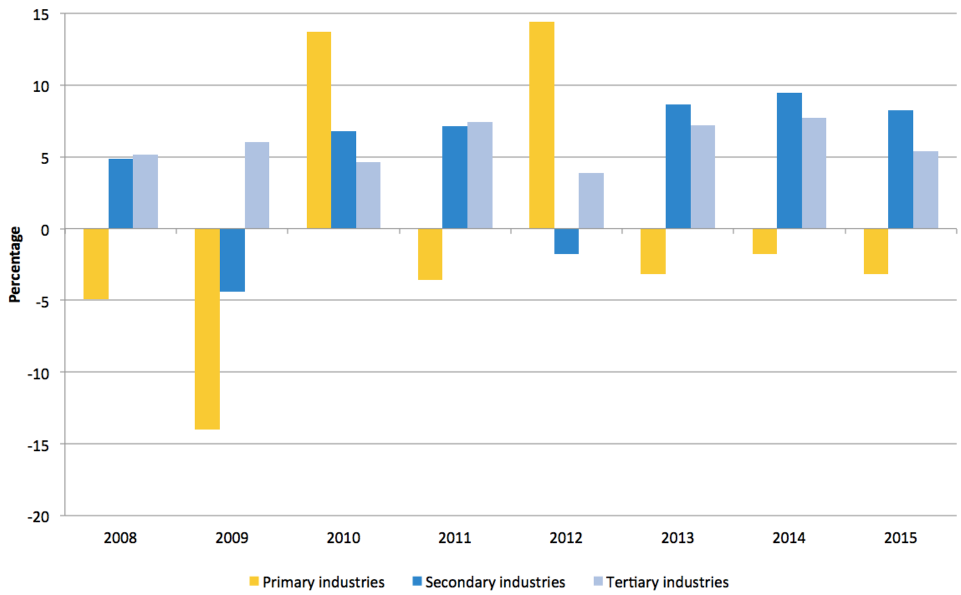



**Figure 1.6. Growth rates of Primary, Secondary and Tertiary industries (%)**

Source: NSA , Annual National Accounts 2015

GDP at current prices amounted to N$ 146 619 million in 2015 compared to N$ 139 500 million in 2014. At constant 2010 prices, the GDP was N$ 108 010million compared to N$ 102 578 million in 2014. The growth rates of GDP at constant 2010 prices is depicted in Figure 1.7 for the period 2008 to 2015 (NSA , Annual National Accounts 2015).

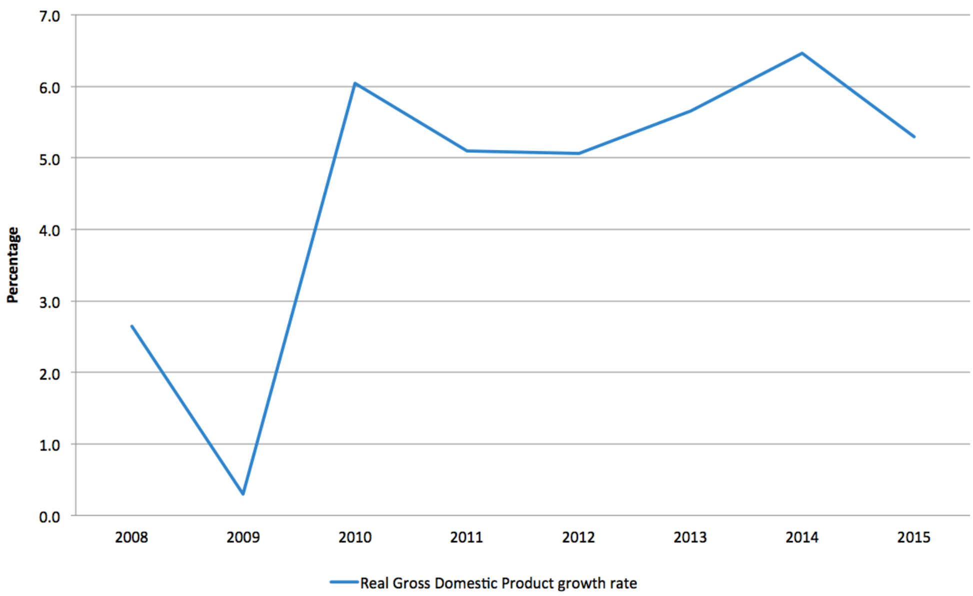



**Figure 1.7. GDP at constant 2010 prices for the period 2008 to 2015.**

Source: NSA , Annual National Accounts – 2015

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 2007 and 2015, 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 Southern African Customs Union (SACU) receipts. GNI stood at N$ 146 857 million in 2015 as opposed to N$ 139 043 million in 2014. GNDI increased from N$ 157 835 million in 2014 to N$ 165 809 million in 2015.

## 1.8. Energy

The most dominant energy source in Namibia is liquid fuel which includes petrol and diesel and accounts for about 63 % of total net energy consumption which is mainly used in the transport sector, followed by electricity with 17 % net consumption, coal with 5 % and the remaining 15 % from other sources of energy such as solar, wood and wind energy among others. Namibia does not produce or export any fossil fuel though it is planned to exploit natural gas from the recently discovered Kudu gas reserve. Most of the fossil fuels imported originates from South Africa.

Currently, Namibia's electricity demand stands at 597 MW, and grows at an annual energy consumption rate of 3 %. On the supply side, Namibia has currently only 3 major power generation stations, with an installed capacity of about 500 MW. The biggest one is the Ruacana Hydro Power station which generates about 332 MW of electricity, Van Eck Coal power station generates about 120 MW and the Paratus and Anixas diesel power stations at the coast with 24 MW and 22.5 MW respectively (Konrad *et al*., 2013). 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).

Studies have shown that energy consumption is related and a driver to economic growth and GDP production. This implies that increasing energy production of the country should be one of the high priority objectives on the economic developmental agenda, so that the economic development plan in place is not slowed by energy shortage. The policy is thus geared towards increasing the amount of energy supply in Namibia through:

- Sustained and improved energy infrastructure;
- Expanded energy research and development;
- Increased energy efficiency awareness; and
- Increased investment in energy sector.

The strategy aims at increasing the exploitation of local energy resources for electricity generation to reduce the country's dependence on foreign sources as well as for other purposes and to increase the share of renewable energy in the future energy mix. Namibia intends to tap solar and wind energy resources in the future while concurrently exploiting efficiently the invasive bush as a biomass energy source since the latter is proving so detrimental to the livestock sector productivity and development.

## 1.9. Transportation

Namibia's road network is regarded as one of the best on the continent with 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 3000 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 as compared with March 2007, when there was a total of 233 640. Out of the total number of vehicles 43.8 % of them are light passenger motor vehicle (less than 12 persons), closely followed by light load vehicle (GVM 3500 kg or less), with 43.5 %.

The railway network comprises 2382 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.

## 1.10. Manufacturing industry

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. It is one of the economic priorities of the Fourth National Development Plan (NDP4) currently running to 2016/17. Manufacturing activities in the country are concentrated in the subsectors of meat processing, fish processing, other food and beverages, and mineral value addition. On average, the manufacturing sector grew by about 5.6 % over the NDP3 period and represented 25 % of total exports in the recent years. However, it is considered that the rate of industrialization has been below expectations due to some of the barriers that have not been removed successfully and despite government incentives. Some of these barriers are a sub-optimal business environment for investors, inadequate quality infrastructure, shortage of specialized skills, lack of a protective framework for local products and, a lack of research and development activities. The Namibian Government has also implemented measures, such as the establishment of the export processing zone (EPZ) regime and the special incentives for manufacturing companies, amongst others. Industrialization remains an essential objective in the context of sustainable wealth and job creation.

Manufacturing is estimated to have recorded a constant growth of 1.2 % and contributed 13.3 % of GDP in 2014 (Ann. Rep. NPC, 2013/2014) . The growth in the sector can mainly be attributed to the sub-sector other food product and beverages. Other manufacturing that recorded a positive growth in output was textiles, plastic products and diamond processing. 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, including quarrying, remained one of the major contributor of Namibia’s national economy with 13 % of the country’s Gross Domestic Product (GDP) in 2014.

## 1.11. 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 in 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 is 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.

The evolution of household solid disposal for the period 2001 to 2010 is given in Figure 1.8. It is clearly seen that domestic solid waste management has improved during this period.

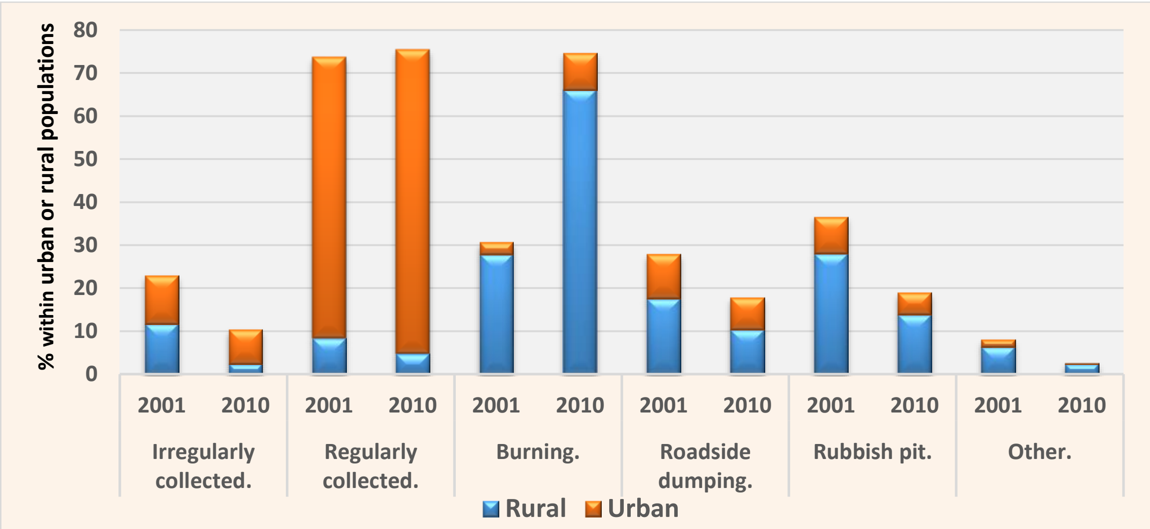



**Figure 1.8. Evolution of household waste disposal for the period 2001 to 2010**

## 1.12. 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, excluding livestock, has seen its share of contribution among the primary industries to GDP gone down to 3.8 % in 2014 from slightly more than 5 % in 2010 and 2011. It still exceeded fishing and fish processing on board (2.8 %), but contributed less to GDP than the mining and quarrying industry (12.8 % in 2014).

Approximately 48 % of Namibia's rural households depend on subsistence agriculture (NDP4). The main crops are maize, wheat, millet and sorghum, cultivated mainly for subsistence purposes under communal and commercial systems. Livestock rearing, a major activity and contributor to GDP comprises cattle as the leading livestock along with sheep and goats. Beef is one of the major agricultural export of Namibia. Poultry is still being developed to enable the country to become self-sufficient.

Forests play an important role in the livelihood of the Namibian. Most 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.

***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. From 1991 until 2012, community conservation 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 6477 jobs and 55 conservancies had a total of 99 enterprises based on natural resources (NACSO, 2012).

***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).

## 1.13. 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 neighbouring riparian states with an obligation for them to be managed and used in terms of the relevant rules of international water law.

It is estimated that only 2 % of the water that falls as rainfall in Namibia 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).

## 1.14. 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 grew 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. However, due to declining stocks and other factors, this importance is declining. The fishery sector contributed only 2.8 % to GDP in 2014 compared to 4.6 % in 2009 and 3.7 % in 2010. The sector is a substantial export earner, with over 85 % of Namibia's fish output destined for international markets.

## 1.15. 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 their combined direct and indirect impacts. In 2014, the tourism sector contributed 1.6 % of GDP. Total tourists arrivals dropped from some 570 000 in 2013 to about 490 000 in 2014 after consistent increases since 2010 as depicted in Figure 1.9.

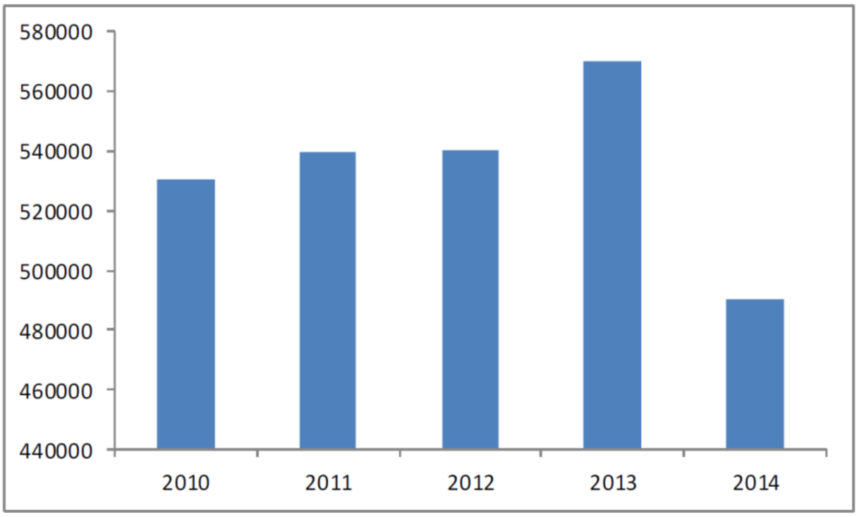



**Figure 1.9. Tourist arrivals during the period 2010 to 2014**

## 1.16. Health

The strategic objectives in the health sector are to reduce mortality and morbidity, reduce the level of malnutrition and ensure staff complement and fleet availability. These objectives are being attained through the programmes on Public Health, Clinical health care services, health system management and planning, disability prevention and rehabilitation and development of social welfare services. 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, even though 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. Malaria incidence in 2010 were recorded as 10.4/1000 while in 2012 it decreased to 1.3/1000. Malaria morbidity and mortality has both declined by above 95 % from the mean baseline of 2002/3 (morbidity = 428 953; mortality = 1062). Figure 1.10 shows the reduction of malaria deaths from 1734 in 2002 to 20 in 2013.

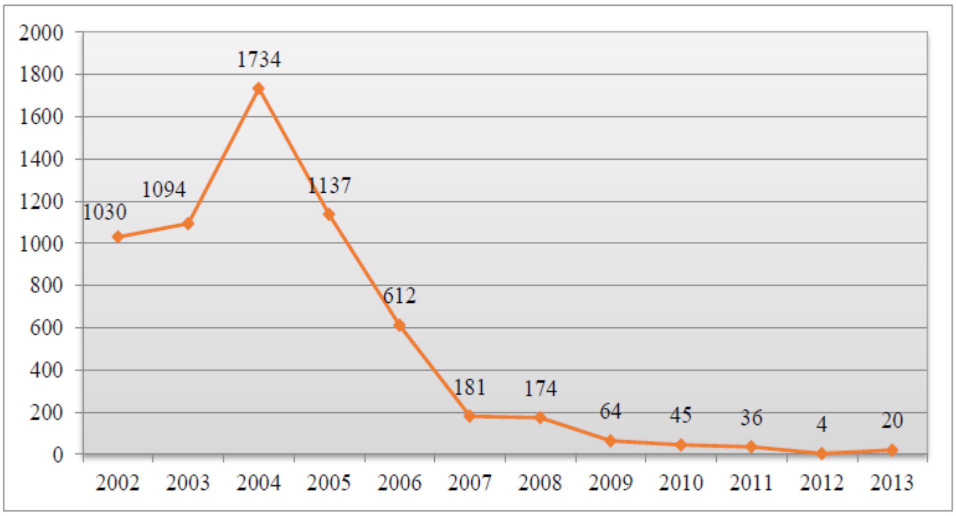



**Figure 1.10. Malaria deaths from 2002 to 2013**

Source: MTEF report 2015-2018

Approximately 15 % of the total Namibian population aged 15-49 is living with HIV/AIDS, but the infection level appears to have stabilized. Seven per cent of all people living with HIV/AIDS are under the age of 15, and 60 % are women. Control of HIV/AIDS through various measures has led to a coverage of 87 % of the infected persons by antiretroviral therapy (ART) in 2014

The very high incidence of tuberculosis in Namibia is fuelled by the HIV/AIDS epidemic, which has reduced life expectancy from 62 years in 1991 to 49 years. This situation has reversed nowadays following implementation of remedial actions by government. Thus, the number of deaths has declined over the years. The treatment success rate has increased consistently since 2002 to attain 85 % in 2012 as depicted in Figure 1.11.

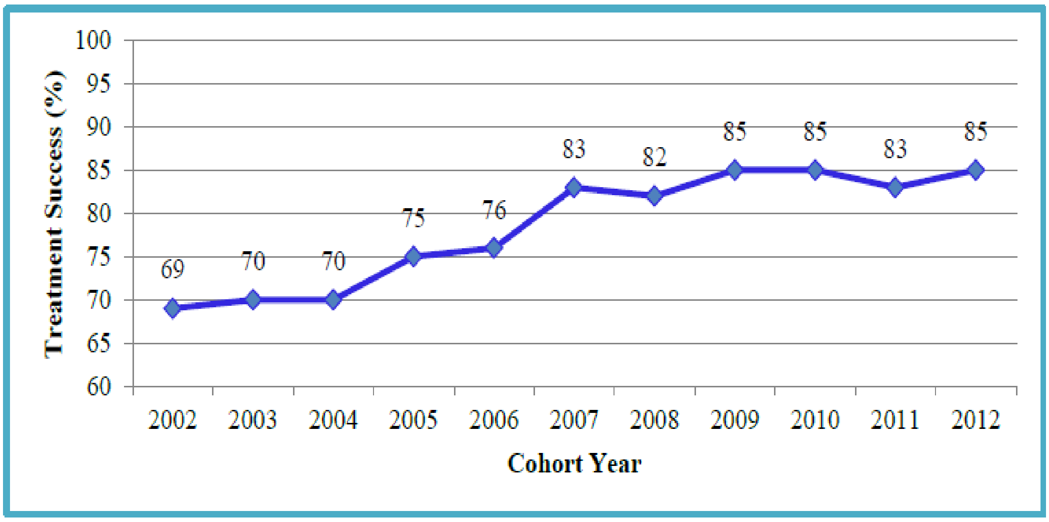



**Figure 1.11. Tuberculosis treatment success rate from 2002 to 2012**

Source: MTEF report 2015-2018

## 1.17. Priorities related to mitigation of climate change

The key sectors and areas identified for mitigation span over all development sectors of the economy and the four IPCC sectors. Emphasis is laid on those sectors and categories responsible for the highest emissions as well as sink potentials as per the key category analysis and development strategies of Namibia. However, other win-win situations such as mitigation in the waste sector which is expected to result in gains in the health of the population has not been neglected despite its low national emissions. Some of the areas earmarked for actions are provided below:

- Increasing the share of renewables in electricity production;
- Increase energy efficiency and other DSM activities;
- Improve passenger and freight transport to reduce fossil fuel use;
- Reduce emissions in industrial processes through the adoption of ESTs and other measures;
- Reduce deforestation rate;
- Reforestation and afforestation;
- Restoration of grasslands;
- Promote alternatives to reduce wood removals from forests and grasslands;
- Promote sylviculture and agro-forestry;
- Improve livestock husbandry practices;
- Enhance soil carbon storage through improved agricultural practices;
- Convert solid waste to energy; and
- Improve solid and liquid waste management.

## 1.18. Adaptation

Namibia is known to be one of the driest countries in sub-Saharan Africa, and is dependent on development sectors highly sensitive to climate. Primary economic sectors which are natural resource based such as agriculture, fisheries and mining account for about one third of the total GDP. More than half of the population depends on subsistence agriculture and in drought years, food shortages are a major problem in rural areas. Namibia is therefore potentially one of the most vulnerable countries to climate change. The predicted temperature rise and evaporation increase as well as higher rainfall variability will exacerbate the existing challenges that Namibia is facing as the driest sub Saharan country. The potential effects of these climatic changes could prove catastrophic to the communities, population and economy at large. Thus, adaptation is of prime importance to the country and is high on government's agenda to guarantee the welfare of the people while reducing risks and building resilience. Adaptation is thus an obligation for the country to fulfil its role within the international context.

Broad avenues for adaptation to climate change in the future consist of:

- Improving technical capacity at the national and sub-national levels to develop a greater understanding of climate change and its impacts;
- Developing and implementing appropriate responses and adaptation strategies to reduce the impacts of floods, low rainfall and high temperatures on people, crops, livestock, ecosystems, infrastructure and services;
- Implementing soil and water conservation policies and practices;
- Improving ecosystem management, protection and conservation; and
- Developing common goals and facilitating better integration of different policies and practices in vulnerable sectors.

# 2. Greenhouse Gas Inventory

## 2.1. The inventory process

### 2.1.1. Overview

GHG inventories are compiled and submitted in line with Article 4.1 (a) of the Convention whereby each signatory 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. This inventory has been prepared to the extent of the country's capabilities and using recommended methodologies of the IPCC which have been agreed upon by the Conference of the Parties. The preparation of the present inventory started toward the end of 2015. One year was allocated to implement and complete the different steps of the inventory cycle as depicted in Figure 2.1.

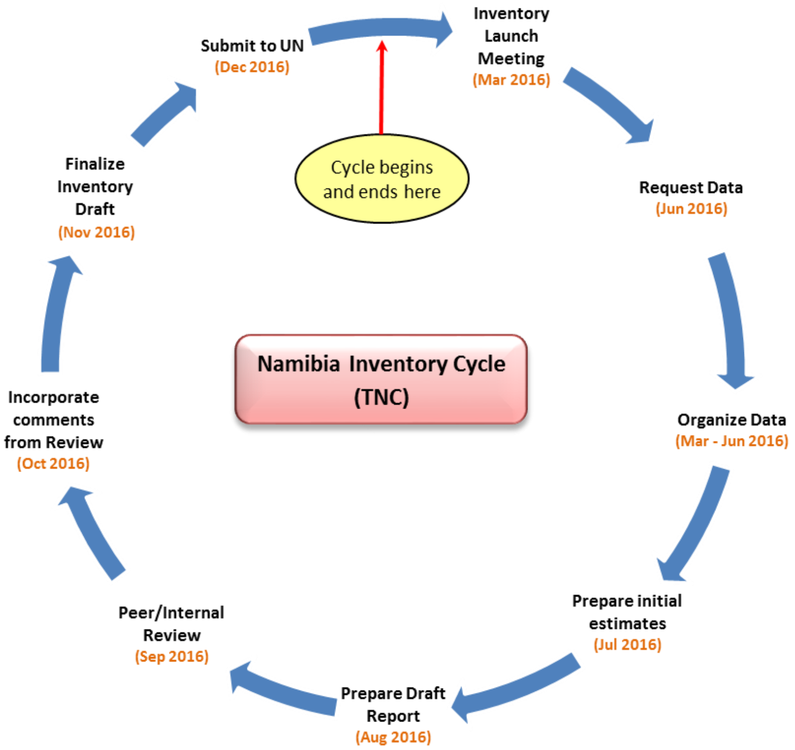



**Figure 2.1. The Inventory cycle of Namibia's BUR2 GHG inventory**

Namibia has so far compiled and submitted 4 GHG inventories. The first and second inventories were compiled using the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC, 1997). These inventories have all been compiled using the sectoral bottom-up approach, Tier level 1, and the GHG Inventory software. The reference approach has also been used for the energy sector, to enable comparison of the two methods. The gases addressed were Carbon Dioxide ($CO_2$), Methane ($CH_4$), Nitrous Oxide ($N_2O$), Oxides of Nitrogen ($NO_x$), Sulphur Dioxide ($SO_2$), Non-Methane Volatile Organic Compounds (NMVOCs) and the precursor Carbon Monoxide (CO). A third Inventory has been compiled using a mix of Tiers 1 and 2 for the First Biennial Report and submitted to the UNFCCC in 2014. The fourth inventory has been submitted as a chapter of the third national communication and as a stand-alone national inventory report. The IPCC 2006 Guidelines and software was used for preparation of the third and fourth inventories.

The present GHG inventory chapter is a summary of the second national inventory report which will be submitted on a stand-alone basis as an accompanying document to the second Biennial Update Report. It provides data on GHG emissions by sources and removals by sinks for a full-time series for the period 2000 to 2012. This inventory is exhaustive, covering all source categories, at a detailed level. Once again, a mix of Tiers 1 and 2 has been adopted.

### 2.1.2. Institutional arrangements and inventory preparation

Namibia continued to invest in producing its inventories in-house after the one published in the BUR1 and the first national inventory report, with the support of an external consultant for capacity building. This exercise for the BUR2 helped to further improve, implement and consolidate the GHG inventory system put in place. The preparation of the GHG inventory is still a very difficult exercise as resources and human capacities continued to be limiting factors. Thus, it is obvious that there still exist shortcomings in this inventory but the country is committed to strive to further raise the quality of future GHG inventories through strengthening of the GHG inventory system and capacity building of the GHG inventory team.

The Climate Change Unit (CCU) of the Ministry of Environment and Tourism spearheaded the process of GHG inventory compilation in its capacity as National Focal Point of the Convention. The same framework adopted for the previous inventory compilation was followed and all stakeholders agreed to pursue with sharing the responsibilities for the compilation exercise between different departments of the key ministries as for the TNC. The exercise of mapping of national institutions and organizations was reviewed to identify additional stakeholders that would contribute in one way or the other for the inventory compilation. Thus data providers and potential institutions and organizations to support derivation of emission factors to suit national circumstances and enable moving to Tier 2 were consolidated. Capacity building of all inventory team members continued on the different steps of the inventory cycle as well as on data management, running the 2006 IPCC software and analysing the outputs.

The roles and responsibilities of the different institutions were:

- The CCU of Ministry of Environment and Tourism for inventory coordination and submission;
- Ministry of Mines and Energy for the Energy sector;
- Ministry of Industrialisation, Trade and SME Development;
- 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 capacity building, inventory compilation and QA; 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 implementation.

The institutional arrangement for the compilation of the inventory and reporting for the different sectors are shown in Figure 2.2.

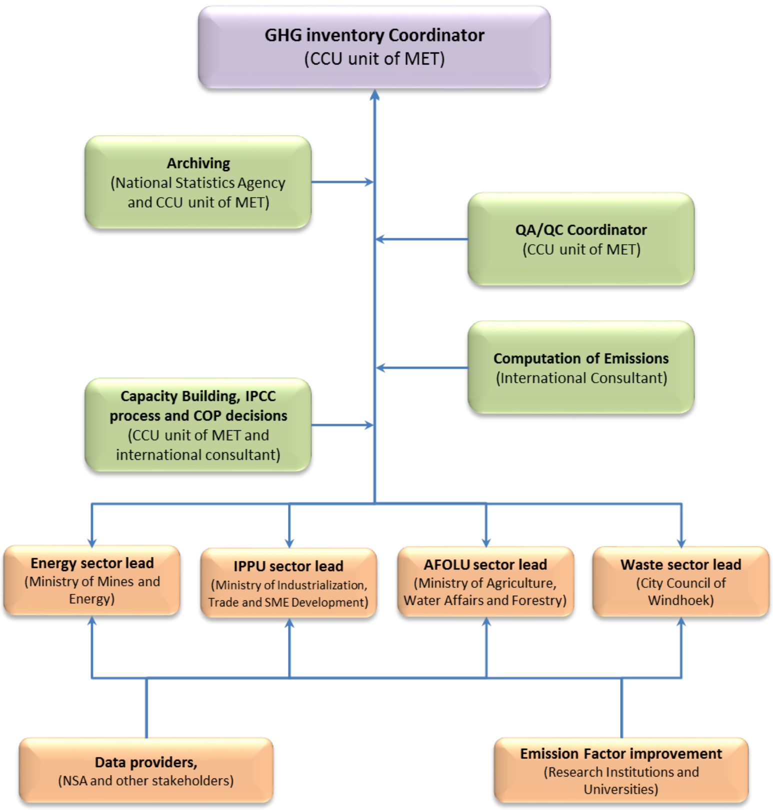



**Figure 2.2. Institutional arrangements for the GHG inventory preparation**

The inventory preparation compilation started in January 2016. A work plan with timeframe and responsibilities was drawn for the preparation of the Inventory using the mix of Tiers 1 and 2. AD were collected for the years 2011 and 2012 to update the existing series. The collected AD were processed and sectoral experts of the inventory team computed emissions and performed recalculations as necessary under the supervision of the external consultant. This exercise took place during a 3-days workshop with the external consultant providing the support for identifying improvement areas relative to data availability and quality, appropriateness of EFs, gaps and constraints. The results were reviewed during another 3-days workshop which was attended by the full GHG inventory team. This exercise was very useful to enhance capacity of the national experts while serving for team building and strengthening collaboration on cross-cutting issues. The different steps adopted for the preparation of the inventory can be summarized as follows:

- Drawing up of work plan with timeline and deliverables;
- Allocation of tasks to sectoral experts;
- Collection, quality control and validation of activity data;
- Selection of Tier level within each category and sub-category;
- Selection of emission factors (EFs) and Derivation of local EFs wherever possible;
- Designing of appropriate MS Excel worksheets for detailed calculations;
- Computation of GHG emissions;
- Uncertainty analysis;
- Implementing QA/QC activities;

- Assessment of completeness;
- Recalculations;
- Trend analysis;
- Gaps, constraints, needs and improvements; and
- Report writing.

### 2.1.3. Key source category analysis

Key Source Category Analysis gives the characteristics of the emission sources and sinks. According to the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (IPCC, 2000), key categories are those which contribute 95 % of the total annual emissions, when ranked from the largest to the smallest emitter. Alternatively, a key source is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct GHGs in terms of the absolute level of emissions, the trend in emissions, or both (IPCC, 2000). Thus, it is a good practice to identify key categories, as it helps prioritize efforts and improve the overall quality of the national inventory.

The Key Category Analysis was performed using the tool available within the IPCC 2006 Software for both level and trend assessment. The results for the level assessment for the year 2012 are presented in Table 2.1 and the trend assessment in Table 2.2. There are eight key categories in the level assessment, six of these from the AFOLU sector, of which enteric fermentation from Agriculture, the other five from FOLU and the remaining two are Road Transportation and Other Sectors-Liquid fuels from the Energy sector.

**Table 2.1. Key Category Analysis for the year 2012 - Approach 1 - Level Assessment**

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| **IPCC Category code** | **IPCC Category** | **GHG** | **"2012 Ex,t (Gg $CO_2$ -eq)"** | **"\|Ex,t\| (Gg $CO_2$ -eq)"** | **Lx,t** | **Cumulative Total of Column F** |
| 3.B.1.a | Forest land Remaining Forest land | $CO_2$ | -24307.6 | 24307.6 | 0.434 | 0.434 |
| 3.B.3.b | Land Converted to Grassland | $CO_2$ | 17721.1 | 17721.1 | 0.316 | 0.750 |
| 3.A.1 | Enteric Fermentation | $CH_4$ | 5169.7 | 5169.7 | 0.092 | 0.842 |
| 1.A.3.b | Road Transportation | $CO_2$ | 2119.5 | 2119.5 | 0.038 | 0.880 |
| 3.C.4 | Direct $N_2O$ Emissions from managed soils | $N_2O$ | 1991.9 | 1991.9 | 0.036 | 0.916 |
| 3.B.1.b | Land Converted to Forest land | $CO_2$ | -1066.0 | 1066.0 | 0.019 | 0.935 |
| 3.C.5 | Indirect $N_2O$ Emissions from managed soils | $N_2O$ | 570.4 | 570.4 | 0.010 | 0.945 |
| 1.A.4 | Other Sectors - Liquid Fuels | $CO_2$ | 348.9 | 348.9 | 0.006 | 0.951 |

The results changes slightly when considering the trend assessment. There are only six key categories that are all common in the level assessment also.

**Table 2.2. Key Category Analysis for the year 2012 - Approach 1 - Trend Assessment**

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| IPCC Category code | IPCC Category | GHG | 2000 Year Estimate Ex0 (Gg $CO_2$ -eq) | 2012 Year Estimate Ext (Gg $CO_2$ -eq) | Trend Assessment (Txt) | % Contribution to Trend | Cumulative Total of Column G |
| 3.B.1.a | Forest land Remaining Forest land | $CO_2$ | -43137.9 | -24307.6 | 0.453 | 0.517 | 0.517 |
| 3.B.3.b | Land Converted to Grassland | $CO_2$ | 17999.1 | 17721.1 | 0.287 | 0.328 | 0.845 |
| 3.A.1 | Enteric Fermentation | $CH_4$ | 4163.7 | 5169.7 | 0.053 | 0.061 | 0.906 |
| 3.B.1.b | Land Converted to Forest land | $CO_2$ | -1066.0 | -1066.0 | 0.017 | 0.019 | 0.925 |
| 3.C.4 | Direct $N_2O$ Emissions from managed soils | $N_2O$ | 1379.2 | 1991.9 | 0.014 | 0.016 | 0.941 |
| 1.A.3.b | Road Transportation | $CO_2$ | 1306.0 | 2119.5 | 0.011 | 0.012 | 0.953 |

## 2.1.4. Methodological issues

This section gives an overview of the methodologies adopted for all sectors and sub-sectors covered in this inventory report. These procedures are more fully described in the respective section covering the individual IPCC Key Source Categories in the full NIR2.

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 for the computation of emissions in an inventory 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 facilitate estimates to be made at the Tier 2 level partially for the livestock and LAND sectors by providing a tool to generate emission or stock factors that were eventually fed in the IPCC 2006 software. Thus the inventory has been compiled using a mix of Tiers 1 and 2. This is good practice and improved the accuracy of the emission estimates and thus reduced the uncertainty level.

Global Warming Potentials (GWP) as recommended by the IPCC have been used to convert GHGs other than $CO_2$ to the latter equivalent. Based on decision 17/CP.8, the values adopted were those from the IPCC Second Assessment Report for the three direct GHGs, namely carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$) (Table 1.3). Additional gases, known as (indirect gases), affect global warming, namely oxides of nitrogen ($NO_x$), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide ($SO_2$), have also been computed and reported in the inventory.

**Table 2.3. Global warming potential**

| Gas | | Global Warming Potential |
|---|---|---|
| Carbon Dioxide | ($CO_2$) | 1 |
| Methane | ($CH_4$) | 21 |
| Nitrous Oxide | ($N_2O$) | 310 |

Default EFs were assessed for their appropriateness prior to being used; namely based on the situations under which they have been developed and the extent to which these were representative of national ones. Country specific EFs have been derived for the livestock sector since the default ones did not reflect the national context and data available allowed for their computation.

Country-specific AD are readily available as a good statistical system exists whereby data pertaining to most of the socio-economic sectors are collected, verified and processed to produce official national statistics reports. Additional and/or missing data, required to meet the level of disaggregation for higher than the Tier 1 level, were sourced directly from both public and private sector operators by the team members and coordinators. Data gaps were filled through personal contacts with the stakeholders by the national experts and/or from results of surveys, scientific studies and by statistical modelling. All the data and information collected during the inventory process have been stored in the software database.

In a few isolated cases, due to the restricted timeframe and lack of a specific National framework for data collection and archiving for preparing GHG inventories, derived data and estimates were used to fill in the gaps. These were considered reliable and sound since they were based on scientific findings and other observations. Estimates used included fuel use for navigation, domestic aviation, food consumption and forest areas by type.

### 2.1.5. Quality assurance and quality control (QA /QC)

Namibia has its own national system for quality control (QC) of data being collected within the different institutions. All data are quality controlled at different stages of the data collection process by the respective institution until the final quality assurance (QA) is made by the National Statistics Agency 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 remained beyond the GHG inventory compiler and the QA/QC process started as from the time the AD are received.

QC and QA procedures, as defined in the *IPCC 2006 Guidelines (IPCC, 2007)* was 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 and 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 main objectives being to:

- Confirm data quality and reliability from different sources wherever possible;
- Compare AD with those available on international websites such as FAO and IEA;
- Review the AD and EFs adopted within each source category as a first step; and
- Review and check the calculation steps in the software to ensure accuracy.

Wherever possible, the data sets used for computing emissions were compared for their soundness with those from international databases such as the UN stats, IEA and FAO for example. Trend analysis of datasets for the full time series also helped to identify outliers and these were corrected.

### 2.1.6. Uncertainty assessment

Uncertainty estimation is an essential element of a complete greenhouse gas emissions and removals Inventory. The purpose of estimating the uncertainty attached to emission estimates is principally to provide information on where inventory resources should be allocated to maximise the future improvements to inventory quality. Inventories prepared in accordance with IPCC guidelines (IPCC, 2006d) will typically contain a wide range of emission estimates, varying from carefully measured and demonstrably complete data on emissions to order-of-magnitude estimates of highly variable emissions such as $N_2O$ fluxes from soils and waterways.

For this Inventory, a Tier 1 uncertainty analysis of the aggregated figures as required by the Climate Change Convention Inventory guidelines (UNFCCC, 2013) and IPCC good practice guidance (IPCC, 2006d) was performed. Data and information used for estimating the emissions were scrutinized for their reliability and accuracy based on their sources and the process for collecting and storing same including the quality control aspect. Consistency where data were available for a time series was also assessed to decide on the uncertainty level. Then the level of uncertainty was assumed to vary from low to high from the range provided for in the IPCC 2006 software based on the final quality of the data. Recorded well quality controlled data were assigned a low uncertainty while the information based on expert knowledge was assigned a high uncertainty. The same approach was adopted for all sectors. The uncertainty analysis has been performed using the tool available within the IPCC 2006 Software and an Excel worksheet to verify the serious overestimations obtained when including the Land sector in the software tool. The results are identical using both methods when excluding the Land sector but not when including it. The problem is still under review and will be reported to the Technical Support Unit of the IPCC for consideration and eventual amendment if necessary. Thus, the uncertainty in total emissions based on the IPCC tool (excluding emissions and removals from the LAND sector) is presented here. Uncertainty levels in the range 5.6 to 6.4 % (Table 2.4).

