# REPUBLIC OF YEMEN

# FIRST BIENNIAL UPDATE REPORT TO THE CONFERENCE OF THE PARTIES OF UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

JULY 2017

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## Foreword

*Despite the continued unstable political and security situation in Yemen since 2014, we have been able to accomplish and produce this national report. We decided to continue working and make all possible efforts to achieve anticipated results and objectives under such high level of challenging work environment because we believe that Yemen has been and will continue to take all possible efforts in order to effectively engaged with the world community to combat climate change.*

*As the preparation of the first BUR is a new issue, national team has faced several technical problems on identifying required approaches and methodologies for analysis of some issues specifically those related to MRVs. Hence, results and proposed arrangement options included in this report are just preliminary findings which may require further improvement in subsequent reporting.*

*In this respect, we are fully confident that challenges,* constraints and gaps, as well as related financial, technical and capacity needs *that were identified and presented in this report as well as in previous national submissions would be adequately addressed by international community to help us to continue. This will not happen unless the required technical, financial and capacity building support is provided.*

***Dr. Abdulqader M. Alkharraz***
***Chairman,***
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## List of Acronyms

| | |
|---|---|
| bbl/day | Barrel/day |
| BUR | Biennial Update Reports |
| BS | Baseline scenarios |
| CDM | Clean Development Mechanism |
| CO2 | Carbon dioxide |
| CSP | Concentrated Solar Power |
| CCU | Climate Change Unit |
| CCGT | Combined-cycle gas turbine |
| CHP | Combined Heat and Power |
| CFL | Compact florescent Lamp |
| CSO | Central Statistic Organization |
| EPA | Environment Protection Authority |
| EE | Energy Efficiency |
| DNA | Designated National Agency |
| PEC | Public Electricity Corporation |
| FNC | First National Communication |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| GHG | Green House Gases |
| GWH | Giga Watt Hours |
| GJ | Giga Joules |
| GWPs | Global Worming Potentials |
| GOY | Government of Yemen |
| ha | Hectares |
| IPCC | Intergovernmental Panel on Climate Change |
| Kg | kilogram |
| Km | Kilometer |
| KWH | Kilo Watt Hours |
| LNG | Liquefied Natural Gas |
| LPG | Liquid Petroleum Gas |
| LULUCF | Land Use, Land-Use Change, and Forestry |
| M&E | Monitoring and Evaluation |
| M3 | Cubic meters |
| MAI | Ministry of Agriculture and Irrigation |
| MoF | Ministry of Finance |
| MEE | Ministry of Electricity and Energy |
| MS | Mitigation scenarios |
| mGJ | Million Giga Joules |
| MER | Monitoring, Evaluation and Reporting |
| MRV | Measurement, Reporting and Verification |
| MJ | Mega joules |
| MW | Mega Watt |
| MoPIC | Ministry of Planning and International Cooperation |

| | |
|---|---|
| MoT | Ministry of Tourism |
| MSRA | Marine Science Research Authority |
| MW`E | Ministry of Water and Environment |
| NAPA | National Adaptation Programme of Action |
| NAMA | Nationally Appropriate Mitigation Actions |
| NBSAP II | National Biodiversity and Action plan 2 |
| NCF | National Climate Fund |
| NG | Natural Gas |
| NSREEE | National Strategy for Renewable Energy and Energy Efficiency |
| PARE | Authority for Rural Electrification |
| PV | Photovoltaic |
| NOx | Nitrogen Oxides |
| RE | Renewable Energy |
| SNC | Second National Communication |
| SHS | Solar Home Systems |
| $SO_2$ | Sulphur Dioxide |
| TNC | Third National Communication |
| TOE | Tone Oil Equivalent |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| ROY | Republic of Yemen |
| WB | World Bank |

# Executive summary

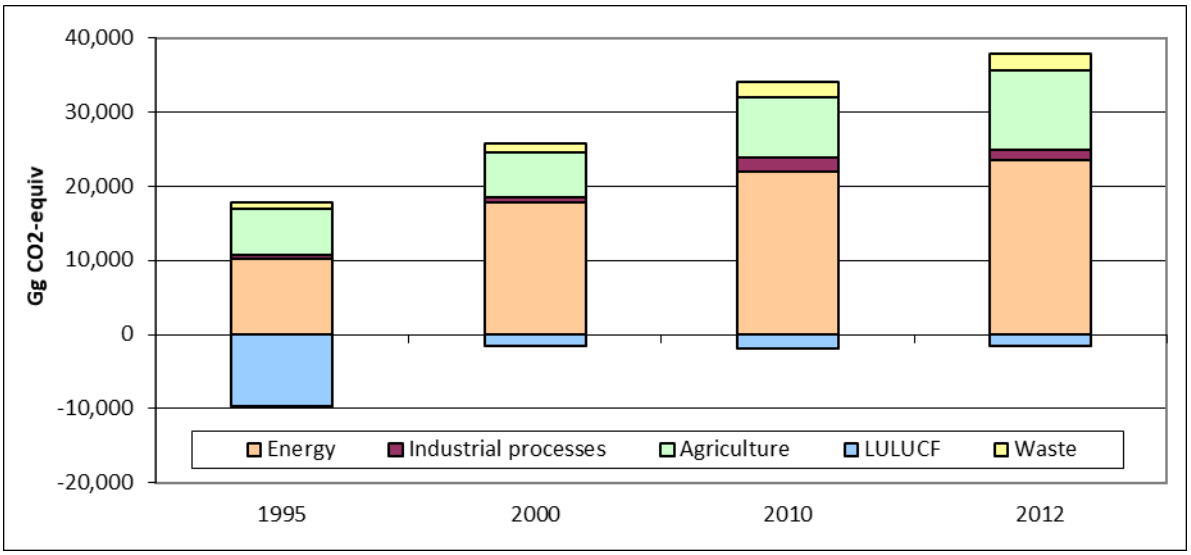
A National Greenhouse Gas (GHG) Inventory for 2012 has been developed by the Yemen Government as an update to its Third National Communication (TNC). The 2012 National GHG Inventory is prepared based on the UNFCCC Guidelines for the national communication from Non-Annex-1 Parties as provided in Decision 17/CP.8 and is summarized in Table ES.1. A detailed breakdown of emissions by sector and gas type has been developed.

**Table ES.1: Total GHG emissions in the Republic of Yemen, 2012 (Gg)**

| GHG Sources & Sinks | $CO_2$-equiv | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| 1 Energy | 23,527 | 21,914 | 74 | 0 | 104 | 577 | 107 | 3 |
| 2 Industrial Processes | 1,398 | 1,398 | 0 | 0 | 0 | 0 | 4 | 1 |
| 3 Solvent & Other Product Use | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 4 Agriculture | 10,770 | 0 | 207 | 21 | 1 | 17 | 0 | 0 |
| 5 Land-Use Change & Forestry | -1,540 | -1,540 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 Waste | 2,106 | 0 | 86 | 1 | 0 | 0 | 0 | 0 |
| Total National Emissions | 37,801 | 23,312 | 367 | 23 | 105 | 594 | 111 | 4 |
| **Net National Emissions** | **36,261** | **21,772** | **367** | **23** | **105** | **594** | **111** | **4** |

Figure 2.1 presents the trend in total GHG emissions for previous 1995, 2000, 2010 inventories, and 2012, the year of the current GHG inventory. Emissions have increased by about 112%; from 17,866 Gg $CO_2$equivalent in 1995 to about 37,801 Gg $CO_2$equivalent in 2012, or roughly 5%/year. On a net $CO_2$equivalent basis, emissions in Yemen increased almost 3 times over the 1995 to 2012 period. A detailed assessment of key trends is also provided by sector and gas type.

**Figure ES.1: Total GHG emission trend, 1995, 2000, 2010, and 2012**




National GHG mitigation and policies are discussed in Section 3. The Government of Yemen recognizes the importance of energy efficiency as means to provide clean, reliable and secure energy supply for economic development and poverty reduction, improve fuel security, enhance the competitiveness of the national economy, protect the local environment as well as contribute to international efforts to combat climate change. Towards this end, the GOY

developed and approved National Strategy for Renewable Energy and Energy Efficiency (NSREEE) in 2009. The Strategy includes 5 specific targets aiming to mitigate GHG emission through introduce renewable energy and 7 specific targets aimed at improving energy efficiency by 2025.

Constraints and gaps, as well as related financial, technical and capacity needs are discussed in the final section. The GHG emission trends are generally attributed to an inadequate enabling environment to promote sustainability. Current production patterns in energy, manufacturing industry, mining, agriculture, forestry and sectors tend to lead to environmental deterioration and represent drivers for GHG emission increase in the atmosphere. The main causal drivers contributing to the continuing GHG emission increase from all production and economic sectors are attributed to extensive use of high carbon content fuels; excessive use of inefficient technologies mainly in power generation, transport, household, and industry.

# 1. Greenhouse gas inventory

The National Greenhouse Gas (GHG) Inventory for 2012 has been developed by the Yemen Government for its First Biennial Update Report under the UNFCCC. The 2012 National GHG Inventory has been prepared on the basis of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, the 2000 IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories, and Good Practice Guidance for Land Use, Land-Use Change, and Forestry (LULUCF). It also includes the use of the global warming potential (GWP) factors recommended by the Revised 1996 IPCC Guidelines and the use of default emission factors recommended by IPCC. Activity data have been mainly obtained from national statistical reports and when data is lacking locally, severally international data sources have been accessed and used upon validation by national experts. this include the use. Detailed inventory tables are provided in the Annex.