**Table 2.4. Overall uncertainty (%) excluding the Land category**

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Uncertainty excl. FOLU | 6.5 | 6.4 | 6.4 | 6.2 | 6.1 | 5.9 | 5.8 | 5.6 | 5.7 | 5.8 | 5.7 | 6.0 | 5.9 |

### 2.1.7. Assessment of completeness

An assessment of the completeness of the inventory was made for individual activity areas within each source category and the results are presented within the sections covering the individual sectors. The methodology adopted was according to the *IPCC 2006 Guidelines (IPCC 2007)* with the following notation keys used:

- X Estimated
- NA Not Applicable
- NO Not Occurring
- NE Not Estimated
- EE Estimated Elsewhere

The level of completeness depicting the scope of the inventory is provided in Table 2.5. Rows where activity are not occurring have been deleted for ease of presentation and understanding.

## Table 2.5. Completeness of the 2000 to 2012 inventories

| Activities | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | 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 | NO | NO | NO | NO | NO | NO | NO |
| 1.C - Carbon Dioxide Transport and Storage | NO | NO | NO | NO | NO | NO | NO |
| 2 - Industrial Processes and Product Use | | | | | | | |
| 2.A - Mineral Industry | | | | | | | |
| 2.A.1- Cement Production | X | NA | NA | NA | NA | NA | NA |
| 2.A.2 - Lime production | X | NA | NA | NA | NA | NA | NA |
| 2.B - Chemical Industry | NO | NO | NO | NO | NO | NO | NO |
| 2.C - Metal Industry | | | | | | | |
| 2.C.6 - Zinc Production | X | NA | NA | NA | NA | NA | NA |

## Table 2.5. Completeness of the 2000 to 2012 inventories

| Activities | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|---|---|---|
| 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.E - Electronics Industry | NO | NO | NO | NO | NO | NO | NO |
| 2.F - Product Uses as Substitutes for Ozone Depleting Substances | | | | | | | |
| 2.F.1 - Refrigeration and Air Conditioning | NE | NE | NE | NE | NE | NE | NE |
| 2.F.2 - Foam Blowing Agents | NO | NO | NO | NO | NO | NO | NO |
| 2.F.3 - Fire Protection | NE | NE | NE | NE | NE | NE | NE |
| 2.F.4 - Aerosols | NE | NE | NE | NE | NE | NE | NE |
| 2.F.5 - Solvents | NE | NE | NE | NE | NE | NE | NE |
| 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 | NE | NE | NE | NE | NE | NE | NE |
| 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 | NE | NE | NE | NE | NE | NE | NE |
| 2.G.4 - Other (Please specify) | NO | NO | NO | NO | NO | NO | NO |
| 2.H - Other | | | | | | | |
| 2.H.2 - Food and Beverages Industry | NE | NE | NE | NE | NE | NE | NE |
| 3 - Agriculture, Forestry, and Other Land Use | | | | | | | |
| 3.A - Livestock | | | | | | | |
| 3.A.1 - Enteric Fermentation | NA | X | NA | NA | NA | NA | NA |
| 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 | NE | NE | NE | NE | NE | NE | NE |
| 3.B.5 - Settlements | NE | NE | NE | NE | NE | NE | NE |
| 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.3 - Urea application | NA | X | X | X | NA | NA | NA |
| 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.D - Other | | | | | | | |
| 3.D.1 - Harvested Wood Products | NE | NE | NE | NE | NE | NE | NE |
| 4 - Waste | | | | | | | |
| 4.A - Solid Waste Disposal | NO | X | NA | NA | NA | X | NO |
| 4.C - Incineration and Open Burning of Waste | X | X | X | X | X | X | X |
| 4.D - Wastewater Treatment and Discharge | NO | X | X | NA | NA | NA | NA |
| 5 - Other | | | | | | | |
| 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

### 2.1.8. Recalculations

The initial inventories submitted for the years 2000 and 2010 in the SNC and BUR1 were recalculated to provide for a consistent series in the TNC and NIR1. Some more recalculations have been performed for the past inventories for the years 2000 to 2010 to maintain consistency with the years 2011 and 2012. The recalculations concerned the waste sector as there has been a change in the default EF in the latest version (v 2.17) of the software. So the emissions for the period 2000 to 2010 have been computed anew with the new default EF to ensure a consistent time series. Additionally, new precise AD was available for fertilizers and these have been used to replace the previous set.

### 2.1.9. Time series consistency

This inventory now covers the period 2000 to 2012 and AD within each of the source categories covered were abstracted from the same sources for all years (Table 2.5). The same EFs have been used and the QA/QC procedures were kept constant for the whole inventory period. This enabled a consistent time series to be built with a good level of confidence in the trends of the emissions.

### 2.1.10. Gaps, constraints and needs

Namibia, as a developing country, has its constraints and gaps that need to be addressed to produce better quality reports to the Convention. This is still a big challenge given that now the reporting standards have been raised and there is also a review of the inventory.

For this inventory, one more category, namely cement production has been covered. Some information was also collected on solvents and Ozone Depleting Substances, but unfortunately, they were not detailed enough to enable computation of emissions.

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 yet been endorsed with the responsibility for collection of specific activity data (AD) needed for the estimation of emissions according to UNFCCC;
- Almost all the AD, including those from the NSA, are still not yet in the required format for feeding in the software to make the emission estimates;

- End-use consumption data for some of the sectors and categories are not readily available and had to be generated based on scientific and consumption parameters;
- Reliable biomass data such as timber, fuelwood, wood waste and charcoal consumed or produced were not available and had to be derived using 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 could have 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 only partly available and had to be derived based on production and demographic data amongst others;
- Lack of EFs to better represent national circumstances and provide for more accurate estimates;
- Emissions for a few categories have not been estimated due to lack of AD; and
- National experts are not yet ready to take over the full inventory compilation process and another round of training on running the IPCC 2006 software was conducted.

### 2.1.11. National inventory improvement plan (NIIP)

Based on the constraints, gaps and other challenges encountered during the preparation of the present inventory, a list of the most urgent improvements has been identified. These are listed below and will be addressed during the preparation of the NC4 inventory.

- Data capture, QC, validation, storage and retrieval mechanism need further improvement to facilitate the compilation of future inventories;
- Capacity building and strengthening of the existing institutional framework to provide improved coordinated action for data collection and accessibility is a priority undertaking in the future;
- Emission factors (EFs) more representative of the national context must be developed;
- Improve the existing QA/QC system to reduce uncertainty and improve inventory quality;
- Find the necessary resources to establish a fully-fledged 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;
- Conduct new forest inventories to supplement available data on the LAND sector;
- Produce new maps for 1990 to 2015 to refine land use change data over 5 years periods as opposed to the decadal one available now which is proving inadequate;
- Refine data collection for determining country specific (CS) weights for dairy cows, sheep and goats;
- 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.

## 2.2. Time series of greenhouse gas emissions

### 2.2.1. Overview

The trends of GHG emissions for the Republic of Namibia cover the period 2000 to 2012. Availability of more disaggregated data enabled the adoption of higher Tier methods, namely a combination of Tiers 1 and 2 for compiling this inventory. The period 2000 to 2012 included additional sectors and sub-sectors that were not covered in the inventories presented in the INC, SNC, BUR1 and TNC previously.

### 2.2.2. The period 2000 to 2012

Namibia remained a net GHG sink over the period 2000 to 2010 because of the Land sector removals exceeding emissions. However, following the steady decrease of the removals, this situation changed as from 2011 when national emissions exceeded removals. The net removal of $CO_2$ thus declined from 17 070 Gg to only 121 Gg in 2010. In 2011 and 2012, the country recorded net emissions of 3088 Gg $CO_2$-eq and 5240 Gg $CO_2$-eq respectively. The trend for the period 2000 to 2012 indicates that the national GHG emissions increased from 27 389 Gg $CO_2$-eq in 2000 to 30 692 Gg $CO_2$-eq in 2012 while national removals decreased from 44 459 Gg $CO_2$-eq to 25 452 Gg $CO_2$-eq during this same period (Table 2.6).

**Table 2.6. GHG emissions (Gg $CO_2$-eq) characteristics (2000 to 2012)**

| | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total emissions** | **27389** | **27772** | **28336** | **28532** | **29394** | **28414** | **30206** | **30692** |
| AFOLU - removals | -44459 | -41501 | -37707 | -34781 | -31641 | -28534 | -27118 | -25452 |
| Net removals | -17070 | -13729 | -9371 | -6249 | -2246 | -121 | 3088 | 5240 |
| Per capita emission (t) | -9.5 | -7.4 | -4.9 | -3.2 | -1.1 | -0.1 | 1.5 | 2.4 |
| GDP emissions index (2000=100) | 100.0 | 75.8 | 44.2 | 26.9 | 8.9 | 0.5 | -11.0 | -17.8 |

Per capita emissions of GHG decreased from a removal of 9.5 t $CO_2$-eq in 2000 to an emission of 2.4 t $CO_2$-eq in 2012 (Table 2.6 and Figure 2.3). The GDP emission index decreased from 100 in the year 2000 to -17.8 in 2012 (Table 2.6 and Figure 2.4).

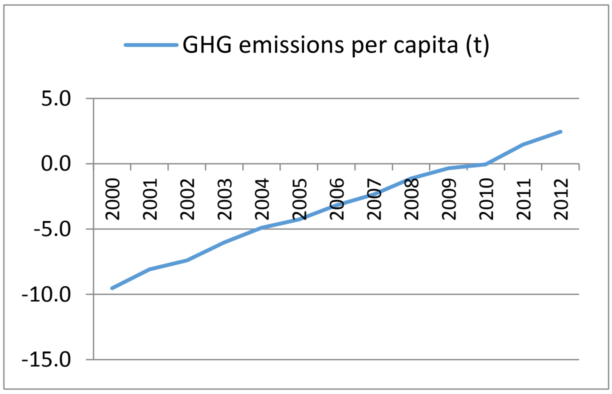



Figure 2.3. Per capita GHG emissions (2000 - 2012)

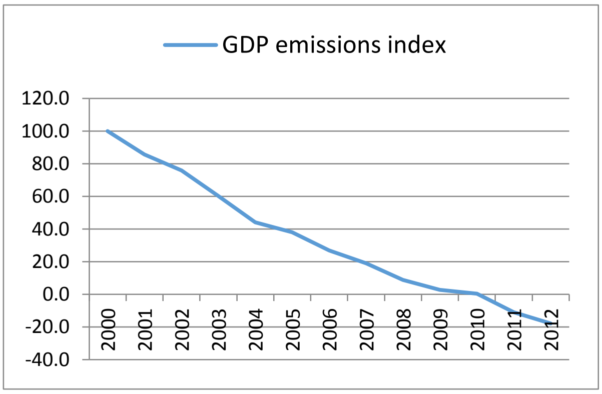



Figure 2.4. GDP emissions index (2000 - 2012)

### 2.2.3. Trend of emissions by source category

Total national emissions increased by 12.1 % over these 13 years. The AFOLU sector remained the leading emitter throughout this period followed by Energy, Waste and IPPU for most of the years under review. Emissions from the AFOLU sector increased slightly from 25 274 Gg $CO_2$-eq in 2000 to 27 028 Gg

$CO_2$-eq (Table 2.7) in 2012, representing a progression of 6.9 % from the 2000 level. In 2012, the share of GHG emissions from AFOLU amounted to 88.1 % of total national emissions.

Energy emissions increased from 1995 Gg $CO_2$-eq (%) of national emissions in 2000 to 2979 Gg $CO_2$-eq (%) in 2012 as depicted in Table 2.7. During the period 2000 to 2012, the average annual increase of GHG emissions was 4.1 %.

The contribution of the IPPU sector in total national emissions increased from 25 Gg $CO_2$-eq in 2000 to 523 Gg $CO_2$-eq in 2012 (Table 2.7). On average, the GHG emissions from the industrial processes sector increased by 166 % annually following the industrialization of the country.

Waste emissions on the other hand varied slightly over this period with the tendency being for a slight increase over time. Emissions from the waste sector increased from the 2000 level of 96 Gg $CO_2$-eq to 162 Gg $CO_2$-eq (Table 2.7) in 2012, representing a 68.8 % increase.

**Table 2.7. National GHG emissions (Gg, $CO_2$-eq) by sector (2000 - 2012)**

| Source Categories | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| Energy | 1995 | 2269 | 2562 | 2795 | 2981 | 2904 | 2851 | 2979 |
| Industrial Processes | 25 | 26 | 235 | 255 | 291 | 302 | 421 | 523 |
| AFOLU | 25274 | 25378 | 25427 | 25359 | 25992 | 25062 | 26779 | 27028 |
| Waste | 96 | 99 | 113 | 123 | 130 | 145 | 155 | 162 |
| Total emissions | 27389 | 27772 | 28336 | 28532 | 29394 | 28414 | 30206 | 30692 |

### 2.2.4. Trend in emissions of direct GHGs

The share of emissions by gas did not change during the period 2000 to 2012. The main contributor to the national GHG emissions remained $CO_2$ followed by $CH_4$ and $N_2O$. In 2012, the share of the GHG emissions was as follows: 69.6 % $CO_2$, 18.8 % $CH_4$ and 11.6 % $N_2O$.

**Table 2.8. Aggregated emissions and removals (Gg) by gas (2000 - 2012)**

| GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 20197 | 20470 | 20965 | 21214 | 21432.0 | 21366 | 21435 | 21385 |
| $CH_4$ ($CO_2$-eq) | 4651 | 4505 | 4545 | 4504 | 4928 | 4336 | 5427 | 5756 |
| $N_2O$ ($CO_2$-eq) | 2541 | 2796 | 2827 | 2814 | 3034 | 2712 | 3345 | 3551 |
| **Total GHG emissions ($CO_2$-eq)** | **27389** | **27772** | **28336** | **28532** | **29394** | **28414** | **30206** | **30692** |
| Removals ($CO_2$) ($CO_2$-eq) | -44459 | -41501 | -37707 | -34781 | -31641 | -28534 | 27118 | 25452 |
| Net removals ($CO_2$-eq) | -17070 | -13729 | -9371 | -6249 | -2246 | -121 | 3088 | 5240 |

The trend of the aggregated emissions and removals by gas is given in Table 2.8 and Figure 2.5. The share of $CO_2$ has decreased while that of $CH_4$ and $N_2O$ has increased over the period 2000 to 2012.

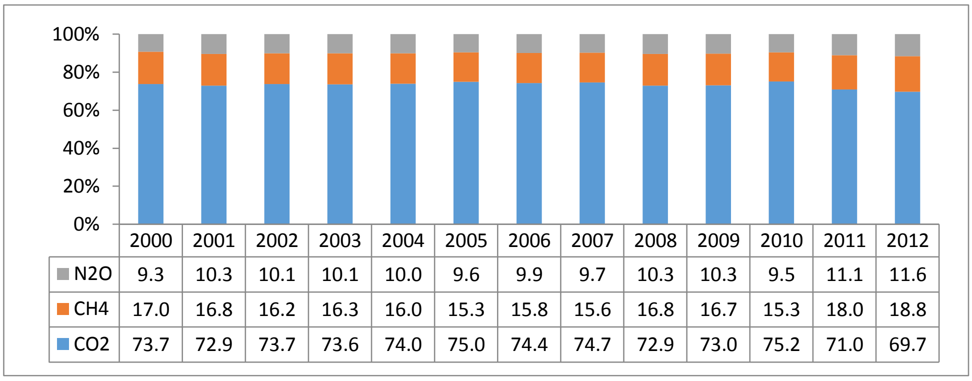


**Figure 2.5. Share of aggregated emissions (Gg $CO_2$-eq) by gas (2000 - 2012)**

#### 2.2.4.1. Carbon dioxide ($CO_2$)

The most significant anthropogenic GHG was $CO_2$. In 2012, it contributed the largest share of national emissions at 21 385 Gg (%). $CO_2$ emissions increased by 1188 Gg from the 2000 level of 20 197 Gg (Table 2.8) to 21 385 Gg in 2012. The sector that emitted the highest amount of $CO_2$ was AFOLU with 17 991 Gg followed by Energy with 2869 Gg (Table 2.9).

**Table 2.9. $CO_2$ emissions (Gg) by source category (2000 - 2012)**

| Source Category | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total emissions** | 20197 | 20470 | 20965 | 21214 | 21432 | 21366 | 21435 | 21385 |
| **Total net removals** | -24262 | -21031 | -16742 | -13567 | -10208 | -7169 | -5683 | -4067 |
| Energy | 1902 | 2173 | 2459 | 2689 | 2871 | 2793 | 2743 | 2869 |
| Industrial Processes | 25 | 26 | 235 | 255 | 291 | 302 | 421 | 523 |
| AFOLU - emissions | 18269 | 18270 | 18269 | 18268 | 18268 | 18268 | 18269 | 17991 |
| AFOLU - removals | -44459 | -41501 | -37707 | -34781 | -31641 | -28534 | -27118 | -25452 |
| Waste | 1.2 | 1.3 | 1.4 | 1.6 | 1.8 | 1.9 | 2.0 | 2.3 |

#### 2.2.4.2. Methane ($CH_4$)

Methane was the next contributor in national emissions after $CO_2$. It contributed 5756 Gg $CO_2$-eq of the total emissions of 2012. Methane emissions increased by 1105 Gg $CO_2$-eq from the 2000 level of 4651 Gg $CO_2$-eq (Table 2.10). AFOLU contributed most of these emissions followed by the Waste sector.

**Table 2.10. $CH_4$ emissions (Gg) by source category (2000 - 2012)**

| Source Category | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total (Gg $CO_2$-eq)** | 4651.5 | 4505.5 | 4544.6 | 4503.8 | 4927.6 | 4335.7 | 5426.9 | 5756.3 |
| **Total** | 221.5 | 214.5 | 216.4 | 214.5 | 234.6 | 206.5 | 258.4 | 274.1 |
| Energy | 2.9 | 3.0 | 3.0 | 3.1 | 3.1 | 3.1 | 3.0 | 3.0 |
| AFOLU - emissions | 215.3 | 208.2 | 209.4 | 207.0 | 226.8 | 198.0 | 249.6 | 265.0 |
| Waste | 3.3 | 3.4 | 4.0 | 4.4 | 4.7 | 5.4 | 5.8 | 6.1 |

#### 2.2.4.3. Nitrous Oxide ($N_2O$)

Nitrous oxide emissions stood at 3551 Gg $CO_2$-eq in 2012. Emissions increased by 1010 Gg $CO_2$-eq from 2540 Gg $CO_2$-eq in the year 2000 to 3551 Gg $CO_2$-eq (Table 2.11) in 2012. The AFOLU sector was the highest emitter of $N_2O$.

**Table 2.11. $N_2O$ emissions (Gg) by source category (2000 - 2012)**

| Source Category | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total (Gg $CO_2$-eq)** | 2540.7 | 2796.4 | 2827.2 | 2814.2 | 3034.1 | 2712.0 | 3344.7 | 3551.0 |
| **Total** | 8.20 | 9.02 | 9.12 | 9.08 | 9.79 | 8.75 | 10.79 | 11.45 |
| Energy | 0.10 | 0.11 | 0.12 | 0.14 | 0.14 | 0.15 | 0.14 | 0.15 |
| AFOLU - emissions | 8.01 | 8.82 | 8.91 | 8.85 | 9.55 | 8.50 | 10.55 | 11.20 |
| Waste | 0.08 | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 |

### 2.2.5. Trends for indirect GHGs and $SO_2$

Emissions of indirect GHGs $SO_2$, CO, $NO_x$ and NMVOC have also been estimated and reported in the inventory. Indirect GHGs have not been included in national total emissions. Emissions of these gases for the period 2000 to 2012 are given in Table 2.12. Emissions of $NO_x$ increased from 31.5 Gg in the year 2000 to 36.3 Gg in 2012. Carbon monoxide emissions increased from 364.9 Gg in 2000 to 375.3 Gg in

2010 and regressed after to 369.2 Gg in 2012. Emissions of NMVOC increased slightly from 19.5 Gg in 2000 to 22.0 Gg in 2010 and fell to 21.6 Gg in 2012 whilst emissions of SO2 increased from 2.2 Gg in 2000 to peak at 4.2 Gg in 2008 and thereafter decreased to 2.9 Gg in 2012.

**Table 2.12. Emissions (Gg) of indirect GHGs and $SO_2$ (2000 - 2012)**

| Gases | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| $NO_x$ | 31.5 | 34.7 | 36.0 | 35.2 | 34.6 | 35.2 | 36.0 | 36.3 |
| CO | 364.9 | 366.9 | 371.6 | 373.8 | 375.6 | 375.3 | 367.5 | 369.2 |
| NMVOC | 19.5 | 20.5 | 21.2 | 21.8 | 22.9 | 22.0 | 21.5 | 21.6 |
| $SO_2$ | 2.2 | 2.8 | 3.6 | 4.2 | 4.2 | 2.8 | 3.3 | 2.9 |

### 2.2.5.1. $NO_x$

Emissions of $NO_x$ increased over the inventory period from 31.5 Gg in the year 2000 to 36.3 Gg in 2012 (Table 2.13). The two main sources of $NO_x$ emissions were the Energy and AFOLU sectors. The energy and AFOLU sectors contributed 61 % and 38 % of total national emissions in 2010.

**Table 2.13. $NO_x$ emissions (Gg) by source category (2000 - 2012)**

| Source category | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total emissions** | 31.5 | 34.7 | 36.0 | 35.2 | 34.6 | 35.2 | 36.0 | 36.3 |
| Energy | 17.5 | 20.7 | 22.0 | 21.1 | 20.5 | 21.1 | 21.9 | 22.2 |
| AFOLU | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 |
| Waste | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 |

### 2.2.5.2. CO

The two main contributors of CO were the AFOLU and Energy sectors (Table 2.14). National CO emissions increased from 365 Gg in the year 2000 to 369 Gg in 2012. In 2012, 76 % of the total CO emissions originated from the AFOLU sector with the Energy sector contributing 22 %. The Waste sector contributed 2.2 % of total CO emissions in 2012 compared to 1.2 % in 2000. CO emissions in the AFOLU sector decreased from 290 Gg in 2000 to 282 in 2012.

**Table 2.14. CO emissions (Gg) by source category (2000 - 2012)**

| Source category | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total emissions** | 364.9 | 366.9 | 371.6 | 373.8 | 375.6 | 375.3 | 367.5 | 369.2 |
| Energy | 70.4 | 73.4 | 79.2 | 82.3 | 85.0 | 85.6 | 78.3 | 79.4 |
| Industrial Processes | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AFOLU | 290.2 | 288.7 | 287.2 | 285.8 | 284.3 | 282.8 | 282.0 | 281.5 |
| Waste | 4.3 | 4.8 | 5.2 | 5.8 | 6.3 | 6.9 | 7.2 | 8.2 |

### 2.2.5.3. NMVOC

In 2012, NMVOC emissions stood at 21.6 Gg compared to 19.5 Gg in the year 2000. The two main emission sources were the Energy and AFOLU (Table 2.15) sectors. NMVOC emissions varied throughout the inventory period for these two sectors. Emissions from the Waste sector increased from 0.2 Gg to 0.5 Gg during the inventory period.

**Table 2.15. NMVOC emissions (Gg) by source category (2000 - 2012)**

| Sector | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total emission** | 19.5 | 20.5 | 21.2 | 21.8 | 22.9 | 22.0 | 21.5 | 21.6 |
| Energy | 9.4 | 9.8 | 10.5 | 10.9 | 11.2 | 11.2 | 10.7 | 10.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Industrial Processes | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AFOLU | 9.9 | 10.4 | 10.5 | 10.6 | 11.4 | 10.3 | 10.3 | 10.3 |
| Waste | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 |

### 2.2.5.4. $SO_2$

The energy sector was the main contributor of $SO_2$ (Table 2.16). Emissions fluctuated during the inventory period 2000 to 2012. $SO_2$ emission increased from 2.2 Gg in 2000 to 4.2 Gg in 2006 and 2008 and then declined to 2.9 Gg in 2012. In 2012, the Energy sector contributed 99.4 % of SO2 emissions and the Waste sector the remaining 0.6 %.

**Table 2.16. $SO_2$ emissions (Gg) by source category (2000 - 2012)**

| Source Category | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Total emissions** | 2.2 | 2.8 | 3.6 | 4.2 | 4.2 | 2.8 | 3.3 | 2.9 |
| Energy | 2.2 | 2.8 | 3.6 | 4.2 | 4.2 | 2.7 | 3.3 | 2.9 |
| Waste | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |

## 2.3. Energy

### 2.3.1. Energy category and sub-categories

***1.A. - Fuel Combustion Activities***

***1.A.1 - Energy Industries***

The Energy Industries sub-category covers the production of electricity from a mix of liquid and solid fossil fuels. The contribution of fossil fuels is however minimal in the national energy balance since the country generates a high proportion of its electricity from hydro to supplement the imported power which stands at about 65 % of Namibia's demand from the South African Power Pool (SAPP) and Zimbabwe.

Namibia's total installed electricity generation capacity in 2012 was nearly 400 MW for a peak demand of some 500 MW normally. A peak of 534 MW was reached in 2012 (http://africa energy forum.com/webfmsend/2013). Hydro contributed for about 250 MW out of this. The fossil fuel generation plants are mainly used to supplement the imports and hydro production during peak demand time. Solar and wind potential exists but are tapped only marginally up to now.

***1.A.2 - Manufacturing Industries and Construction***

Fossil fuel inputs are primarily used for generating process heat within the mining sector and in the production of cement. The two main mining companies also 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 included domestic aviation, road transportation, railways and domestic water-borne navigation. Emissions for the four sub-categories have been computed in this inventory. Fuel supplied for international bunkering was also covered.

***1.A.4 - Other Sectors***

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

The fuel mix used within the residential sector by households for cooking was wood/charcoal (54 %), electricity (33 %) and the remainder being LPG. Paraffin and waxes (50 %) and electricity (43 %) were the main sources of energy used for lighting. About 50 % of households consumed wood/charcoal for heating purposes and 30 % had recourse to electricity.

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

#### 2.3.1.1. Memo items

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

### 2.3.2. Methodology

It is Good Practice to estimate emissions using both the Reference and Sectoral approaches. During this exercise, emission estimates were computed using both approaches. The top down Reference approach was carried out using import, export, production and stock change data that constituted the basis for producing the national energy balance. The bottom up Sectoral Approach generally involves the quantification of fuel consumption from end use data by the different sector source categories. Thereafter the IPCC conversion and emission factors were adopted to compile GHG emissions. The Sectoral approach covered all the IPCC source categories where AD were available. AD could not be traced for a few minor sub-categories such as Agriculture, Forestry, Commercial and institutional but this does not really affect the quality of the inventory as the fossil fuels consumed in these sub-categories have been allocated and burned in other categories.

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

$$\text{Emissions}_{\text{GHG fuel}} = \text{Fuel Consumption}_{\text{fuel}} \times \text{Emission Factor}_{\text{GHG fuel}}$$

**where**

| | |
|---|---|
| **Emissions $_{\text{GHG, fuel}}$** | = emissions of a given GHG by type of fuel (kg GHG) |
| **Fuel Consumption $_{\text{fuel}}$** | = amount of fuel combusted (TJ) |
| **Emission Factor $_{\text{GHG, fuel}}$** | = default emission factor of a given GHG by type of fuel (kg gas/TJ). For $CO_2$, it includes the carbon oxidation factor, assumed to be 1. |

#### 2.3.2.1. Activity Data

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. Data on biomass used were derived from data on consumption of different fuels by households collected in the censuses conducted by the NSA. The same approach was used to determine the amount of charcoal used. The data collection covered all solid, liquid and gaseous fossil fuels, fuelwood and charcoal. Summary of data sources is given in Table 2.17.

**Table 2.17. Summary of data sources**

| Category | Fuel type | Data source |
|---|---|---|
| International marine bunkers | Diesel | 2010 data from marine surveyor.<br>2000 data from the Second National Communication (SNC).<br>Interpolation between 2000 data from SNC and 2010 data of BUR1. |
| | Gasoline | No data was available and thus the data (622 tonnes) used in 2010 was adopted for period 2000 to 2009. |
| | Residual fuel oil | Interpolation between average (1999 to 2001) data from SNC and 2010 data from BUR1. |
| International aviation bunkers | Jet kerosene | 2010 data from Airport profile information as those available for the period 2000 to 2009 from ECB varied widely. Average of ECB data from 2000 to 2009 taken as median for year 2004 and 1 % variation applied for the remaining years. |
| Domestic aviation | Aviation Gasoline | Net of import and export for period 2006 to 2009. An average volume of 3200 for the period 2006 to 2009 is assumed for 2000 to 2005. Airport profile data available from September 2009 to 2011. |
| | Jet kerosene | Data for 2000 to 2009 from UNSD are high compared to airport profile data 2010. Same allocation of 10 % for domestic use applied for period 2000 to 2009 as for year 2010. |
| Energy industries | Fuel oil | Data from Nampower. |
| | Coal | Data from Nampower. |
| Manufacturing, Mining and Other manufacturing | Gasoline/Diesel | Data from ECB report. |
| | Gasoline/Diesel | Official data provided by Ministry of Trade and Industry for industries used, excluding mining. |
| Road Transport | Gasoline/Diesel | Gasoline and diesel estimated from vehicles fleet and fuel consumption indicators. |

| Category | Fuel type | Data source |
|---|---|---|
| | LPG | Difference from net import and export with 1100 allocated for residential sector from SNC. |
| Railways | Diesel/residual | Data from TransNamib. |
| Residential | Kerosene | Kerosene for years 2007 and 2008 taken from net of import and export. Data inconsistent for remaining years. For the period 2000 to 2006, a uniform increase of 1 % was adopted in line with urbanisation rate as it is considered that people moving to the cities consumed electricity *in lieu* of kerosene. |
| | LPG | Taken from imports. |
| | Wax candles | Amount produced locally plus balance from net of import and export. |
| | Wood fuel | Derived from census data on the basis of % households using this energy source. |
| Agriculture/ fishing | Gasoline | A nominal allocation to balance import and export data. Interpolation for year 2000 taken from SNC and 2001 to 2009 interpolated using AD for years 2000 and 2010. |
| | Diesel | Consumption of diesel derived from fish catch data from (SNC). |

Activity data used for the Energy sector is provided in Table 2.18. AD were not always available and in the format required as well as at the level of disaggregation needed. This is due to the fact that the country is still in the process of putting in place its GHG inventory management system.

**Table 2.18. Activity data (t) for the Energy sector (2000 - 2012)**

| Categories | Type of fuel | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy generation | HFO and LFO | 53 | 119 | 131 | 628 | 130 | 1239 | 2610 | 2569 | 554 | 774 | 1123 | 2246 | 8610 |
| | Bitum. coal | 2926 | 3609 | 18 | 7942 | 718 | 20384 | 63877 | 76599 | 95876 | 57453 | 13105 | 4745 | 3841 |
| Mining | Motor gasoline | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 | 2454 |
| | Gas/diesel | 11778 | 11508 | 10994 | 11938 | 15007 | 14771 | 17309 | 23244 | 25310 | 22536 | 21145 | 19767 | 21149 |
| | Bitum. coal | 7360 | 39040 | 25800 | 38040 | 38040 | 32600 | 32840 | 28400 | 23960 | 31160 | 36160 | 49640 | 38986 |
| | Waste oil | 4655 | 4784 | 5041 | 5425 | 5842 | 6233 | 6448 | 6855 | 6965 | 7046 | 7128 | 7610 | 8092 |
| Other manufacturing | Gasoline | 218 | 212 | 221 | 223 | 239 | 231 | 232 | 239 | 226 | 253 | 257 | 259 | 271 |
| | Gas/Diesel | 317 | 326 | 387 | 371 | 396 | 395 | 404 | 398 | 408 | 421 | 440 | 405 | 483 |
| Civil aviation | Aviation Gasoline | 3012 | 3043 | 3074 | 3105 | 3136 | 3167 | 3210 | 3210 | 3210 | 3210 | 3596 | 1559 | 1808 |
| | Jet kerosene | 3074 | 3105 | 3136 | 3168 | 3200 | 3232 | 3264 | 3297 | 3330 | 3363 | 3456 | 5913 | 6859 |
| Road transportation | Motor gasoline | 233707 | 237990 | 248782 | 265686 | 283498 | 300461 | 308626 | 326575 | 329529 | 331785 | 333283 | 286747 | 297946 |
| | Diesel oil | 184696 | 194803 | 207799 | 225562 | 249491 | 269389 | 281124 | 300275 | 314526 | 330463 | 348809 | 343721 | 377663 |
| | LPG | - | - | - | - | - | - | - | 72 | 276 | 496 | 715 | 500 | 500 |
| Railways | Diesel oil | 12900 | 13607 | 14314 | 15021 | 15728 | 16435 | 16808 | 17207 | 16022 | 15710 | 6571 | 5948 | 6416 |
| | Residuel fuel oil | - | - | - | - | - | - | - | - | - | - | 9857 | 8922 | 9624 |
| Residential | Kerosene | 3316 | 3283 | 3251 | 3219 | 3187 | 3155 | 3124 | 3093 | 2700 | 2357 | 2057 | 1796 | 1568 |
| | LPG | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1200 | 1200 |
| | Parafin fax | 27123 | 27319 | 29577 | 30332 | 34193 | 30765 | 29070 | 29128 | 34625 | 35989 | 27529 | 29510 | 29405 |
| | Wood fuel | 510086 | 517208 | 517428 | 517550 | 517573 | 517494 | 517310 | 517018 | 516615 | 516097 | 515463 | 514707 | 507886 |
| | Charcoal | 8000 | 8000 | 8000 | 9000 | 9000 | 9000 | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 |
| Fishing | Motor gasoline | 3300 | 3470 | 3640 | 3810 | 3980 | 4150 | 4320 | 4490 | 4660 | 4830 | 5000 | 5170 | 5340 |
| | Diesel oil | 98000 | 107000 | 128000 | 132000 | 121000 | 116000 | 90700 | 71900 | 65700 | 75500 | 67200 | 85800 | 74500 |
| Non-specified | Diesel | 10797 | 11812 | 12339 | 12853 | 13442 | 13512 | 13625 | 13668 | 13499 | 13002 | 12807 | 13561 | 16112 |
| | Gasolene | - | - | - | - | - | - | - | - | - | - | - | 238 | 282 |
| Int. aviation | Jet kerosene | 27665 | 27945 | 28227 | 28512 | 28800 | 29088 | 29379 | 29673 | 29969 | 30269 | 31120 | 39573 | 45904 |
| Int. water-borne navigation | Diesel oil | 25247 | 24614 | 23982 | 23349 | 22717 | 22084 | 21451 | 20819 | 20186 | 19554 | 18921 | 18921 | 18921 |
| | Gasolene | 622 | 622 | 622 | 622 | 622 | 622 | 622 | 622 | 622 | 622 | 622 | 622 | 622 |
| | Residual oil | 16196 | 17519 | 18842 | 20166 | 21489 | 22812 | 24135 | 25458 | 26782 | 28105 | 29428 | 31194 | 33065 |

Gaps were filled using statistical methods such as trend analysis, interpolation and extrapolation as appropriate. In some cases, fuels had to be allocated or determined according to the activity area. One such example is the amount of fuel used in the fishing sector which is directly related to fishing vessel

campaigns. Fuel used 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.

#### 2.3.2.2. Emission factors

Namibia does not have national emission factors for the Energy sector. Thus, the IPCC default emission factors were adopted to compute greenhouse gas emissions. The EFs are listed in Table 2.19.

**Table 2.19. List of emission factors (kg/TJ) 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 |
| Waste oils | 73300 | 30.0 | 4.0 | Vol. 2, table 2.2 | Vol. 2, table 2.2 | Vol. 2, table 2.2 |
| 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 |

#### 2.3.2.3. Emission estimates

***Reference approach***

***Comparison of the Sectoral approach (SA) with the Reference approach (RA)***

$CO_2$ emissions were estimated anew under the RA as updated data sets on energy became available. The results differed widely for a few years with quite serious underestimates for the reference approach as for the year 2007 (Table 2.20). The wide differences between the two approaches possibly occurred, as import-export data on fuels were quite erratic with even net exports sometimes. It appears that all fuels entering the country are not being systematically recorded. As well, it could be that fuels are purchased outside the borders and then burned. This is computed in the sectoral approach as the outputs in the transportation category for example are based on the number of vehicles and their

consumption rather than delivery at the pumps, the latter data not being available. It is worth highlighting that the country is in the process of making annual energy balances that will help refine AD for this sector.

**Table 2.20. Comparison of the Reference and Sectoral Approaches (Gg $CO_2$) (2000 - 2012)**

| Approach | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Approach | 1835 | 2062 | 2000 | 1799 | 1895 | 2112 | 2133 | 1624 | 3341 | 2936 | 2498 | 2233 | 2758 |
| Sectoral Approach | 1902 | 2062 | 2173 | 2355 | 2459 | 2590 | 2689 | 2788 | 2871 | 2876 | 2793 | 2743 | 2869 |
| Difference (%) | -3.5 | 0.0 | -7.9 | -23.6 | -22.9 | -18.5 | -20.7 | -41.8 | 16.3 | 2.1 | -10.6 | -18.6 | -3.8 |

## *Sectoral approach*

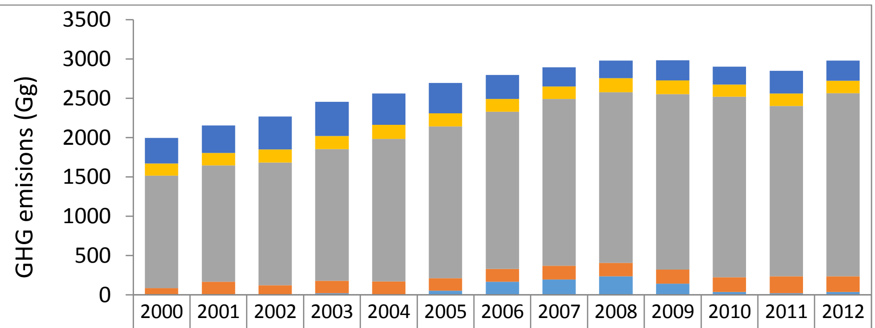
Total aggregated emissions are provided in Table 2.21 while the share of emissions by category is depicted in Figure 2.6 for the five IPCC source categories for the years 2000 to 2012. Total emissions from Fuel Combustion Activities amounted to 1995 Gg $CO_2$-eq in 2000 and reached 2975 Gg $CO_2$-eq in 2012. This represented an increase of 980 Gg $CO_2$-eq since the year 2000 or a 4.1% annual increase in emissions during the 12 years starting 2000.