## 1.1. Total GHG Emissions

Table 2.1 presents total GHG emissions and sinks for the year 2012. Total GHG emissions in 2012 were 37,801 Gg CO2-equivalent, which includes 23,527 Gg from energy; 1,398 Gg from industrial processes; 10,770 Gg from agriculture and 2,106 Gg from waste. $CO_2$ sequestration by the forestry and land use sector in 2012 amounted to 1,540 Gg. Net GHG emissions are estimated at 36,261 Gg CO2-equivalent. Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) in Yemen are negligible as the products containing these gases are not produced in the country.

**Table 1.1: Total GHG emissions in Yemen, 2012 (Gg)**

| GHG Sources & Sinks | $CO_2$-equiv | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| 1 Energy | 23,527 | 21,914 | 74 | 0 | 104 | 577 | 107 | 3 |
| 2 Industrial Processes | 1,398 | 1,398 | 0 | 0 | 0 | 0 | 4 | 1 |
| 3 Solvent & Other Product Use | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 4 Agriculture | 10,770 | 0 | 207 | 21 | 1 | 17 | 0 | 0 |
| 5 Land-Use Change & Forestry | -1,540 | -1,540 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 Waste | 2,106 | 0 | 86 | 1 | 0 | 0 | 0 | 0 |
| Total National Emissions | 37,801 | 23,312 | 367 | 23 | 105 | 594 | 111 | 4 |
| **Net National Emissions** | **36,261** | **21,772** | **367** | **23** | **105** | **594** | **111** | **4** |

Energy-related activities accounted for the dominant portion of GHG emissions in Yemen in 2012. Approximately 62% of all GHG emissions are associated with the combustion of fossil fuels for electricity production and the release of fugitive emissions from oil and gas operations. Emissions from agriculture accounted for 28% of all GHG emissions, followed by the waste and industrial sectors which accounted for about 6% and 3% of total emissions, respectively.

## 1.2. Emissions by sector

### *1.2.1. Energy*

Table 2.2 summarizes GHG emissions associated with energy activity in 2000. Relative to overall anthropogenic GHG emissions, the 23,527 Gg $CO_2$-equivalent represents about 62%

of total national emissions. Activity data have been obtained from published statistics by relevant agencies in Yemen. Energy data obtained from oil, gas and mineral statistics, published by the statistics technical committee in the Ministry of Oil and Minerals. Other local sources that were relied upon include annual statistics published by Central Statistics and surveys and reports developed the Yemen Geological Survey and Mineral Resources Board (GSMRB). Where data was either unavailable or of low quality, data from international sources were used after being validated. These international data sources included the U.S. Energy Information Administration, the United Nations Statistics Division, and the International Energy Agency (IEA).

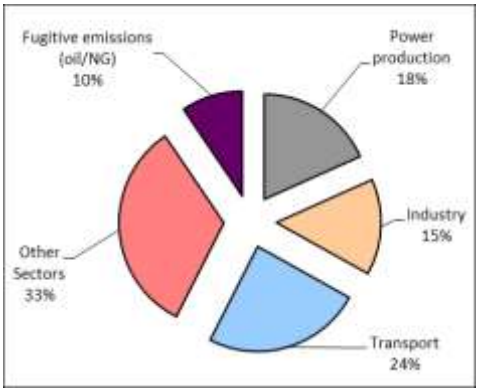
**Table 1.2: GHG emissions from energy use, 2012 (Gg)**

| GHG Source Categories | $CO_2$-equiv | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NM VOC | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **All energy emissions** | **23,527** | **21,914** | **74** | **0** | **104** | **1** | **1** | **577** |
| *A Fuel Combustion Activities* | *21,297* | *21,113* | *6* | *0* | *104* | *1* | *1* | *577* |
| 1 Energy Industries | 4,311 | 4,296 | 0 | 0 | 12 | 0.1 | 0.1 | 1 |
| 2 Manufacturing Industries & Construction | 3,474 | 3,464 | 0 | 0 | 8 | 0.1 | 0.1 | 0 |
| 3 Transport | 5,739 | 5,696 | 1 | 0 | 50 | 0.5 | 0.5 | 508 |
| 4 Other Sectors | 7,773 | 7,657 | 4 | 0 | 34 | 0.3 | 0.3 | 68 |
| *B Fugitive Emissions from Fuels* | *2,230* | *801* | *68* | *0* | *0* | *0* | *0* | *0* |
| 1 Solid Fuels | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 Oil and Natural Gas | 2,230 | 801 | 68 | 0 | 0 | 0 | 0 | 0 |
| *Memo Items* | *335* | *335* | *0* | *0* | *0* | *0* | *0* | *0* |
| International Bunkers | 335 | 335 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 Emissions from Biomass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GHG emissions from energy production and consumption activities are due to fossil fuel combustion and fugitive emissions from oil and gas exploration activities. Fuel combustion emissions are associated with the use of a variety of petroleum products such as diesel, residual oil, and LPG. For the 2012 inventory year, natural gas was not consumed for either power or heat production. All of the diesel and gasoline quantities are consumed in road transport, with relatively negligible small quantities used for industrial processes. LPG is used in the residential and commercial/institutional sectors for cooking.

Figure 1.1 illustrates the breakdown in energy-related GHG emissions in 2012 by consuming activity. Emissions from Other Sectors showed the highest share of GHG emissions in 2012, about 33%. Fuel use is mainly LPG, Kerosene and Diesel. Power production is based overwhelmingly on the use of residual oil and diesel oil and accounted for about 18% of total emissions from energy-consuming activities in Yemen. The transport sector (gasoline and diesel) accounted for 24%. The industrial sector (mostly food/dairy and cement) is relatively small in Yemen and accounted for about 15% of all energy-related emissions in 2012. Notably, fugitive emissions of methane, a gas that has

**Figure 1.1: Breakdown of GHG emissions associated with energy activities, 2000**



a high global warming potential, accounted for about 10% of all GHG emissions in the energy industries sector.

### *1.2.2. Industrial Processes and Other Product Use*

Table 1.3 summarizes GHG emissions associated with industrial processes and product use in 2012. Industrial processes are the fourth largest emitter of anthropogenic GHG emissions in Yemen, accounting for 1,398 Gg of $CO_2$–equivalent, or about 4% of national $CO_2$–equivalent emissions in 2012. Activity data for the industrial sector were based on Trade Statistics and surveys of key industries.

Other than for mineral products, there is negligible industrial activity in Yemen that produces process-related emissions. Cement production is the dominant source of industrial GHG emissions, accounting for the entirety of emissions from the sector.

**Table 1.3: GHG emissions from industrial activity, 2012 (Gg)**

| GHG Source Categories | $CO_2$-equiv | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|---|---|---|---|
| **All industry emissions** | **1,398** | **1,398** | **0** | **0** | **0** | **0** | **5** | **1** |
| *Industrial Processes* | *1,398* | *1,398* | *0* | *0* | *0* | *0* | *5* | *1* |
| A Mineral Products | 1,398 | 1,398 | 0 | 0 | 0 | 0 | 3 | 1 |
| B Chemical Industry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Metal Production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D Other Production | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| E Production of Halocarbons and Sulphur Hexafluoride | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F Consumption of Halocarbons and Sulphur Hexafluoride | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Total Solvent and Other Product Use* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| A Paint Application | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B Degreasing and Dry Cleaning | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Chemical Products, Manufacture and Processing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

### *1.2.3. Agriculture*

Table 1.4 summarizes GHG emissions associated with agriculture in 2012. Agricultural practices are the second largest emitter of anthropogenic GHG emissions in Yemen, accounting for 10,770 Gg of $CO_2$–equivalent, or about 28% of national $CO_2$–equivalent emissions in 2012. Activity data for the agriculture sector was based on the Agricultural Statistics Yearbook published by the Ministry of Agriculture and Irrigation.

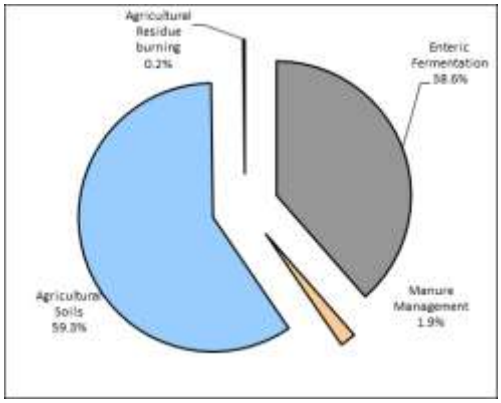
**Table 1.4: GHG emissions from agricultural activity, 2012 (Gg)**

| GHG Source Categories | $CO_2$-equiv | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC |
|---|---|---|---|---|---|---|---|
| **All agriculture emissions** | **10,770** | | **207** | **20.7** | **1** | **1** | **0** |
| A Enteric Fermentation | 4,154 | | 198 | 0 | 0 | 0 | 0 |
| B Manure Management | 206 | | 9 | 0 | 0 | 0 | 0 |
| C Rice Cultivation | 0 | | 0 | 0 | 0 | 0 | 0 |
| D Agricultural Soils | 6,386 | | 0 | 21 | 0 | 0 | 0 |
| E Prescribed Burning of Savannas | 0 | | 0 | 0 | 0 | 0 | 0 |
| F Field Burning of Agricultural Residues | 24 | | 1 | 0 | 1 | 1 | 0 |

Figure 1.2 illustrates the breakdown in agriculture-related GHG emissions in 2012 by activity. Emissions associated with agricultural soils showed the highest share of GHG emissions in 2012, about 59%. These emissions are associated with nitrogen applications to cultivatable soils through the use of synthetic fertilizers, animal excreta, and crop residues. Emissions from enteric fermentation accounted for the second highest share, about 39%. Collectively, cattle, goats, and sheep account for the overwhelming majority of such emissions, nearly 90%, with the balance from camels, horses, mules, and donkeys.