**Table 2.21. Emissions for Fuel Combustion Activities (Gg $CO_2$-eq) (2000 - 2012)**

| Source of emission | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| Fuel combustion activities | 1994.8 | 2269.1 | 2561.6 | 2795.5 | 2981.0 | 2904.1 | 2851.2 | 2978.6 |
| Energy Industries | 7.3 | 0.5 | 2.2 | 164.9 | 236.9 | 35.7 | 18.7 | 36.4 |
| Manufacturing Industries and Construction | 79.1 | 123.3 | 168.7 | 165.1 | 170.4 | 187.8 | 217.9 | 197.8 |
| Transport | 1429.0 | 1561.2 | 1814.1 | 2000.0 | 2172.3 | 2296.6 | 2165.32 | 2331.5 |
| Other Sectors | 479.3 | 584.4 | 576.6 | 465.4 | 401.4 | 384.0 | 449.4 | 411.9 |

Other sectors: include Residential and Fishing

Transport contributed the major share of these emissions, between 72 and 78 % for the period 2000 to 2012. Emissions from transport increased by 63 % over these 12 years. That from Other Sectors category fluctuated between 479 Gg $CO_2$-eq in the year 2000 to 412 Gg $CO_2$-eq in 2012. Emissions from Manufacturing Industries and Construction stayed at around 6 % of the Energy sector emissions. Energy Industries emissions varied widely because local electricity generation is only to supplement import deficits. Emissions hit a maximum of 8 % in 2008 and represented only 1 % in 2012.




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture/Fishing | 324 | 353 | 421 | 435 | 400 | 384 | 304 | 244 | 225 | 257 | 231 | 291 | 255 |
| Residential | 155 | 157 | 163 | 165 | 177 | 166 | 161 | 162 | 177 | 177 | 153 | 159 | 157 |
| Transport | 1429 | 1481 | 1561 | 1676 | 1814 | 1935 | 2000 | 2121 | 2172 | 2229 | 2297 | 2165 | 2332 |
| Manufacturing Industries & Construction | 79 | 156 | 123 | 157 | 169 | 156 | 165 | 174 | 170 | 180 | 188 | 218 | 198 |
| Energy Industries | 7 | 9 | 0 | 21 | 2 | 54 | 165 | 196 | 237 | 143 | 36 | 19 | 36 |

**Figure 2.6. Share of GHG emissions (Gg) by Energy sub-category (2000 - 2012)**

As depicted in Table 2.22, it is obvious that out of the nine sub-categories, road transport remained the major contributor of emissions, expressed in terms of Gg $CO_2$-eq, followed by Fishing, Residential and

Mining. Emissions from the road transportation sub-category increased from 1334 Gg $CO_2$-eq in 2000 to reach a peak of 2181 Gg $CO_2$-eq in 2010 to regress slightly to 2163 Gg $CO_2$-eq in 2012.

**Table 2.22. GHG emissions (Gg $CO_2$-eq) by Energy sub-category (2000 - 2012)**

| Fuel Combustion Activities-Energy sub-categories | Emission expressed in $CO_2$-eq | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
| Energy (Total) | 1994.8 | 2269.1 | 2561.6 | 2795.5 | 2981.0 | 2904.1 | 2851.2 | 2978.6 |
| Electricity Generation | 7.3 | 0.5 | 2.2 | 164.9 | 236.9 | 35.7 | 18.7 | 36.4 |
| Mining (excluding fuels) and Quarrying | 77.4 | 121.4 | 166.7 | 163.1 | 168.4 | 185.6 | 215.8 | 195.5 |
| Non-specified Industry | 1.7 | 1.9 | 2.0 | 2.0 | 2.0 | 2.2 | 2.1 | 2.4 |
| Civil Aviation | 19.1 | 19.5 | 19.9 | 20.3 | 20.5 | 22.1 | 23.6 | 27.4 |
| Road Transportation | 1333.7 | 1456.0 | 1700.3 | 1881.9 | 2056.7 | 2181.0 | 2017.5 | 2162.8 |
| Railways | 41.2 | 45.8 | 50.3 | 53.7 | 51.2 | 51.9 | 47.0 | 50.7 |
| Residential | 155.2 | 163.1 | 176.8 | 161.5 | 176.5 | 153.3 | 158.6 | 156.7 |
| Fishing (mobile combustion) | 324.1 | 421.3 | 399.9 | 303.9 | 224.8 | 230.7 | 290.8 | 255.1 |
| Mobile (Other) | 35.0 | 40.0 | 43.6 | 44.2 | 43.8 | 41.5 | 77.1 | 91.6 |

The evolution of emissions of all gases in the Energy sector is presented in Table 2.23. Throughout the period 2000 to 2012, $CO_2$ contributed the major part of the emissions followed by $CH_4$ and $N_2O$. Among the indirect gases, CO was the main gas emitted over the same period followed by $NO_x$ and NMVOCs. The emissions increased very slightly over time for most gases except for CO2 over the time series due to increased economic activity. It is interesting to note that from 2010 to 2012, a slight decrease is observed for $CH_4$, $N_2O$, CO and NMVOCs.

**Table 2.23. Emissions by gas (Gg) for the Energy sector (2000 - 2012)**

| GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **$CO_2$** | 1902.2 | 2172.6 | 2459.3 | 2689.3 | 2871.4 | 2793.4 | 2743.1 | 2868.5 |
| **$CH_4$** | 2.9 | 3.0 | 3.0 | 3.1 | 3.1 | 3.1 | 3.0 | 3.0 |
| **$N_2O$** | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 |
| **$NO_x$** | 17.5 | 20.7 | 22.0 | 21.1 | 20.5 | 21.1 | 21.9 | 22.2 |
| **CO** | 70.4 | 73.4 | 79.2 | 82.3 | 85.0 | 85.6 | 78.3 | 79.4 |
| **NMVOC** | 9.4 | 9.8 | 10.5 | 10.9 | 11.2 | 11.2 | 10.7 | 10.8 |
| **$SO_2$** | 2.2 | 2.8 | 3.6 | 4.2 | 4.2 | 2.7 | 3.3 | 2.9 |

### 2.3.2.4. Evolution of emissions by gas (Gg) in the Energy Sector (2000 to 2012)

Emissions of $CO_2$ (Figure 2.7) in the Energy category showed a general increase from 2000 to 2012, from 1902 and 2869 Gg. The annual increase which was quite sharp up to 2008 plateaued thereafter until 2012. Average emission was 2552 Gg over the period under review.


**Figure 2.7. Evolution of $CO_2$ emissions (Gg) in the Energy Sector for the period 2000 to 2012**

With regard to Methane, emissions varied between 2.9 Gg and 3.1 Gg during the period 2000 to 2012 (Figure 2.8). After increasing to 3.1 Gg in during the period 2006 to 2010, emissions dipped down to 3.0 Gg in 2011 and 2012.

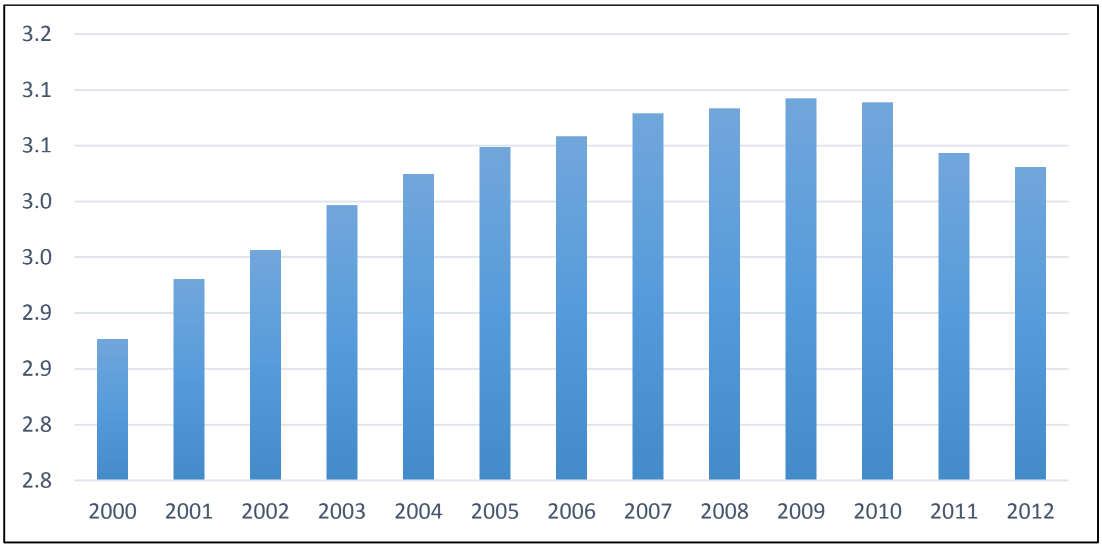



**Figure 2.8. Evolution of $CH_4$ emissions (Gg) in the Energy Sector (2000 - 2012)**

Emissions of $N_2O$ increased from 0.10 to 0.15 Gg (Figure 2.9) over the period 2000 to 2012.

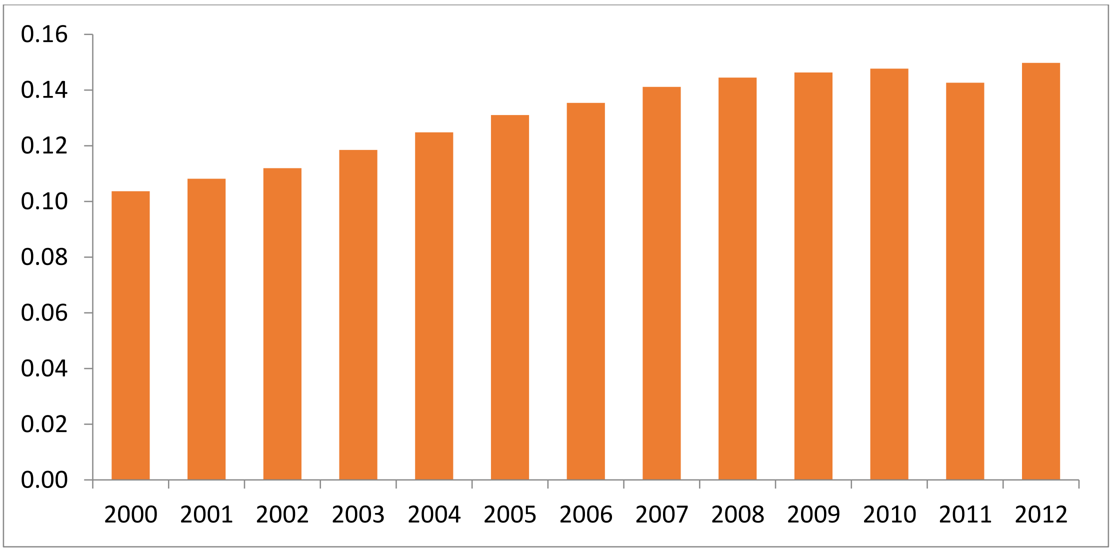



**Figure 2.9. Evolution of $N_2O$ emissions (Gg) in the Energy Sector (2000 - 2012)**

Emissions of $NO_x$ varied from 17.5 Gg in 2000 to 22.4 Gg in 2005 (Figure 2.10), and regress to 22.2 in 2012. Average emissions were 20.9 Gg over the period 2000 to 2012.

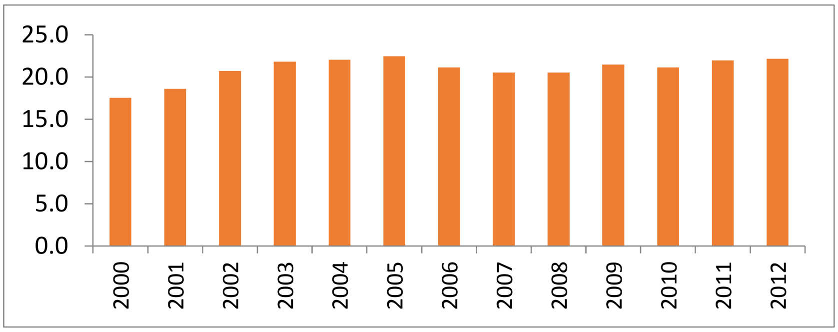



**Figure 2.10. Evolution of $NO_x$ emissions (Gg) in the Energy Sector (2000 - 2012)**

Emissions of CO averaged 79.4 Gg over the period, starting at 70.4 Gg in year 2000 to reach a peak of 85.8 Gg in 2009, representing a 20 % increase (Figure 2.11). It ten decreased to 79.4 Gg in 2012.

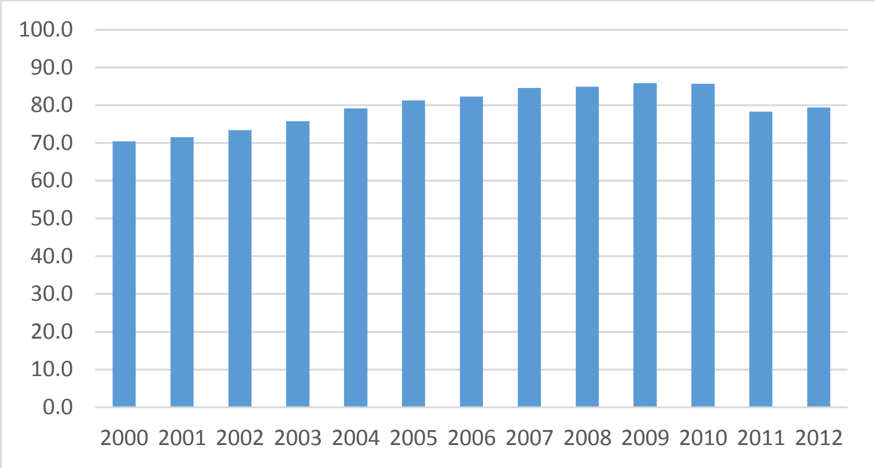



**Figure 2.11. Evolution of CO emissions (Gg) in the Energy Sector (2000 - 2012)**

NMVOCs emissions increased by nearly 20 % over the inventory period 2000 to 2010, starting at 9.4 Gg in 2000 to peak at 11.3 Gg in year 2009 (Figure 2.12), and regress to 10.8 Gg in 2012.

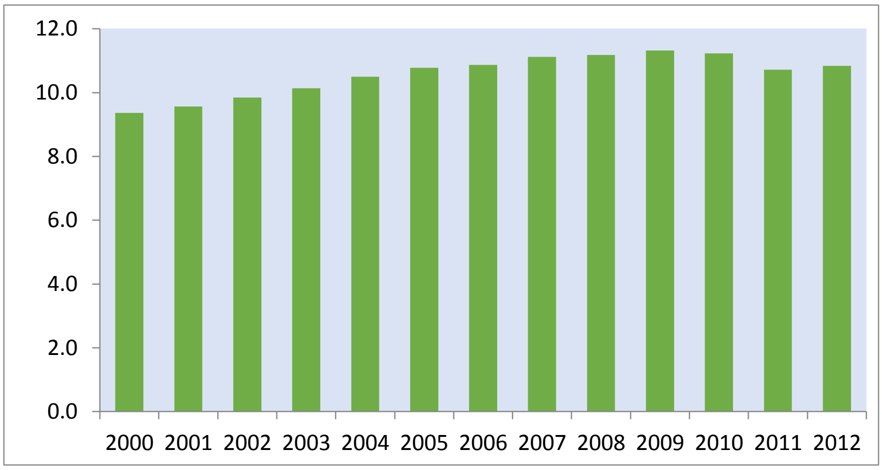



**Figure 2.12. Evolution of NMVOC emissions (Gg) in the Energy Sector (2000 - 2012)**

$SO_2$ emissions increased from 2.2 Gg in 2000 to reach a peak of 4.2 Gg in 2006, a 98 % increase. However, emissions fluctuated thereafter and decreased to 2.9 Gg in 2012 (Figure 2.13).

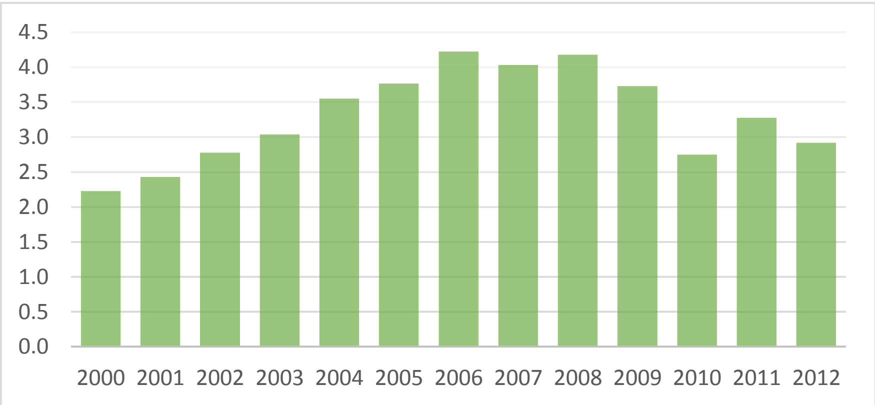



**Figure 2.13. Evolution of $SO_2$ emissions (Gg) in the Energy Sector (2000 - 2012)**

## Table 2.24. Energy Sector emissions (Gg) in 2012

**Inventory Year: 2012**

| Categories | Emissions (Gg) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CO2 | CH4 | N2O | NOx | CO | NMVOCs | SO2 |
| **1 - Energy** | 2868.5 | 3.0 | 0.1 | 22.2 | 79.4 | 10.8 | 2.9 |
| **1.A - Fuel Combustion Activities** | 2868.5 | 3.0 | 0.1 | 22.2 | 79.4 | 10.8 | 2.9 |
| **1.A.1 - Energy Industries** | 36.3 | 1E-03 | 4E-04 | 0.1 | 6E-03 | 9E-04 | 0.3 |
| 1.A.1.a - Main Activity Electricity and Heat Produc | 36.3 | 1E-03 | 4E-04 | 0.1 | 6E-03 | 9E-04 | 0.3 |
| 1.A.1.a.i - Electricity Generation | 36.3 | 1E-03 | 4E-04 | 0.1 | 6E-03 | 9E-04 | 0.3 |
| **1.A.2 - Manufacturing Industries and Construction** | 196.3 | 2E-02 | 3E-03 | 0.7 | 1.2 | 0.2 | 1.0 |
| 1.A.2.i - Mining (excluding fuels) and Quarrying | 193.9 | 2E-02 | 3E-03 | 0.7 | 1.2 | 0.2 | 1.0 |
| 1.A.2.m - Non-specified Industry | 2.4 | 1E-04 | 2E-05 | 2E-02 | 2E-03 | 8E-04 | 2E-03 |
| **1.A.3 - Transport** | 2197.3 | 0.5 | 0.1 | 14.3 | 42.8 | 4.7 | 2E-02 |
| 1.A.3.a - Civil Aviation | 27.2 | 2E-04 | 8E-04 | 0.1 | 2.2 | 0.0 | 9E-03 |
| 1.A.3.a.i - International Aviation (International Bunkers) (1) | | | | | | | |
| 1.A.3.a.ii - Domestic Aviation | 27.2 | 2E-04 | 8E-04 | 0.1 | 2.2 | 4E-02 | 9E-03 |
| 1.A.3.b - Road Transportation | 2119.5 | 0.5 | 0.1 | 13.3 | 40.4 | 4.6 | 2E-02 |
| 1.A.3.b.i - Cars | 443.0 | 0.2 | 2E-02 | 1.4 | 10.2 | 1.2 | 5E-03 |
| 1.A.3.b.i.1 - Passenger cars with 3-way catalyst | 142.8 | 0.1 | 7E-03 | 0.4 | 3.3 | 0.4 | 2E-03 |
| 1.A.3.b.i.2 - Passenger cars without 3-way cata | 300.2 | 0.1 | 1E-02 | 0.9 | 6.9 | 0.8 | 3E-03 |
| 1.A.3.b.ii - Light-duty trucks | 923.6 | 0.3 | 0.0 | 4.1 | 28.1 | 2.8 | 0.0 |
| 1.A.3.b.ii.1 - Light-duty trucks with 3-way catal | 692.7 | 0.2 | 3E-02 | 3.1 | 21.1 | 2.1 | 6E-03 |
| 1.A.3.b.ii.2 - Light-duty trucks without 3-way ca | 230.9 | 0.1 | 1E-02 | 1.0 | 7.0 | 0.7 | 2E-03 |
| 1.A.3.b.iii - Heavy-duty trucks and buses | 750.6 | 4E-02 | 4E-02 | 7.9 | 1.8 | 0.5 | 2E-03 |
| 1.A.3.c - Railways | 50.5 | 2E-03 | 4E-04 | 0.8 | 0.2 | 0.1 | 1E-04 |
| 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.4 - Other Sectors** | 348.9 | 2.5 | 3E-02 | 6.5 | 35.3 | 5.9 | 1.7 |
| 1.A.4.b - Residential | 95.2 | 2.4 | 0.0 | 0.6 | 31.7 | 4.8 | 0.1 |
| 1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms | 253.8 | 3E-02 | 2E-03 | 5.9 | 3.6 | 1.2 | 1.6 |
| 1.A.4.c.iii - Fishing (mobile combustion) | 253.8 | 0.0 | 0.0 | 5.9 | 3.6 | 1.2 | 1.6 |
| **1.A.5 - Non-Specified** | 89.7 | 2E-02 | 4E-03 | 0.5 | 0.2 | 3E-02 | 3E-04 |
| 1.A.5.b - Mobile | 89.7 | 2E-02 | 4E-03 | 0.5 | 0.2 | 3E-02 | 3E-04 |
| 1.A.5.b.iii - Mobile (Other) | 89.7 | 2E-02 | 4E-03 | 0.5 | 0.2 | 3E-02 | 3E-04 |
| **1.B.2 - Oil and Natural Gas** | | | | 0 | 0 | 0 | 0 |
| **1.B.3 - Other emissions from Energy Production** | | | | 0 | 0 | 0 | 0 |
| **1.C - Carbon dioxide Transport and Storage** | 0 | | | 0 | 0 | 0 | 0 |

| Categories | Emissions (Gg) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CO2 | CH4 | N2O | NOx | CO | NMVOCs | SO2 |
| **Memo Items (3)** | | | | | | | |
| International Bunkers | 310.3 | 2E-02 | 8E-03 | 4.6 | 0.8 | 0.3 | 1.1 |
| 1.A.3.a.i - International Aviation (International Bunke | 144.7 | 1E-03 | 4E-03 | 0.5 | 5E-02 | 2E-02 | 4E-02 |
| 1.A.3.d.i - International water-borne navigation (Inter | 165.6 | 2E-02 | 4E-03 | 4.1 | 0.7 | 0.3 | 1.1 |
| 1.A.5.c - Multilateral Operations (1)(2) | | | | 0 | 0 | 0 | 0 |
| **Information Items** | | | | | | | |
| CO2 from Biomass Combustion for Energy Production | 920.4 | | | | | | |

### 2.3.2.5. Emissions by gas by category across the period 2000 to 2012

#### *$CO_2$ emissions*

Emissions (Gg) of $CO_2$ for the years 2000 to 2012 are summarized in Table 2.25. Total $CO_2$ emissions emanating from Fuel combustion activities increased from 1902 Gg in 2000 to 2876 in 2009 and declined to 2869 Gg in 2012. For the Transport category, $CO_2$ emissions increased from 1366 Gg in 2000 to peak at 2210 Gg in 2010, whilst for Energy Industries, it increased from 7.3 Gg in 2000, to 235.7 Gg in 2008. It fluctuated to between 142.6 and 18.6 Gg thereafter until 2012. Emissions from the Other sectors sub-category increased from 416 Gg as in the year 2000 to 535 Gg in 2003 and decreased thereafter to 349 Gg in 2012. The Non-specified sub-category emissions increased from 34 Gg to 90 in 2012.

**Table 2.25. $CO_2$ emissions (Gg) (2000 - 2012)**

| Year | Total | Energy Industries | Manufacturing Industries and Construction | Transport | Other Sectors | Non-Specified |
|---|---|---|---|---|---|---|
| **2000** | 1902.2 | 7.3 | 78.4 | 1366.0 | 416.0 | 34.4 |
| **2001** | 2061.6 | 9.2 | 155.3 | 1413.8 | 445.7 | 37.6 |
| **2002** | 2172.6 | 0.5 | 122.3 | 1490.8 | 519.7 | 39.3 |
| **2003** | 2355.4 | 21.3 | 156.3 | 1601.7 | 535.1 | 41.0 |
| **2004** | 2459.3 | 2.2 | 167.4 | 1735.1 | 511.8 | 42.8 |
| **2005** | 2590.5 | 53.6 | 154.5 | 1853.0 | 486.2 | 43.1 |
| **2006** | 2689.3 | 164.1 | 163.8 | 1916.9 | 401.0 | 43.4 |
| **2007** | 2788.2 | 195.0 | 173.1 | 2034.9 | 341.7 | 43.6 |
| **2008** | 2871.4 | 235.7 | 169.2 | 2086.1 | 337.5 | 43.0 |
| **2009** | 2875.9 | 142.6 | 178.3 | 2143.5 | 370.1 | 41.4 |
| **2010** | 2793.4 | 35.5 | 186.4 | 2210.4 | 320.4 | 40.8 |
| **2011** | 2743.1 | 18.6 | 216.2 | 2047.3 | 385.5 | 75.5 |
| **2012** | 2868.5 | 36.3 | 196.3 | 2197.3 | 348.9 | 89.7 |

#### *$CH_4$ emissions*

A total of 3.0 Gg of methane ($CH_4$) was emitted from the Energy category in 2012, with 2.5 Gg from the fishing sub-category within the Other Sectors sub-category, (Table 2.26). Transport accounted for 0.50 Gg of emissions of this sector. Total CH4 emissions from the Energy Industries sub-category contributed 0.001 Gg and manufacturing Industries and Construction 0.023 Gg in 2012.

**Table 2.26. $CH_4$ emissions (Gg) (2000 - 2012)**

| Year | Total | Energy Industries | Manufacturing Industries and Construction | Transport | Other Sectors | Non-Specified |
|---|---|---|---|---|---|---|
| **2000** | 2.9 | 8.2E-05 | 9.4E-03 | 0.37 | 2.5 | 1.8E-03 |
| **2001** | 2.9 | 1.1E-04 | 1.8E-02 | 0.38 | 2.5 | 2.0E-03 |
| **2002** | 3.0 | 1.6E-05 | 1.5E-02 | 0.40 | 2.5 | 2.1E-03 |
| **2003** | 3.0 | 2.8E-04 | 1.8E-02 | 0.43 | 2.5 | 2.2E-03 |
| **2004** | 3.0 | 3.4E-05 | 1.9E-02 | 0.46 | 2.5 | 2.3E-03 |
| **2005** | 3.0 | 6.8E-04 | 1.8E-02 | 0.49 | 2.5 | 2.3E-03 |
| **2006** | 3.1 | 2.0E-03 | 1.9E-02 | 0.50 | 2.5 | 2.3E-03 |
| **2007** | 3.1 | 2.3E-03 | 1.9E-02 | 0.53 | 2.5 | 2.3E-03 |
| **2008** | 3.1 | 2.5E-03 | 1.8E-02 | 0.54 | 2.5 | 2.3E-03 |
| **2009** | 3.1 | 1.6E-03 | 2.0E-02 | 0.54 | 2.5 | 2.2E-03 |
| **2010** | 3.1 | 4.7E-04 | 2.1E-02 | 0.55 | 2.5 | 2.1E-03 |
| **2011** | 3.0 | 3.9E-04 | 2.5E-02 | 0.48 | 2.5 | 1.8E-02 |
| **2012** | 3.0 | 1.1E-03 | 2.3E-02 | 0.50 | 2.5 | 2.1E-02 |

## $N_2O$ emissions

Total emissions from fuel combustion activities varied between 0.10 Gg (2000) to 0.15 Gg in 2012 (Table 2.27). In general, the highest emission was noted in the Transport sub-category which accounted for 0.11 Gg in 2012 compared to 0.06 Gg in 2000. A total of 0.00036 Gg of $N_2O$ was emitted from the Energy Industries sub-category in 2012, compared to 0.00011 Gg in the year 2000.

**Table 2.27. $N_2O$ emissions (Gg) (2000 - 2012)**

| Year | Total | Energy Industries | Manufacturing Industries and Construction | Transport | Other Sectors | Non-Specified |
|---|---|---|---|---|---|---|
| 2000 | 0.10 | 1.1E-04 | 0.001 | 0.06 | 0.035 | 1.8E-03 |
| 2001 | 0.11 | 1.4E-04 | 0.003 | 0.07 | 0.036 | 2.0E-03 |
| 2002 | 0.11 | 3.9E-06 | 0.002 | 0.07 | 0.037 | 2.1E-03 |
| 2003 | 0.12 | 3.2E-04 | 0.003 | 0.08 | 0.037 | 2.2E-03 |
| 2004 | 0.12 | 3.1E-05 | 0.003 | 0.08 | 0.037 | 2.3E-03 |
| 2005 | 0.13 | 8.2E-04 | 0.003 | 0.09 | 0.036 | 2.3E-03 |
| 2006 | 0.14 | 2.5E-03 | 0.003 | 0.09 | 0.036 | 2.3E-03 |
| 2007 | 0.14 | 3.0E-03 | 0.003 | 0.10 | 0.035 | 2.3E-03 |
| 2008 | 0.14 | 3.7E-03 | 0.003 | 0.10 | 0.035 | 2.3E-03 |
| 2009 | 0.15 | 2.2E-03 | 0.003 | 0.10 | 0.035 | 2.2E-03 |
| 2010 | 0.15 | 5.3E-04 | 0.003 | 0.11 | 0.035 | 2.1E-03 |
| 2011 | 0.14 | 2.4E-04 | 0.004 | 0.10 | 0.036 | 3.8E-03 |
| 2012 | 0.15 | 3.6E-04 | 0.003 | 0.11 | 0.035 | 4.5E-03 |

## $NO_x$ emissions

Emissions (Gg) of $NO_x$ from the combustion of fuels increased from 17.5 Gg in 2000 to 22.2 Gg in 2012. The main contributor was the Transport and Other Sectors (mainly fishing) sub-categories, followed by the Manufacturing Industries and Construction, and Non-Specified sectors (Table 2.28). Transport emissions increased from 8.4 Gg in 2000 to 14.3 in 2012. Emissions from the Other Sectors sub-category increased from 8.4 Gg in 2000 to 11.1 Gg in 2003 and decreased by nearly 50 % from 2003 to 2012. Energy industries with less than 1 Gg contributed marginally.

**Table 2.28. $NO_x$ emissions (Gg) (2000 - 2012)**

| Year | Total | Energy Industries | Manufacturing Industries and Construction | Transport | Other Sectors | Non-Specified |
|---|---|---|---|---|---|---|
| **2000** | 17.5 | 0.02 | 0.38 | 8.4 | 8.4 | 0.36 |
| **2001** | 18.6 | 0.02 | 0.34 | 8.7 | 9.1 | 0.39 |
| **2002** | 20.7 | 0.00 | 0.33 | 9.2 | 10.8 | 0.41 |
| **2003** | 21.8 | 0.05 | 0.35 | 9.9 | 11.1 | 0.43 |
| **2004** | 22.0 | 0.00 | 0.59 | 10.8 | 10.2 | 0.45 |
| **2005** | 22.4 | 0.12 | 0.56 | 11.5 | 9.8 | 0.45 |
| **2006** | 21.2 | 0.36 | 0.62 | 11.9 | 7.8 | 0.46 |
| **2007** | 20.5 | 0.43 | 0.73 | 12.5 | 6.4 | 0.46 |
| **2008** | 20.5 | 0.52 | 0.76 | 12.9 | 5.9 | 0.45 |
| **2009** | 21.5 | 0.31 | 0.73 | 13.3 | 6.6 | 0.43 |
| **2010** | 21.1 | 0.08 | 0.73 | 13.9 | 6.0 | 0.43 |
| **2011** | 21.9 | 0.04 | 0.76 | 13.3 | 7.4 | 0.46 |
| **2012** | 22.2 | 0.07 | 0.74 | 14.3 | 6.5 | 0.54 |

## *CO emissions*

CO emissions originated mainly from the Other Sectors and Transport sub-categories and accounted for 98.3 % of emissions (Table 2.29) in 2012. CO emissions for the Energy sector evolved from 70 Gg in 2000 to 86 Gg in 2010, and regressed to 79 Gg in 2012. Emissions from the Other Sectors sub-category dwindled around 36 Gg for the full time series 2000 to 2012.

**Table 2.29. CO emissions (Gg) (2000 - 2012)**

| Year | Total | Energy Industries | Manufacturing Industries and Construction | Transport | Other Sectors | Non-Specified |
|---|---|---|---|---|---|---|
| 2000 | 70.4 | 7.0E-04 | 0.17 | 34.7 | 35.5 | 0.08 |
| 2001 | 71.6 | 9.0E-04 | 0.15 | 35.3 | 36.0 | 0.09 |
| 2002 | 73.4 | 1.0E-04 | 0.16 | 36.8 | 36.4 | 0.09 |
| 2003 | 75.7 | 2.2E-03 | 0.17 | 38.9 | 36.5 | 0.10 |
| 2004 | 79.2 | 2.0E-04 | 1.10 | 41.4 | 36.5 | 0.10 |
| 2005 | 81.3 | 5.3E-03 | 0.98 | 43.4 | 36.7 | 0.10 |
| 2006 | 82.3 | 3.6E-01 | 1.00 | 44.6 | 36.6 | 0.46 |
| 2007 | 84.6 | 4.3E-01 | 0.90 | 47.0 | 36.6 | 0.46 |
| 2008 | 85.0 | 2.2E-02 | 0.82 | 47.4 | 36.6 | 0.10 |
| 2009 | 85.8 | 1.3E-02 | 0.98 | 48.0 | 36.7 | 0.10 |
| 2010 | 85.6 | 3.6E-03 | 1.10 | 48.9 | 35.5 | 0.10 |
| 2011 | 78.3 | 2.4E-03 | 1.43 | 41.0 | 35.7 | 0.14 |
| 2012 | 79.4 | 6.1E-03 | 1.19 | 42.8 | 35.3 | 0.17 |

## *NMVOC emissions*

NMVOCs also originated from the Other Sectors and Transport sub-categories mainly. The emissions from these two sub-categories represented 98.1 % of emissions (Table 2.30) of the Energy sector. Emissions increased from 3.5 Gg in 2000 to 4.7 Gg in 2012 for transport and varied around 6 Gg for the same period for the Other sectors sub-category. Total NMVOC emissions increased from 9.4 Gg in 2000 to 11.3 Gg in 2009 and fell slightly to 10.8 Gg in 2012 in the Energy sector.

**Table 2.30. NMVOCs emissions (Gg) (2000 - 2012)**

| Year | Total | Energy Industries | Manufacturing Industries and Construction | Transport | Other Sectors | Non-Specified |
|---|---|---|---|---|---|---|
| **2000** | 9.4 | 1.0E-04 | 0.07 | 3.5 | 5.8 | 0.02 |
| **2001** | 9.6 | 1.0E-04 | 0.07 | 3.6 | 5.9 | 0.02 |
| **2002** | 9.8 | 0 | 0.08 | 3.7 | 6.0 | 0.02 |
| **2003** | 10.1 | 3.0E-04 | 0.08 | 4.0 | 6.1 | 0.02 |
| **2004** | 10.5 | 0 | 0.18 | 4.2 | 6.1 | 0.03 |
| **2005** | 10.8 | 6.0E-04 | 0.17 | 4.5 | 6.1 | 0.03 |
| **2006** | 10.9 | 0.002 | 0.18 | 4.6 | 6.1 | 0.03 |
| **2007** | 11.1 | 0.002 | 0.18 | 4.9 | 6.0 | 0.03 |
| **2008** | 11.2 | 0.003 | 0.17 | 4.9 | 6.0 | 0.03 |
| **2009** | 11.3 | 0.002 | 0.18 | 5.0 | 6.1 | 0.02 |
| **2010** | 11.2 | 4.0E-04 | 0.20 | 5.1 | 5.9 | 0.02 |
| **2011** | 10.7 | 3.0E-04 | 0.23 | 4.5 | 6.0 | 0.03 |
| **2012** | 10.8 | 9.0E-04 | 0.21 | 4.7 | 5.9 | 0.03 |

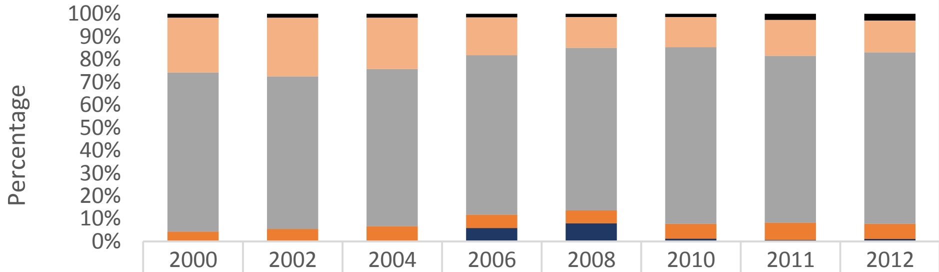
## *SO₂ emissions*

Emissions (Gg) of $SO_2$ across the period were more important in the Other Sectors sub-category followed by the Manufacturing Industries and Construction sub-category (Table 2.31). However, emissions in that sub-category varied between 1.6 Gg and 2.8 Gg while in the Manufacturing and Construction sub-category, the emissions increased consistently from 0.03 Gg in the year 2000 to 0.96 in 2012. Total $SO_2$ emissions in the Energy sector increased from 2.2 Gg in 2000 to peak at 4.2 in the years 2006 and 2008. Thereafter, emissions decreased to 2.9 Gg in 2012.

**Table 2.31. $SO_2$ emissions (Gg) (2000 - 2012)**

| Year | Total | Energy Industries | Manufacturing Industries and Construction | Transport | Other Sectors | Non-Specified |
|---|---|---|---|---|---|---|
| **2000** | 2.2 | 0.06 | 0.03 | 0.02 | 2.1 | 2.0.E-04 |
| **2001** | 2.4 | 0.08 | 0.03 | 0.02 | 2.3 | 2.0.E-04 |
| **2002** | 2.8 | 0.00 | 0.03 | 0.02 | 2.7 | 2.0.E-04 |
| **2003** | 3.0 | 0.18 | 0.03 | 0.02 | 2.8 | 2.0.E-04 |
| **2004** | 3.6 | 0.02 | 0.92 | 0.02 | 2.6 | 2.0.E-04 |
| **2005** | 3.8 | 0.46 | 0.80 | 0.02 | 2.5 | 2.0.E-04 |
| **2006** | 4.2 | 1.40 | 0.81 | 0.02 | 2.0 | 2.0.E-04 |
| **2007** | 4.0 | 1.67 | 0.72 | 0.02 | 1.6 | 2.0.E-04 |
| **2008** | 4.2 | 2.04 | 0.62 | 0.02 | 1.5 | 2.0.E-04 |
| **2009** | 3.7 | 1.23 | 0.78 | 0.02 | 1.7 | 2.0.E-04 |
| **2010** | 2.7 | 0.30 | 0.89 | 0.02 | 1.5 | 2.0.E-04 |
| **2011** | 3.3 | 0.15 | 1.20 | 0.02 | 1.9 | 2.0E-04 |
| **2012** | 2.9 | 0.25 | 0.96 | 0.02 | 1.7 | 3.0E-04 |

Across the reporting period, the share of emissions from the five sub-categories, expressed as a % of total emissions on a $CO_2$-eq basis, is highest from the Transport sub-category, which increased from 70 % in 2000 to 78 % in 2010 (Figure 2.14) to decrease to 75% in 2012. Emissions from the Manufacturing Industries and Construction sub-category increased from 4.0 % in 2000 to 7.6 % in 2011, whilst the Energy Industries sub-category emissions increased from 0.4 % in 2000 to peak at 8 % in 2008 and thereafter decreased to 1 % of the total in 2012. Other Sectors sub-category witnessed a decrease in emissions from the year 2000 to 2012, namely from 24% to 13.8 %. The Non-specified sub-category decreased from 1.8 % to 1.4 % from the year 2000 to 2010 but increased again to reach 3.1 % in 2012.




| | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| Non-specified | 1.8 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 2.7 | 3.1 |
| Other sectors | 24.0 | 25.8 | 22.5 | 16.6 | 13.5 | 13.2 | 15.8 | 13.8 |
| Transport | 69.9 | 67.0 | 69.1 | 70.0 | 71.4 | 77.7 | 73.2 | 75.3 |
| Manufacturing Industries & Construction | 4.0 | 5.4 | 6.6 | 5.9 | 5.7 | 6.5 | 7.6 | 6.7 |
| Energy Industries | 0.4 | 0.0 | 0.1 | 5.9 | 7.9 | 1.2 | 0.7 | 1.1 |

**Figure 2.14. Share of emissions ($CO_2$-eq) Energy sector sub-categories (2000 - 2012)**

## *Emissions (Gg) by gas from Energy Generation*

Within the Energy Generation sub-category, GHG emissions, in Gg $CO_2$-eq, increased from 7 Gg in 2000 to reach a peak at 237 Gg in 2008 and then decreased to 36 Gg in 2012 (Table 2.32). The largest share of emission came from $CO_2$.

**Table 2.32. Emissions (Gg) by gas from energy generation (2000 - 2012)**

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 73 | 7.3 | 1.1.E-04 | 1.E-04 | 0.02 | 7.0.E-04 | 1.0E-04 | 0.06 |
| **2001** | 9.2 | 9.2 | 1.4.E-04 | 1.E-04 | 0.02 | 9.0.E-04 | 1.0E-04 | 0.08 |
| **2002** | 0.5 | 0.5 | 3.9.E-06 | 4.E-06 | 0.001 | 1.0.E-04 | 0 | 0.003 |
| **2003** | 21.5 | 21.3 | 3.2.E-0.4 | 3.E-04 | 0.05 | 2.2.E-03 | 3.0E-04 | 0.18 |
| **2004** | 2.2 | 2.2 | 3.1.E-05 | 3.E-05 | 0.00 | 2.0.E-04 | 0.0E+00 | 0.02 |
| **2005** | 53.9 | 53.6 | 8.2.E-04 | 8.E-04 | 0.12 | 5.3.E-03 | 6.0E-04 | 0.46 |
| **2006** | 164.9 | 164.1 | 2.5.E-03 | 3.E-03 | 0.36 | 3.6.E-01 | 1.9E-03 | 1.40 |
| **2007** | 196.0 | 195.0 | 3.0.E-03 | 3.E-03 | 0.43 | 4.3.E-01 | 2.2E-03 | 1.67 |
| **2008** | 236.9 | 235.7 | 3.7.E-03 | 4.E-03 | 0.52 | 2.2.E-02 | 2.5E-03 | 2.04 |
| **2009** | 143.4 | 142.6 | 2.2.E-03 | 2.E-03 | 0.31 | 1.3.E-02 | 1.6E-03 | 1.23 |
| **2010** | 35.7 | 35.5 | 5.3.E-04 | 5.E-04 | 0.08 | 3.6.E-03 | 4.0E-04 | 0.30 |
| **2011** | 18.7 | 18.6 | 3.9E-04 | 2.4E-04 | 0.04 | 2.4E-03 | 3.0E-04 | 0.15 |
| **2012** | 36.4 | 36.3 | 1.1E-03 | 3.6E-04 | 0.07 | 6.1E-03 | 9.0E-04 | 0.25 |

## *Emissions (Gg) by gas from Mining and Quarrying*

Within the Mining and Quarrying sub-category, GHG emissions, expressed as Gg $CO_2$-eq, increased from 77 Gg in 2000 to peak at 216 Gg in 2011 (Table 2.33), and then regressing to 196 Gg in 2012. Nearly all emissions (99.2 %) stemmed from $CO_2$. Emissions increased by 153 % when compared with the year 2000 with a very sharp increase from 2000 to 2001.

**Table 2.33. Emissions (Gg) by gas from the Mining and Quarrying sub-category (2000 - 2012)**

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 77.4 | 76.7 | 9.E-03 | 1.E-03 | 0.37 | 0.2 | 0.07 | 0.03 |
| **2001** | 154.8 | 153.6 | 2.E-02 | 3.E-03 | 0.33 | 0.1 | 0.07 | 0.03 |
| **2002** | 121.4 | 120.4 | 1.E-02 | 2.E-03 | 0.32 | 0.2 | 0.08 | 0.03 |
| **2003** | 155.6 | 154.4 | 2.E-02 | 3.E-03 | 0.34 | 0.2 | 0.08 | 0.03 |
| **2004** | 166.7 | 165.4 | 2.E-02 | 3.E-03 | 0.58 | 1.1 | 0.18 | 0.92 |
| **2005** | 153.8 | 152.5 | 2.E-02 | 3.E-03 | 0.55 | 1.0 | 0.17 | 0.79 |
| **2006** | 163.1 | 161.8 | 2.E-02 | 3.E-03 | 0.61 | 0.6 | 0.17 | 0.81 |
| **2007** | 172.4 | 171.1 | 2.E-02 | 3.E-03 | 0.72 | 0.7 | 0.18 | 0.71 |
| **2008** | 168.4 | 167.2 | 2.E-02 | 3.E-03 | 0.75 | 0.8 | 0.17 | 0.62 |
| **2009** | 177.5 | 176.2 | 2.E-02 | 3.E-03 | 0.72 | 1.0 | 0.18 | 0.78 |
| **2010** | 185.6 | 184.2 | 2.E-02 | 3.E-03 | 0.71 | 1.1 | 0.19 | 0.89 |
| **2011** | 215.8 | 214.1 | 2.5E-02 | 3.7E-03 | 0.74 | 1.4 | 0.23 | 1.20 |
| **2012** | 195.5 | 193.9 | 2.3E-02 | 3.4E-03 | 0.73 | 1.2 | 0.21 | 0.96 |

## *Emissions (Gg) by gas from Non-Specified Industry*

GHG emissions (Gg $CO_2$-eq) in the Non-specified Industry sub-category (Table 2.34) increased from 1.7 Gg the year 2000 to 2.4 Gg in 2012, representing a 41 % increase, with nearly all emissions (99.7 %) from $CO_2$.

**Table 2.34. Emissions (Gg) by gas from the Non-Specified Industry sub-category (2000 - 2012)**

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 1.7 | 1.7 | 7.0.E-05 | 1.4.E-05 | 1.2.E-02 | 1.5.E-03 | 6.0.E-04 | 1.1.E-03 |
| **2001** | 1.7 | 1.7 | 7.0.E-05 | 1.4.E-05 | 1.2.E-02 | 1.5.E-03 | 6.0.E-04 | 1.1.E-03 |
| **2002** | 1.7 | 1.7 | 7.0.E-05 | 1.4.E-05 | 1.2.E-02 | 1.5.E-03 | 6.0.E-04 | 1.1.E-03 |
| **2003** | 1.9 | 1.9 | 7.7.E-05 | 1.5.E-05 | 1.3.E-02 | 1.7.E-03 | 6.0.E-04 | 1.2.E-03 |
| **2004** | 2.0 | 2.0 | 8.3.E-05 | 1.7.E-05 | 1.4.E-02 | 1.8.E-03 | 7.0.E-04 | 1.3.E-03 |
| **2005** | 2.0 | 2.0 | 8.2.E-05 | 1.6.E-05 | 1.4.E-02 | 1.8.E-03 | 7.0.E-04 | 1.3.E-03 |
| **2006** | 2.0 | 2.0 | 8.3.E-05 | 1.7.E-05 | 1.4.E-02 | 1.4.E-02 | 7.0.E-04 | 1.3.E-03 |
| **2007** | 2.0 | 2.0 | 8.3.E-05 | 1.7.E-05 | 1.4.E-02 | 1.4.E-02 | 7.0.E-04 | 1.3.E-03 |
| **2008** | 2.0 | 2.0 | 8.3.E-05 | 1.7.E-05 | 1.4.E-02 | 1.8.E-03 | 7.0.E-04 | 1.3.E-03 |
| **2009** | 2.1 | 2.1 | 8.8.E-05 | 1.8.E-05 | 1.5.E-02 | 1.9.E-03 | 7.0.E-04 | 1.4.E-03 |
| **2010** | 2.2 | 2.2 | 9.1.E-05 | 1.8.E-05 | 1.6.E-02 | 2.0.E-03 | 8.0.E-04 | 1.4.E-03 |
| **2011** | 2.1 | 2.1 | 8.7E-05 | 1.7E-05 | 1.5E-02 | 1.9E-03 | 7.0E-04 | 1.4E-03 |
| **2012** | 2.4 | 2.4 | 9.8E-05 | 2.0E-05 | 1.7E-02 | 2.2E-03 | 8.0E-04 | 1.5E-03 |

## ***Emissions (Gg) by gas from Civil Aviation***

The two main gases emitted in the Civil Aviation sub-category were $CO_2$, 19 Gg in 2000 increasing to 27 Gg in 2012 and CO, 3.6 Gg in 2000 which decreased to 2.2 Gg in 2012 after an increase to 4.3 Gg in 2010 (Table 2.35).

**Table 2.35. Emissions (Gg) by gas from the Civil Aviation sub-category (2000 - 2012)**

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 19.1 | 18.9 | 1.3.E-04 | 5.4.E-04 | 4.4.E-02 | 3.6 | 5.8.E-02 | 6.1.E-03 |
| **2001** | 19.3 | 19.1 | 1.4.E-04 | 5.4.E-04 | 4.4.E-02 | 3.7 | 5.8.E-02 | 6.1.E-03 |
| **2002** | 19.5 | 19.3 | 1.4.E-04 | 5.5.E-04 | 4.5.E-02 | 3.7 | 5.9.E-02 | 6.2.E-03 |
| **2003** | 19.7 | 19.5 | 1.4.E-04 | 5.5.E-04 | 4.5.E-02 | 3.7 | 5.9.E-02 | 6.3.E-03 |
| **2004** | 19.9 | 19.7 | 1.4.E-04 | 5.6.E-04 | 4.6.E-02 | 3.8 | 6.0.E-02 | 6.3.E-03 |
| **2005** | 20.1 | 19.9 | 1.4.E-04 | 5.7.E-04 | 4.6.E-02 | 3.8 | 6.1.E-02 | 6.4.E-03 |
| **2006** | 20.3 | 20.1 | 1.4.E-04 | 5.7.E-04 | 4.7.E-02 | 3.9 | 6.1.E-02 | 6.5.E-03 |
| **2007** | 20.7 | 20.5 | 1.5.E-04 | 5.8.E-04 | 4.7.E-02 | 3.9 | 6.3.E-02 | 6.6.E-03 |
| **2008** | 20.5 | 20.4 | 1.4.E-04 | 5.8.E-04 | 4.7.E-02 | 3.9 | 6.1.E-02 | 6.5.E-03 |
| **2009** | 20.6 | 20.5 | 1.5.E-04 | 5.8.E-04 | 4.8.E-02 | 3.9 | 6.1.E-02 | 6.6.E-03 |
| **2010** | 22.1 | 21.9 | 1.6.E-04 | 6.2.E-04 | 5.0.E-02 | 4.3 | 6.9.E-02 | 7.1.E-03 |
| **2011** | 23.6 | 23.4 | 1.6E-04 | 6.6E-04 | 6.7E-02 | 1.9 | 3.0E-02 | 7.5E-03 |
| **2012** | 27.4 | 27.2 | 1.9E-04 | 7.7E-04 | 7.8E-02 | 2.2 | 3.5E-02 | 8.7E-03 |

## ***Emissions (Gg) by gas from Road Transportation***

The Road Transportation sub-category (Table 2.36) sub-category emissions, emitted 1334 Gg $CO_2$-eq in 2000 compared to 2163 Gg $CO_2$-eq in 2012. Emissions of $NO_x$ increased from 8 Gg in 2000 to reach 13 Gg in 2012, representing a 62 % increase. CO and NMVOCs emissions increased over the period, from 31 Gg to 40 Gg for CO and from 3.4 Gg to 4.6 Gg for NMVOCs for the years 2000 and 2012 respectively.

Table 2.36. Emissions (Gg) by gas from the Road Transportation sub-category

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 1333.7 | 1306.0 | 0.37 | 0.06 | 7.7 | 30.9 | 3.4 | 1.E-02 |
| **2001** | 1379.9 | 1351.3 | 0.38 | 0.07 | 8.0 | 31.5 | 3.4 | 1.E-02 |
| **2002** | 1456.0 | 1425.9 | 0.40 | 0.07 | 8.4 | 32.9 | 3.6 | 1.E-02 |
| **2003** | 1566.7 | 1534.4 | 0.43 | 0.08 | 9.1 | 35.0 | 3.8 | 1.E-02 |
| **2004** | 1700.3 | 1665.3 | 0.46 | 0.08 | 9.9 | 37.5 | 4.1 | 1.E-02 |
| **2005** | 1818.1 | 1780.8 | 0.48 | 0.09 | 10.6 | 39.5 | 4.3 | 1.E-02 |
| **2006** | 1881.9 | 1843.2 | 0.50 | 0.09 | 11.0 | 40.5 | 4.5 | 2.E-02 |
| **2007** | 2000.6 | 1959.6 | 0.53 | 0.10 | 11.6 | 42.3 | 4.7 | 2.E-02 |
| **2008** | 2056.7 | 2014.6 | 0.54 | 0.10 | 12.0 | 43.4 | 4.8 | 2.E-02 |
| **2009** | 2116.2 | 2073.0 | 0.54 | 0.10 | 12.5 | 44.0 | 4.9 | 2.E-02 |
| **2010** | 2181.0 | 2136.7 | 0.55 | 0.11 | 13.0 | 44.4 | 4.9 | 2.E-02 |
| **2011** | 2017.5 | 1977.0 | 0.5 | 0.10 | 12.4 | 39.0 | 4.4 | 1.4E-02 |
| **2012** | 2162.8 | 2119.5 | 0.5 | 0.11 | 13.3 | 40.4 | 4.6 | 1.5E-02 |

## Emissions (Gg) by gas from Railways

Within the Railways sub-category, GHG emissions (Gg $CO_2$-eq), increased by nearly 23 % over the period, from 41 Gg in 2000 to 51 Gg in 2012 (Table 2.37), with the largest share of emissions (99.7 %) from $CO_2$.

Table 2.37. Emissions (Gg) by gas from the Railways sub-category (2000 - 2012)

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 41.2 | 41.1 | 1.7.E-03 | 3.3.E-04 | 0.68 | 0.14 | 6.1.E-02 | 1.0.E-04 |
| **2001** | 43.5 | 43.4 | 1.8.E-03 | 3.5.E-04 | 0.71 | 0.15 | 6.4.E-02 | 1.0.E-04 |
| **2002** | 45.8 | 45.6 | 1.8.E-03 | 3.7.E-04 | 0.75 | 0.15 | 6.7.E-02 | 1.0.E-04 |
| **2003** | 48.0 | 47.9 | 1.9.E-03 | 3.9.E-04 | 0.79 | 0.16 | 7.1.E-02 | 1.0.E-04 |
| **2004** | 50.3 | 50.1 | 2.0.E-03 | 4.1.E-04 | 0.82 | 0.17 | 7.4.E-02 | 1.0.E-04 |
| **2005** | 52.5 | 52.4 | 2.1.E-03 | 4.2.E-04 | 0.86 | 0.18 | 7.7.E-02 | 1.0.E-04 |
| **2006** | 53.7 | 53.6 | 2.2.E-03 | 4.3.E-04 | 0.88 | 0.18 | 7.9.E-02 | 1.0.E-04 |
| **2007** | 55.0 | 54.8 | 2.2.E-03 | 4.4.E-04 | 0.90 | 0.18 | 8.1.E-02 | 1.0.E-04 |
| **2008** | 51.2 | 51.1 | 2.1.E-03 | 4.1.E-04 | 0.84 | 0.17 | 7.5.E-02 | 1.0.E-04 |
| **2009** | 50.2 | 50.1 | 2.0.E-03 | 4.1.E-04 | 0.82 | 0.17 | 7.4.E-02 | 1.0.E-04 |
| **2010** | 51.9 | 51.8 | 2.0.E-03 | 4.1.E-04 | 0.86 | 0.18 | 7.7.E-02 | 1.0.E-04 |
| **2011** | 47.0 | 46.9 | 1.8E-03 | 3.7E-04 | 0.78 | 0.16 | 7.0E-02 | 1.0E-04 |
| **2012** | 50.7 | 50.5 | 2.0E-03 | 4.0E-04 | 0.84 | 0.17 | 7.5E-02 | 1.0E-04 |

## Emissions (Gg) by gas from the Residential sub-category

Emissions in the Residential sub-category (Gg $CO_2$-eq) increased from 155 in the year 2000 to reach a peak of 177 in 2009 (Table 2.38) and then regressing to 157 Gg $CO_2$-eq in 2012. The main direct contributors were CO2 and CH4 to the tune of 61 % and 32 % of the total emissions in 2012.Emissions of $NO_x$, NMVOC and CO did not change much over the period 2000 to 2010. NOx stood at around 0.66 Gg, NMVOC around 4.9 Gg and CO around 32.6 Gg.

**Table 2.38. Emissions (Gg) by gas from the Residential sub-category (2000 - 2012)**

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 155.2 | 93.6 | 2.4 | 3.3.E-02 | 0.67 | 32.9 | 4.9 | 9.0.E-02 |
| **2001** | 156.5 | 94.1 | 2.5 | 3.3.E-02 | 0.67 | 33.2 | 5.0 | 9.1.E-02 |
| **2002** | 163.1 | 100.7 | 2.5 | 3.3.E-02 | 0.68 | 33.4 | 5.0 | 9.2.E-02 |
| **2003** | 165.4 | 102.8 | 2.5 | 3.3.E-02 | 0.68 | 33.4 | 5.0 | 9.2.E-02 |
| **2004** | 176.8 | 114.1 | 2.5 | 3.3.E-02 | 0.68 | 33.4 | 5.0 | 9.2.E-02 |
| **2005** | 166.5 | 103.9 | 2.5 | 3.3.E-02 | 0.68 | 33.5 | 5.0 | 9.2.E-02 |
| **2006** | 161.5 | 98.8 | 2.5 | 3.3.E-02 | 0.68 | 33.5 | 5.0 | 9.2.E-02 |
| **2007** | 161.5 | 98.9 | 2.5 | 3.3.E-02 | 0.68 | 33.5 | 5.0 | 9.2.E-02 |
| **2008** | 176.5 | 113.8 | 2.5 | 3.3.E-02 | 0.68 | 33.4 | 5.0 | 9.2.E-02 |
| **2009** | 177.3 | 114.7 | 2.5 | 3.3.E-02 | 0.67 | 33.4 | 5.0 | 9.2.E-02 |
| **2010** | 153.3 | 90.9 | 2.5 | 3.3.E-02 | 0.65 | 32.2 | 4.8 | 8.9.E-02 |
| **2011** | 158.6 | 96.2 | 2.5 | 3.3.E-02 | 0.65 | 32.1 | 4.8 | 8.8E-02 |
| **2012** | 156.7 | 95.2 | 2.4 | 3.3.E-02 | 0.64 | 31.7 | 4.8 | 8.7E-02 |

### *Emissions (Gg) by gas from Fishing (mobile combustion) sub-category*

Total GHG emission from the Fishing sub-category increased from 324 Gg $CO_2$-eq in 2000 to 435 Gg $CO_2$-eq in 2003 and then fluctuated to reach 255 Gg $CO_2$-eq (Table 2.39) in the year 2012. The largest share of emissions, above 99 %, was $CO_2$. Emissions of all gases, the direct GHGs and precursors as well as $SO_2$ followed the same trend as CO2. SO2 emissions are relatively more important when compared with the other sub-categories. This decrease observed up to 2003 is due to lower fishing activities because of the depletion of fish stocks and the fluctuations thereafter attributable to the imposition of fishing quotas.

**Table 2.39. Emissions (Gg) by gas from the Fishing sub-category (2000 - 2012)**

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 324.1 | 322.4 | 0.04 | 0.00 | 7.7 | 2.6 | 0.87 | 2.0 |
| **2001** | 353.5 | 351.6 | 0.05 | 0.00 | 8.4 | 2.8 | 0.93 | 2.2 |
| **2002** | 421.3 | 419.0 | 0.06 | 0.00 | 10.1 | 3.0 | 1.02 | 2.6 |
| **2003** | 434.6 | 432.3 | 0.06 | 0.00 | 10.4 | 3.2 | 1.06 | 2.7 |
| **2004** | 399.9 | 397.8 | 0.05 | 0.00 | 9.5 | 3.2 | 1.06 | 2.5 |
| **2005** | 384.4 | 382.4 | 0.05 | 0.00 | 9.1 | 3.2 | 1.08 | 2.4 |
| **2006** | 303.9 | 302.3 | 0.04 | 0.00 | 7.2 | 3.2 | 1.04 | 1.9 |
| **2007** | 244.2 | 242.9 | 0.03 | 0.00 | 5.7 | 3.1 | 1.02 | 1.5 |
| **2008** | 224.8 | 223.6 | 0.03 | 0.00 | 5.2 | 3.2 | 1.03 | 1.4 |
| **2009** | 256.8 | 255.4 | 0.03 | 0.00 | 6.0 | 3.3 | 1.09 | 1.6 |
| **2010** | 230.7 | 229.5 | 0.03 | 0.00 | 5.3 | 3.4 | 1.10 | 1.4 |
| **2011** | 290.8 | 289.3 | 0.04 | 2.4E-03 | 6.8 | 3.6 | 1.18 | 1.8 |
| **2012** | 255.1 | 253.8 | 0.03 | 2.1E-03 | 5.9 | 3.6 | 1.18 | 1.6 |

### *Emissions (Gg) by gas from Non-Specified subcategory*

Emissions from this sub-category are mainly from mobile sources. Total emissions ($CO_2$-eq) increased gradually from 35 Gg $CO_2$-eq in the year 2000 to 42 Gg $CO_2$-eq in 2010 and then shot to 77 and 92 Gg $CO_2$-eq in 2011 and 2012 (Table 2.40). $CO_2$ represented some 98 % of these total emissions in 2012.

**Table 2.40. Emissions (Gg) by gas from the Non-Specified sub-category (2000 - 2012)**

| Year | $CO_2$-eq | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **2000** | 35.0 | 34.4 | 1.8.E-03 | 1.8.E-03 | 0.36 | 0.08 | 2.1.E-02 | 2.0.E-04 |
| **2001** | 38.3 | 37.6 | 2.0.E-03 | 2.0.E-03 | 0.39 | 0.09 | 2.2.E-02 | 2.0.E-04 |
| **2002** | 40.0 | 39.3 | 2.1.E-03 | 2.1.E-03 | 0.41 | 0.09 | 2.3.E-02 | 2.0.E-04 |
| **2003** | 41.7 | 41.0 | 2.2.E-03 | 2.2.E-03 | 0.43 | 0.10 | 2.4.E-02 | 2.0.E-04 |
| **2004** | 43.6 | 42.8 | 2.3.E-03 | 2.3.E-03 | 0.45 | 0.10 | 2.6.E-02 | 2.0.E-04 |
| **2005** | 43.8 | 43.1 | 2.3.E-03 | 2.3.E-03 | 0.45 | 0.10 | 2.6.E-02 | 2.0.E-04 |
| **2006** | 44.2 | 43.4 | 2.3.E-03 | 2.3.E-03 | 0.46 | 0.46 | 2.6.E-02 | 2.0.E-04 |
| **2007** | 44.3 | 43.6 | 2.3.E-03 | 2.3.E-03 | 0.46 | 0.46 | 2.6.E-02 | 2.0.E-04 |
| **2008** | 43.8 | 43.0 | 2.3.E-03 | 2.3.E-03 | 0.45 | 0.10 | 2.6.E-02 | 2.0.E-04 |
| **2009** | 42.2 | 41.4 | 2.2.E-03 | 2.2.E-03 | 0.43 | 0.10 | 2.5.E-02 | 2.0.E-04 |
| **2010** | 41.5 | 40.8 | 2.1.E-03 | 2.1.E-03 | 0.43 | 0.10 | 2.4.E-02 | 2.0.E-04 |
| **2011** | 77.1 | 75.5 | 1.8E-02 | 3.8E-03 | 0.46 | 0.14 | 2.9E-02 | 2.0E-04 |
| **2012** | 91.6 | 89.7 | 2.1E-02 | 4.5E-03 | 0.54 | 0.17 | 3.5E-02 | 3.0E-04 |

## 2.4. Industrial processes and product use

### 2.4.1. Description of IPPU sector

Greenhouse gas emissions occur during the process of production of a wide range of industrial products. Emissions arise 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 when fossil fuels are used as chemical feedstock). The cement industry is another notable example of an industrial process that releases 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 and include $SF_6$ and NMVOC.

Activities occurred in three out of the eight categories falling under the IPPU sector and emissions were estimated for these source categories, namely cement production and lime production under mineral industry, and zinc production under metal industry. As well as lubricants and paraffin wax use under non-energy products under the fuel and solvents use category was covered for its emissions.

Quite a number of activity areas have not been included as activity data were still not available to compute the estimates despite special efforts being devoted to collect these AD. ODS have been identified but they are all blends and work is ongoing to trace the exact amounts and the different blends including their composition for estimating emissions. These sources are.

- **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

### 2.4.2. Methods

The method adopted is according to the IPCC 2006 Guidelines, at the Tier 1 level, due to unavailability of disaggregated information on the technologies used in the production processes for moving to higher Tiers. Only the three main GHGs $CO_2$, $CH_4$ and $N_2O$ were estimated through computations made using the IPCC 2006 software. Other gases are not emitted in the reported categories.

### 2.4.3. Activity Data

Activity data for the IPPU sector were obtained mainly from the NSA and complemented with those requested from the industrialists. Outputs from the production units and the annual report of the Chamber of Mines were used to supplement the import and export AD from the NSA for the metal industry. All AD from the different sources were compared and quality controlled to identify the most reliable sets which were then used in the software for generating emissions. AD for lubricants and paraffin wax use were derived from the mass balance of import and export data. Activity data used for the time series is shown in Table 2.41.

**Table 2.41. Activity data for the IPPU sector (2000 - 2012)**

| Year | Cement production (t) | Lime production (t) | Zinc production t) | Lubricant use (TJ) | Paraffin wax (TJ) |
|---|---|---|---|---|---|
| **2000** | * | 9 161 | * | 38.8 | 1182.5 |
| **2001** | * | 10 735 | * | 18.0 | 1098.2 |
| **2002** | * | 11 200 | 35 | 11.8 | 1189.0 |
| **2003** | * | 12 400 | 47 436 | 81.3 | 1219.3 |
| **2004** | * | 12 600 | 119 205 | 22.0 | 1374.5 |
| **2005** | * | 13 050 | 132 813 | 251.8 | 1236.7 |
| **2006** | * | 13 500 | 129 897 | 280.2 | 1168.6 |
| **2007** | * | 14 500 | 150 800 | 450.2 | 1171.0 |
| **2008** | * | 15 400 | 145 396 | 598.4 | 1391.9 |
| **2009** | * | 17 600 | 150 400 | 619.3 | 1446.7 |
| **2010** | * | 19 800 | 151 688 | 558.7 | 1225.5 |
| **2011** | 284 000 | 17 600 | 144 755 | 612.3 | 1315.1 |
| **2012** | 504 000 | 17 600 | 145 342 | 615.0 | 1315.1 |

* No activity

### 2.4.4. 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's development level, the factor associated with developing countries was chosen. The EFs used for the different source categories are listed in Table 2.42.

Table 2.42. References for EFs for the IPPU sector

| Category | IPPC 2006 Guideline | Table and page No. |
|---|---|---|
| Cement | V3_2_Ch2 Mineral Industry | Chapter 2.2.1.2 Page 2.11 |
| Liming | V3_2_Ch2 Mineral Industry | Table 2.4 Page 2.22 |
| 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 |

### 2.4.5. Emission estimates

Total aggregated emissions also representing estimates by sub-category is given in Table 2.43 as they did not differ being only $CO_2$. Aggregated emissions for the IPPU sector which amounted to 25.0 Gg $CO_2$-eq in the year 2000, increased sharply in 2003 and 2011 when zinc and cement production started. Emissions reached 302.3 Gg $CO_2$-eq in 2010 and 421.2 Gg $CO_2$-eq in 2011. The Metal Industry category became the highest emitter of this sector and contributed 47.7 % in 2012. Cement production came next with 231.4 Gg $CO_2$-eq representing 44.2 %. Use of paraffin wax ranged between 16.1 to 19.3 Gg $CO_2$-eq during that period. The remaining two sources are lime production and lubricant use which stood in 2012 at 13.6 and 9.0 Gg $CO_2$-eq respectively.

Table 2.43. Aggregated emissions ($CO_2$-eq) by IPPU source category

| Source category | GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|
| **TOTAL** | **$CO_2$-eq** | **25.0** | **26.3** | **235.2** | **255.1** | **291.1** | **302.3** | **421.2** | **523.2** |
| 2.A.1 - Cement production | $CO_2$ | NO | NO | NO | NO | NO | NO | 130.4 | 231.4 |
| 2.A.2 - Lime production | $CO_2$ | 7.1 | 8.6 | 9.7 | 10.4 | 11.9 | 15.2 | 13.6 | 13.6 |
| 2.C.6 - Zinc Production | $CO_2$ | 0.0 | 0.1 | 205.0 | 223.4 | 250.1 | 260.9 | 249.0 | 250.0 |
| 2.D - Non-Energy Products from Fuels and Solvent Use | $CO_2$ | 17.9 | 17.6 | 20.5 | 21.2 | 29.2 | 26.2 | 28.3 | 28.3 |
| 2.D.1 - Lubricant Use | $CO_2$ | 0.6 | 0.2 | 0.3 | 4.1 | 8.8 | 8.2 | 9.0 | 9.0 |
| 2.D.2 - Paraffin Wax Use | $CO_2$ | 17.3 | 17.4 | 20.2 | 17.1 | 20.4 | 18.0 | 19.3 | 19.3 |

## 2.5. Agriculture, forest and other land use (AFOLU)

### 2.5.1. Description of sector

The AFOLU sector comprises activities responsible for GHG emissions and removals linked to Agriculture (crops and livestock), changes in land use among and between the 6 IPCC land use categories, soil organic matter dynamics, fertilizer use and management of land categories. Emissions and removals were estimated for activity areas falling under all four IPCC categories of this sector.

Country specific emission and stock factors derived for the country and used in the BUR1 report for the livestock and land categories were adopted while some additional amendments have been made to better represent the land sub-categories within the national context.

Various activities in the AFOLU sector occur in Namibia with different intensities. The country has both commercial and communal systems of production in the livestock and crop sectors. Land use changes due to human activities mainly in forestland, woodland, grassland and cropland were significant contributors to emissions while also acting as sinks.

### 2.5.1.1. Emission estimates for the AFOLU sector

The AFOLU sector remained a net sink over 12 out of the 13 years of the inventory period because the land sub-category removals exceeding total AFOLU emissions. However, the net removals decreased constantly over this period from 19 185 Gg $CO_2$-eq in the year 2000 to 339 in 2011 to change to a net emitter status in 2012 by 1577 Gg $CO_2$-eq. Emissions from livestock remained more or less constant for the period 2000 to 2010 and increased in 2011 and 2012. A small increase is observed for aggregate sources and non-$CO_2$ emissions from land. The land sub-category removed 26 191 Gg $CO_2$ in 2000 and this potential fell to 7462 Gg in 2012 (Table 2.44 and Figure 5.1).

**Table 2.44. Aggregated emissions ($CO_2$-eq) from the AFOLU sector**

| Source and sink Categories | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **3 - Agriculture, Forestry, and Other Land Use** | -19185.0 | -16123.7 | -12279.9 | -9422.3 | -5648.9 | -3472.2 | -338.5 | 1576.8 |
| **3.A - Livestock** | 4,513.5 | 4,390.1 | 4,419.9 | 4,367.0 | 4,819.7 | 4,181.5 | 5336.5 | 5677.4 |
| **3.A.1 - Enteric Fermentation** | 4,163.7 | 4,005.8 | 4,031.1 | 3,983.6 | 4,391.1 | 3,805.2 | 4857.8 | 5169.7 |
| **3.A.2 - Manure Management** | 349.8 | 384.3 | 388.8 | 383.5 | 428.5 | 376.3 | 478.7 | 507.7 |
| **3.B - Land** | -26,190.6 | -23,233.2 | -19,438.9 | -16,513.2 | -13,372.5 | -10,266.4 | -8849.8 | -7461.6 |
| **3.C - Aggregate sources and non-CO2 emissions sources on land** | 2492.2 | 2719.5 | 2739.1 | 2723.8 | 2903.9 | 2612.6 | 3174.7 | 3360.9 |

The evolution of the direct and indirect GHGs is given in Table 2.45. CO2 removals exceeded emissions over the whole period 2000 to 2012 but with a decreasing trend. Net removals declined from 26 190 Gg to 7461 Gg. Emissions of $CH_4$ increased by 23 % and $N_2O$ by 40 % during the period 2000 to 2012. NOx and NMVOCs emissions remained stable around 14 and 10 Gg respectively for the time series. Emissions of CO decreased by 3 %.

**Table 2.45. Emissions (Gg) by gas for AFOLU**

| GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| $CO_2$ - Emissions | 18 268.6 | 18 270.1 | 18 268.7 | 18 268.2 | 18 268.1 | 18 268.2 | 18 268.5 | 17 990.6 |
| $CO_2$ - Removals | -44 458.7 | -41 501.3 | -37 707.0 | -34 781.2 | -31 640.6 | -28 534.4 | -27 117.8 | -25 451.7 |
| $CO_2$ – Net removals | -26 190.1 | -23 231.1 | -19 438.3 | -16 513.0 | -13 372.4 | -10 266.3 | -8 849.3 | -7 461.1 |
| $CH_4$ | 215.3 | 208.2 | 209.4 | 207.0 | 226.8 | 198.0 | 249.6 | 265.0 |
| $N_2O$ | 8.0 | 8.8 | 8.9 | 8.9 | 9.5 | 8.5 | 10.5 | 11.2 |
| NOx | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 |
| CO | 290.2 | 288.7 | 287.2 | 285.8 | 284.3 | 282.8 | 282.0 | 281.5 |
| NMVOCs | 9.9 | 10.4 | 10.5 | 10.6 | 11.4 | 10.3 | 10.3 | 10.3 |

The evolution of aggregated emissions, excluding removals, of the three direct GHGs is presented in Figure 2.15. $CO_2$ was the major gas emitted throughout the period with 72.3 % in year 2000 (18 269 Gg $CO_2$-eq) decreasing to 66.6 % in 2012 (17991 $CO_2$-eq). CH4 emissions which stood at 4522 Gg $CO_2$-eq in 2000 (17.9 %) increased to 5565 Gg $CO_2$-eq, representing 20.6 % in 2012. N2O emissions progressed from 2483 Gg $CO_2$-eq (9.8 %) to 3473 Gg $CO_2$-eq (12.8 %) during the same period.