The remaining sources of GHG in the agricultural sector (i.e., manure management and field burning of crop residues) accounted for the balance of about 2%. Emissions from manure management are mostly from dairy farms, poultry farms, and beef feedlots where animals are managed in confined spaces. GHG emissions from field burning of crop residues are negligible (i.e., just over 0.2%) and are associated with the burning of sorghum, wheat and millet crop wastes after each harvest cycle.

**Figure 1.2: Breakdown of GHG emissions associated with agricultural activities, 2012**




### *1.2.4. Land Use, Land Use Change and Forestry*

Table 1.5 summarizes GHG emissions associated with land use, land use change and forestry in 2012. The 1,540 Gg $CO_2$-equivalent sequestered through changes in forested lands is roughly 4% of Yemen's overall anthropogenic GHG emissions. Annual activity data was obtained from both national and international statistics and were considered adequate to establish emission estimates inventories for only a few of the IPCC categories, namely changes in forest and biomass stock as well as $CO_2$ uptake associated with land use change and management. Annual activity for other categories such as land conversion and abandoned lands was either unavailable or outdated for purposes of the GHG inventory update. As noted later in this chapter, the availability of better national documentation on forested areas, afforested areas, and tree plantation/removals would reduce the uncertainty of the current inventory significantly.

**Table 1.5: GHG emissions from LULUCF activity, 2012 (Gg)**

| GHG Source Categories | $CO_2$-equiv | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO |
|---|---|---|---|---|---|---|
| **All LULUCF emissions** | -1,540 | -1,540 | 0 | 0 | 0 | 0 |
| A Changes in Forest & Other Woody Biomass Stocks | -11,235 | -11,235 | 0 | 0 | 0 | 0 |
| B Forest and Grassland Conversion | 0 | 0 | 0 | 0 | 0 | 0 |
| C Abandonment of Managed Lands | -132 | -132 | 0 | 0 | 0 | 0 |
| D CO2 Emissions and Removals from Soil | 9,827 | 9,827 | 0 | 0 | 0 | 0 |
| E Other | 0 | 0 | 0 | 0 | 0 | 0 |

Changes in forest stocks accounted for a net 11,235 Gg $CO_2$-equivalent sequestered in Yemen. This amount is associated with roughly an additional 2,342 thousand hectares planted with various acacia species as well as a small amount of managed non-forested areas. Sequestered amounts are offset by roughly 134.4 thousand hectares that have been converted to cropland, leading to emissions of 9,827 Gg $CO_2$-equivalent. Combining these sources and sinks, there is a net sequestered amount of 1,540 Gg $CO_2$-equivalent.

### *1.2.5. Waste*

Table 1.6 summarizes GHG emissions associated with waste management activity in 2012. Relative to overall anthropogenic GHG emissions, the 2,196 Gg $CO_2$-equivalent represented about 6% of total national emissions. Sources for waste management data included the Statistical Yearbook, as well as data contained in feasibility and other reports from the Environment Protection Authority and the Ministry of Water and Irrigation.

In Yemen, there is no waste incineration of any kind. Hazardous wastes are collected and transferred outside the country for incineration, while all types of other solid waste (domestic, medical and industrial) are collected and transferred to municipal landfills distributed around the country, where they are burned in the open air. A small fraction of biogenic wastes are disposed of at landfills, where in some governorates they are scavenged and sold to companies which transfer it outside the country for recycling. Combustion of wastes occurs in the open air by the informal sector in their search for metals and other materials of commercial value. There are 36 landfills in Yemen; of these only 23 sites receive significant amounts of waste.

**Table 1.6: GHG emissions from waste management activity, 2012 (Gg)**

| GHG Source Categories | $CO_2$-equiv | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC |
|---|---|---|---|---|---|---|---|
| **All waste emissions** | **2,196** | **0** | **86** | **1.2** | **0** | **0** | **0** |
| A Solid Waste Disposal on Land | 1,262 | 0 | 60 | 0 | 0 | 0 | 0 |
| B Wastewater Handling | 935 | 0 | 26 | 1 | 0 | 0 | 0 |
| C Waste Incineration | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D Other (please specify) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

The main source of greenhouse gases within Yemen's waste sector is solid waste disposal which accounted for about 57% of waste-related emissions. Domestic and commercial wastewater handling in a total of nine wastewater treatment facilities accounted for the balance of waste-related emissions.

## 1.3. Emissions by gas

Yemen's GHG emissions of 2012 were mainly emitted in the form of $CO_2$ , $N_2O$ and $CH_4$, as summarized in Table 1.7. $CO_2$ was the largest contributor to total national emissions followed by $CH_4$ and then $N_2O$. Of the national total, $CO_2$ accounted for 61.5% of all emissions (23,312 Gg $CO_2$), while $CH_4$ and $N_2O$ accounted for 20.4% (7,713 Gg $CO_2$-eq) and 18.1% (6,864 Gg $CO_2$-eq), respectively.

**Table 1.7: Sectoral breakdown of GHG emissions by type, 2012**

| Gas | Source | CO2-equivalent (Gg) | Share relative to total GHG emissions (%) |
|---|---|---|---|
| CO2 | Energy | 21,914 | 57.8% |
| | Industrial Processes | 1,398 | 3.7% |
| Total CO2 | | 23,312 | 61.5% |
| Ch4 | Energy | 1,545 | 4.1% |
| | Agriculture | 4,354 | 11.5% |
| | Waste | 1,814 | 4.8% |
| Total CH4 | | 7,713 | 20.4% |
| N2O | Energy | 66 | 0.2% |
| | Agriculture | 6,415 | 16.9% |
| | Waste | 382 | 1.0% |
| Total N2O | | 6,864 | 18.1% |
| Total National Emission | | 37,889 | 100% |

### *1.3.1. Carbon Dioxide Emission*

$CO_2$ emissions in 2012 were 23,312 Gg $CO_2$. The overwhelming majority of these emissions, 21,914 Gg $CO_2$ (i.e., 94%), are attributed to fuel combustion in all energy subsectors, with the remaining 6% (i.e., 1,398 Gg $CO_2$) associated with industrial processes. Rangelands and forests accounted for sequestration of 1,540 Gg $CO_2$.

### *1.3.2. Methane Emissions*

In 2012 total $CH_4$ emissions amounted to 7,713 Gg of $CO_2$-eq, generated from three socio-economic activities, agriculture at a share of 56% (i.e., 4,354 Gg $CO_2$-eq), waste at 24% (i.e., 1,814 Gg $CO_2$-eq), and energy at a share of 20% (i.e., 1,545 Gg $CO_2$-eq).

### *1.3.3. Nitrous Oxide Emissions*

Nitrous oxide in 2012 accounted for a total of 6,864 Gg $CO_2$-eq with the largest portion, 93% (i.e., 6,415 Gg $CO_2$-eq) associated with agricultural activities in the form of fertilizer use and from animal waste and the burning of agricultural residues. Waste handling ranks second, accounting for about 6% (i.e., 382 Gg $CO_2$-eq) and emissions from fuel combustion in the transportation sector accounted for the remaining 1% (i.e., 66 Gg $CO_2$-eq) of national $N_2O$.

### *1.3.4. Indirect GHGs and SO2 emissions*

Yemen's GHG emission inventory of 2012 also provides emission estimates of indirect GHGs gases like $NO_x$, CO, NMVOC and $SO_2$, and their emission estimates are summarized in Table 1.8 and the bullets below.

- *$NO_x$:* $NO_x$ emissions in 2012 were 105 Gg, with the vast majority generated from the energy sector 99.2% (104 Gg $NO_x$) with modest contribution of 1% (1 Gg $NO_x$) from field

burning of agricultural residues. Energy-related emissions of $NO_x$ are attributed to fuel combustion in energy generation 11.1%, manufacturing industries (8.1%), transport (47.7%) and Other Sectors (32.9%).

- *CO:* total CO emissions in 2012 amounted to 594 Gg and were generated from fuel combustion 97.2% (577 Gg CO) and agriculture 3% (17 Gg CO). The majority of total CO emissions of energy sector is attributable to fuel combustion in transport sector and Other-energy sub sectors at a share of 85.5% and 11.7% respectively. The rest of the energy categories, namely the energy generation, manufacturing industries, and fugitive sub-sectors account for less than 0.1% each.