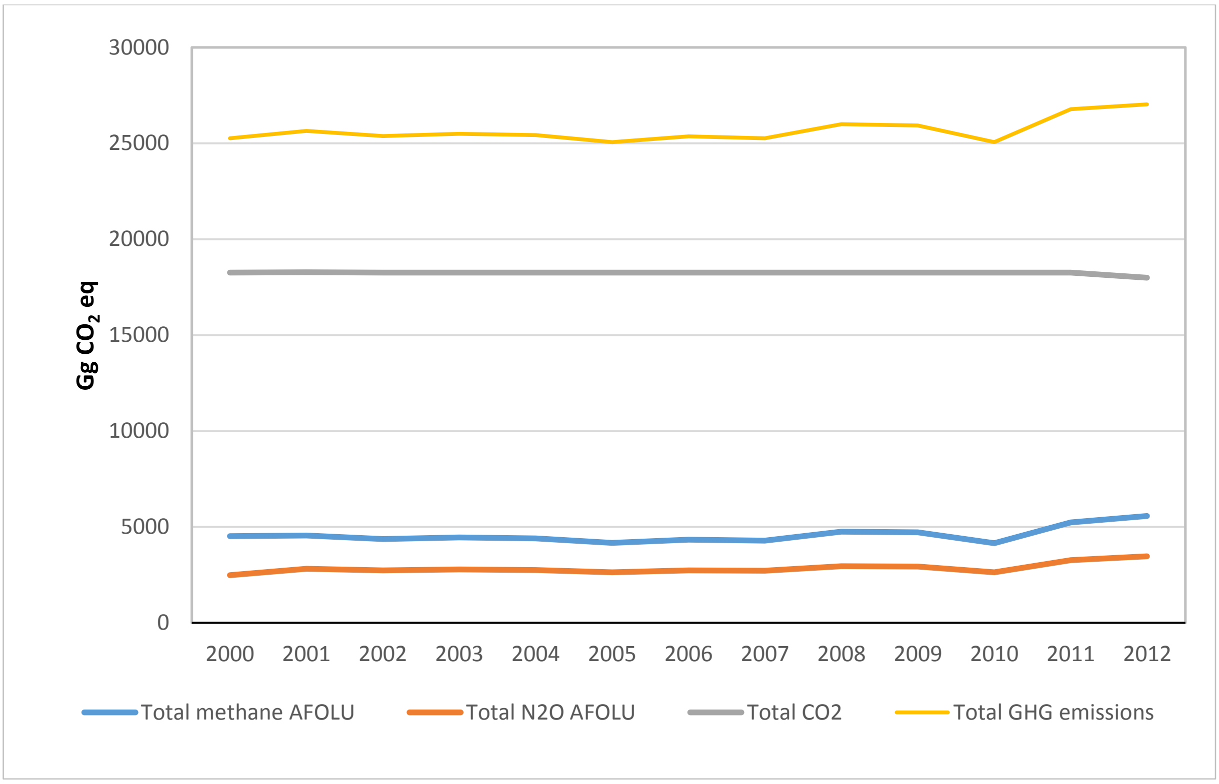



**Figure 2.15. Evolution of aggregated emissions ($CO_2$-eq) in the AFOLU sector (2000 - 2012)**

### 2.5.2. Livestock

Livestock rearing is an important activity in Namibia because its dry climate. Cattle rearing is the dominant component of the livestock sector followed by the smaller ruminants like goats and sheep. This activity occurs at the commercial and communal levels under different management conditions. Commercial chicken production is in its infancy while farmers are phasing out ostrich farming.

### 2.5.3. Methods

Tier 2 level has been adopted for cattle and dairy cows for both enteric fermentation and manure management while Tier 1 has been applied for all remaining animal groups. Available country specific data on live weight, pregnancy and other parameters were collected and used. Missing data were generated as described in the EF section later in this chapter. Derivation of methane EFs were done with the ALU software that uses the same IPCC principles and methods while the computation of nitrogen excretion rates for the different animal groups has been done using an Excel spreadsheet and the formula provided in the IPCC 2006 Guidelines.

#### 2.5.3.1. Activity Data

Information from the NSA and annual surveys done by the Ministry of Agriculture was used. The data is considered of good quality and the few missing data points were generated using statistical modelling techniques, interpolation or trend analysis. The livestock population used as AD for making emission estimate is provided in Table 2.46 for the years 2000, 2005, 2010, 2011 and 2012.

The number of dairy cows increased from 1500 over the inventory period 2000 to 2010 to 2500 for the years 2011 and 2012, following new AD collection. The remaining cattle in the commercial and communal sector was 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). This split on gender and age was available

for communal animals only and assumed to be the same for the commercial sector also in the absence of AD specific to this category.

Table 2.46. Number of animals in 2000, 2005 and 2010 - 2012

| | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| **Total cattle** | 2,504,930 | 2,219,330 | 2,389,891 | 2762240 | 2904451 |
| Sheep | 2,446,146 | 2,663,795 | 1,378,861 | 2209593 | 2677913 |
| Goats | 1,849,569 | 2,043,479 | 1,690,467 | 1736565 | 1933103 |
| Horses | 61,885 | 47,429 | 49,852 | 45529 | 46643 |
| Mules and asses | 167,548 | 140,291 | 141,588 | 105062 | 174946 |
| Swine | 23,148 | 55,931 | 63,498 | 43865 | 69430 |
| Poultry | 476,331 | 998,278 | 777,480 | 689030 | 946306 |
| Camels | 54 | 63 | 43 | 69 | 47 |

Average live weights for the non-dairy cattle sub-categories have been derived from slaughterhouse data of Meatco Namibia and animals auctioned by group, similar to those adopted for the segregation of the cattle for the inventory purposes. The live weight for dairy cows has been assumed the same as for commercial cows being slaughtered. Daily weight gain was derived from the live weight and age of the different animal groups at slaughtering or auction time.

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 slaughtered or sold by auction. For dairy and non-dairy commercial cattle, the mature animal weight adopted was 464 kg/head and for communal cattle, a typical mature weight of 451 kg was used.

#### 2.5.3.2. Emission factors

The management factors for livestock plays an important role in emissions. These factors depend on the feeding system, daily work performed, lactation period and frequency of pregnancy, feeding situation and the management of the excreta. These factors influence both enteric fermentation and manure management EFs. Livestock with cattle being the most important component results in emissions falling as a key category. Thus, emissions for cattle have been calculated using a Tier 2 approach as specified by IPCC methodologies. For the other animal groups, the default EFs (1996 IPCC GL, Table 4-3 to 4-5, p. 4.10-4.12, developing countries) have been used to compute enteric and manure methane emissions.

The EFs for enteric and manure $CH_4$ for cattle have been derived with the use of the ALU software which uses the same formulae as the IPCC 2006 software. Use of the ALU software rendered this exercise easier and less time-consuming as the programming already exists which avoided repeating the same exercise in new worksheets. The national EF for manure $N_2O$ was obtained by using the live weights along with default nitrogen excretion rates in the IPCC 2006 software. Country specific values were thus generated for use in making emission estimates. The datasets described above were used to calculate the maximum methane production capacity for the cattle sub-groups while default EFs from the IPCC 2006 Guidelines were used for the other animal groups.

The feeding situation is based on information available from the census and surveys conducted by the Ministry of Agriculture, Water Affairs and Forestry and NSA while manure management system (MMS) for cattle are based on country expert judgment and on information in the farming system guide (NNFU, 2006). Manure from dairy cows was assigned to the liquid slurry MMS while the manure from other cattle sub-categories were subdivided with 50 % under pasture/range/paddock, 49 % as solid storage

and 1 % used for construction (assigned to burning in the software as this process does not exist therein). For swine, liquid slurry was the MMS adopted, while for poultry, manure with bedding (60 %) and manure without bedding (40 %) was the case. PRP was assigned as the MMS for the remaining animal groups.

Pregnancy is derived from the number of young females in the population and intact males was allocated a percentage of the cattle population needed for reproduction purposes. It is assumed that a percentage young animals are sold annually as there exists no carrying capacity above a critical total number of heads of livestock. Moreover, data available on young animals being sold in auctions supported this assumption, which is further backed by 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 on an annual basis.

The digestible energy is taken from IPCC 2006, Chapter 10 annex Table 10A2 for animals in large grazing areas and based on feed characteristics obtained from Feed Master Ltd, the sole 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 members of the Namibian GHG inventory team for mature male castrates only, as the other animal groups do not perform any work.

### 2.5.4. Emission estimates for Livestock

Aggregated emission estimates from enteric fermentation and manure management are presented in Figure 2.16. Enteric fermentation remained the highest contributor to emissions and varied as a function of the number of animals recorded in that year. Enteric fermentation contributed about 4000 Gg $CO_2$-eq representing about 91 % and manure management the difference for the period 2000 to 2010. Emissions from enteric fermentation increased substantially as from 2011 as the number of dairy cows jumped from 1500 to 2500 heads. This is being further investigated to smooth the trend through a confirmation of a more precise evolution of the number of dairy cows annually during the period 2000 to 2012.

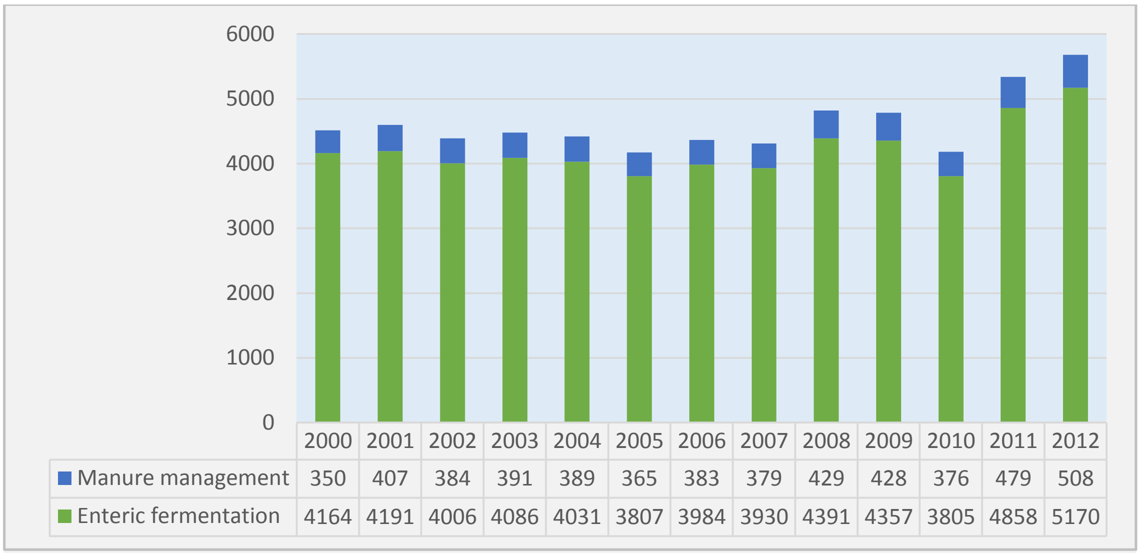



**Figure 2.16. Emissions (Gg $CO_2$-eq) from enteric fermentation and manure management of livestock (2000 - 2012)**

The evolution of emissions of the three gases methane, nitrous oxide and NMVOCs emitted by the Livestock category is given in Table 2.47.

**Table 2.47. Emissions (Gg) by gas for Livestock**

| GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| $CH_4$ | 204.1 | 197.0 | 198.3 | 196.0 | 215.9 | 187.1 | 238.7 | 254.2 |
| $N_2O$ | 0.7 | 0.8 | 0.8 | 0.8 | 0.9 | 0.8 | 1.0 | 1.1 |
| NMVOCs | 9.9 | 10.4 | 10.5 | 10.6 | 11.4 | 10.3 | 10.3 | 10.3 |

Methane varied in the range 187.1 to 254.2 Gg while nitrous oxide varied between 0.7 and 1.1 Gg. The sharp increase in 2011 and 2012 for these two gases is due to the higher number of heads of dairy cows as mentioned previously. NMVOCS dwindled around 10 Gg annually.

A typical summary report from the software for the emissions for the year 2010 with the contribution from each sub-category and animal group is presented in Table 2.48.

**Table 2.48. Summary of emissions from livestock**

| Inventory Year: 2012 | | | | | |
|---|---|---|---|---|---|
| Categories | Emissions | | | | |
| | CH4 | N2O | NOx | CO | NMVOCs |
| **3 - Agriculture, Forestry, and Other Land Use** | 265.0 | 11.2 | 13.7 | 281.5 | 10.3 |
| **3.A - Livestock** | 254.2 | 1.1 | 0 | 0 | 10.3 |
| 3.A.1 - Enteric Fermentation | 246.2 | 0 | 0 | 0 | 0 |
| 3.A.1.a - Cattle | 220.5 | 0 | 0 | 0 | 0 |
| 3.A.1.a.i - Dairy Cows | 0.2 | | 0 | 0 | 0 |
| 3.A.1.a.ii - Other Cattle | 220.2 | | 0 | 0 | 0 |
| 3.A.1.b - Buffalo | 0 | | 0 | 0 | 0 |
| 3.A.1.c - Sheep | 13.4 | | 0 | 0 | 0 |
| 3.A.1.d - Goats | 9.7 | | 0 | 0 | 0 |
| 3.A.1.e - Camels | 2E-03 | | 0 | 0 | 0 |
| 3.A.1.f - Horses | 0.8 | | 0 | 0 | 0 |
| 3.A.1.g - Mules and Asses | 1.7 | | 0 | 0 | 0 |
| 3.A.1.h - Swine | 0.1 | | 0 | 0 | 0 |
| 3.A.1.j - Other (please specify) | 0 | | 0 | 0 | 0 |
| 3.A.2 - Manure Management (1) | 8.0 | 1.1 | 0 | 0 | 10.3 |
| 3.A.2.a - Cattle | 6.6 | 1.1 | 0 | 0 | 8.6 |
| 3.A.2.a.i - Dairy cows | 0.2 | 2E-03 | 0 | 0 | 1E-02 |
| 3.A.2.a.ii - Other cattle | 6.4 | 1.1 | 0 | 0 | 8.6 |
| 3.A.2.b - Buffalo | 0 | 0 | 0 | 0 | 0 |
| 3.A.2.c - Sheep | 0.6 | 0 | 0 | 0 | 0.2 |
| 3.A.2.d - Goats | 0.4 | 0 | 0 | 0 | 0.9 |
| 3.A.2.e - Camels | 1E-04 | 0 | 0 | 0 | 1E-05 |
| 3.A.2.f - Horses | 0.1 | 0 | 0 | 0 | 0.2 |
| 3.A.2.g - Mules and Asses | 0.2 | 0 | 0 | 0 | 0.2 |
| 3.A.2.h - Swine | 0.1 | 0 | 0 | 0 | 3E-02 |
| 3.A.2.i - Poultry | 2E-02 | 8E-04 | 0 | 0 | 0.1 |
| 3.A.2.j - Other (please specify) | 0 | 0 | 0 | 0 | 0 |

## 2.5.5. Land

All lands within the Namibian territory have been classified under the six IPCC land categories and have been treated in this inventory as managed land. Thus, they have all been accounted for in the compilation of emissions and removals. Activities within the six IPCC land classes and between the classes were taken into consideration. Land use has been derived from the land covers attributed on the maps generated from satellite imagery, described more fully below under land representation and changes.

The six land categories 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

#### 2.5.5.1. Methods

Estimation of emissions by source and removals by sink for the LAND sector has been done using Approach 2 with a mix of Tier 1 and Tier 2 levels. The latter has been applied for the categories falling under LAND as some of these were amongst the key source categories in the last inventory. Most of the stock factors have been derived using data from past forest inventories and other available in-country information and resources.

#### 2.5.5.2. Activity Data

AD used for the LAND categories are summarized in this section, together with assumptions and sources of information.  AD for the land use changes have been generated from geospatial maps produced for two time steps, the years 2000 and 2010, and then annualized as described in more details further down. Since no new maps have been generated, the same land use change pattern has been adopted for the years 2011 and 2012 which are being added to the existing time series.

***Land representation and changes***

Maps were generated from LandSat satellite imagery, 30m resolution for the years 2000 and 2010. Both maps provided for the area within the six IPCC land classes.  Climate and soil maps of the country were overlaid on the land cover land use maps to generate the combined Climate-Soil-Land classifications to meet IPCC requirements.

The data comprised two climates and four soil types, reclassified to fit IPCC climates and soils as follows:

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

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 as settlements being converted to Forestland or still Cropland. As these did not reflect the reality, adjustments were made a first time to cater for these inconsistencies as reported in the BUR1 and NIR. 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 considered. 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 such as annual agricultural surveys that are done to determine the extent under cultivation for food security purposes and to remove inconsistencies mentioned previously. Initial areas for the years 2000 and 2010 and annual change used in land matrices are given in Table 2.49.

**Table 2.49. Total land use adjusted area and annual change used in land matrix**

| Land Type category | Area (ha) | | | |
|---|---|---|---|---|
| | Year 2000 | Year 2011 | Annual gain | Annual loss |
| Forestland | 8,404,206 | 6,629,983 | 321,475 | 482,768 |
| Cropland | 403,178 | 271,882 | 23,067 | 35,003 |
| Grassland | 60,731,438 | 62,636,957 | 306,489 | 133,260 |
| Wetlands | 657,613 | 657,613 | - | - |
| Settlements | 31,163 | 31,163 | - | - |
| Other land | 11,682,154 | 11,682,154 | - | - |

It was not possible to account for land use changes in Wetlands, Settlements and Other Land categories because of the mapping issues previously mentioned. Furthermore, due to the mapping inconsistencies mentioned previously, it was assumed that no changes between the land type categories in the minor soil types by climate combinations TRDLAC, TRDWET, TRMDHAC and TRMDSAN, which represent altogether less than 3 % of the territory for this inventory series and in the recalculations of the 2012 inventory.

As reported above and with no new maps produced due to lack of resources, the same land use changes within and between land classes were adopted for the years 2011 and 2012. The trends obtained with this method brought up other inconsistencies in the TRDHAC and TRDSAN land classes. The land class Forestland Woodland < 20 years no longer existed as from end 2011, resulting from the fact that all the woodlands are converted over the period 2000 to 2012 to other uses. Thus, the annual gain and loss in Forestland and Grassland had to be amended to accommodate this anomaly. In practice, it is known that woodlands still exist in the country. Similarly, if the same mapping exercise and land use changes are adopted, 2815 ha in TRDSAN will also disappear completely in 2013. This situation is totally off and against the real national circumstances. This situation can be depicted from Table 2.50.

**Table 2.50. Evolution of the areas under different land use categories**

| Woodland category | 2000 | 2010 | 2011 | 2012 | Annual loss | Annual gain |
|---|---|---|---|---|---|---|
| **Woodland <20** | | | | | | |
| TRDHAC | 524805 | 76525 | 31697 | -13131 | 58148 | 13320 |
| TRDSAN | 232724 | 30564 | 10348 | -9868 | 25783 | 5567 |
| Minor soil types | 3619 | 3619 | 3619 | 3619 | - | - |
| **TOTAL** | **761148** | **110708** | **45664** | **-19380** | **83931** | **18887** |
| **Woodland >20** | | | | | | |
| TRDHAC | 144600 | 31060 | 19706 | 8352 | 16009 | 4655 |
| TRDSAN | 64123 | 13033 | 7924 | 2815 | 7098 | 1989 |
| Minor soil types | 998 | 998 | 998 | 998 | - | - |
| **TOTAL** | **209721** | **45091** | **28628** | **12165** | **23107** | **6644** |

Based on all the inconsistencies observed to-date, past problems and future ones being encountered, the big issue is how representative and confidence one may have on the use of GIS technology coupled with satellite imagery for determining changes in land use between the different land classes. It is considered imperative that new maps more representative of actual land cover and land use changes over the inventory period be generated.

## ***Deforestation***

The deforestation rate from the initial maps was estimated to be 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. A QC exercise done with the areas and deforestation rates from the FAO database revealed the incorrectness of the maps. Adjustments were made to the initial areas and a more realistic deforestation rate of 161 293 ha/year was obtained. This rate is still high compared to FRA 2010 report where deforestation rate is estimated at 74 000 ha/year. Nevertheless, it is still considered sustainable, and was thus adopted for this inventory pending reviewed maps with better estimates of areas and land cover.

## ***Forest land stratification***

Forests were divided in two sub-categories and the definitions adopted for the interpretation of the maps are provided below:

- Forest-Forests (FLFL): tree height of 5 m and a canopy cover of more than 20 %; and

- Forest-Woodlands (FLWD): tree height of 5 m and a canopy cover between 10 % and 20 %.

The forest category is further subdivided by age classes using non-spatial datasets. It was calculated from the forest inventories that 45 % of the trees are <20 years and 55 % are >20 years. 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 of forestland was classified as 45 % less than 20 years and the remainder more than 20 years. For woodland the area was classified as 40 % less than 20 years and the remainder more than 20 years on a similar basis.

## ***Description of growth rates***

In Namibia fuel wood is harvested in forestland and grassland and comprises live and deadwood. 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 is a constituent of the litter pool. For the remaining 80 % fuel wood, 100 % removal has been allocated to forestland, which included biomass from grassland since no wood removal can be applied in the Grassland sub-category in the 2006 IPCC software. 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. Growing stock levels and biomass accumulation rates have been calculated based on estimates made in past forest inventories. A density of 0.7 t dm/m3 for fuelwood was used. BCEF default values provided in the IPCC table (Vol 4, chapter 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 removal volumes have been calculated from data obtained in censuses made by the NSA and from other reports. The volume of fuelwood was calculated from the amount used by households in the rural and urban areas (NHIES main report 2009-2010 from NSA) and fuelwood production (woodchips in Namibia). Charcoal exported was estimated from the mass balance of imports and exports, plus a fixed national consumption of 8000 t from 2000 to 2002, 9000 t from 2003 to 2005, 10 000 tons onwards annually over the inventory period (2000 -to2012. 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, 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 woodland 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. Figure 2.17 gives an overview of the final volumes extracted from forestland and woodland for fuelwood and poles.

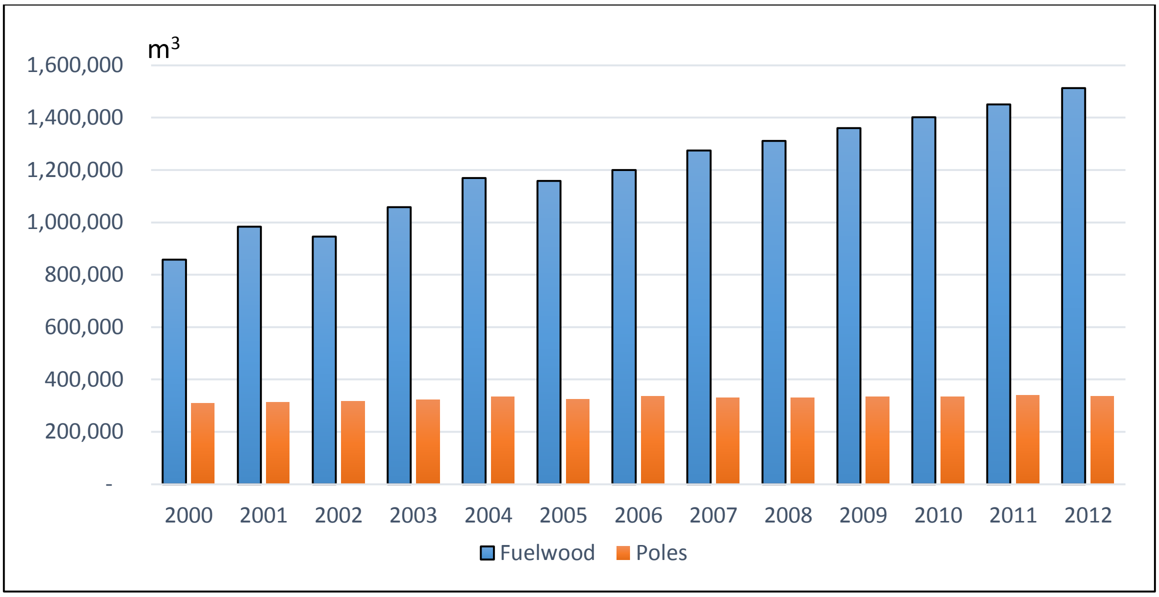



**Figure 2.17. Volume of woody biomass removed from forestland and woodland (2000 - 2012)**

## *Cropland stratification*

Cropland areas were not stratified and the total area was considered as Annual Cropland since perennial crops cover a marginal area of total cropland, about 0.001 % only. The annual crop management systems assessed are wheat, millet, sorghum, and maize grown under commercial and communal set-ups. Stock factors for annual cropland are derived based on management practices of the individual crops under these two systems. Following visits made across the country on communal farms mainly to collect information and set up future AD collection to refine the quality on inventories, a very interesting feature of the agricultural system cropped up. In fact, almost all farms had a number of trees growing on it. This is a feature of Namibian communal farms as the trees provide shade for the people and the animals. However, the IPCC 2006 software has not made provision for including this woody stock and the growth emanating from these trees. Again, this is not representative of the national circumstances and should be considered to improve the carbon balance of the country and better reflect emissions and removals. This situation has been reported by Zomer, et al. (2016) and is illustrated in plate 1.

## *Area*

Cropland area was overestimated from the maps when compared to annual surveys undertaken for food security purposes by the Ministry of Agriculture, Water Affairs and Forestry. Thus, the areas from the surveys were adopted for making the yearly inventory estimates, along with the information on the specific crop cultivated. The annual crop survey revealed that about 50 % of the area, attributed to cropland from the maps, is not cultivated. Therefore, this area was accounted as set aside in the BUR1 inventory. The carbon sequestration by this cropland set aside was creating a serious overestimation of the sink capacity of the country. Thus, the area of cropland set-aside was further reduced by transferring 250 000 ha to the Other Land category in the land matrix. It has been assumed that most of the managed annual cropland are in the soil climate-combinations HAC and SAN under 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.

**Plate 1. Trees on communal farm in Namibia (*photo R Nayamuth*)**

#### *Grassland stratifications*

Grassland, which was sub-divided into three sub-categories in the BUR1 inventory, was considered as a single land category after merging the three sub-categories. Woody biomass present on the part of the territory (shrubland) was averaged on the whole grassland area when computing estimates.

#### *Wetlands stratification*

The wetlands have not been further subdivided. It was also assumed that there was no change in this land category over the inventory period.

#### *Settlements stratification*

This land also has not been further subdivided. It was also assumed that there was no change in this land category over the inventory period.

#### *Other Land stratification*

This land was further subdivided into bare land, rock outcrops and desert sand. For this inventory, these sub-classes were not taken into consideration as there is no activity leading to emissions or removals in them. It was also assumed that there was no change in this land category over the inventory period.

### 2.5.6. Emission and stock factors

This section describes how emission and other stock factors have been analysed, screened, adopted and generated so as to be representative of the national circumstances of Namibia. Where an EF is not country specific, the most appropriate default value contained in the IPCC 2006 software or Guidelines has been used.

#### 2.5.6.1. Above ground biomass stock and growth

***Forestland***

The above ground biomass stock (Bm) (t dm/ha) and annual growth rate (Iv) ($m^3$/ha/year) in forests was estimated for:

- Forests younger than 20 years;
- Forests older than 20 years;
- Woodland younger than 20 years; and
- 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 the IPCC 2006 Guidelines.

Namibia conducted an extensive assessment of its woody biomass resources during the period 2000 to 2006 towards sustainable use of biomass by the country. Thirteen regions of the country were covered and inventories of woody biomass made. The method was the one usually adopted for making National Forest Inventories (NFI) whereby all trees with a dbh exceeding 5cm are counted for estimating 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, was 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 the sub-classes Forest, Closed Woodlands, Open Woodlands, Thicket, closed Shrubland and Bushland. 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, 2013). The average density has been computed as 0.7 t dm/$m^3$.

**Bm (t dm/ha) = Growing Stock ($m^3$/ha) x Density (t dm/$m^3$)**

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 (IPCC volume 4 Chapter 4), 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 years was estimated at 21.44 t dm/ha and Bm for forest with age >20 year at 50.03 t dm/ha. The above ground biomass excluded herbaceous biomass. The age classes have been derived from the dbh distribution (Mendelsohn, 2007).

The biomass growth rate was estimated based on 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. Woody biomass in grassland was estimated at 6.88 t dm on 14 M ha of shrubland and averaged over the whole grassland area. Harvest of the invasive bush was calculated for 2010 for charcoal and fuelwood use and this area was estimated to be the average yearly value harvested. From previous records, an average of 300 plants was left out of 3800 present. Regrowth of the invasive bush was estimated to occur on those harvested areas during ten years for plants to reach maturity, while a reduced growth rate over 20 years was maintained over the remaining area. However, due to unavailability of data, the rate of invasion of savanna and pure grassland by the invasive bush to

shrubland was not accounted for. This is under investigation for refining future inventories. For herbaceous 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 2.51.

**Table 2.51. 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 | 3.18 |
| Forest >20y | 50.03 | 0.90 | 1.94 |
| Woodlands <20 | 12.97 | 1.80 | 2.84 |
| Woodlands >20 | 42.08 | 1.17 | 2.21 |
| Saplings | 2.00 | NA | NA |
| Herbaceous biomass | 2.00 | NA | NA |

### *Cropland*

Since there are only annual crops, no woody biomass growth factors have been assigned. It should be noted here that substantial biomass as tress do occur in the cropland and these woody biomass stocks should be incorporated in future inventories as well as the gains occurring in these croplands to better reflect the national circumstances.

### *Grassland*

Stock factors for grassland are shown in Table 2.52.

Herbaceous biomass is taken as 2.3 t dm/ha, which is the IPCC default value 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 0.18 t dm/ ha and herbaceous biomass is 2.0 t dm/ ha.

**Table 2.52. Above ground biomass for grassland (t dm/ha)**

| | Bm woody | Bm herbaceous | Bm woody after conversion | Bm herbaceous after conversion |
|---|---|---|---|---|
| **Grassland** | 2.40 | 2.3 | 0.18 | 2.00 |

Similarly, as for woody biomass stocks, annual increments cannot be accounted for 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 calculated from the forest inventory. The annual growth of shrubland was based on an annual average age of 10 years because of the regular harvest for making charcoal and providing fuelwood. Based on this, a fixed value of 1.04 t dm/ha/yr was added to the growth rate of forestland and woodland to account for this woody grassland biomass. However, with time, there is an overall loss since there is deforestation and the lower area can no longer reflect the amount of standing and growth in woody biomass occurring in the Grassland class. This shortcoming stemming from the IPCC 2006 software will also have to be dealt with in such a manner to reflect the national circumstances.

### ***Disturbances***

In the category forest land remaining forest land, a total of 3 % of the area 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. The grass layer present is also estimated to be lost through burning. The same 3 % area burned has been estimated for grassland and the herbaceous layer only is affected. Biomass burned for the different land classes are provided in Table 2.53.

**Table 2.53. Biomass amounts burned in the different land categories and subcategories**

| Land categories | Biomass (t bm/ha) lost through fire |
|---|---|
| Forestland less than 20 years | 4.14 |
| Forestland more than 20 years | 6.00 |
| Woodland less than 20 years | 3.30 |
| Woodland more than 20 years | 5.21 |
| Grassland | 2.00 |

## *Management factors*

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 status of moderate degradation obtained from expert judgement.

For croplands, the land use stock factor is 0.58 and the management and input factor is 1. For set aside, factors adopted are respectively 0.93 and 1.17 for the land use and management, and input.

### *2.5.6.2.* Emissions and removals estimates

Estimates of emissions and removals for the LAND sector is depicted in Table 2.54. In 2012, the LAND sector acted as a net sink, with a total net removal of 7462 Gg of $CO_2$. Forestland acted as a sink for 25 373 Gg $CO_2$ while Grassland emitted 17 721 Gg and Cropland 191 Gg. Over the inventory period 2000 to 2012, the sink capacity of forests decreased by some 19 000 Gg $CO_2$ from 44 204 to 25 373 Gg $CO_2$.

**Table 2.54. Emissions ($CO_2$) for the FOLU sector for period 2000 to 2012**

| *Year* | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| *3.B.1 - Forest land* | -44,204 | -41,112 | -37,553 | -34,663 | -31,520 | -28,429 | -27031 | -25373 |
| *3.B.2 - Cropland* | 14 | -120 | 115 | 151 | 148 | 163 | 182 | 191 |
| *3.B.3 - Grassland* | 17,999 | 17,999 | 17,999 | 17,999 | 17,999 | 17,999 | 17999 | 17721 |
| *Total net* | -26,191 | -23,233 | -19,439 | -16,513 | -13,372 | -10,266 | -8850 | -7462 |

The summary of results from the software output is provided in Table 2.55.

Table 2.55. Emissions and removals from the land category for 2012

| Inventory Year: 2012 | | | | | | |
|---|---|---|---|---|---|---|
| Categories | (Gg) | | | | | |
| | Net CO2 emissions / removals | Emissions | | | | |
| | | CH4 | N2O | NOx | CO | NMVOCs |
| **3.B - Land** | -7461.6 | 0 | 0 | 0 | 0 | 0 |
| 3.B.1 - Forest land | -25373.5 | 0 | 0 | 0 | 0 | 0 |
| 3.B.1.a - Forest land Remaining Forest land | -24307.6 | | | 0 | 0 | 0 |
| 3.B.1.b - Land Converted to Forest land | -1066.0 | 0 | 0 | 0 | 0 | 0 |
| 3.B.1.b.i - Cropland converted to Forest Land | -7.3 | | | 0 | 0 | 0 |
| 3.B.1.b.ii - Grassland converted to Forest Land | -1058.7 | | | 0 | 0 | 0 |
| 3.B.2 - Cropland | 190.8 | 0 | 0 | 0 | 0 | 0 |
| 3.B.2.a - Cropland Remaining Cropland | -27.9 | | | 0 | 0 | 0 |
| 3.B.2.b - Land Converted to Cropland | 218.7 | 0 | 0 | 0 | 0 | 0 |
| 3.B.2.b.i - Forest Land converted to Cropland | 97.1 | | | 0 | 0 | 0 |
| 3.B.2.b.ii - Grassland converted to Cropland | 121.6 | | | 0 | 0 | 0 |
| 3.B.3 - Grassland | 17721.1 | 0 | 0 | 0 | 0 | 0 |
| 3.B.3.a - Grassland Remaining Grassland | 0 | | | 0 | 0 | 0 |
| 3.B.3.b - Land Converted to Grassland | 17721.1 | 0 | 0 | 0 | 0 | 0 |
| 3.B.3.b.i - Forest Land converted to Grassland | 17771.3 | | | 0 | 0 | 0 |
| 3.B.3.b.ii - Cropland converted to Grassland | -50.2 | | | 0 | 0 | 0 |
| **3.C - Aggregate sources and non-CO2 emissions sources on** | 0.5 | 10.8 | 10.1 | 13.7 | 281.5 | 0 |
| 3.C.1 - Emissions from biomass burning | 0 | 10.8 | 0.8 | 13.7 | 281.5 | 0 |
| 3.C.1.a - Biomass burning in forest lands | | 4.4 | 0.2 | 2.8 | 100.3 | 0 |
| 3.C.1.b - Biomass burning in croplands | | 0 | 0 | 0 | 0 | 0 |
| 3.C.1.c - Biomass burning in grasslands | | 6.4 | 0.6 | 10.9 | 181.3 | 0 |
| 3.C.3 - Urea application | 0.5 | | | 0 | 0 | 0 |
| 3.C.4 - Direct N2O Emissions from managed soils (3) | | | 6.4 | 0 | 0 | 0 |
| 3.C.5 - Indirect N2O Emissions from managed soils | | | 1.8 | 0 | 0 | 0 |
| 3.C.6 - Indirect N2O Emissions from manure management | | | 1.0 | 0 | 0 | 0 |
| **3.D - Other** | 0 | 0 | 0 | 0 | 0 | 0 |

## 2.5.7. Aggregated sources and non-$CO_2$ emission sources on land

### 2.5.7.1. 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; and
- 3.C.6 Indirect emissions from manure management.

### 2.5.7.2. Methods

Methods are according to the IPCC 2006 Guidelines and the 2006 IPCC Software has been used to compute emissions for this sub-category.

### 2.5.7.3. Activity data

The activity data are those adopted for computing direct emissions for the land and livestock categories, which have been used by default by the software to aggregate emissions from different sources. AD for fertilizers and urea are from the mass balance of imports and exports data from the NSA. N content of a few fertilizers have been assumed in relation with the cultivated crops of the country to arrive at total N for computing $N_2O$ emissions. Following a new set with more details on the fertilizer AD, the full series have been recalculated. It should be noted that up to now there is the possibility that some of the urea has been used for preparing animal feeds. The inventory team is still tracking this to improve results of future inventories.

### 2.5.7.4. Emission factors

All biomass burning was accounted to occur because of wildfires. Default EFs were used for all gases in forestland including woodland and grassland burning except for the combustion factor in forestland and woodland that was considered as 0.85.

Default EFs were used for estimating emissions from urea application as well as for estimates of indirect emissions from managed soils and manure management.

### 2.5.7.5. Emissions estimates

Aggregated emissions for aggregate sources and non-$CO_2$ emissions on land (Table 2.56) varied between 2492 Gg $CO_2$-eq for the year 2000 and 3361 Gg $CO_2$-eq for 2012.

**Table 2.56. Aggregated emissions (Gg $CO_2$-eq) for aggregate sources and non-$CO_2$ emissions on Land**

| 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| 2492 | 2719 | 2739 | 2724 | 2904 | 2613 | 3175 | 3361 |

Emissions by gas are given in Table 2.57. The major gas emitted in this category remained $CH_4$ throughout the period followed by $N_2O$. Carbon dioxide emission was minimal for all years.

**Table 2.57. Emissions (Gg) by gas for aggregate sources and non-$CO_2$ emissions on Land**

| Gas | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 0.5 | 2.1 | 0.6 | 0.1 | 0.1 | 0.1 | 0.4 | 0.5 |
| $CH_4$ | 11.3 | 11.2 | 11.1 | 11.0 | 11.0 | 10.9 | 10.8 | 10.8 |
| $N_2O$ | 7.3 | 8.0 | 8.1 | 8.0 | 8.6 | 7.7 | 9.5 | 10.1 |

## 2.6. WASTE

### 2.6.1. 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, industrialization rate and 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.

During the period under review, the waste categories from which emission data were captured were as follows:

- 4.A.3 - Solid Waste Disposal;

- 4.C.2 - Open Burning of Waste;
- 4.D.1 - Domestic Wastewater Treatment and Discharge; and
- 4.D.2 - Industrial Wastewater Treatment and Discharge.

#### 2.6.1.1. Disposal of domestic waste/garbage

Some of the factors determining solid waste disposal and treatment and changes noted with respect to the disposal of domestic waste/garbage during the period 2000 to 2010 is enumerated below and given in Table 2.58.

- The percentage of households having recourse to waste burning increased from 18.0 % to 37.8 %. This trend was more marked among the rural population where waste burning increased from 27.9 % to 66.1 % as compared with the increase from 2.8 % to 8.6 % for urban households. This gain in importance of waste burning may be explained by the fact that fewer households practiced roadside dumping combined with a decrease in the use of rubbish pits over the same period as reported below.
- Waste / Garbage collection has been improved since in 2010 waste collection was done on a regular basis for 37.2 % of Namibian households as compared with 30.9 % ten years back. Conversely, the number of households which were serviced in an irregular way decreased from 11.5 % to 5.2 % over the same period.
- Roadside dumping of waste / garbage decreased from 14.7 % to 8.9 % at country level. The trend was more marked in the rural regions where the percentage of household dumping waste / garbage decreased from 17.6 % to 10.4 % as compared with the urban region where it declined from 10.3 % to 7.4 %.
- The use of rubbish pits decreased from 20.3 % to 9.5 % at country level, the rate for both urban and rural regions being roughly similar.

**Table 2.58. Waste garbage disposal partitioned between urban and rural areas (2001 and 2010)**

| Means of waste / garbage disposal | 2001 | 2010 | 2001 | 2010 | 2001 | 2010 |
|---|---|---|---|---|---|---|
| | Namibia | | Urban | | Rural | |
| Irregularly collected | 11.5 | 5.2 | 11.3 | 8 | 11.7 | 2.4 |
| Regularly collected | 30.9 | 37.2 | 65.3 | 70.6 | 8.4 | 4.8 |
| Burning | 18.0 | 37.8 | 2.8 | 8.6 | 27.9 | 66.1 |
| Roadside dumping | 14.7 | 8.9 | 10.3 | 7.4 | 17.6 | 10.4 |
| Rubbish pit | 20.3 | 9.5 | 8.6 | 5.1 | 28 | 13.9 |
| Other | 4.6 | 1.4 | 1.7 | 0.3 | 6.5 | 2.4 |

The relative importance of waste disposal methods between urban and rural populations is illustrated in Figure 2.18.

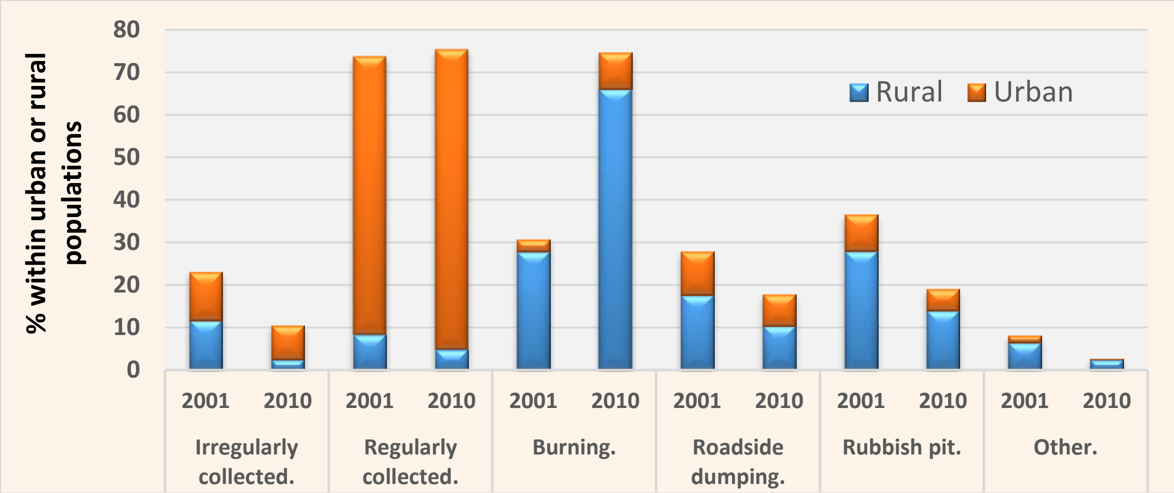



**Figure 2.18. % distribution of households by means of waste/garbage disposal (2001 and 2010)**

#### 2.6.1.2. Uncategorised Waste Disposal Sites and Open Burning of Waste

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.

### 2.6.2. Domestic Wastewater Treatment and Discharge

Percent distribution of household by type of main toilet facility is given in Table 2.59. 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 systems via septic tanks/ cesspools and 9.3 % use pit latrines.

**Table 2.59. Percent distribution of household by type of main 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

#### 2.6.2.1. 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. Because unavailable data, only the meat sector and fish processing are covered in this inventory. It should be noted that these two activities account for the major part of industrial waste water in the country.

### 2.6.3. 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 computed using the IPCC 2006 software.

### 2.6.4. Activity Data

#### 2.6.4.1. 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 2000 to 2012.

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 estimations 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 2012 was then estimated for the other urban areas. Activity data for the period 2000 to 2012 is given in Table 2.60.

**Table 2.60. Activity data for MSW in Waste Sector (2000 - 2012)**

| | Population | | | Municipal Solid Waste (MSW) (t) | | | Sent to MSW (t) | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Urban high** | **Urban low** | **Rural** | **Urban high** | **Urban low** | **Rural** | **Sludge** | **Industrial waste** |
| **2000** | | 582 736 | 1 210 299 | | 70 503 | 97 136 | 10.0 | 33.4 |
| **2001** | 287 780 | 316 229 | 1 226 321 | 40 281 | 39 216 | 100 883 | 10.4 | 34.9 |
| **2002** | 299 643 | 331 444 | 1 225 051 | 44 039 | 43 158 | 105 817 | 10.8 | 36.5 |
| **2003** | 311 506 | 347 302 | 1 223 501 | 48 071 | 47 484 | 110 967 | 11.3 | 38.1 |
| **2004** | 323 369 | 363 817 | 1 221 664 | 52 397 | 52 229 | 116 341 | 11.8 | 39.9 |
| **2005** | 335 232 | 381 000 | 1 219 532 | 57 035 | 57 430 | 121 944 | 12.3 | 41.7 |
| **2006** | 347 096 | 398 867 | 1 217 096 | 62 007 | 63 130 | 127 786 | 12.8 | 43.6 |
| **2007** | 358 959 | 417 429 | 1 214 350 | 67 332 | 69 371 | 133 873 | 13.3 | 45.5 |
| **2008** | 370 822 | 436 701 | 1 211 284 | 73 035 | 76 202 | 140 211 | 13.9 | 47.6 |
| **2009** | 382 685 | 456 697 | 1 207 891 | 79 140 | 83 676 | 146 809 | 14.4 | 49.7 |
| **2010** | 394 548 | 477 431 | 1 204 161 | 85 673 | 91 849 | 153 674 | 15.0 | 52.0 |

| | Population | | | Municipal Solid Waste (MSW) (t) | | | Sent to MSW (t) | |
|---|---|---|---|---|---|---|---|---|
| Year | Urban high | Urban low | Rural | Urban high | Urban low | Rural | Sludge | Industrial waste |
| **2011** | 406 411 | 498 916 | 1 200 085 | 92 662 | 100 781 | 160 811 | 15.6 | 54.3 |
| **2012** | 419 323 | 520 533 | 1 196 180 | 97 455 | 107 186 | 184 317 | 16.1 | 58.3 |

#### 2.6.4.2. 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 (beef and sheep) (source Meatco factories, Agric Stats 2009, AGRA) and fish (Pilchard and Mackerel processing) (source: Ministry of Fisheries, Annual report 2005, Source for 2006 to 2010 - Preliminary census 2011 data). 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. Activity data for industrial waste water is given in Table 2.61. It is to be noted that an average daily protein intake of 67 g (source: World Bank, Namibia open data for Africa) per capita per day was used to feed the per capita protein consumption in the IPCC software.

**Table 2.61. Activity data for industrial wastewater (2000 - 2012)**

| Year | Fish processing (t) | Meat and poultry (t) |
|---|---|---|
| 2000 | 369 602 | 44 822 |
| 2001 | 326 008 | 42 135 |
| 2002 | 263 343 | 47 869 |
| 2003 | 383 002 | 46 104 |
| 2004 | 339 010 | 46 147 |
| 2005 | 352 828 | 53 176 |
| 2006 | 312 294 | 46 395 |
| 2007 | 225 182 | 46 219 |
| 2008 | 205 751 | 46 855 |
| 2009 | 236 133 | 48 269 |
| 2010 | 205 902 | 47 950 |
| 2011 | 241 937 | 43 329 |
| 2012 | 207 044 | 42 722 |

#### 2.6.4.3. 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.

### 2.6.5. Emission estimates

A comparison of the overall GHG emissions for 2000 and 2010 for the Waste Sector is provided in Table 2.62.

Table 2.62. Emissions (Gg) by gas period from the Waste Sector (2000 - 2012)

| GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| CO | 4.3 | 4.8 | 5.2 | 5.8 | 6.3 | 6.9 | 7.2 | 8.2 |
| $CH_4$ | 3.3 | 3.4 | 4.0 | 4.4 | 4.7 | 5.4 | 5.8 | 6.1 |
| $CO_2$ | 1.2 | 1.3 | 1.4 | 1.6 | 1.8 | 1.9 | 2.0 | 2.3 |
| NMVOCs | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 |
| $NO_x$ | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 |
| $N_2O$ | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| $SO_2$ | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.0 | 0.0 |

Figure 2.19 illustrates the evolution of emissions for the waste sector from 2000 to 2012.

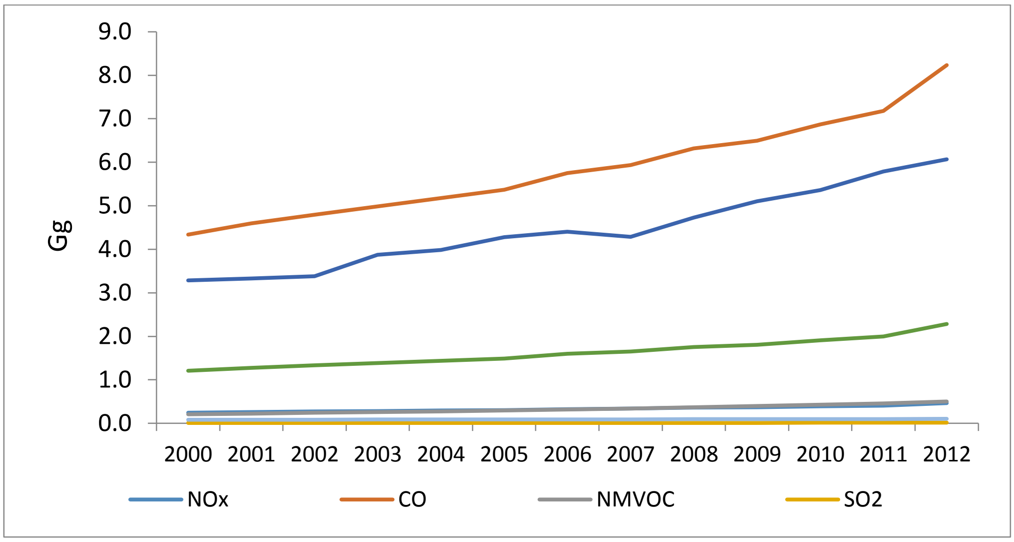



Figure 2.19. GHG emissions (Gg) from the Waste Sector (2000 - 2012)

### 2.6.5.1. $CO_2$, $NO_x$, CO and $SO_2$ Emissions

CO, $CO_2$, $NO_x$ and $SO_2$ emissions that have been inventoried for the Waste Sector originated from Open Burning of Waste (Table 2.63).

From 2000 to 2012 the percentage increase in emissions for $CO_2$, $NO_x$, CO and $SO_2$ was 89 %.

Table 2.63. CO, $CO_2$, $NO_x$ and $SO_2$ emissions (Gg) from the Waste Sector

| Waste Category | GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|
| 4.C.2 - Open Burning of Waste | **$CO_2$** | 1.206 | 1.332 | 1.439 | 1.599 | 1.756 | 1.910 | 1.996 | 2.287 |
| 4.C.2 - Open Burning of Waste | **$NO_x$** | 0.247 | 0.273 | 0.295 | 0.328 | 0.360 | 0.391 | 0.409 | 0.469 |
| 4.C.2 - Open Burning of Waste | **CO** | 4.34 | 4.79 | 5.18 | 5.75 | 6.32 | 6.87 | 7.180 | 8.229 |
| 4.C.2 - Open Burning of Waste | **$SO_2$** | 0.009 | 0.009 | 0.010 | 0.011 | 0.014 | 0.014 | 0.014 | 0.016 |

### 2.6.5.2. $CH_4$ Emissions

Figure 2.20. $CH_4$ emissions (Gg) from different Waste categories (2000 - 2012)

$CH_4$ emissions originated from Solid Waste Disposal, Open Burning of Waste, Domestic Wastewater Treatment & Discharge and Industrial Wastewater Treatment &

Discharge activities (Table 2.64, Figure 2.20). The activity contributing the most towards emissions was Solid Waste Disposal. $CH_4$ emissions increased by 84.8 % from 3.3 Gg in 2000 to 6.1 Gg in 2012.

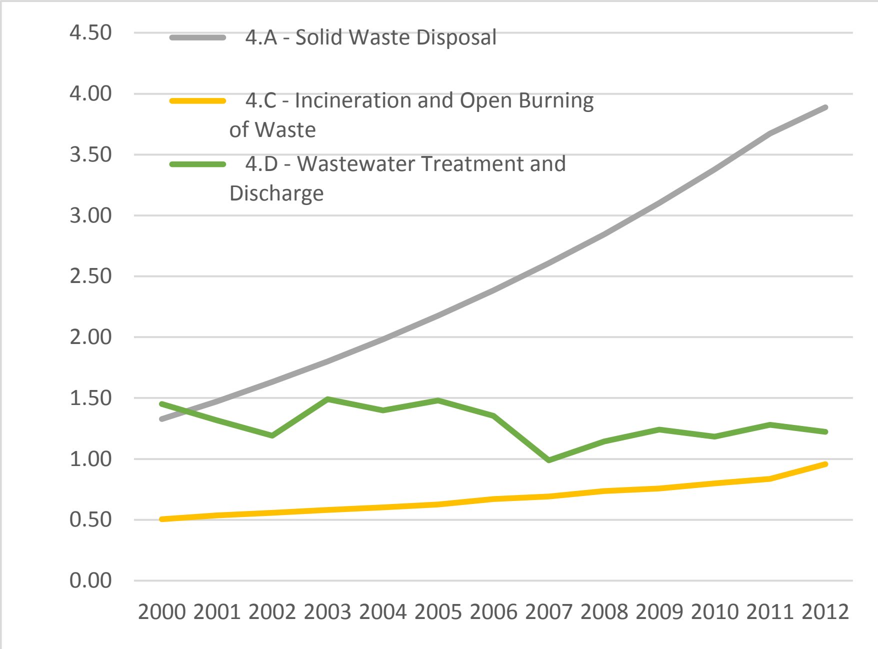



**Table 2.64. $CH_4$ emissions (Gg) from the Waste Sector**

| Categories | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **4 - Waste** | **3.285** | **3.382** | **3.985** | **4.408** | **4.725** | **5.360** | **5.790** | **6.071** |
| 4.A - Solid Waste Disposal | 1.328 | 1.632 | 1.983 | 2.384 | 2.846 | 3.378 | 3.674 | 3.890 |
| 4.C - Incineration and Open Burning of Waste | 0.505 | 0.558 | 0.603 | 0.670 | 0.736 | 0.800 | 0.836 | 0.958 |
| 4.C.2 - Open Burning of Waste | 0.505 | 0.558 | 0.603 | 0.670 | 0.736 | 0.800 | 0.836 | 0.958 |
| 4.D - Wastewater Treatment and Discharge | 1.451 | 1.192 | 1.400 | 1.354 | 1.144 | 1.183 | 1.281 | 1.224 |
| 4.D.1 - Domestic Wastewater Treatment and Discharge | 0.371 | 0.359 | 0.389 | 0.407 | 0.455 | 0.489 | 0.518 | 0.548 |
| 4.D.2 - Industrial Wastewater Treatment and Discharge | 1.080 | 0.833 | 1.011 | 0.947 | 0.689 | 0.694 | 0.763 | 0.676 |

#### 2.6.5.3. NMVOCs Emissions

NMVOCs emissions originated from Managed Waste Disposal Sites, Open Burning of Waste, Domestic Wastewater Treatment & Discharge and Industrial Wastewater Treatment & Discharge activities (Table 2.65). The categories contributing most towards emissions in decreasing order of importance were Managed Waste Disposal Sites and Open Burning of Waste. Emissions from these two categories increased by 190 % and 90 % respectively from 2000 to 2012 (Figure 2.21). NMVOC emissions from Waste Water Treatment and Discharge was negligible over the full inventory period.

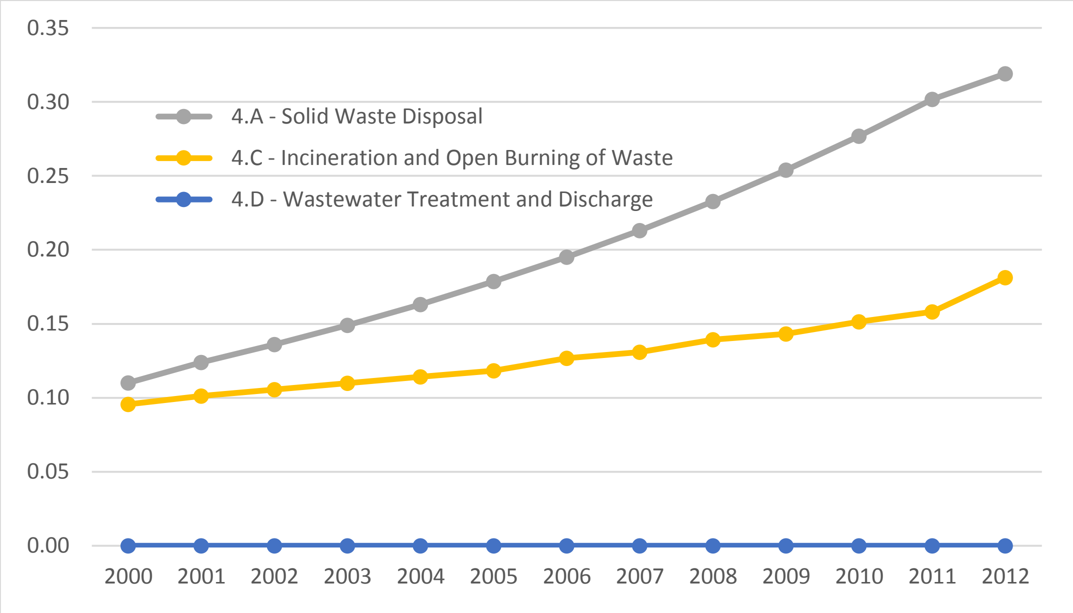



**Figure 2.21. NMVOCs emissions (Gg) from different waste categories (2000 - 2012)**

**Table 2.65. NMVOCs emissions (Gg) from the Waste Sector**

| Waste Categories | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| 4 - Waste | 0.21 | 0.24 | 0.28 | 0.32 | 0.37 | 0.43 | 0.46 | 0.50 |
| 4.A - Solid Waste Disposal | 0.11 | 0.14 | 0.16 | 0.20 | 0.23 | 0.28 | 0.30 | 0.32 |
| 4.C - Incineration and Open Burning of Waste | 0.10 | 0.11 | 0.11 | 0.13 | 0.14 | 0.15 | 0.16 | 0.18 |
| 4.D - Wastewater Treatment and Discharge | 1.3E-06 | 1.3E-06 | 1.3E-06 | 1.3E-06 | 1.2E-06 | 1.2E-06 | 1.2E-06 | 1.2E-06 |

### 2.6.5.4. $N_2O$ Emissions

$N_2O$ emissions originated from Open Burning of Waste and Domestic Wastewater Treatment & Discharge categories (Table 2.66). The category contributing most towards $N_2O$ was Wastewater Treatment and Discharge (Domestic). From 2000 to 2012, $N_2O$ emissions increased by 24.8 % (Figure 2.22).

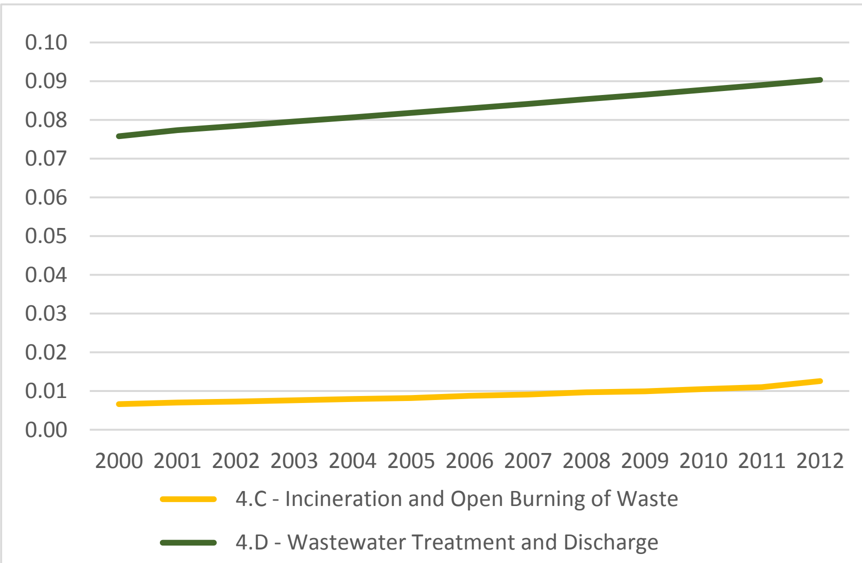



**Figure 2.22. $N_2O$ emission (Gg) from incineration and open burning of waste and wastewater treatment and discharge (2000 - 2012)**

### Table 2.66. $N_2O$ emissions (Gg) from Waste Sector

| Categories | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| 4 - Waste | 0.083 | 0.086 | 0.089 | 0.092 | 0.095 | 0.099 | 0.100 | 0.103 |
| 4.C - Incineration and Open Burning of Waste | 0.007 | 0.008 | 0.008 | 0.009 | 0.010 | 0.011 | 0.011 | 0.013 |
| 4.D - Wastewater Treatment and Discharge | 0.076 | 0.078 | 0.081 | 0.083 | 0.085 | 0.088 | 0.089 | 0.090 |

## 2.6.5.5. Emissions in terms of $CO_2$ equivalent

In terms of $CO_2$ equivalent, the total contributions to emissions increased from 95.7 Gg $CO_2$-eq in 2000 to 161.7 Gg $CO_2$-eq in 2012 (Table 2.67), that is a 68.9 % increase. The gas contributing most to emissions from the waste sector was $CH_4$.

### Table 2.67. Aggregated emissions (Gg $CO_2$-eq) by gas from Waste Sector

| GHG | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 | % Change |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 1.2 | 1.3 | 1.4 | 1.6 | 1.8 | 1.9 | 2.0 | 2.3 | 89.6% |
| $CH_4$ | 69.0 | 71.0 | 83.7 | 92.6 | 99.2 | 112.6 | 121.6 | 127.5 | 84.8% |
| $N_2O$ | 25.6 | 26.6 | 27.5 | 28.5 | 29.5 | 30.5 | 31.0 | 31.9 | 24.8% |
| Total | 95.7 | 98.9 | 112.6 | 122.6 | 130.4 | 144.9 | 154.6 | 161.7 | 68.9% |

In 2000 the major contributor to emissions from the Waste Sector was the Wastewater Treatment and Discharge category with 54.0 Gg $CO_2$-eq, representing 56.1 % of emission) (Table 2.68). However, in 2012 the major contributor was the Solid Waste Disposal category with 82 Gg (50.5 % of emissions).

### Table 2.68. Aggregated emissions (Gg $CO_2$-eq) by Category for the Waste Sector

| Waste Categories | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| 4 - Waste | 95.7 | 98.9 | 112.6 | 122.6 | 130.4 | 144.9 | 154.6 | 161.7 |
| 4.A - Solid Waste Disposal | 27.9 | 34.3 | 41.6 | 50.1 | 59.8 | 70.9 | 77.1 | 81.7 |
| 4.C - Incineration and Open Burning of Waste | 13.9 | 15.3 | 16.6 | 18.4 | 20.2 | 22.0 | 23.0 | 26.3 |
| 4.C.2 - Open Burning of Waste | 13.9 | 15.3 | 16.6 | 18.4 | 20.2 | 22.0 | 23.0 | 26.3 |
| 4.D - Wastewater Treatment and Discharge | 54.0 | 49.4 | 54.4 | 54.2 | 50.5 | 52.0 | 54.5 | 53.7 |
| 4.D.1 - Domestic Wastewater Treatment and Discharge | 31.3 | 31.9 | 33.2 | 34.3 | 36.0 | 37.5 | 38.5 | 39.5 |
| 4.D.2 - Industrial Wastewater Treatment and Discharge | 22.7 | 17.5 | 21.2 | 19.9 | 14.5 | 14.6 | 16.0 | 14.2 |

# 3. Mitigation actions and their effects

## 3.1. Context

Namibia has made efforts as a signatory Party to implement the Convention according to its capabilities. Namibia is geared towards a progressive decoupling of carbon emissions from economic growth to match the low carbon pathway embedded in its policies and strategies. The NCCC was established in 2001 to drive implementation of mitigation actions. Cabinet approved the first NPCC in 2011 and the NCCSAP in 2014 to climate change mitigation efforts.

Mitigation measures have been piecemeal. However, the outcomes of COP21 and Namibia's commitment, have created the impetus for a more structured and focused mitigation effort. The country has committed to reducing its emissions under the UNFCCCC. Namibia submitted its Intended Nationally Determined Contribution (INDC) that includes a willingness to contribute to the global effort to mitigate GHG emissions. Namibia aims at a reduction of about 89% of its GHG emissions at the 2030-time horizon compared to the BAU scenario. The projected GHG emissions to be avoided in 2030 is of the order of 20000 Gg $CO_2$-eq inclusive of sequestration in the AFOLU sector and compared to the BAU scenario (Republic of Namibia 2015b).

The contribution will be economy-wide and addresses the Intergovernmental Panel on Climate Change (IPCC) sectors Energy, Industrial Process and Product Use (IPPU), Agriculture Forestry and Land Use (AFOLU) and Waste. The INDC envisaged mitigation in all sectors with the primary reductions anticipated in the AFOLU sector as shown in Table 3.1.

**Table 3.1. Namibia's measures contributing to mitigation as per the INDC**

| Sector | Measure | GHG amount | % of BAU scenario in 2030 |
|---|---|---|---|
| ENERGY | Increase share renewables in electricity production from 33% to 70% | 740 | 3.3 |
| | Increase energy efficiency and DSM | 51 | 0.2 |
| | Mass transport in Windhoek, car and freight pooling | 510 | 2.3 |
| IPPU | Replace 20% clinker in cement production | 36 | 0.2 |
| AFOLU | Reduce deforestation rate by 75 % | 13 537 | 59.8 |
| | Reforest of 20 000 ha per year | 1779 | 7.9 |
| | Restore 15 M ha of grassland | 1359 | 6.0 |
| | Reduce removal of wood by 50 % | 701 | 3.1 |
| | Afforest 5000 ha per year | 578 | 2.6 |
| | Plant 5000 ha of arboriculture per year | 358 | 1.6 |
| | Fatten 100 000 cattle heads in feedlots | 201 | 0.9 |
| | Soil carbon | 180 | 0.8 |
| WASTE | Transform 50% MSW to electricity and compost | 205 | 0.9 |

Source: Republic of Namibia 2015b.

Namibia has developed its first Nationally Appropriate Mitigation Action (NAMA) and it has been deposited into the UNFCCC NAMA registry. The NAMA represents an opportunity for sustainable development for Namibia, and at the same time an opportunity for mitigation. The overall target of the NAMA is to support Namibia in achieving the goal defined in the Off-Grid Energisation Master Plan (OGEMP), namely to provide access to appropriate energy technologies to everyone living or working in off-grid areas. More specifically, the NAMA aims at giving access to electricity for regions, households

and companies which are currently without access to electricity, as well as improving the share of renewable energies (mainly using solar energy). The NAMA will reduce GHG emissions through the replacement of fossil fuels with renewable energies and will provide the conditions for income generation and new business opportunities. This will also lead to enhanced private sector involvement. Finally, the NAMA aims to achieve additional sustainable development benefits, such as better air quality and livelihoods for the poor (UNDP 2015). Further information is provided in Appendix A.

Appendix A provides information on the implemented and planned mitigation policies, programmes and projects and their effects.  Within the framework of the NC3, data has been collected and analysed and has subsequently been submitted to the UNFCCC. Further detail is provided in The MRV chapter of this report. There is a focus on improving data collection and management, formalizing institutional arrangements that support the long-term collection, analysis and reporting of information on mitigation actions, capacity building and efforts to explore the reporting co-benefits in more detail.

## 3.2. Mitigation actions implemented and planned

As noted in Nambia's INDC, reductions of the order of 162 Gg $CO_2$-eq were achieved in 2010 (unconditionally through government funding) and this was estimated to exceed 216 Gg $CO_2$-eq in 2015. Namibia has prioritised mitigation actions based on those activities contributing most to GHG emissions (IPCC key categories) as well as areas such as waste management that has a direct bearing on the quality of the environment and can provide multiple side benefits.

### 3.2.1. Key mitigation actions

Namibia's INDC identified key mitigation actions funded by the Namibian government as being the Solar Revolving Fund, the commissioned hydro generation plant of Ruacana and other demand side management (DSM) measures. Few measures in the AFOLU section had been reported on previously. However, the AFOLU sector is a key category and among the highest emitters. Emissions come from the use of fuelwood, production of charcoal and wood removals for construction and other purposes, especially in the rural areas. Mitigation actions therefore target reductions in these sources. The livestock industry is also a major contributor through mainly enteric fermentation but offers restricted mitigation avenues because the extensive production system.

Actions in the AFOLU are largely planned or in early stages of development. No AFOLU options were reported on in BUR1 and the addition is driven largely by Namibia's INDC. Key actions include:

- Using cattle feedlots to reducing methane emissions while creating; opportunities for local farmers and improving manure management;
- Reducing emissions from soil degradation;
- Afforestation and measures to reduce deforestation; and
- Restoring grassland.

The only information available on GHG reductions is based on potentials included in the INDC. There is no information on the GHG emission reduction achieved to date. The greatest potential for emission reductions is associated with a reduction in deforestation.

Mitigation actions in the energy sector focus on the shift from fossil fuels to renewable energy sources, improved energy efficiency through various DSM measures and reduced fossil fuel consumption through a series of measures in the road transportation sector. Actions in the energy sector include:

- Driving energy efficiency through providing audits (implementation of identified savings has not been measured), distributing free LED lightbulbs, and capacity building;
- Establishing commercial net metering (feeding back into the grid) which has facilitated private investment in rooftop solar PV;
- Establishing National Renewable Energy Policy, a Renewable Energy Feed in Tariff (REFIT) programme and a draft Independent Power Producer Framework to stimulate investments into renewable technologies. Under the REFIT, 14 IPPS, each generating 5 MW are expected to save in the region of 180 000 t $CO_2$-eq per year
- Currently developing a solar thermal technology roadmap and implementing a Concentrated Solar Power (CSP) technology transfer programme with the support of the GEF through UNDP;
- NamPower has conducted a feasibility to consider CSP implementation options (through or central receiver with storage) of between 50 and 200 MW;
- Part of the Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) and supported various Solar Water Heater demonstration projects (included in the SOLTRAIN initiative);
- Exploring projects to generate electricity from invader bush (biomass-to-electricity power station);
- Supporting the use of solar technologies in the residential sector;
- Developing a sustainable urban transport master plan for Windhoek including the mass transport, cars and freight pooling
- Considering options related to gas and hydro power to generate electricity (including the 332 MW Ruacana hydro project, the proposed 880 MW Kudu power plant and the proposed 300MW Baines hydropower plant both of which are still under consideration)
- Submission of a NAMA to the UNFCCC NAMA Registry to support A) Minigrids and B) Energy Zones (intended to contribute toward achieving the goal defined in the Off-Grid Energisation Master Plan); and
- Using biomass (from de-bushing) to generate electricity

Namibia is not a highly industrialized country and thus mitigation potential from the IPPU sector is limited. However, there exists a cement production unit with clinker production integrated. Namibia is focusing on opportunities related to clinker replacement with both extenders and substitute materials with hydraulic properties.

Namibia's has a small population (2.113 million in 2011) and therefore has limited potential to reduce GHG emissions from the waste sector. Actions targeted in this sector include waste to energy projects with multiple benefits. There are relatively fewer interventions to prevent GHG emissions associated with the transport, handling, management and decomposition of waste streams. There are some efforts to stimulate recycling through, for example, the Recycle Namibia Forum (http://rnf.com.na/). Namibia has developed emissions reduction projects in the waste sector under the Clean Development Mechanism (CDM). These relate to capturing landfill gas and biogas from waste water treatment works. Additionally, the large municipalities are exploring opportunities to generate electricity from Municipal Solid Waste (MSW). Further details on these projects can be found in Table 3.6.