**Table 1.8: Indirect GHG emissions and sectoral/overall shares**

| | $NO_x$ | | | CO | | | NMVOCs | | | $SO_x$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category sources | Gg | Sector Share (%) | Overall share (%) | Gg | Sector Share (%) | Overall share (%) | Gg | Sector Share (%) | Overall share (%) | Gg | Sector Share (%) | Overall share (%) |
| ***Energy (Fuel Combustion)*** | ***104*** | ***100%*** | ***99.2%*** | ***577*** | ***0.0%*** | ***97.2%*** | ***107*** | ***100%*** | ***96.2%*** | ***3*** | ***100%*** | ***79.6%*** |
| Energy generation | 12 | 11.1% | 11.0% | 1 | 0.1% | 0.1% | 0 | 0.3% | 0.3% | 0 | 0.0% | 0.0% |
| Manufac. Industries | 8 | 8.1% | 8.0% | 0 | 0.1% | 0.1% | 0 | 0.2% | 0.2% | 0 | 0.0% | 0.0% |
| Transport | 50 | 47.7% | 47.4% | 508 | 88.0% | 85.5% | 95 | 89.5% | 86.1% | 0 | 0.0% | 0.0% |
| Other Sectors | 34 | 32.9% | 32.7% | 68 | 11.7% | 11.4% | 7 | 6.3% | 6.0% | 0 | 0.0% | 0.0% |
| Fugitive from Oil and NG | 0 | 0.2% | 0.2% | 0 | 0.1% | 0.1% | 4 | 3.8% | 3.6% | 3 | 100% | 79.6% |
| ***Industrial Processes*** | ***0*** | ***0.0%*** | ***0.0%*** | ***0*** | ***0.0%*** | ***0.0%*** | ***4*** | ***100%*** | ***3.8%*** | ***1*** | ***100%*** | ***20.4%*** |
| Mineral Products | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 60% | 2.3% | 1 | 100% | **20.4%** |
| Other Production | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 40% | 1.5% | 0 | 0% | 0% |
| ***Agriculture*** | ***1*** | ***100%*** | | ***17*** | ***100%*** | | ***0*** | ***0.0%*** | | ***0*** | ***0.0%*** | ***0.0%*** |
| Burning of Agri. Residues | 1 | 100% | 0.8% | 17 | 100% | 3% | 0 | | 0% | 0 | | |
| **Total** | **105** | | **100%** | **594** | | **100%** | **111** | | **100%** | **4** | | **100%** |

- *NMVOC:* NMVOC emissions accounted for a total of 111 Gg, with the largest portion, 96.2% (107 Gg) associated with energy use and the remaining 3.8% (4 Gg) from industrial processes, namely road paving with asphalt and production of food and drink at a share of 60% and 40% respectively. Energy-related NMVOC emissions are mainly attributed to fuel combustion in the transport sector at a share of 89.5%, Other-energy sub sectors with share of 6.3%, fugitive emission associated with extraction oil and natural gas with a share of 3.8%, and all other categories accounting for negligible shares.

- *$SO_2$:* $SO_2$ accounted for a total of 4 Gg, of which 79.6% (3 Gg $SO_2$) were due to energy use and 20.4% (1 Gg $SO_2$) were from industrial process associated with cement production. The $SO_2$ emissions energy sectors came only from the fugitive emission associated with extraction oil and natural gas.

# 2. GHG Emission Trends

## 2.1. Emission trends by sector

Figure 2.1 presents the trend in total GHG emissions for previous 1995, 2000, 2010 inventories, and 2012, the year of the current GHG inventory update. Emissions have increased by about 112%; from 17,866 Gg $CO_2$equivalent in 1995 to about 37,801 Gg $CO_2$equivalent in 2012, or roughly 5%/year. On a net $CO_2$ equivalent basis.

**Figure 2.1: Total GHG emission trend, 1995, 2000, 2010, and 2012**

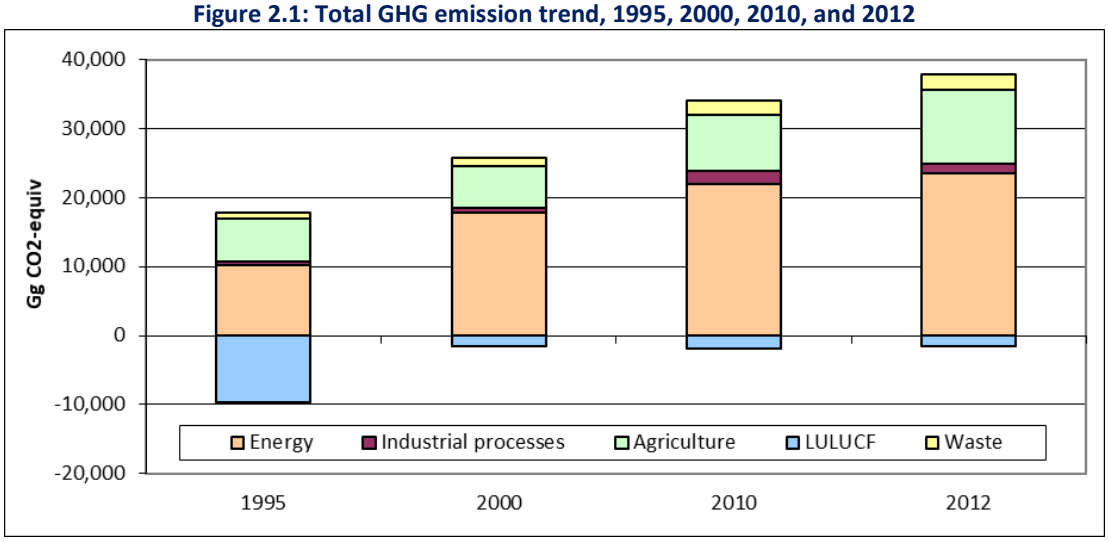
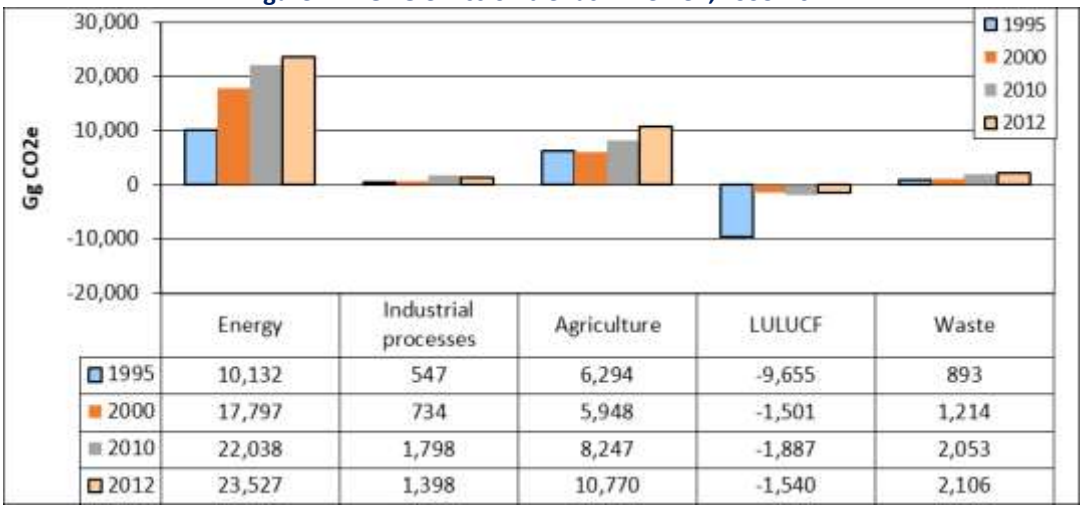



Figure 2.2 compares GHG emissions for each sector for the years 1995, 2000, 2010, and 2012 and highlights the fact that energy and agriculture are the main components responsible for the overall increasing trend in GHG emission levels in Yemen. Over the period, $CO_2$-equivalent emissions from energy use have increased by 132%, or about 5% per year. This is due primarily to increases in energy use for power generation and process heat in manufacturing industries. Also over this period, CO2-equivalent emissions from agriculture have increased by 71%, or about 3% per year.

**Figure 2.2: GHG emission trends in Yemen, 1995-2012**




| | Energy | Industrial processes | Agriculture | LULUCF | Waste |
|---|---|---|---|---|---|
| 1995 | 10,132 | 547 | 6,294 | -9,655 | 893 |
| 2000 | 17,797 | 734 | 5,948 | -1,501 | 1,214 |
| 2010 | 22,038 | 1,798 | 8,247 | -1,887 | 2,053 |
| 2012 | 23,527 | 1,398 | 10,770 | -1,540 | 2,106 |

## 2.2. Emission trends by gas

GHG emissions were dominated by CO2 in all inventory years of 1995, 2000 and 2012, as summarized in Figure 2.3. Specifically, CO2 emissions represented 62% of total GHG emissions in 2012, compared with 68% in 2000 and 67% in 1995. CH4 follows with a relative share of 20% in 2012 compared 17% in each of the year 2000 and in 1995. N2O ranks third with a share of 18 % in 2012 and 17% in 1995.

**Figure 2.3: GHG emission trends, by gas type**

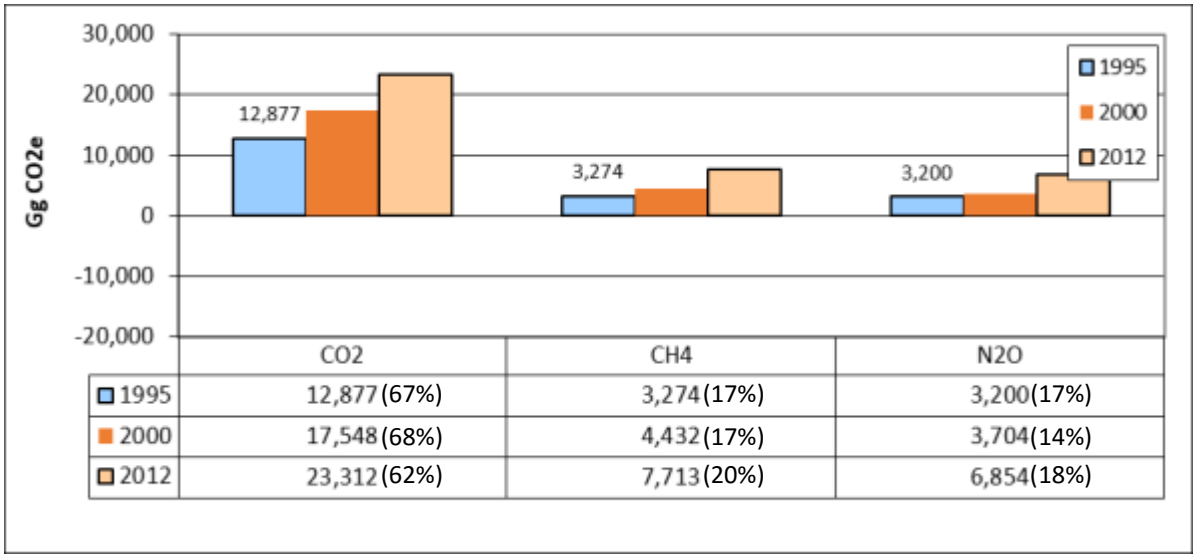



Table 2.1 provides additional details of GHG emission trends by category source from1995 through 2012. CO2 emissions have increased from 12,872 Gg CO2-eq in 1995 to 17,548 Gg CO2-eq in 2000 and reached 23,312 Gg-CO2 eq in 2012. This indicates an increase of 10,441 Gg, or 81% relative to 1995 emission levels. The largest portion of the CO2 emission increase, 92% (i.e., 9,586 Gg / 10,4412 Gg), is attributed to the increase of fossil fuel combustion within the Fuel Combustion category, namely energy Industry, transportation. manufacturing and other energy sectors, while the remaining 8% is due to cement production.

**Table 2.1: GHG emission trends, by gas type**

| Gas | GREENHOUSE GAS SOURCE AND SINK CATEGORIES | Emissions (Gg) | | | Emission increase Between 1995-2012 | Percentage Change (%) from 1995 |
|---|---|---|---|---|---|---|
| | | 1995 | 2000 | 2012 | | |
| CO2 | Energy | 12,328 | 16,814 | 21,914 | 9,586 | 78 |
| | Cement | 544 | 734 | 1,398 | 854 | 157 |
| | LULUCF | -2,032 | -1,501 | -1,540 | 492 | -24 |
| | Total CO2 emissions excluding net CO2 from LULUCF | 12,872 | 17,548 | 23,312 | 10,441 | 81 |
| | Total CO2 emissions including net CO2 from LULUCF | 10,839 | 16,047 | 21,772 | 10,933 | 101 |
| CH4 | Energy | 842 | 976 | 1,545 | 704 | 84 |
| | Agriculture | 1,796 | 2,261 | 4,354 | 2,558 | 142 |
| | Waste | 636 | 1,195 | 1,814 | 1,178 | 185 |
| | Subtotal | 3,274 | 4,432 | 7,713 | 4,439 | 136 |
| N2O | Energy | 4 | 5 | 66 | 62 | 1536 |
| | Agriculture | 3,179 | 3,680 | 6,415 | 3,236 | 102 |
| | Waste water treatment | 17 | 19 | 382 | 366 | 2179 |
| | Subtotal | 3,200 | 3,704 | 6,864 | 3,663 | 114 |
| | National Total Excluding LULUCF | 19,346 | 25,684 | 37,889 | 18,543 | 96 |
| | National Total Including LULUCF | 17,313 | 24,184 | 36,349 | 19,036 | 110 |

Similarly, CH4 emissions have increased from 3,274 Gg CO2-eq in 1995 to 4,432 Gg CO2 eq in 2000 and reached 7,713 Gg CO2 eq in 2012. This indicates an increase of CH4 of 4,439 Gg $CO_2$ eq or 136% more than 1995 emission levels. The increase of CH4 emissions is mainly due to enteric fermentation and manure management (58%), followed by emissions from and solid waste disposal along with waste-water management at a share of 27%, and fugitive emissions at a share of 16%.

Finally, N2O emissions have increased from 3,200 Gg CO2-eq in 1995 to 3,704 Gg CO2-eq in 2000 to reach 6,864 Gg CO2-eq in 2012. This increase in N2O emissions represents a 114% increase relative to 1995 emission levels and is mainly due to increased emissions from agricultural soils (88%), waste-water treatment (10%) and fossil fuel combustion (2%).

# 3. National Mitigation Policies and Targets

To address GHG mitigation issue, Yemen has not yet developed and implemented nationally appropriate mitigation actions (NAMAs) to reduce GHG emissions from various sectors. This shortage is partly because the NAMA is not compulsory but rather voluntary process, and mainly because it is very demanding process in terms of financial requirement and in terms of complicated institutional structures needed for NAMA implementation. This shortage, however, does not imply that Yemen is not committing to transition towards greener economy, but conversely the government has already taken fundamental steps to mainstream mitigation concept into sectoral policies. These efforts have led to recognition of green energy and renewable climate change into several policies and documents like the second national Communication (SNC) report of 2013, the National Biodiversity and Action plan (NBSAP) of 2016, the National Strategy for Renewable Energy and Energy Efficiency (NSREEE) of 2009, and the National Adaptation Programme of Action (NAPA) of 2008.

## 3.1. Second National Communication (SNC)

The SNC report provided analysis of measures to limit and reduce the GHGs emissions with no measures to enhance the GHG sinks. The report sets the GHG reduction along with national priorities for mitigating GHG emission from all energy sectors contributing to national GHG emission. The SNC identifies transport household, and industry as the highest priority sectors due to their high energy consumption as well as to low efficiencies. Additionally, the report builds on Mitigations assessment findings to identify national target to be achieved by 2025, and identifies mitigation measures to meet the country intended target.

The SNC report identifies the year 2000 as the reference for baseline and mitigation scenarios of GHG emission, and also identifies emission projections for 2025 for the two scenarios. These projections were the reference of policy makers in defining 2025 emission reduction target of Yemen which is included in the SNC. The National emission target- as given by the SNC- calls to curb GHG emission incurred by the current Business as Usual Case (BAU) policy with aim at promoting energy resilience and achieving 14% reduction of energy-related GHG emissions in 2020, and achieving 23% reduction in 2025. These targets are proposed to be realized through three strategic options respectively dealing with *Energy efficiency,* Fuel *switching* and shift to renewable energy.

The *Energy efficiency target calls* for the introduction and widespread penetration of efficient compact fluorescent lighting and efficient refrigeration in the household sector; the introduction of fuel economy *standards* for light and heavy duty vehicles (11% and 10% improvement in fuel economy by 2025, respectively), and a scrap page policy for old gas-guzzling vehicles.

The *fuel switching target include* switching from diesel and residual fuel oil to natural gas in power generation (1,000 MW by 2025), *commercial* bakeries, cement factories and small industrial applications. It also involved switching from diesel to gasoline for heavy duty trucks and buses (85% and 90% shares by 2025, respectively).

The shift to renewable energy will effectively include the introduction of large-scale, grid connected geothermal (200 MW by 2025), wind (400 MW by 2025), and solar stations (100 MW by 2025) as well as the widespread introduction of solar water pumps to replace diesel pumps in shallow wells (65% share by 2025).

In this context, the second National communication (SNC) also supports reduction of GHG emission in the range of 7-20% below the BAU particularly in energy and transportation sector in 2020. Measures identified to be implemented for GHG emission reduction in the SNC include:

- Development of renewable and alternative energy sources;
- Energy efficiency improvement in industries, buildings, transportation and power generation;
- Use of natural gas fuels in transport

### 3.2. Other past policy frameworks

To address GHG emission issues, the second National Biodiversity and Action Plan (NBSAP2) calls for achieving a 14% reduction of GHG emissions from energy-related sectors in 2020, and 37% in 2025. These targets will realized through improving climate change mitigation based on restructuring EPA to host the National Climate Fund (NCF) and the adoption of nationally appropriate mitigation actions (NAMAs) with specific focus on reducing GHG emissions through multiple actions including the shift to renewable energy, the promotion of smart agricultural practices and the introduction of bio-energy production especially from solid waste and wastewater in main cities. The promotion of smart agricultural practices is to be achieved through carbon sequestration activities such as the expansion of protected areas, restoration of "Blue Carbon" ecosystems (mangroves and sea-grass beds), reforestation to reduce emission from deforestation and forest degradation (REDD).