### 3.2.2. Detailed information on Mitigation Actions

**Table 3.2. AFOLU Sector**

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| Fatten 50 000 cattle heads in feedlots (INDC Measure) | Reduce cattle growth time to reduce emissions per unit | Meatco has invested and has a plan to continue investing in expanding feedlots to increase the number of animals to be fattened for fast growth and reaching market sizes within a shorter time. This also enables effective manure management and reduces land required to keep the animals. | $CH_4$ | Programme: cattle management (goal) | Planned | Meatco, O&L, & Feed-master | Number of feedlots establish-ed countrywide. | Included in Namibia's INDC | It is assumed that when animals are kept in feedlots there is less enteric fermentation (less energy is required to produce a unit of beef). | Project not yet started | Contribution to food safety. Manure management (collection of manure for energy production and fertilizers). Improved livelihood of local farmers (who sell weiners to Meatco) | 201 000 t $CO_2$-eq/year in 2030 (planned; conditional) |
| Afforest 5000 ha per year (INDC Measure) | Combine actions related to the prevention of land degradation in Namibia | Reforesting and increasing the productivity of forest land that has been converted in to other forms of land use will contribute to achieving Namibia's land degradation neutrality target. | $CO_2$ | Policy: soil carbon (goal) | Ongoing | MET (with funding from UNCCD) | Draft report and database. Samples taken from a number of regions in the country. | Included in Namibia's INDC | ISRIC for soil grid model | Reduction in degradation | Improved land management | 578 000 t $CO_2$-eq/year in 2030 (planned; conditional) |
| Soil carbon (INDC Measure) | Plant trees to act as a carbon sink | Planting of trees including in places where there have never been plants before | CH4, $CO_2$ | Policy: afforest (goal) | Ongoing | Dept of Forestry, MAWF | Trial made in some areas | Mobilization of land identified for planting the species | Not yet identified | | Contribution to food security | 180 000 t $CO_2$-eq/year in 2030 (planned; conditional) |
| Plant 5000 ha of arboriculture per year (INDC Measure) | Cultivation of trees and scrubs to act as a sink | Cultivate and manage individual trees, shrubs and other woody plants | CH4, $CO_2$ | Policy: arboriculture (goal) | Planned | | Ha of arbori-culture planted | Included in Namibia's INDC | Not yet identified | Project not yet started | Job creation | 358 000 t $CO_2$-eq/year in 2030 (planned; conditional) |
| Reduce deforestation rate by 75 % (INDC Measure) | Reduce deforestation to maintain the carbon sink | A forestry research strategy was developed which included the identification and mapping of drivers of deforestation in order to target reductions | CH4, $CO_2$ | Policy: reduce deforestatio n (goal) | Ongoing. The strategy is to be revised. | MAWF with support from GOPA and NAFOLA project as well as GIZ | Research publication available. Forest act being implemented and enforced | Research publication; extension messages disseminated; research being carried out; and law enforcement being implemented. | Forest research strategy. No methodology for estimating GHG emissions reductions applied | Community forests established through Nafola/GOPA project and GIZ | Local employment. Biodiversity conservation. Improved ecosystem services. | 13 537 000 t $CO_2$-eq/year in 2030 (planned; conditional) |
| Reduce | Reduce wood | The Forest Act includes rules to | $CH_4$, $CO_2$ | Policy: | Ongoing | MAWF | Number of | Alternative | Forest Act. No | Reduction in | None identified | 701 000 t $CO_2$- |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| removal of wood by 50 % (INDC Measure) | removal to maintain the carbon sink | regulate removal of wood which will increase the sink. | | reduce deforestatio n (goal) | | | wood harvesting permits issued. | energy source identified. Permit system for wood harvesting in place. | methodology for estimating GHG emissions reductions applied | wood removal due to the permit control system in place. | | eq/year in 2030 (planned; conditional) |
| Reforest 20 000 ha per year (INDC Measure) | Reforestation to form a carbon sink | The tree planting strategy was developed to guide planting activities in the country. | $CH_4$ | Policy: reforest (goal) | Ongoing | MAWF | Number of hectares planted | Mobilization of land identified for planting the species. Species identification. | Tree planting strategy. No methodology for estimating GHG emissions reductions applied | | Contribution to food safety. | 1 779 000 t $CO_2$-eq/year in 2030 (planned; conditional) |
| Restore 15 M ha of grassland (INDC Measure) | Restore grassland | The rangeland management policy was developed. The de-bushing project is underway. | $CH_4$ | Policy: reforest (goal) | Ongoing | MAWF | Number of hectares de-bushed. | Identified affected area. Mobilising funds | Rangeland Policy & Forest Act. No methodology for estimating GHG emissions reductions applied | | Increased carrying capacity of rangeland. Poverty alleviation. | 1 359 000 t $CO_2$-eq/year in 2030 (planned; conditional) |

## Table 3.3. Energy Sector

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| Climate Change Strategy and Action Plan (CCSAP) | Mainstream Climate change adaptation and mitigation in the medium to long-term national development goals. | The CCSAP was developed to implement the National Policy on Climate Chaneg (NPCC) and covers the period 2013 to 2020. The CCSAP paves the way to the strategic options to be adopted for coping with climate change challenges while contributing to the international agenda to meet COP requirements. | All greenhouse gas not controlled by the Montreal protocol | Policy: climate change (cross cutting) | Ongoing | MAWF, MME | Number of institutions to have mainstreamed climate change into their planning / budgets. Renewable Energy Policy final draft submitted to MME for approval and the Energy Policy at zero draft stage project to finalise March 2017 | Envisage: Subsea wells, Floating Production Facility, export pipeline, Onshore reception facilities. Execution of the implementation plans | Individual actions within the policy will be measured | | Improved food security, carbon stock enhancement, improved livelihood | Uncertain |
| Rooftop Solar PV (Commercial Net-metering), e.g. Solar PV grid tied system at Spar | Increase the share of Renewable Energy | The Electricity Control Board (ECB) has drafted the net-metering rules to allow feeding back in the grid. This has stimulated private sector investment in rooftop solar PV | $CO_2$ | Project: Solar PV | ECB net metering rules submitted to the legal drafters for gazetting before end of 2016 | ECB and Electricity Distribution license holders, e.g. City of Windhoek, Regional Electricity Distributors, etc. | No. of audits undertaken (audits inform potential) MW of rooftop PV installed | Feed in tariff put in place by Erongo Red | IPCC GL, Energy generated is compared to equivalent grid energy emissions | PV system installed, Feed in tariff implemented | Energy security | 300 t $CO_2$-eq/yr |
| Assessment of investment and financial flows to mitigate climate change in the energy sector | Quantify the required investment and financial flows required to mitigate in the energy sector | The energy and agricultural sectors are key to Namibia's economic growth and development but at the same time are the sectors responsible for the large chunk of greenhouse emission in the country. It has been well acknowledged that there is a huge potential for carbon mitigation in the energy sector. Under the energy sector, electricity generation and transport where | $CO_2$ | Programme: Energy (cross cutting) | | MET | | Subsidy to be provided on the LPG kits | Modelling approach used and estimates of emissions reduction based on GHG inventory of INDC ; Fuel switching to LPG will be adopted by car owners | 1.13 billion US$ for electricity generation plants, and 69 million US$ for fuel switching | | 1 200 000 t $CO_2$-eq/yr by 2030 (expected) |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | chosen for analysis as these are subsectors where more potential for mitigation were foreseen in the energy sector. | | | | | | | | | | |
| Renewable Energy and Energy Efficiency Capacity Building Programme (REEECAP) | To increase the use of renewable energy and energy efficiency measures to promote environmentally sustainable socio-economic development of Namibia. | The objective was to do an assessment of the extent to which energy efficiency is incorporated into rural and peri-urban houses in Namibia | $CO_2$ | Programme: Renewable energy and energy efficiency | Completed in 2009 | Renewable Energy & Energy Efficiency Institute (REEEI). In 2014 this institution was transformed into the Namibia Energy Institute (NEI) to include the other energy sectors. | No. of audits undertaken People trained | | | | | |
| NAMA: Intervention B | Invest in Energy Zones | Intervention B will support the installation of Energy Zones (EZs). Currently, so-called Energy Shops sell suitable, approved energy products and compatible appliances to consumers. Under Intervention B, these will be developed into the concept of Energy Zones, by adding a Rural Productivity Zone component. Get more info from Sion and Ashili | $CO_2$ | Project: energy (cross cutting) | Project proposal being developed | MET, MME, NEI | NAMA Proposals accepted. Funding secured (Namibia's government will provide 30 per cent of funding; the private sector 15 per cent; and NAMA donors 55 per cent); Energy Zones installed | NAMA submitted to the UNFCCC NAMA Registry | Estimated using Institute for Energy and Transport Joint Research Centre (European Commission) (IET) (2012). Photovoltaic Geographical Information System. Geographical Assessment of Solar Resource and Performance of Photovoltaic Technology. Available from http://re.jrc.ec.europa.eu/pvgis/. | None | Number of households having access to electricity services – 30; Number of people with access to RE electricity services – 180; Number of new income-generating activities (enterprises) – 2; Number of additional new women's enterprises – 1; New sales points for RE&EE technologies – | 18 t $CO_2$-eq/yr (expected) |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | | | | | | | | | | 1. | |
| Biomass harvesting and power plants | Harvest invader bush (which is a local fuel source, currently a nuisance for farmers) to generate electricity | The National Integrated Resource Plan (NIRP) suggests that a commercial scale pilot project owned by the government would support the operation and economic characteristics of a Biomass-to-Electricity power station to encourage private sector investment. Implementation plan of the first Biomass power plant from feasibility to commercial operation is planned to start March 2017 (Technical, Economic and Environmental feasibility) and Power Station Commercial Operation is expected for June 2020 with a capacity of 20-30 MW. | $CO_2$ | Project: Biomass-to-electricity | Planned | Nampower | MW installed capacity | Pre-feasibility study undertaken | Not yet determined | Initial planning | Job creation, improved rangeland productivity through de-bushing | To be determined once the installed capacity has been confirmed |
| Organic Energy Solutions | Reduce O&L carbon footprint by 20% by 2019 | Ohlthaver & List (O&L) Energy is converting invader bush to energy. The bush-thinning project will eventually replace 80% of the current 3600 tons of heavy fuel oil (HFO) used by it brewery (Namibia Breweries Limited (NBL). | $CO_2$ | Project: biomass | Ongoing | Ohlthaver & List | MW installed capacity | Area invaded by bush identified. Biomass boiler installed at the O&L brewery. | Not yet determined | Boiler installed | Improved agricultural productivity through improved rangeland as results of removal of unwanted bush that compete with grass (animal feed). Reduction in the use of fossil fuel. | Uncertain |
| Rural Electricity Distribution Master Plan (REDMP), 2010 | Improve rural electrification | The REDMP for Namibia was conceptualized and developed as part of the Government's policy agenda to guide the social upliftment of especially poor, rural communities and economic development of the nation. The 2010 REDMP aims to:<br>• establish the status quo with regards to the planned versus | $CO_2$ | Policy: energy | Originally introduced in 2000. It is reviewed and updated every 5 years | MME | | | | | | |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | achieved electrification of rural communities from 2005 up until 2010<br>• establish rural electrification targets and priorities for the next 20 years, and<br>• establish a structured methodology and approach to derive a rural electrification master plan for achieving the 20-year targets. | | | | | | | | | | |
| Xaris gas power plant. | Increase electricity generation capacity | 250MW Gas power plant worth N$7 billion located in Walvis Bay. | $CO_2$ | Project: Gas | Ongoing tendering stage | Nampower | MW installed capacity | | Not yet determined | None | Energy security | Uncertain |
| Kudu Gas-to-Power Project | Increase electricity generation capacity | The 884 megawatt (MW) Kudu power plant will be located in the area of Oranjemund and is expected to be commissioned in 2019. Since the expected Namibian domestic electricity demand from the power plant is approximately 400MW, the remainder of the electricity must be exported by means of power purchase agreements with Zambia (Copperbelt Energy Corporation) and South Africa (Eskom). | $CO_2$ | Project: Gas to power | | NAMCOR | MW installed capacity | Envisage: Subsea wells, Floating Production Facility, export pipeline, Onshore reception facilities | Not yet determined | None | Energy security; revenue from the sale of electricity to neighbouring countries | Uncertain |
| Concentrated Solar Power (CSP) with Thermal Energy Storage (TES) | Develop a CSP Plant with | Aim to provide:<br>1. A clean and renewable solution for flexible and dispatchable power,<br>2. Voltage support and system stability to the national grid, and<br>3. Ancillary services (including frequency response reserves, frequency<br>regulating reserves, spinning reserves and ramping reserves).NamPower's feasibility study considered CSP implementation options<br>(trough or central receiver with storage) of between 50 and 200 MW. The project will involve The construction of the CSP Plant with | $CO_2$ | Project: CSP | Ongoing | Nampower | MW installed capacity | Pre-feasibility studies undertaken | Not yet determined | Initial planning | Increased security of energy supply. Employment and taxes. Technology transfer. | To be determined once the installed capacity has been confirmed |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | storage and potentially hybridized with PV. The implementation is expected to commence late 2016 and commercial operation is expected for March 2021. | | | | | | | | | | |
| Solar Thermal Technology Roadmap for Namibia | To achieve widespread adoption of flat plate solar thermal collector capacity in Namibia by 2030. | | $CO_2$ | Policy: Solar CSP | Ongoing: Preparation work has started | NEI | Flat plate solar thermal collector capacity installed | Preparation undertaken | Not yet determined | Policy development underway | Energy security; skills transfer; job creation | Uncertain |
| Concentrating Solar Power (CSP) Technology Transfer for electricity generation in Namibia (NAM CSP TT) | Increase the share of solar CSP in the energy mix | The CSP TT NAM aims to develop the necessary technological framework and conditions for the successful tranfer and deployment of CSP technology for on-grid power generation. Renewable Energy and Energy Efficiency Institute (REEEI) now known as Namibia Energy Institute did pre-feasibility study (in 2012) on concentrated solar power and produced a map of sun radiation. The GEF, through UNDP, is providing funding for a full feasibility study. | $CO_2$ | Programme: Solar CSP | Ongoing | MME, NPC, NEI | Programme components implemented; CSP installed capacity | Capacity development conducted in concentrated solar power technology. Site for first CSP project has been identified. | IPCC GL, zero emission CSP output (MWh) compared to the SAPP grid emissions factor for equivalent energy | Programme underway | Energy security; skills transfer; job creation | 482 944 t $CO_2$-eq/yr (expected) |
| Photovoltaic water pumps | Reduce energy consumption from the grid, increase water availability to communities and growers | | $CO_2$ | Programme: Solar PV | Completed in 2004 | | No. of solar water pumps installed Capacity installed | Government incentive, Bank loans at low interest, | IPCC GL, Water is available, cost not prohibitive, technology is user friendly | 659 by 2004 | improved quality of life | 800 000 t $CO_2$-eq/yr |
| Independent Power Producer (IPP): Mariental Solar PV | Generate solar energy as part of the NamPower Sol PV Tender | 37 Megawatt solar photovoltaic (PV) power plant which will be situated in Mariental | $CO_2$ | Project: Solar PV | Ongoing tendering stage | Nampower | MW installed | Project put out to tender | Standardized baseline for the Southern African power pool (0.9801 t $CO_2$-eq /MWh); 30% availability factor | None | Energy security; job creation during construction | 95 000 t $CO_2$-eq/yr (expected) |
| Renewable Energy Feed-in Tariff (REFIT) Programme: | Generate electricity from solar and wind energy; | A capacity of 70 MW is expected to be generated through the REFIT Programme, which translates to 14 Independent Power Produces (IPPs) | $CO_2$ | Project: Solar PV | Ongoing : two project on PV are completed while 12 are | Nampower, with Inter-pendent Power | No. of audits undertaken | N$110 secured for Areva Mine Solar PV construction | Standardized baseline for the Southern African power pool (0.9801 t $CO_2$-eq /MWh); 30% availability factor | Increased share of renewable energy in the | Energy security; skills transfer; improved | 180 000 t $CO_2$-eq/yr (expected) |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| Solar PV and Wind energy | increase renewable energy share in the energy mix. | each generating 5 MW. Thirteen of the IPPs that Nampower (national power utility) is working with are involved in solar PV technologies, with one specialising in wind power. | | | still under construction | Producers | | phase. | | energy mix. Reduced emissions from the electricity production | livelihood through job creation: 50 - 60 construction jobs per plant | |
| Support to De-bushing | Reducing bush encroachment and creating energy supply opportunities | Namibia has established a national de-bushing Programme which supports the large-scale expansion of effective activities to fight bush encroachment. The Programme is supported by public- and private-sector stakeholders. | $CO_2$ | Programme: biomass | Underway (2014 - 2017) | MAWF | Ha de-bushed; MW installed capacity | | Not yet determined | None | De-bushing could potentially create over 20,000 jobs in Namibia | Uncertain |
| The CBEND Project (Combating Bush Encroachment for Namibia's Development) | Supply electricity to remote community through off-grid system, Use of biomass from invader bush to produce electricity, | The CBEND Project has installed a 250 kW bush-to-electricity power plant on a commercial farm in the Otavi area, in one of the most bush infested areas of Namibia. The gasifier is fuelled with invader bush, and feeds electricity directly into the national grid. It is considered as a proof-of-concept project to determine the financial feasibility of this approach, assess the technical robustness of the technology, and establish Namibia's first independent power producer | $CO_2$ | Programme: biomass | Power plant completed but not in operation | Desert Research Foundation of Namibia (DRFN) | MW installed capacity | Small grid built to supply electricity produced, grid connected | IPCC GL, Biomass supply for long term operation, Technology mastered | Plant Commission-ed but not started operating up to now, technical problem | Job creation, increasing rangeland productivity through de-bushing | 300 t $CO_2$-eq/yr |
| Baynes Hydropower Project | Increase renewable energy generation capacity | The 300 megawatt (MW) Baynes hydropower plant will be developed by Namibia and Angola at a cost of US$ 1,3 billion and is expected to be commissioned by 2024. The hydropower project is situated along the Cunene River, 200 kilometres downstream of Ruacana in the Kunene region. | $CO_2$ | Project: hydro | The two respective Ministers of Energy (Namibia & Angola) have agreed to proceed with the implementation of the Project | Namibian and Angolan Energy Ministries | MW installed capacity | Initial studies completed; decision to proceed pending | Not yet determined | None | Energy security | Uncertain |
| Ruacana hydro project 4th turbine | Increase renewable energy generation capacity | The Ruacana Hydropower station on the Kunene river is the core of the Namibian power supply system. It is a run-of-river plant with capacity of 332 MW. However, due to being a run-of-river plant, the | $CO_2$ | Project: hydro | Completed | Nampower | MW installed capacity | Additional electricity needs exist, grid can support output and transmit to | IPCC GL, dependency on electricity imports reduced, improve GDP, electricity security | Turbine installed in 2012 | improved quality of life, income generation, job creation | 150 000 t $CO_2$-eq/yr since 2012 |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | variations in Southern Angola's rainfall limit its performance. It is therefore operated as a base load plant during the rainy season (February-May) and as a peak plant for the rest of the year. | | | | | | users | | | | |
| Erongo wind farm | Increase share of renewable energy | | $CO_2$ | Project: wind | Ongoing: under development | | MW installed capacity | PPA made with Nampower | IPCC GL, market exists for additional electricity | Farm site identified, EIA under way, Licence granted by regulator | | 250 000 t $CO_2$-eq/yr (expected) |
| Wind park in Walvis Bay | Increase share of renewable energy | the wind park Walvis Bay with one turbine and a capacity of 220 kW, which was erected in 2005, feeds the power grid operated the by regional provider ErongoRED | $CO_2$ | Project: wind | Completed | | MW installed capacity | | IPCC GL, zero emission wind output (MWh) compared to the SAPP grid emissions factor for equivalent energy | | | 661 t $CO_2$-eq/yr |
| NAMA: Intervention A | Increase minigrids | Mini grids will be established in rural communities. These mini grids will preferably be in the vicinity of schools and potential future tourism projects, such as ecologies. The mini grids will use renewable energy sources (solar, wind, hydro) and will provide electricity for lighting, radio and phone charging for households, for service and production activities in Rural Productivity Zones (RPZs), and for lighting and the Internet for public buildings. The mini grids to be financed will be selected using the approach of "reversed auctioning". Under reversed auctioning, offers are accepted, starting from the cheapest, until the budget available for the specific auction is used up. In the case of the mini grids, auctioning will be based on value for money. Proposals will be ranked by their standing in the Value for Money Index (VMI), which will be | $CO_2$ | Project: minigrids | Proposal in a drafting stage | MET, MME, NEI | NAMA Proposals accepted. Funding secured (Namibia's government will provide 30 per cent of funding; the private sector 15 per cent; and NAMA donors 55 per cent); Minigrids developed | NAMA submitted to the UNFCCC NAMA Registry | Estimated using Institute for Energy and Transport Joint Research Centre (European Commission) (IET) (2012). Photovoltaic Geographical Information System. Geographical Assessment of Solar Resource and Performance of Photovoltaic Technology. Available from http://re.jrc.ec.europa.eu/pvgis/. | Improved access to the grid, improved livelihood | Number of health care institutions (clinics) electrified- 1; Number of households electrified - 100; Number of people with access to RE electricity- 600; Number of educational institutions (schools) electrified- 1; Number of new income-generating activities (enterprises)-5; Number of new jobs (total)- 2; | 110 t $CO_2$-eq/yr (expected) |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | calculated as "grant support requested (in N$) per one OGEMP Point Score | | | | | | | | | Number of new jobs for women-1. | |
| Draft Independent Power Producer Framework, 2016 | Achieving energy security and improving Electronic Supplementary Information (ESI) efficiency through competition both among the buyers and suppliers. | The policy seeks to reduce Namibia's dependence on energy imports, increase access to reliable and affordable electricity for all consumers, as well as support Namibia's economic growth and employment enhancement targets. | $CO_2$ | Policy: energy (IPPs) | Suggested completion by late 2016 | ECB; MME; Nampower | IPP Frame-work Establish-ed; MW installed capacity | Framework drafted | Not yet determined | Increased private investment in the country | Energy security; Job creation | Uncertain |
| Tsumkwe solar -200 KW solar hybrid system energy project | Provide electricity to 1000 persons in a rural settlement | Tsumkwe was identified in the Off-Grid Energisation Master Plan (OGEMP) as a potential location for a mini grid. | $CO_2$ | Project: energy (Solar PV minigrid) | Completed | Desert Research Foundation of Namibia (DRFN), Otjozondjupa Regional Council, MME, Nampower | KW installed capacity | Rural electricity distribution master plan implemented | IPCC GL, quality of life raised, job creation, lower dependency on fuelwood | Socio-economic data available. Plant commissioned in 2010 and operational 2011, all households (1000 people) connected, improved quality of life, job creation | Improved livelihood, job creation | 250 t $CO_2$-eq/yr |
| Gobabeb Mini Grid | Provide rural electricity | Gobabeb Solar PV with Diesel Backup Mini Grid (26 kWp PV). The mini grid has been constructed as part of the Demonstration Gobabeb Renewable Energy and Energy Efficiency (DEGREEE) project. DEGREEE implemented a complex system, including hybrid power generation, energy efficiency and energy saving utilities, an energy management system, an energy tariff structure, and an energy awareness programme, that replaces two economically expensive and environmentally | $CO_2$ | Project: energy (Solar PV minigrid) | | | Projects implemented | Demonstration minigrid constructed | IPCC GL, zero emission energy (MWh) compared to the SAPP grid emissions factor for equivalent energy | | Energy security; energy access | 67 t $CO_2$-eq/yr |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | harmful diesel generators. The system provides electricity to the centre's buildings and offices, as well as housing for staff and visitors. | | | | | | | | | | |
| Ohorongo cement using wood chips to replace coal | Increase renewable energy use in the industrial sector | Ohorongo cement is planning to use wood chips from invasive bushes for energy production including heat to be used in the production process. Invasive bushes will be selectively harvested. | $CO_2$ | Project: biomass (cement) | Planned | The German Schwenk Zement Group | Amount of coal replaced | Measures adopted for burning wood chips instead of coal | IPCC GL, wood chips production will remain cost effective | None | Job creation, improved rangeland productivity through debushing | Uncertain |
| Barrier Removal to Namibian Renewable Energy Programme (NAMREP) | Increase the share of Renewable Energy | The project ran from 2003-2011; the first phase (NAMREP I) focused on providing technical assistance to government, NGOs, finance and other sectors to remove and reduce barriers in terms of capacities, institutional development, technical constraints, financial instruments and public awareness. Phase II focused on promoting the delivery of commercially, institutionally and technically sustainable solar energy services to rural and off-grid communities. | Energy (Residential) sector; $CO_2$ | Programme: Renewable Energy | Complete | MME | Increased share of renewable energy in the mix | Installed solar home systems, solar water heaters and solar water pumps in 5 villages; Provided solar rechargeable batteries and electrical installations to 148 households | Survey on adoption rates and penetration in the rural communities. | 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 | Energy security; job creation; energy access | Uncertain |
| Off Grid Energy Master Plan (OGEMP), 2007 | Increase energy access and the share of renewables in the energy mix | The OGEMP includes the following three components: Supporting small business in rural areas to establish 'energy shops' which sell energy products and compatible appliances, with emphasis on renewable energy and energy efficiency technologies (they also serve as payment collection centres for the solar revolving fund); a Solar Revolving Fund that provides loans to households and communities for solar water heaters, solar water pumps or solar homes systems with a favourable interest rate; and electrification of rural public institutions in off grid | $CO_2$ | Policy: energy (cross cutting) | Implementation begun in 2011. Runs for 20 years | MME; The small business component is implemented by the REEEI (now RNI). The Solar Revolving Fund is administered by the Renewable Energy Division of the MME | Shops established, loans granted, electrification rates improved | Approved by cabinet in 2007; Barrier removal study completed for solar energy; PPA made with Nampower | Not yet determined | 13 shops have been established in 12 regions (every region except Khomas). | Energy access | Uncertain |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| | | areas using solar power, with the aim of reaching all public institutions (including schools, churches and government buildings) in 5 years. | | | | | | | | | | |
| Namibia Energy Efficiency Programme (NEEP) in buildings | Improve energy efficiency of buildings through identifying savings potentials | To develop a rating system for buildings and building codes to improve energy efficiency in buildings. Included 60 energy efficiency audits in commercial and industrial sectors. GEF funded Programme | $CO_2$ | Programme: energy efficiency | 2010 - 2014 | MME; Renewable Energy & Energy Efficiency Institute (REEEI). In 2014 this institution was transformed into the Namibia Energy Institute (NEI) to include the other energy sectors. | No. of audits undertaken Savings opportunities identified Reduced energy consumption per m2 in buildings Cost savings | Audits undertaken | Audits measured. No follow up to assess levels of implementation | Fifteen audits were done, three facilities implemented energy efficiency measures. Project supported the establishment of the Green Building Council of Namibia | Cost savings | 17 000 t $CO_2$-eq/yr savings identified |
| 1M LED Campaign | Replacement incandescent bulbs with compact fluorescent bulbs. | Nampower is providing one Million LED bulbs free of charge to save energy from lighting as LED bulbs are more energy efficient. This project will contribute to awareness regarding energy efficiency. | $CO_2$ | Project: energy efficiency | Ongoing: awareness campaign and provisioning of LED bulbs has commenced | Nampower | No. of LED bulbs installed | Awareness campaigns, free distribution to launch the lamps and encourage community to adopt | IPCC GL, Lamps used over a period of 12 hours daily on average, | 900 000 bulbs distributed, public aware of benefits, | Improved lighting, cost saving | 6600 t CO2e per year |
| Solar home systems and solar water heaters | Increase renewable energy use in the residential sector | Introducing solar (solar PV and solar water heaters) to reduce the reliance on fossil fuel based energy in the residential sector | $CO_2$ | Project: Solar PV and SWH | Complete | | No. of systems installed No. of solar water heaters installed over time | Sensitization campaign done, Loan incentive, Incentives offered by Govt | IPCC GL, Barriers to technology adoption removed, Cost is not prohibitive. Savings are assumed to be sustained | 1145 solar systems and 808 SWHs installed by 2004. | Improved quality of life; generation of income | 5100 t $CO_2$-eq/yr (since 2004) |
| Solar cookers | Reduce use of fuelwood | | $CO_2$ | Project: solar thermal | implemented | | No. of cookers installed | | IPCC GL, Barriers to technology adoption removed, Cost is not prohibitive. Benefits assumed to be sustained | 562 installed in 2004 | Improved quality of life | Minimum of 80 t $CO_2$-eq/yr since 2004 |
| National Renewable | Increase share renewables in | The overarching mission of Namibia's National Renewable | $CO_2$ | Policy: renewable | Finalised 2016. | MME | Feed in tariffs partly worked | Feed in tariffs partly worked | Not yet determined | The share of renewable | Energy security, job | 740 000 t $CO_2$-eq/yr by 2030 |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| Energy Policy for Namibia, 2016 | electricity production from 33% to 70% | Energy Policy is to enable access to modern, clean, and affordable energy services for all Namibians. This policy aims to make renewable energy a powerful tool for the Government of Namibia to meet its short-term and long-term national development goals, and to assist Namibians climb the development ladder, empowered by access to energy at levels that facilitate engagement in productive activity. Additionally, the policy's vision is for Namibia to become a regional leader in the development and deployment of renewable energy within southern Africa. | | electricity | | | out; Barrier removal studies completed; Technicians trained on installation and maintenance of RE systems, 19 independent power producer (IPP) licenses delivered by regulator | out; Barrier removal studies completed; Technicians trained on installation and maintenance of RE systems, 19 independent power producer (IPP) licenses delivered by regulator. | | energy has increased with commissioning of hydro, biomass, wind and solar plants | creation, improved health | (expected) (Note that actual emission reductions reduced reported per project) |
| Gam off-grid solar system | Provide electricity to 2000 inhabitants through an off-grid system | Implementing a mini grid at Gam village in the Tsumkwe Constituency, Otjozondjupa Region. The solar power plant will provide the whole of the Gam settlement, comprising about 1630 people, with electricity. | $CO_2$ | Project: Solar power | Underway | MME | KW installed capacity; minigrid installed | Rural electricity distribution master plan implemented | IPCC GL, Decrease in fuelwood consumption, increased welfare of community with access to more utilities and equipment, etc | 2000 inhabitants provided with electricity in their household, improved quality of life, job creation. | Expected improved quality of life, job creation | 300 t $CO_2$-eq/yr |
| Various Solar Water Heater demonstration projects (included in the SOLTRAIN Programme) | Implement solar thermal demonstration projects | Projects include:<br>1. Eenhana Vocational Training Centre (500 litres, 4.6 KWth)<br>2. Joe's Beerhouse (2538 litres, 42 KWth)<br>3. National Housing Enterprise (160 litres, 1.47 KWth)<br>4. National Youth Service (300 litres, 2.8 KWth)<br>5. Okakarara Vocational Training Centre (500 litres, 4.6 KWth)<br>6. Polytechnic Hotel School (500 litres, 5.6 KWth) | $CO_2$ | Project: Solar Thermal | Underway | NEI (in Namibia) | KWt installed capacity | Demonstration projects supported | IPCC GL, estimated based on reference case electricity offset (at the SAPP grid average emission factor) | 6 Projects implemented | Energy security | 157 t $CO_2$-eq/yr |
| The Solar Thermal Training and | Support the target countries in changing | A regional initiative on capacity building and demonstration of solar thermal systems in the SADC region. | $CO_2$ | Programme: Solar Thermal | Phases I and II completed (2008 – 2016). | NEI (in Namibia) | People trained, workshops | Trainings and workshops conducted | GHG emission reductions methodology not yet identified | Capacity of solar thermal installers | Energy security; skills transfer; | Not available |

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| Demonstration Initiative: SOLTRAIN Project | from a largely fossil energy supply system to a sustainable supply structure based on renewable energy in general, and on solar thermal in particular. | SOLTRAIN started in 2009, and is now in its third phase of cooperation with Botswana, Lesotho, Mozambique, Namibia, South Africa and Zimbabwe.<br><br>The programme focuses on:<br>Raising awareness of the potentials in solar thermal technology;<br>Building of competence in solar thermal technology;<br>Creating solar thermal technology platforms; and<br>Demonstrating that solar thermal technology works. | | | Phase III underway | | undertaken, solar thermal Roadmap implemented | | | improved. Improved power supply in various vocational training centres. | capacity building | |
| Sustainable urban transport master plan for Windhoek including the mass transport, cars and freight pooling (INDC Measure) | Reduce transport energy consumption | The German Cooperation through funding from the German government is supporting the municipalities of Windhoek in purchasing of buses for local transportation. | $CO_2$; $CH_4$; $N_2O$ | Programme: Transport | Planned | City of Windhoek | Mass transport systems implemented; modal shifts; % people carpooling | The masterplan is in place and is currently under review through the support of GIZ. Several buses have been purchased already and are in operation | Not yet determined | Masterplan draft developed | Improved traffic safety, reduced congestion, improved local air quality thus improved health and lastly improved productivity | 510 000 t $CO_2$-eq/yr by 2030 (planned; conditional) |

## Table 3.4. IPPU Sector

| Description | | | | | | Implementation | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Name of Action** | **Main objective** | **Description** | **Gases** | **Type** | **Status** | **Implementing entity** | **Progress Indicators** | **Steps taken / envisaged** | **Methodologies / Assumptions** | **Outcomes achieved** | **Co-benefits** | **GHG reductions** |
| Clinker reduction through replacement with similar production (extending process) at Ohorongo cement production (INDC Measure) | Reduce IPPU emissions resulting from the production of clinker | Certain Supplementary Cementitious Materials (SCMs) have hydraulic properties (i.e. they function similarly to clinker). These occur naturally (pozzalans, mainly metakaolin) or are the result of human activities (mainly industrial waste activities). Extenders with hydraulic properties in particular, and geopolymers and clinker replacement to a lesser extent, do represent potentially significant mitigation options for the cement sector. Blending with Supplementary Cementitious Materials (SCMs) that do not have hydraulic properties (e.g. limestone) reduces emissions but also reduces the quality of the cement. | $CO_2$ | Project: IPPU | Planned | The German Schwenk Zement Group | Reduced $CO_2$ per tonne of clinker produced or per tonne of cementitious product | Being considered at Ohorongo cement | Not yet determined | None | None identified | 36 000 t $CO_2$-eq/yr in 2030 (planned; conditional) |

## Table 3.5. Waste Sector

| Description | | | | | Implementation | | | | Methodology | Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of Action | Main objective | Description | Gases | Type | Status | Implementing entity | Progress Indicators | Steps taken / envisaged | Methodologies / Assumptions | Outcomes achieved | Co-benefits | GHG reductions |
| Municipal solid waste (MSW) to energy | Transform 50% MSW to electricity and compost | The three main municipalities (Windhoek, Walvis Bay and Swakopmund) are planning on collecting unsorted industrial and household waste in special mudular waste processing plants with high temperature pyrolysis in thermochemical reactors which will allow 100% treatment of all types of unsorted waste (household, industrial, medical, construction etc.). | $CO_2$ | Programme: Municipal Solid Waste | Planned | The three municipalities of Windhoek, Walvis Bay and Swakopmund | Amount of waste converted to energy MW installed capacity | Initial planning | Not yet determined | None as yet | Improved hygiene because of improved solid waste management. Creation of a significant quantity of jobs and apprenticeship. Decentralized perceptible generation of electricity (6-12 MW) for each of the three municipalities. | Uncertain |
| Waste to energy projects under the CDM | Convert waste to energy | Biogas Fish river small CDM (UNFCCC 2012) from landfill and water treatment plants. Kupferberg CDM from landfill gas UNFCCC 2012, Windhoek CDM from Gammams water treatment plant (245 kW) | $CH_4$ | Project: Waste-to-Energy (landfill and wastewater treatment biogas) | Range from planned to implemented | Windhoek City Council | CDM proposal submitted for approval | CDM approved to kick start project implementation | CDM approved methodologies | Not available | Sales revenue from carbon credit thus foreign currency earnings. Improved energy security | 7869 t $CO_2$ -eq |

### 3.2.3. Information on mitigation actions

**Table 3.6. Summary information on Mitigation Actions**

| Name of Action | Main Objective | Description | GHG Reductions | Co-benefits |
|---|---|---|---|---|
| **AFOLU** | | | | |
| Forestation/ Restoration | Increase area of forests in order to form a carbon sink | Programmes: Afforest 5000 ha per year (INDC Measure) (Ongoing), Plant 5000 ha of arboriculture per year (INDC Measure) (Planned), Reforest 20 000 ha per year (INDC Measure) (Ongoing), Restore 15 M ha of grassland (INDC Measure) (Ongoing) | 4 074 000 t $CO_2$-eq/yr (potential, conditional) | Job creation; contribution to food safety; increased carrying capacity of rangeland; poverty alleviation; conservation of biodiversity |
| Reduce Deforestation | Reduce deforestation to maintain existing carbon sink | Programmes: Reduce deforestation rate by 75 % (INDC Measure) (Ongoing). The strategy is to be revised), Reduce removal of wood by 50 % (INDC Measure) (Ongoing) | 14 238 000 t $CO_2$-eq/yr (potential, conditional) | Conservation of biodiversity; improved ecosystems; increased tourism. |
| Reduce Enteric Fermentation | Reduce growth time of cattle to decrease emissions per unit | Programme: Fatten 50 000 cattle heads in feedlots (INDC Measure) (Planned) | 201 000 t $CO_2$-eq/yr (potential, conditional) | Contribution to food safety; manure management (collection of manure for energy production and fertilizers); improved livelihood of local farmers. |
| Reduce Soil Carbon Emissions | Reduce carbon emissions associated with soil | Programme: Soil carbon (INDC Measure) (Ongoing) | 180 000 t $CO_2$-eq/yr (potential, conditional) | Contribution to food safety; decreased soil erosion. |
| **Energy** | | | | |
| Cross-cutting | Reduce emissions associated with the energy sector | Policies: Climate change strategy and action plan (CCASP) (Ongoing), Rural Electricity Distribution Master Plan (REDMP), 2010 (Reviewed and updated every 5 years), Programmes: Assessment of investment and financial flows to mitigate climate change in the energy sector, Renewable Energy and Energy Efficiency Capacity Building Programme (REEECAP) (Completed), Project: Nationally Appropriate Mitigation Action (NAMA) Intervention B (Proposal developed and submitted into the NAMA Registry), Off Grid Energy Master Plan (OGEMP), 2007 (Implementation begun in 2011, runs for 20 years); Mass transport in Windhoek, car and freight pooling (INDC Measure), Xaris gas power plant (Ongoing tendering stage), Kudu Gas-to-Power Project (decision pending) | Additional 510 000 t $CO_2$-eq/yr (potential, conditional) | Improved livelihoods; poverty alleviation; community upliftment; decreased reliance on fossil fuels; increased access to electricity; small business creation and promotion of entrepreneurs. |
| Renewable Energy | Increase share of renewable energy sources in the market | Policies: Draft Independent Power Producer Framework, 2016 (Suggested completion date late 2016); Solar Thermal Technology Roadmap for Namibia (Ongoing), National Renewable Energy Policy for Namibia, 2016 (Finalised 2016) Programmes: Concentrating Solar Power (CSP) Technology Transfer for electricity generation in Namibia (NAM CSP | Additional 740 000 t $CO_2$-eq/yr (potential, conditional); 955 600 t $CO_2$- | Community upliftment; decreased reliance on fossil fuels; increased access to electricity; small business creation and promotion of entrepreneurs; job creation; GDP growth due to sale of electricity to neighbouring |

| Name of Action | Main Objective | Description | GHG Reductions | Co-benefits |
|---|---|---|---|---|
| | | TT) (Ongoing), Photovoltaic water pumps (Completed in 2004), Support to De-bushing (Ongoing), The CBEND Project (Combating Bush Encroachment for Namibia's Development) (Power plant completed but not in operation), Barrier Removal to Namibian Renewable Energy Programme (NAMREP) (Complete), The Solar Thermal Training and Demonstration Initiative: SOLTRAIN Project (Phase 1 & 2 completed, Phase 3 underway) Projects: Rooftop Solar PV (Commercial Net - metering), e.g. Solar PV grid tied system at Spar (Planned before end of 2016), Biomass harvesting and power plants (Planned), Organic Energy Solutions (Ongoing), Concentrated Solar Power (CSP) with Thermal Energy Storage (TES) (Ongoing), Independent Power Producer (IPP): Mariental Solar PV (Ongoing, tendering stage), Renewable Energy Feed-in Tarrif (REFIT) Programme: Solar PV and Wind energy (Ongoing), Baynes HydroPower Project (Agreed to proceed with implementation), Ruacana hydro project 4th turbine (Completed), Erongo wind farm (Ongoing: under development), Wind park in Walvis Bay (Completed), NAMA: Intervention A (Proposal developed and submitted into the NAMA Registry), Tsumkwe solar -200 KW solar hybrid system energy project (Completed), Gobabeb Mini Grid (GAP), Ohorongo cement using wood chips to replace coal (Planned), Solar home systems and solar water heaters (Complete), Solar cookers (Implemented), Gam off-grid solar system (Underway), Various Solar Water Heater demonstration projects (included in the SOLTRAIN Programme) (Underway) | eq/yr (achieved, measured) | countries (decreased reliance on neighbouring countries for electricity); increased Foreign Direct Investment; skills creation; improved quality of life; improved health; decrease in pollution. |
| Energy Efficiency | Reduce Namibian energy consumption relative to economic activity | Programme: Namibia Energy Efficiency Programme (NEEP) in buildings (Completed, 2010-2014), Project: 1M LED Campaign (Ongoing) | Additional 51 000 t $CO_2$-eq/yr (potential, conditional); 17 000 t $CO_2$-eq/yr (achieved, measured) | Cost savings; improved lighting; increase in number of children educated; decrease in waste from longer lasting bulbs. |
| **IPPU** | | | | |
| Clinker Replacement | Reduce emissions resulting from the production of clinker | Project: Clinker reduction through replacement with similar production (extending process) at Ohorongo cement production (INDC Measure) (Planned) | 36 000 t $CO_2$-eq/yr (potential, conditional) | None |
| **Waste** | | | | |

| Name of Action | Main Objective | Description | GHG Reductions | Co-benefits |
|---|---|---|---|---|
| Waste to Energy | Increase share of electricity generated from waste to energy processes | Program: Transform 50% of Municipal Solid Waste (MSW) to electricity and compost (INDC Measure) Project: Waste to energy projects under the CDM (Ranges from planned to implemented) | 205 t $CO_2$-eq/yr (potential, conditional), 7 900 t $CO_2$-eq/yr (expected as part of CDM projects) | Improved health; improved hygiene; job creation; decentralized generation of electricity (6-12 MW) for each of the three major municipalities. |

### 3.2.4. Barriers to mitigation and lessons learned

Namibia faces several challenges in planning and implementing mitigation actions: lack of financial support and capacity being the most significant of these. In addition, each IPCC sector faces different barriers and opportunities to mitigate GHG emissions.