The National Adaptation Programme of Action (NAPA) - through 3 baseline studies - identified three drivers of GHG emission increase, and these are the lack of National Mitigation Plan and policy, weak regulatory frameworks to mitigate GHG emissions and inadequate funding to green technology. At policy level, there are no national mitigation plans (NMPs) delineated to reduce GHG emissions from energy, transport, households, and industry. At the regulatory level, there is a lack of norms, benchmarks and standards advocating emission reduction environmental agencies are not adequately mandated and capacitated to put these instruments in place. At the financial level, the republic of Yemen, as a Least Developed Country, has its own pressing development problems, under which climate change is not one of its national priority funding areas. In such a circumstance, fuel and electricity use in households and industry can be characterized by inefficient lighting system; inefficient heating and cooking systems; limited use of LPG for cooking and intensive biomass for cooking stoves. This situation is further aggravated by an inability to switch to natural gas and renewables in energy generation and transportation and promote bio-energy production from solid waste. Key actions that are focused on the following priority areas:

- Promotion of modern irrigation technologies to increase water use efficiency and reduce fuel use in irrigation

- Promotion of water desalination using renewable energy sources, especially on Yemeni islands and coastal areas, where drinking water is not available or subject to seawater intrusion to ensure continuity of life
- Promoting alternatives for fuel wood to control woodcutting and preserve plant cover through promotion of LPG use for cooking.

Moreover, the Yemen NAPA calls for mitigating GHG emissions through adoption of National Mitigation Plans (NMP) for energy, transport, household, and industrial with specific focus on introduction and enforcements of norms, bench marks and standards; fuel switching to natural gas in energy generation and transportation; switching to renewable energy; promotion of bio-energy production from wastewater and solid waste; application of efficient lighting system and efficient heating and cooking systems; increase of LPG use for cooking and improve biomass and LPG stoves performance.

The Government of Yemen recognizes the importance of energy efficiency as means to provide clean, reliable and secure energy supply for economic development and poverty reduction, improve fuel security, enhance the competitiveness of the national economy, protect the local environment as well as contribute to international efforts to combat climate change. Towards this end, the GOY developed and approved National Strategy for Renewable Energy and Energy Efficiency (NSREEE) in 2009. The Strategy includes 5 specific targets aiming to mitigate GHG emission through introduce renewable energy (Table 3.1) and 7 targets aimed at improving energy efficiency by 2025 (Table 3.2).

**Table 3.1: Highlights of planned National Mitigation Policies, Targets and Measures – renewables**

| **Intended Outcome1: Renewable Energy introduced, displacing wasteful emission from national grid** | | |
|---|---|---|
| **Intended Output** | **Targets** | **Mitigation Measures/Action** |
| 1.1 Concentrated Solar Power (CSP) systems integrated into existing steam and single cycle power plants | By 2025, a total capacity 100 MW of CSP stations installed in installed in at least three sites across the country and are delivering 366 GWH of electricity, being 2.1%of National generation mix in the target year | Promote renewable energy and reduce GHG emissions through the introduction of Concentrated Solar Power (CSP) sources in electricity generation.<br>- Grid electrification based on introduction of large-scale grid-connected solar stations |
| 1.2 Off-grid solar PV promoted in rural areas | By 2025, 110 000 rural households connected with individual solar home systems (SHS) amounting to a total peak capacity of 5.5 MWp, being 45 percent of identified market potential | Promote renewable energy and reduce GHG emissions through the introduction of individual solar home systems (SHS) in electricity generation.<br>- Off-grid electrification of individual rural households to be electrified Solar Home Systems |
| 1.3 Wind farms power plants developed and interconnected into existing national grid | By 2025, a total capacity of 400 MW of wind farms installed in 16 sites across the country and is delivering 1,465 GWH of electricity, being 8.5% of National generation mix in target year | Promote renewable energy and reduce GHG emissions through the introduction wind power farms in electricity generation<br>Grid electricity based on introduction of large-scale grid connected wind farms |
| 1.4 Geothermal power plants developed and interconnected into existing national grid | By 2025, a total capacity of 200 MW of geothermal power plants installed in at least six sites and are delivering 732 GWH of electricity, being 4.2% of National generation mix in target year 2025 | Promote renewable energy and reduce GHG emissions through the introduction of large-scale grid connected geothermal plants |
| 1,5 Biomass power plants developed and interconnected into existing national grid | By 2025, a total capacity of 6 MW of biomass power plants using landfill gas installed in 4 sites across the country and are delivering 22 GWH of electricity, being 0.1%of National generation mix in the target year | Promote renewable energy and reduce GHG emissions through using landfill gas in power generation<br>Landfill gas capturing for flaring or using for |

The introduction of renewable energy option aims to reduce GHG emissions from national grid through the following renewable policy options:

- the introduction of 100 MW of Concentrated Solar Power (CSP) systems into existing national grid by 2025;
- the integration of 400 MW of Wind farms power plants into existing national grid by 2025;
- the integration of 200 MW of geothermal power plants national generation mix by 2025;
- installation of 6 MW of biomass power plants using landfill gas; and
- the promotion of individual solar home systems (SHS) in rural areas to cover 110 000 rural households by 2025, see table 3.1 on renewable energy targets.

**Table 3.2: Highlights of planned National Mitigation Policies, Targets and Measures - efficiency**

| **Intended outcome2: Energy efficiency improved, leading to GHG emissions reduction** | | |
|---|---|---|
| **Intended Outputs** | **Targets** | **Mitigation Measure/Action** |
| 2.1 Natural gas-based power plants developed and interconnected into existing national grid | By 2025, a total capacity of 1000 MW of energy produced based on NG consumption in replacement of diesel and residual fuel oil | Reduce GHG emission from electricity generation through the switch from diesel and fuel oil-based in electricity generation to natural gas at a grid-connected stationary combustion thermal plant |
| 2.2 Efficiency in Power generation, transmission and distribution widely improved | By 2025, Efficient power generation, transmission and distribution improved by 15 percent, leading to significant emission reduction<br>Efficiencies of newly installed centralized Combined-cycle gas turbine (CCGT) plants will improved b y60% by 2025.<br>Efficiencies of newly installed decentralized Combined heat and power (CHP) generation systems will improved by 80 % by 2025. | Improve Efficiency in Power generation through switch to efficient Combined-cycle gas turbine (CCGT) plants , and switch to Combined heat and power (CHP) generation systems |
| 2.3 Energy Efficiency on Demand Side improved | By 2025, energy efficiency in the power sector improved by 15% saving potential of app. 220 MW generation capacity or 650 GWh electricity generation should be un-locked within 3 - 5 years | Promotion of CFL (90 MW), linear fluorescent lamps (7.3 MW), solar water heaters (23.6 MW), water heating improvement (12.6MW), power factor correction in government installations (32.4 MW), industrial energy audits (1.5 MW), standardization and labeling (44 MW) and introduction of time of use tariffs (37.8 MW) |
| 2.4 Solar water heaters widely promoted in Household & Commercial sectors | By 2020, about 200,000 units of solar water heaters installed, being 40 % of market potential, resulting a saving potential of 457 GWh in the target year<br>By 2025, about 300,000 units installed, being 60 % of market potential, resulting in a saving potential of 686 GWh in the target year | - Promote active use of solar energy through use of solar water heaters instead of electric water heaters and use of solar-driven air-conditioning and solar refrigeration.<br>- Efficient Lighting using compact fluorescent lamp (CFL) |
| 2.5 Efficiency of energy consumption in transportation sector widely improved through fuel switching | By 2025, 85% of heavy duty trucks uses NG instead fossil fuel diesel to gasoline for heavy duty trucks and 90% of buses uses NG | - Improving energy use efficiency in transportation sector by switching from diesel to gasoline for heavy duty trucks and buses to natural gas |
| 2.6 Efficiency of energy consumption in agriculture sector widely improved through introduction of Solar Pumps in Irrigation Systems | Widespread introduction of solar water pumps to replace diesel pumps in shallow wells (65% share by 2025). | - Introduction of solar photovoltaic (PV) water pumping systems for irrigation<br>- Proper land management to reduce methane from soil |
| 1.7 Energy from waste water treatment plants produced and utilized for heating, lighting and cooking. | By 2025, a total capacity of 1MW generated from biogas of wastewater treatment plants in 4 sites across | - Methane captures from wastewater treatment plants |

The NSREEE aims at increasing energy efficiency by 2025 in power generation, transmission and distribution by 15%, compared to 2010. Specific mitigation measures identified by the

strategy to achieve this target include the switch to efficient combined-cycle gas turbine (CCGT) plants, and switching to combined heat and power (CHP) generation systems (see table 3.2).

Additionally, the NSREEE aims at improving energy efficiency through fuel switch to natural gas in energy generation, the shift to NG fuel in transportation, introduction of solar pumps in irrigation and Energy production from waste water treatment plants for heating, lighting and cooking. Finally, the strategy calls for improving energy efficiency by 2025 in demand side by 15% through the promotion of CFL in lighting, solar water heaters, power factor correction in government installations, industrial energy audits, standardization and labeling and introduction of time of use tariffs. Table 3.2 summarizes specific targets.

### 3.3. Intended Nationally Determined Contributions

In addition to above mentioned policy review, this document has further consulted the Intended Nationally Determined Contributions (INDCs) of *November 2015 and* the most recent baseline and mitigation scenarios with aims to define potential emission reduction at aggregated national levels.