***AFOLU:***

- Implementing mitigation actions in the AFOLU sector is challenging given a lack of data and complexities associated with multiple stakeholders at multiple scales.

***Energy***

- Namibia has significant renewable energy potential and has taken steps to direct investment and creating an enabling environment for private sector investment in renewables.
- Namibia's transport is dominated by the road component for both passengers and goods. Taking into consideration the extended geographic nature of the country with low population densities outside its urban areas, there is little prospect for the transport landscape to change in the short or medium term. There is no other means of transport which can replace the existing modes in the present context of the country's development and bring a significant change in its total energy demand profile and reduce its heavy reliance on imported fuel. In view of its rather small fleet of vehicles and therefore small volume of consumption of petroleum products, there is no economic incentive for these fuels to be replaced by alternative energy sources (TNC).

***IPPU***

- Use of extenders and other materials to replace GHG-intensive clinker is a way of reducing the GHG intensity of cementitious products. The challenge is that the long-term properties of these products is not known. This makes it difficult to find an appropriate "properties" metric to use as the denominator.
- There is a risk that a metric based only on clinker content could incentivise extending at the expense of quality. This could, in the longer term, require more cement which would have GHG emission implications. Alternatively cement companies could shift the non-hydraulic extender blending process from the downstream value chain to within its direct operational boundary. This would change the emissions profile of the country but would not impact emissions of the final products used (there is an argument that emissions could increase as centralised blending may not be optimal relative to decentralised needs).

***Waste***

- Limited waste is generated in Namibia (due to a small population). There are long distances between the municipalities making it expensive to transport waste. And there is a Lack of waste characterization.
- Waste industries are not incentivised to reduce or prevent waste. Disposals costs (the gate fees) are not high enough to incentivise alternatives such as waste use in energy generation. Viable waste to energy projects require access to reliable and suitable feedstock which, given the current system, presents a potential barrier.
- Finally administrative and technical capacity requirements tend to be quite high

# 4. Information on domestic Measurement Reporting and Verification

Prior to the publication of BUR1 Namibia did not have a system to track mitigation benefits in terms of emission reductions or sink enhancements as well as indirect returns within the wider context of sustainable development. However, efforts have been made to develop systems and build capacity domestically to sustainably assess and report mitigation actions within the framework of the UNFCCC. Progress has been made but there remain challenges relating to:

- Availability of data and resources required to gather and manage relevant data
- Capacity to undertake mitigation assessments; and
- Formalised roles and responsibilities to which institutions and individuals are held accountable

Given the outcomes of COP21, it is clear that a sustainable, capacitated system is required to meet the ongoing reporting requirements. Additionally, Namibia needs to generate evidence to inform domestic investment in mitigation, motivate for access to climate finance and other support and equip the country to engage more effectively around what represents a fair contribution to the global climate change mitigation effort.

## 4.1. Overall coordination of MRV

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 (Republic of Namibia 2014).

Namibia is experiencing challenges integrating climate change MRV into the NPC's M&E system. The NPC is responsible for M&E of National Development and serves on the NCCC but systems for integrating climate change MRV elements within the national M&E process still need to be formalised.

The multi-sectoral NCCC oversees the implementation and coordination of sector-specific and cross-sectoral climate change activities while also providing advice and guidance on them. The NCCC reports to Cabinet through the NPC. The MET through its DEA and CCU reports on the climate change activities including reporting to the Convention within this context of M&E. Sectoral MRV activities rests with the respective Ministries through their concerned Directorates.

This system is based on the institutional structure for implementation of the National Climate Change Policy as shown in Figure 4.1. 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.

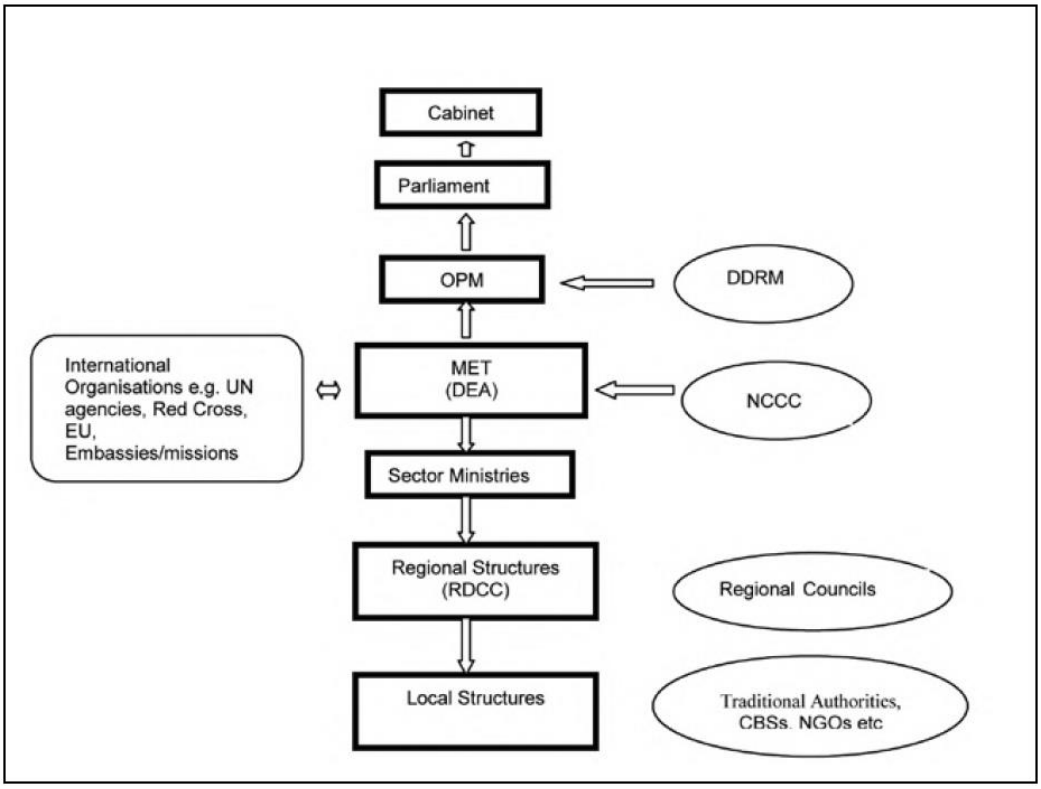



**Figure 4.1. Institutional structure for implementation of the National Climate Change Policy**

Source: Namibia National Policy on Climate Change; 2011

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 analysed 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 delivered 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.

The CCU is considering establishing a Memorandum of Understanding (MOU) with the NSA. This would facilitate better data collection from the Ministries as the NSA has a legal framework to require data. A challenge is that the NSA has capacity and staff turnover challenges which would need to be overcome if such a system were to be established.

The establishment of the QA/QC system remain in progress. 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 subsections.

### 4.1.1. Building a sustainable domestic MRV system

The BUR1 noted that Namibia has decided to produce UNFCCC 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.

To date Namibia has outsourced the GHG inventory components of the 1st, 2nd and 3rd National Communications but has been able to utilise working groups in the process of the TNC. The development of the NAMA was supported by UNDP. However, the compilation of chapters in the BUR2 have utilised more local consultants. The terms of reference for the consultancies explicitly included the need for local capacity building to enable the transition to a sustainable system managed and delivered by Namibian public and private sector institutions.

## 4.2. GHG Inventory System

The GHG Inventory System is described in the Inventory chapter of this report.

## 4.3. Mitigation Actions (including NAMAs)

Namibia continues to build and improve its system for measuring, reporting and verifying mitigation actions and their effects. The institutional arrangements follow closely those described above for the GHG inventory, involving the same institutions but with somewhat different responsibilities within the system. A Mitigation Working Group (MWG) has been established with representatives responsible for collecting and reporting data related to mitigation actions according to the IPCC sectors of AFOLU, Energy, IPPU and Waste. The list of institutions represented in the MWG can be found in Table 4.1.

**Table 4.1. Mitigation Working Group**

| Mitigation Working Group Institutions Represented | IPCC Sector |
|---|---|
| City of Windhoek | Waste |
| Electric Control Board | Energy |
| Environment Investment Fund | Cross Cutting |
| Ministry of Agriculture, Water and Forestry | AFOLU |
| Ministry of Environment and Tourism | Cross Cutting |
| Ministry of Mines and Energy | Energy |

| Mitigation Working Group Institutions Represented | IPCC Sector |
|---|---|
| Ministry of Trade and Industry | IPPU |
| Ministry of Works and Transport | Energy |
| Namibia Chamber of Commerce and Industry | Cross Cutting |
| Nampower | Energy |
| NAMWATER | Energy |
| National Planning Commission | Cross cutting |

Although established, formalising the reporting of relevant data by the members of the group remains a challenge. If no progress is made in establishing an MOU with the NSA, then the CCU may need to consider MOUs with each Ministry to ensure that climate change MRV receives adequate priority.

Responsibility for MRV of individual mitigation policies, programmes and projects rests with the relevant MWG member depending on the relevant IPCC sector. MWG members can delegate data collection and reporting responsibilities to the managing institutions. For example, project implementers could be required to report according to an M&E plan established at the beginning of project implementation.

Data reporting templates have been created. The following information on mitigation actions is gathered, to the extent possible:

- Mitigation action description: name, main objective, description, coverage (sector and gases) and type (policy, programme or project);
- Implementation information: status (planned, ongoing, implemented), implementing agency and progress indicators;
- Methodology (including assumptions)
- Effects: outcomes achieved, co-benefits (non-GHG impacts) and estimated GHG emission reductions
- Costs and support
- Other: barriers and opportunities for mitigation.

Data is collected via the reporting templates. Consultants work with MWG members and draw on relevant documentation to populate the template. The mitigation action and MRV workshop held in Tsumeb in September 2016 served to refine the data collection templates and to fill gaps, to the extent possible, as part of reporting on mitigation actions and their effects in the BUR2.

The implementing institution will be responsible for the quality control of measurements and data collected. No third-party verification is undertaken will be undertaken at this stage unless required by the funder or Party supporting the mitigation action. MET will also perform a QC on the report submitted and eventually apply quality assurance through its staff independently.

### 4.3.1. Improving the capacity of the Mitigation Working Group

The mitigation and MRV workshop held in Tsumeb also served to build the capacity of the MWG to measure and report on mitigation actions. A Namibian consultancy with support from an international climate change mitigation and MRV expert facilitated the workshop to develop an understanding within the MWG of why and what Namibia is required to implement and report on; to improve the capacity of the MWG to assess mitigation and report on MRV requirements; and to collectively determine key interventions for improving the MRV system. The workshop focused on different types of mitigation actions and key methodologies for measuring GHG emissions and non-GHG impacts of mitigation actions.

Following the workshop, the following recommendations were made and will inform the process of improving the MRV system going forward:

### 4.3.2. Measurement and Monitoring of Sustainable Development Benefits

In addition to GHG emissions, the MRV system will monitor the impact of the key mitigation actions on selected Sustainable Development (SD) indicators or mitigation co-benefits. The selection of the SD indicators will be done on a project by project basis and will align with priority indicators relevant to the achievement of Vision 2030. Initially the intention is to focus on a small number of projects to test potential methods understand the potential value associated with measuring and reporting of SD co-benefits. This acknowledges the challenges in reporting on SD co-benefits and Namibia's limited capacity in this regard. Efforts will be made to improve the reporting of SD co-benefits over time. As an example, the capacity building workshop undertaken as part of reporting on mitigation actions in the BUR2 included a focus on SD co-benefits.

### 4.3.3. NAMAs

Namibia has submitted its first NAMA to the UNFCCC NAMA registry to seek financial, capacity-building and technology support. The NAMA includes the following proposed MRV system (UNDP 2015).

Implementation of the NAMA will be led by the Ministry of Environment as the NAMA Coordinating Authority (NCA). The Ministry of Environment has already been appointed as NAMA Approver/Focal Point to the UNFCCC and as the National Designated Authority (NDA) to the Green Climate Fund (GCF). The Environmental Investment Fund (EIF) will take on the role of NAMA Implementing Entity (NIE) and will be supported in technical issues by the Namibia Energy Institute (NEI). The Namibia Climate Change Committee (NCCC) will act as the supervisory board for the NAMA.

The main responsibility for the MRV system lies with the managing institution, which may delegate some of the tasks to the project implementers (PPPs, grid operators, equipment suppliers). The process should unfold in the following sequence.

- The Executing Entities collect data according to the monitoring plan (as part of their approved application) and ensure they fulfill all related requirements such as record keeping and quality control.
- The Executing Entities report the monitoring results to the NIE in an annual report.
- The NIE collects all monitoring reports, combines them in a central monitoring database and summarizes the results in a NAMA monitoring report.
- This report contains information on GHG emission reductions, progress in the sustainable development (SD) indicators, and the financial performance of the NAMA activities.
- The NCA checks and approves the annual monitoring report.
- The NIE arranges for an external verification entity to verify the annual monitoring report.
- The final monitoring report together with the verification report of the external verifier is submitted to the NAMA donor(s).

The NCA is charged with creating reporting form templates. These forms will include at a minimum the following information.

- Details about the venture;
- ESP contact details;
- Description of the measuring system;
- Data parameters measured;
- The default values applied;
- Sampling plan details;
- Calculations of emission reductions.

The reporting form template will be provided by the NAMA Coordinating Authority to the NEEs. The completed forms will be submitted annually to the NCA by the NEEs.

The goal of verification is to have an independent third party auditor ensure that the NAMA is operating as planned and that the measuring and reporting system is being implemented as planned. The verification also ensures that emissions reductions and SD benefits are real and measurable. Auditors should be accredited entities. They can be entities accredited under the CDM or under another accreditation system acceptable to the Government of Namibia and the NAMA donor(s).

Verification should occur every one or two years. The verification will consist of:

- Desk review of documents;
- Site visits/interviews of key stakeholders;
- The drafting of the verification report;
- Provision of feedback on the report by the NAMA Coordinating Authority;
- Finalization of verification report.

The proposed NAMA MRV process is shown in Figure 4.2.

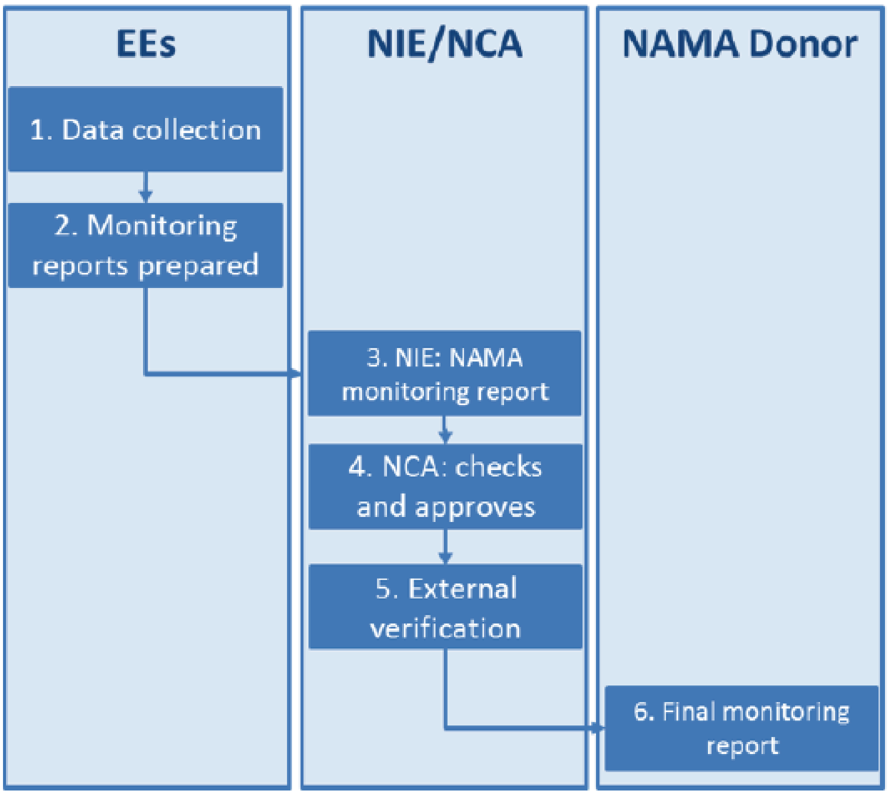



**Figure 4.2. NAMA MRV process**

Source: UNDP 2015

## 4.4. Support

Responsibility for support required lies with the members of the MWG responsible for implementing planned mitigation actions and is overseen by the CCU of the MET. This data is gathered via the data collection template described above as well as through ad hoc, bilateral engagements between the CCU and the various members of the MWG. Information on support received is provided by the NPC and the Ministry of Finance.

## 4.5. Major data / information gaps

A lack of data on the GHG emission reductions and the SD benefits of mitigation actions represents a general challenge. There is a lack of financial resources to support the comprehensive MRV of mitigation actions required by the UNFCCC. Details of support needed in this regard is provided in relevant Chapter in BUR2. Additionally, there is a lack of capacity to conduct assessments. The process of reporting on mitigation actions and their effects in the BUR2 also included an emphasis on capacity building. This was principally achieved through the mitigation and MRV workshop in Tsumeb. Further capacity building is needed to ensure a sustainable domestic MRV system that meets the ongoing UNFCCCC reporting requirements.

Institutional arrangements also need to be formalised to ensure ongoing and sustainable domestic MRV. Financial resources to implement the MRV system are lacking. 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. Additional support is required.

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

## 5.1. Reporting

Namibia is still facing serious challenges and encountering constraints and gaps to report to the required standards and frequency to the UNFCCC. Despite notable progress on the shift from outsourcing to in-house reporting, the country is not ready to complete this exercise on a stand-alone basis. Thus, further strengthening of the capacity of national experts was undertaken during the preparation of the BUR2 report to enable them overcome the constraints and gaps. This process will continue with the preparation of future reports, namely the NC4 and it is expected that constraint removal and filling of gaps will progress more rapidly in the medium and longer terms. To achieve this, national investments will continue, the institutional arrangements will be further enhanced but sustained support will be needed from the bilateral and multilateral partners, and donor institutions to hasten the process.

## 5.2. Implementation

Implementation of mitigation actions remains a major challenge for the country when taking stock of the multiple barriers and difficulties being confronted to in various areas. Weaknesses exist at the institutional, organizational and individual levels over and above financial and technology transfers needs, especially at a time when the country is being seriously affected by a drought running into its fourth consecutive year. There is a need to create the enabling environment in the country. Barriers must be removed to speed up the process of implementation of mitigation projects while enhancing further work on new mitigation measures and preparation of project proposals thereon for funding. Namibia has high expectations on the ratification of the Paris Agreement and sincerely hopes that the pledges will become reality soon and needs will be fulfilled by the Annex I Parties for it to start implementing the identified mitigation and adaptation projects.

## 5.3. Technical and capacity building needs

In the absence of tangible support as requested in the BUR1, Namibia is at a standstill and has not progressed significantly on furthering technical and capacity building. Conscious of this situation, the country invested in capacity building of national experts for reporting to the Convention within the grant availed by the GEF. However, this is only marginal and for reporting only while enhancing of technical and capacity building for implementation of mitigation projects remain a void that should be filled urgently. An updated list of the technical and capacity building needs is provided in Table 5.1.

**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 and NCs (Strengthen existing institutional arrangements) | Ongoing | Additional technical assistance from partners and resource persons or consultants | Some technical assistance and capacity building under the UNFCCC GHG inventory capacity building project, Consultants | Specific technical assistance to analyze weaknesses and propose solutions for enhancing the existing institutional arrangements |

| Activity | Status | Support needed | Support received | Additional support needed |
|---|---|---|---|---|
| | | | with the GEF funds | |
| Preparation of BUR (enhance coordination) | Ongoing | Technical assistance from partners and resource persons or consultants | Consultant contracted with the BUR2 GEF funds | Further technical assistance and or resource persons to prepare a Guidebook on this issue |
| Preparation of BUR (compile GHG inventories) | Ongoing | Further capacity building on generating missing AD, computing emissions, undertaking Uncertainty estimates, running the LAND module of the IPCC 2006 software and applying the EMEP Corinair methods | Some capacity building for running the ALU software under the UNFCCC GHG inventory capacity building project, IPCC training on the 2006 Guidelines and Consultant contracted with the BUR GEF funds | Further technical assistance on generating missing AD, computing emissions, undertaking Uncertainty estimates, running the LAND module of the IPCC 2006 software and applying the EMEP Corinair methods |
| Preparation of BUR and NCs (Prepare maps for refining the FOLU component) | Planned | Funds lacking under BUR2 to realize this activity. Assistance for correcting satellite images, producing reliable land cover land use maps and generating land use changes over time | Very minimal technical assistance and capacity building under the UNFCCC GHG inventory capacity building project | Further technical assistance for correcting satellite images, producing reliable land cover land use maps and generating land use changes over the period 1990 to 2015 at 5 years' intervals |
| 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 | Assistance to enhance capacities to understand and take advantage of existing market mechanisms for developing mitigation and adaptation projects | None | |
| Resource mobilization (funds) | Planned | Assistance for building capacity of national experts to prepare projects of the required standard to attract investors | None | |
| Natural gas to electricity (Kudu project) | Planned | Technical assistance for efficient implementation and capacity building on implementation and management thereafter | None | |
| Fuel switching to LPG | Ongoing | Capacity building for | None | Further support to |

| Activity | Status | Support needed | Support received | Additional support needed |
|---|---|---|---|---|
| for motor vehicles | | installation and maintenance of LPG kits | | increase number of available technicians |
| Solar home systems | Ongoing | Capacity building for installation and maintenance of solar home systems and assessment of impacts | None | Further support to increase number of available technicians and capacity building on assessing impacts |
| Solar water heaters | Ongoing | Capacity building for installation and maintenance of solar water heaters and assessment of impact | None | Further support to increase number of available technicians and capacity building on assessing impacts |
| Photovoltaic pumps | Ongoing | Capacity building for installation and maintenance of photovoltaic pumps and assessment of impact | None | Further support to increase number of available technicians and capacity building on assessing impacts |
| Solar cookers | Ongoing | Technical assistance for promoting penetration, adoption and assessment of impact | None | Further support to enhance capabilities of more NGO members for sensitization of the public |
| Low emission bulbs | Ongoing | Capacity building to assess impact | None | |
| Solar street lighting | Ongoing | Capacity building to assess impact | None | |
| Establishment of the Renewable Energy and Energy Efficiency Institute (REEEI) | Ongoing | Capacity building to enhance capabilities of Institute | None | Further support to enhance capabilities of more officers of the Institute |
| Improve energy efficiency in buildings | Ongoing | Capacity building of architects and engineers to integrate energy efficiency concepts in new buildings | None | Further support to enhance capabilities of a higher number of professionals working in the construction industry |
| Reduce distribution losses in the electricity network | Planned | Capacity building of engineers to assess and implement measures to reduce losses | None | Additional support to improve the capacity of engineers and other concerned staff |
| Energy audits in industries | Planned | Assistance to train engineers and technicians in performing energy audits to kick-start the programme | None | |
| Reduce deforestation | Ongoing | Technical assistance to assess degradation level | Some support received from German Development Bank (KfW) through GIZ | Technical assistance to further enhance capacity of foresters |
| Promote reforestation and afforestation | Planned | Technical assistance on transplanting techniques | | Technical assistance to further enhance capacity of foresters on the latest techniques for successful reforestation and |

| Activity | Status | Support needed | Support received | Additional support needed |
|---|---|---|---|---|
| | | | | afforestation |
| Promote community forest management | Ongoing | Technical assistance for awareness raising | Information not available, being looked into | Technical assistance to further enhance capacity of foresters and the communities at large |
| Use alternatives to poles for construction | Ongoing | Assistance to evaluate impact and rate of adoption of alternative materials and market evaluation | None | Support to design, implement and analyse study on adoption of alternative construction materials |
| Improve livestock feed quality to reduce enteric fermentation | Ongoing | Assistance to evaluate impact of feed quality on enteric fermentation, research on quality of pastures | None | Support to design, implement and analyse study on better quality feeds on enteric fermentation and on pastures |
| Switch from Fuelwood/charcoal to solar/LPG | Ongoing | Assistance to promote technology and evaluate impact | None | Support for capacity building of NGOs to promote the technology adoption and assess impacts thereafter |
| Promote waste sorting and recycling | Ongoing | Assistance to promote sorting and recycling of waste and evaluate impact | None | Support for capacity building to enhance adoption of the technology and assess impacts thereafter |
| Reduce waste generation | Ongoing | Assistance to sensitize public to reduce waste generation and evaluate impact | None | Support for preparation of materials for, and sensitization campaigns and evaluate results afterwards |
| Convert waste to energy | Planned | Technical assistance to prepare projects for funding | None | |
| Composting of abattoir sludge | Ongoing | Assistance to evaluate impact and prepare project for funding | None | |
| Promote composting of domestic waste | Ongoing | Technical assistance to promote technology absorption rate | None | Further support to train more sensitizers to enhance technology adoption |
| Switch to improved water treatment technologies | Ongoing | Assistance to evaluate impact and other benefits | None | Additional support to develop sound project proposals |

## 5.4. Financial Needs

Substantial funding is required to enable Namibia meet its reporting obligations and implement the Convention. 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, faces serious difficult challenges to feed its population and provide it with the minimum requirements for a decent livelihood. As such, the

country will not be able to allocate adequate funding to meet the climate change agenda, even if this is of prime importance to it.

Reporting has become more stringent and regular timewise. This demands for proper management and a reporting system to be put in place. Human and other resources are already lacking and it is a fact that countries need to have a fully-fledged team dedicated to data collection, QA/QC, analysis, report preparation and be prepared for verification amongst others to meet the standards and frequency of reporting as they stand today. It has to be supported by a full array of 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 some support through the implementing agencies of the GEF, these amounts are insufficient and there are often problems in the timing for the release of the funds that impacts on the quality of the national reports.

Implementation is even a more gigantic task because 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. Pledges by Annex I Parties did not become a reality and Namibia is suffering from the impacts of climate change, experiencing now a drought running in its fourth year. There is need for these shortcomings to be corrected urgently 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 of Initial National Communication of the Republic of Namibia to the UNFCCC | Completed | USD 130 000 | USD 130 000 from the GEF<br>USD 10 000 from government | None |
| National Capacity Needs Self-Assessment (NCSA) for Global Environmental Management | Completed | USD 200 000 | USD 200 000 from the GEF<br>USD 20 000 from government | None |
| Climate Change Enabling Activity (Additional financing for Capacity Building in Priority Areas | Completed | USD 100 000 | USD 100 000 from GEF | None |
| Barrier removal to Namibian renewable energy programme, Phase I | Completed | USD 2 600 000 | USD 2 600 000 from GEF,<br>4 730 000 from government | None |
| Barrier removal to Namibian renewable energy programme, Phase II | Completed | USD 2 600 000 | USD 2 600 000 from GEF,<br>7 636 000 from government | |
| CPP Namibia: Country Pilot Partnership for Integrated Sustainable Land Management, Phase 1 | Completed | USD 1 040 000 | USD 1 040 000 from GEF,<br>USD 6 046 000 from government | None |
| CPP Namibia: Adapting to Climate Change through the Improvement of Traditional | Completed | USD 960 000 from GEF | USD 960 000 from GEF,<br>USD 5 795 806 from government | None |

| Activity | Status | Support needed | Support received | Additional support needed |
|---|---|---|---|---|
| Crops and Livestock Farming (SPA) | | | | |
| Strengthening Capacity to Implement the Global Environmental Conventions in Namibia | Completed | USD 475 000 from GEF | USD 475 000 from GEF, USD 260 000 from government | None |
| Namibia Energy Efficiency Programme (NEEP) In Buildings | Completed | USD 859 000 from GEF | USD 859 000 from GEF, USD 3 500 000 from government | None |
| Concentrating Solar Power Technology Transfer for Electricity Generation in Namibia (CSP TT NAM) | Ongoing | USD 1 718 000 from GEF | USD 1 718 000 from GEF,<br>USD 18 436 000 from government | |
| Namibian Coast Conservation and Management Project | Completed | USD 1 925 000 from World Bank | USD 1 925 000 from World Bank,<br>USD 5 872 000 from government | |
| Scaling Up Community Resilience to Climate Variability and Climate Change in Northern Namibia, with a Special Focus on Women and Children | Completed | USD 3 050 000 from GEF | USD 3 050 000 from GEF,<br>USD 40 500 000 from government | |
| Preparation and submission of second national communication | Completed | USD 405 000 from GEF | USD 405 000 from GEF,<br>USD 50 000 from government | |
| Preparation and submission of BUR1 | Completed | USD 352 000 from GEF | USD 352 000 from GEF, USD 50 000 from government | None |
| Preparation and submission of third national communication | Completed | USD 500 000 from GEF | USD 500 000 from GEF, USD 50 000 from government | None |
| Preparation and submission of BUR2 | Ongoing | USD 352 000 from GEF | USD 352 000 from GEF, USD 50 000 from government | None |
| Preparation and submission of Fourth national communication | Approved | USD 500 000 from GEF | USD 500 000 from GEF, USD 50 000 from government | USD 500 000 for preparation of appropriate land use and land cover maps for the period 1990 to 2015 |
| Community-based Adaptation (CBA) Programme | Ongoing | USD 4 525 140 from GEF for Global project | USD 4 525 140 from GEF for Global project,<br>USD 4 125 140 from government | |
| Enhancing Climate Change Resilience in the Benguela Current Fisheries System | Completed | USD 4 725 000 from GEF for Regional project | USD 4 725 140 from GEF for Regional project, | |

| Activity | Status | Support needed | Support received | Additional support needed |
|---|---|---|---|---|
| | | | USD 14 650 000 from government | |
| Preparation of intended nationally determined contribution (INDC) to the 2015 Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) | Completed | USD 180 000 from GEF | USD 180 000 from government | USD 200 000 for preparation of implementation plan |
| Natural gas to electricity (Kudu project MW) | Planned | USD >1 200 000 000 | None | Will be provided in NC4 or BUR3 |
| Wind power electricity generation plan | Ongoing | Financial needs being worked out | None | Will be provided in NC4 or BUR3 |
| Plan for photovoltaics for generating electricity for the grid | Ongoing | Financial needs being worked out | None | Will be provided in NC4 or BUR3 |
| Energy efficient bulbs | Ongoing | USD 1 000 000 | USD 150 000 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 NC4 or BUR3 |
| Off grid energization master plan | Ongoing | Financial needs being worked out | None | Will be provided in NC4 or BUR3 |
| Barrier removal to RE program in 2005 | Completed | USD 100 000 | USD 100 000 from government | Will be provided in NC4 or BUR3 |
| Assessment of investment and financial flows to mitigate climate change in the energy sector | Completed for road transport and Agriculture sectors | Provided under UNDP Global Project | Not estimated | None in the near future and will be provided in future NCs or BURs |
| Replace 1M incandescent lamps with compact fluorescent lamps | Ongoing | 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 |
| 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 |
| Ruacana refurbishment | Completed | USD 5 000 000 | None | |

| Activity | Status | Support needed | Support received | Additional support needed |
|---|---|---|---|---|
| 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 NC4 or BUR3 |
| Windhoek CDM from Gammams water treatment plant | Ongoing | Financial needs being updated | None | Will be provided in NC4 or BUR3 |
| Kupferberg CDM project from landfill gas | Ongoing | Financial needs being updated | None | Will be provided in NC4 or BUR3 |
| Ohorongo cement using wood chips to replace coal | Ongoing | Financial needs being worked out | None | Will be provided in NC4 or BUR3 |
| Erongo wind farm (220 kW) | Planned short term | Financial needs being worked out | None | Will be provided in NC4 or BUR3 |
| Several 1 kW mini hydro for water pumping | Planned short term | Financial needs being worked out | None | Will be provided in NC4 or BUR3 |
| 44 MW windfarm in Luderitz | Planned short term | Financial needs being worked out | None | Will be provided in NC4 or BUR3 |

## 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 for both mitigation and adaptation to climate change. This exercise is being done piecemeal within the national communications framework when identifying potential mitigation and adaptation activities, 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 national adaptation and mitigation strategies to inform the stakeholders and to develop proper implementation plans. 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 500 000 | Small amounts of funds from GEF allocation for NC3 | USD 500 000 |
| Barrier removal for RE technology transfer | Planned | USD 100 000 annually over next 5 years | None | USD 500 000 |
| Natural gas to electricity | Planned | Assessment and costing | None | Will be provided in |

| Activity | Status | Support needed | Support received | Additional support needed |
|---|---|---|---|---|
| (Kudu project) | | under way | | NC4 or BUR3 |
| Wind power electricity generation plan | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Plan for photovoltaics for generating electricity for the grid | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Off grid electricity generation | Ongoing | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Photovoltaic pumps | Ongoing | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Energy efficient bulbs | Ongoing | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Fuel switching to reduce fuelwood consumption | Ongoing | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Biomass conversion to electricity | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Waste to energy | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Wastewater treatment | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Biogas production and conversion to electricity | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Viable seedlings transplanting techniques for reforestation and afforestation | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Mass transport systems | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Traffic monitoring | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Preparation mitigation plan including full set of comprehensive NAMAs | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |
| Preparation of NAP including proposals for funding | Planned | Assessment and costing under way | None | Will be provided in NC4 or BUR3 |

# 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 agency, provided funds to the tune of USD 352 000 to support Namibia prepare its first and second Biennial Update Reports (BUR1 and BUR2) 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 to realize these two projects.

## 6.2. Technical

Capacity to prepare the BUR is low in most Non-Annex I Parties including Namibia since 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.

### 6.2.1. 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.

### 6.2.2. 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 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 using 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. Several 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.

### 6.2.3. 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.

### 6.2.4. 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.

### 6.2.5 Africa workshop on GHG inventory management systems

This workshop was organised by the UNFCCC in collaboration with the IPCC and the GEF implementing agencies UNEP and UNDP and took place from the27 to the 29 October 2016 in Windhoek, Namibia. The workshop covered institutional arrangements based on the US-EPA template workbook on developing a national GHG inventory system, the different steps to compute a comprehensive good quality GHG inventory using the IPCC 2006 Guidelines and the QA/QC process for the AFOLU sector. Hands-on training on the IPCC 2006 software was also provided to participants. The workshop was attended by some national experts along with other experts from the African region to build capacity on these issues towards the production of good quality GHG inventories.

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

Conscious of the threat Climate Change is posing to humanity and already bearing heavily the consequences of climate change, Namibia signed the Paris Agreement on the 22 April 2016 and ratified it on the 21 September of the same year. As such, the country is looking forward to moving ahead with the implementation of all the voluntary actions identified in its INDC to reduce emissions and increase sinks as reported in the mitigation chapter. However, only the minor activities where the country can progress alone are being implemented. The full array of activities earmarked can only be possible when resources needed will be received from the international partners to tap on the economies of scale. For the time being, Namibia is working on a strategy and plan to translate the intentions into project proposals for funding and eventual implementation.

This project formulation exercise is well in line with the need for the country to prepare its NAMAs. Namibia has not yet identified and worked on NAMAs extensively except for one project designed on rural electrification using renewable energy in off-grid systems. The country strengthened its mitigation assessment within the context of its NC3 and this exercise will continue within the NC4 project to be implemented next year. Based on these results, Namibia will attempt at developing a mitigation plan in accordance with the national development strategies and plans, namely the next National Development Plan (NDP5) that is under way. The most promising and feasible projects will be identified and NAMA projects developed on these for implementation. Key source categories, based on the latest GHG inventory results, will be prioritized. As it stands now, the objectives are to reduce emissions in the road transport, electricity production, residential, cement production, livestock, wood removals and solid waste sectors while increasing sinks in the Forests and soils.

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 an appropriate system 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, increase in biomass stocks from growth and loss of carbon stocks from deforestation and forest degradation.

Namibia cannot disregard adaptation to climate change as its consequences can be catastrophic to not only the economy but also to its citizens, especially the poorest and most vulnerable segments of the population as well as the environment and ecosystems which hosts unique biodiversity. The country is presently under severe water stress with a drought running for the fourth consecutive year. This situation has impacted significantly on the primary sectors of the economy, namely Agriculture and

Forestry as can be seen from Table 7.1. This sector, which was contributing to the tune of 5% of national GDP from 2010 to 2012, saw its contribution regressing by 31% on average for the period 2013-2015. This in turn affected the manufacturing industries based on Agriculture and Forestry, threatening food security and the subsistence livelihood of the communities.

**Table 7.1. Contribution (%) of the Agriculture and Forestry sector and its components in national GDP**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| **Agriculture and Forestry** | **5.1** | **5.0** | **4.9** | **3.4** | **3.8** | **3.2** |
| Livestock farming | 3.0 | 3.2 | 3.0 | 1.9 | 2.3 | 1.9 |
| Crop farming and Forestry | 2.1 | 2.8 | 1.9 | 1.5 | 1.5 | 1.3 |

This highlights strongly the very high level of vulnerability of Namibia and the prime importance of adaptation. It is thus crucial that support be provided to Namibia and other countries in similar situations to adapt in the short term and build resilience to climate change in the mid to longer term. Such actions will enable these countries to maintain the welfare of the communities while contributing to resolve the root cause of global warming which is GHG emissions as determined and presented in the INDCs.

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