The Intended Nationally Determined Contributions (INDCs), submitted in November 2015, propose a 14% GHG emission reduction by 2030 below BAU levels. This corresponds to an estimated total cumulative GHG reduction of about 35 Mt CO2-eq from 2020 through 2030as shown in Table 3.3. The INDC also provides an overview of mitigation priority measures, which are consistent with those listed in table 3.1 and 3.2.

**Table 3.3: Potential mitigation reduction proposed as Intended Nationally Determined Contributions**

| Years | 2010 | 2020 | 2025 | 2030 | Total (2010-2030) |
|---|---|---|---|---|---|
| Emissions- BAU (Mt Carbon Dioxide equivalent) | 24.18 | 35.94 | 39.68 | 43.81 | 437.30 |
| Emissions Unconditional Scenario (Mt CO2eq) | 24.18 | 35.90 | 39.50 | 43.35 | 434.97 |
| Emissions Conditional Scenario (Mt CO2eq) | 24.18 | 35.25 | 36.74 | 37.67 | 402.33 |
| Expected Emission Reduction- Unconditional Scenario | 0.00 | 0.04 | 0.18 | 0.46 | 2.33 |
| Expected Emission Reduction- Conditional Scenario | 0.00 | 0.68 | 2.94 | 6.13 | 34.97 |

The GHG mitigation analysis undertaken for the Yemen's TNC updates the baseline scenario (BS) and mitigation scenario (MS) developed under the 2nd national communication, and subsequently predicts national emission reductions for the Time Horizon Years (2010 - 2040). This new update has been developed using the Long-range Energy Alternatives Planning System (LEAP) modeling, and Table 3.4 summarizes projected emissions of the two scenarios, including the corresponding emission reduction for the years 2010 to 2040. As shown in the table, by 2040 total energy-related GHG emission reductions are projected to be 19.7 million tonnes of $CO_2$ Equivalent, or 33.5% below emission of the Baseline Scenario.

Given that the mitigation analysis in the TNC provides emissions reduction estimates which have been developed based on the most recent data on emissions of Baseline and Mitigation scenarios, it is recommended to update the country intended national mitigation targets in the next national communication and upcoming mitigation policies in synergy with findings of this report as stipulated in table 4.3. The report also presents Baseline and Mitigation scenarios Electrical Energy Generated (mGJ) by Output Fuels for Years (2010 -2040), which can be referred to identify future targets on energy saving from various fuel types.

**Table 3.4: Total National GHG Emissions Reduction from all Fuels and all GHGs**

| Scenario | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| BS (million tonne CO2-eq) | 24 | 27.7 | 31.8 | 37.4 | 43.4 | 50.5 | 58.8 |
| MS (million tonne CO2-eq) | 24 | 27.6 | 27.7 | 30.1 | 32.9 | 36 | 39.1 |
| Total Reduction (million tonne CO2-eq) | 0 | 0.1 | 4.1 | 7.3 | 10.5 | 14.5 | 19.7 |
| Reduction change between the two scenarios (%) | 0.0 | 1.9 | 12.9 | 19.5 | 24.2 | 28.7 | 33.5 |

## 3.4. State of Implementation of National Mitigation Policies and Targets

Following its endorsement of the UNFCCC, Yemen has implemented few measures to curb down GHG emissions. These can be clustered in two activity groups or outcomes which are respectively devoted for prompting renewable energy aimed at GHG emission reduction from national grid (intended outcome 1 of National policies), and improving energy efficiency, leading to GHG emissions reduction (Intended outcome 2), as summarized in Tables 3.1 and 3.2. Progress towards achieving mitigation targets is presented in Table 3.5.

**Table 3.5: Highlights of Status of Implementation of National Mitigation Policies, Targets and Measures**

| | Quantitative Achievement due to Mitigation Measure up to end 2013 | | |
|---|---|---|---|
| **Intended Outputs** | Annual Electricity Saving (GWh) | Ann. Emission Reduction 000 tonnes CO2-eq | Emission reductions through 2013 000 tonnes CO2-eq |
| Introduction of Concentrated Solar Power (CSP) into national grid | NE | NE | NE |
| Promoting solar PV in households | NE | NE | NE |
| Promotion of Wind farms power plants | NP | NP | NP |
| Promotion of Geothermal power plants | NP | NP | NP |
| Promotion of Biomass power plants | NP | NP | NP |
| Promotion of Natural gas-based power plants | 2,059 | 568 | 2,274 |
| Promotion of Efficiency in Power generation, transmission | NP | NP | NP |
| Improvement of Energy Efficiency on Demand Side | NP | NP | NP |
| Promotion of Solar water heaters in Household & commercial sectors | NE | NE | NE |
| Promotion of energy Efficiency in transportation | NP | NP | NP |
| Promotion of Solar Pumps in Irrigation Systems | NP | NP | NP |
| Promotion of waste water energy for heating, lighting and cooking. | NP | NP | NP |
| Total | 2,059 | 568 | 2,274 |
| Notes: NE Means Not estimated due to lack of Data, though significant progress made, NP means No significant achievement produced | | | |

As reflected in table 3.5, the implementation of national mitigation measures have led to total estimated reduction in GHG emission amounting to 2,274 thousand tonnes of CO2-eq over the period 2010-2013, with the only source of emission reductions from a shift to natural gas plant in energy generation. Total annual energy saving from the shift to natural gas totaled 2,059 GWH, due to the introduction of natural gas plant into current national grid.

It is worth recalling that the list of measures is not comprehensive due to the unavailability of data needed to quantify environmental impact associated the shift of the Yemeni people to natural gas in road transportation along with the nationwide application of household solar PV for meeting their household energy needs during the continuing political unrest since 2011 and the subsequent war time of 2015 to date. During the political crises and war

time, the Yemeni people have suffered from frequent rolling blackouts, which extend sometime to more than 12 hours a day before the war and this status has been escalated by the war, leading to full closure of all national power plants. More drastically, Yemeni households could not even access energy from prevailing small diesel-based generators due to fuel shortage incurred by fuel monopoly and the breakthrough of black market of fuels, which have collectively led to unprecedented and unaffordable of rise in prices of fuel, including transportation cost.

To this end, the Yemeni people have adopted an innovative coping strategy by which entails the shift to solar panels in meeting their household energy and the shift to natural gas for fueling their vehicles. This policy has led to the installation of solar systems in more than 80% of urban households and 90% of rural households, according to the judgment of national experts. This step has led not only creating self-reliant society in terms of energy needs, but also led to displacing black market price which has been reduced from 20,000 Riyals per gallon to settle at 5,000 riyals per gallon. Additionally, people no longer wait in long queues for petrol and diesel stations.

More importantly, this coping strategy have certainly led to unprecedented emission reduction reported elsewhere in such a relative short time. Therefore, this report highly recommended to conduct immediate surveys of household solar systems voluntary introduced by people and transportation modes utilizing NG. This are very important steps for quantifying emission reduction from these sources, which is anticipated to exceed the intended target planed by national strategies by 2025.

Full sectoral description on mitigation actions undertaken with a description of objectives, coverage, achieved emission reduction, and calculation methodologies are provided in tabular format as per decision 2/CP.17 in Tables 3.6 for clean fuels.

**Table 3.6: Mitigation Actions Undertaken and Their Effects – clean fuels**

| Intended outcome2: Use of cleaner fuel promoted, leading to reduction of GHG emissions from national grid | | | | | | |
|---|---|---|---|---|---|---|
| Intended output 2.1: Natural gas-based power plants developed and interconnected into existing national grid<br>Objective: To reduce GHG emission from electricity generation through the switch from diesel and fuel oil-based in electricity generation to natural gas at a grid-connected stationary combustion thermal plant | | | | | | |
| Target: By 2025, a total capacity of 1000 MW of energy produced based on NG consumption in replacement of diesel and residual fuel oil | | | | | | |
| | | | | Progress made in Implementing mitigation intended output | | |
| | | | | Quantitative Achievement Under mitigation intended output through the end 2013 | | |
| Gas/ Sector | Methodology to Calculate GHG Reductions | Steps taken | Assumptions | Electricity Savings (GWh/yr) | Emission Reduction (K ton CO2-eq/yr) | Cumulative emission reductions through 2013 (K ton CO2-eq) |
| Energy/ CO2 | The emission reduction is calculated as net emission of the baseline scenario associated with fossil fuels use and mitigation scenario utilizing natural gas, assuming producing the same quantity of energy (2,059 GWh ) to be produced by the natural Gas. CO2 Emission for baseline and Mitigation scenarios are calculated by multiplying the net power generation (2,059 GWh ) by the national grid emission factors of Baseline and Mitigation scenarios respectively. In the absence of national grid emission factors, the LEAP calculated emission factors of the baseline | In 2010, a total capacity amounting to 341 MW installed in Marib and is contributing to national Electrification mix and reducing GHG emission . | • Significant Emissions of the baseline electricity would be avoided through the introduction of Natural gas into the national Generation mix<br>• Baseline Emissions incurred from electricity | 2,059 | 568 | 2,274 |
| | | | | As calculated in column 1, the introduction of Ma'rib-I, 341 MW open-cycle gas turbine power plant Into the national grid in 2010 led to avoidance of emissions from steam plant burning HFO amounting to 568 Kton CO2 e annually. This emission reduction would be worth US$11.4 million per year against the sale of carbon credits if the project has been registered as CDM project. Nevertheless, the amount cannot be claimed by Yemen, simply because the project owner has not registered it to the CDM. Additionally, it is unlikely that the government would be able to to tape to such CDM finance potential, while implementing the phase | | Total Emission reduction from the introduction of NG into National Gird by end 2013 is 2,274 Ktons CO2-eq, which is equivalent to avoided electricity generated from fuel oil-fired and diesel-fired thermal plant in |

| | | | | | |
|---|---|---|---|---|---|
| | scenario(793 Tons CO2/ GWh) and of the mitigation scenario (517 Tons CO2/ GWh ) were used instead. Results obtained from these calculation are as follows: Baseline emission(due to fuel oil/diesel use in 2010)= 2,059 (GWh)*× 793( Tons/ GWh)= 1,632 Kton CO2e. The NG emissions for 2010= 2,059 (GWh) *517 Tons/ GWh) = 1,064 kton CO2e. Net Annual CO 2 Reduction =1,632 - 1,064= 568 Kton CO2e | | generation based on fossil fuel use will reduced based on introduction of NG which has less carbon content | II Marib- Gas Turbine powered plant. The Ma'rib-II, 420 MW open-cycle gas turbine power plant is claiming emission reductions of 680 Kton CO2 e annually and is worth US$13.6 million per year or, equivalent to over US$100 million as a lump sum over the crediting period. Again, a review of the UNFCCC website shows that no CDM projects have yet been registered by Yemen and no project design documents have been submitted, which indicate that the country national climate finance readiness is generally weak | the bas year emission(2010). |

### *3.4.1. State of Implementation of Intended Outcome1 - Renewable Energy*

As for implementation of Solar energy measures recommend by the NSREEE, no significant progress was made by the government. However, the Yemeni people, under escalating war of 2015, were forced to shift to household solar PV Systems to meet their daily need of energy. According to preliminary results of Rapid Solar survey conducted in Sana'a capital and Sana'a governorate in 2017, the shift to household solar PV Systems has led to rising access rate from less than 0.3% and 1.0% in 2014 to nearly 86% and 95% in 2017 of the entire urban and rural population respectively. More importantly, this coping strategy have led to emission reduction totaled to 75,000 tons CO2 eq in 2017, but quantification of mitigation impacts of these measures are not considered in this assessment report simply because SHS activities have been implemented after 2013 or after the reporting frame work of this report.

### *3.4.2. State of Implementation and Achievement of Intended Outcome2 clean fuels*

As indicated earlier in Table 3.2, the intent of Yemen's mitigation policies is to reduce energy intensity and GHG emission by 2025 based on a variety of measures, including a shift to cleaner fuels such as natural gas; improving efficiency in power generation, transmission and distribution; improving efficiency on demand side, namely in household & commercial sectors; improving transportation sector through fuel switching; and improving energy consumption in agriculture through introduction of Solar Pumps in Irrigation. Unfortunately, over the past 15 years little progress has been made and was only devoted to improving energy efficiency through the shift from fuel oil and diesel to natural gas-based power plants combined with introduction solar water heaters to household & commercial sectors.

The shift to natural gas-based power plants has been assessed to the most viable mitigation options undertaken by far in saving energy and reducing GHG emission from electricity generation. Furthermore, this policy option translated to reduction of the Matzoth and Diesel in Generating Plants, and thus lead to a great reduction in GHG Emission. Specifically, it led to estimated annual reduction in GHG emission amounting to 568 K ton of $CO_2e$ in the base year of 2010 and this has gradually accumulated over four years to reach 2,274 K ton of $CO_2e$ by end of 2013. The shift to natural gas-based power plants also resulted in annual energy saving in 2010, amounting to 2,059 GWH, which implies that accumulated energy saving over 2010 to end 2013 is estimated to be around 8,236 GWH.

# 4. Constraints and Gaps, and Related Financial, Technical and Capacity Needs

The GHG emission trends discussed in previous sections are generally attributed to an inadequate enabling environment to promote sustainability. Current production patterns in energy, manufacturing industry, mining, agriculture, forestry and sectors tend to lead to environmental deterioration and represent drivers for GHG emission increase in the atmosphere. The main causal drivers contributing to the continuing GHG emission increase from all production and economic sectors are attributed to extensive use of high carbon content fuels; excessive use of inefficient technologies mainly in power generation, transport, household, and industry.

This situation is further aggravated by weak national mitigation capacity plagued by numerous constraints and gaps including: (i) Inadequate institutional set up combined with ineffective manpower to handle climate change mitigation policies; (ii) Policy and legislative distortions; (iii) inadequate public and donor funding for delivering mitigation policies; (iv) weak monitoring capacity of mitigation impact; (v) poor research capacity on clean energy technologies, and (vi) a weak information base as well as low public awareness on green energy. The following sections present additional details on these constraints and gaps and identifies key priority needs to improve GHG mitigation performance.

## 4.1. Inadequate Institutional set up to Promote Green Energy and Mitigation policies

Institutional weakness of the Energy sector is attributed to weak coordination in the field of renewable energy and energy efficiency; inadequate institutional frameworks promoting renewable energy; inadequate enforcement regimes; inadequate government funding of renewable energy and energy efficiency projects; and inadequate institutions for promoting decentralized management of rural power supply. This weakness is further aggravated by shortage of technical capacity of poorly remunerated civil servants, limited specialized staff in renewable energy and poor personal skills and performance under inadequate training programs. Towards this end, there is an urgent needs to reverse institutional weakness through two strategic options, respectively geared towards restructuring the agencies involved in energy production and supply, and building human resources capacities. Restructuring needs is to focus on harmonizing the mandates of national agencies working in the energy sectors, enforcement and rationalized of institutional frameworks of these agencies; creation of higher level inter-institutional mechanism to oversight and monitor implementation of energy policies; and promotion of inclusive management and planning of power supply, allowing greater involvement of private sector in the management and planning of electricity supply.

It worth pointing out that restructuring efforts will be undertaken at both central and local levels. At central level, efforts is to be given to restructuring the Ministry of Electricity and Energy (MEE) to act as the leading coordinating agency for the promotion of grid-based renewable energy generation technologies. This include the creation of a separate authority for renewable energy and energy efficiency attached to the MEE. The creation of this entity will capitalize on experience gained while creating the General Department for renewable energy & energy efficiency under MEE. The new body is proposed include 6 units concerned

with wind energy, solar energy, geothermal energy, policy planning, investment promotion and fund raising and energy efficiency.

At local level, it is vital to reverse decentralization in management and planning of energy supply through shifting to a decentralized management. Specifically through restructuring the Public Authority for Rural Electrification (PARE) so as to act as the sole national agency for the promotion of renewable energy technologies for decentralized off-grid electrification. Additionally, the NSREEE calls for improving coordination mechanism at the local level via creation of an inter-ministerial committee with representation of all agencies concerned with aim to oversight activate rural energy development.

To address capacity building needs in the energy sector, the primary needs focuses on strengthening the management capacities of PARE and inter-ministerial committee through appropriate training in management and planning. Also thigh priority is to be given to establishing of an attractive remuneration scheme in the renewable energy / energy efficiency sector to facilitate recruitment of skilled and highly motivated employees. Further, efforts will be given to improving personal skills and performance through, training and education programs to overcome shortage in the technical cadre and limited specialized staff in research, planning management of renewable energy. Specific training needs are presented under Measuring, Reporting and Verifying (MRV) section bellows.

### 4.2. Policy and Legislative Distortion

Generally, Yemen policies is not adequately mainstreamed towards mitigation of climate change issues and so the largest segment of the society has modest role or no role in the planning and management process of climate change issues as well as in promotion of energy efficiency. As a result community and private sectors are rarely mobilized for implementing climate changes mitigation projects and the burden of projects' funding rest on donning communities. Also climate change is not among national priorities, for which mitigation issues have never been taken into account while preparing national development plans . More drastically, energy, manufacturing industry and development sectors are not adequately committed to sustainability and environmental excellence and their production activities are reported to be destructive, polluting & hazardous to environment . Unsustainable production patterns in development sectors is clearly manifested by extensive use of high carbon content fuels in energy production, excessive use of non-green or antiquated technologies, inadequate application of recycling, non-compliance with EIA and environmental excellence & standards and lack of national mitigation plans.

About 99.9% of energy generation is produced from fossil fuels, with only 0.1% produced form renewable energy, namely from Solar PV. This indicates that current energy policy in Yemen is highly tilted toward fossil fuel use at the expense of green energy. Such a bias is also reflected by current financial and fiscal incentive that subsidize the use of oil for energy generation, while there are no policies promoting renewable energy and energy efficiency. In addition, green energy projects do not enjoy customs duty exemptions or internal tax privileges. As a result, current energy production scheme in Yemen is reported to be wasteful, inefficient and inadequate to meet growing demands of energy.

Similarly, the transport sector is environmentally wasteful due to intensive fuel use, along with the use of environmentally polluting of transportation modes & the resultant emission of greenhouse gases in the form of hydrocarbons, lead and the oxides of Sulphur, Nitrogen and Carbon in addition to particulates.

The Manufacturing and industry is also clearly marked by a low political will towards sustainable production which is ultimately reflected in the prevailing destructive, polluting & hazardous production modes, non-compliance with EIA, air quality and waste management standards. This situation is further deprived by ineffective government capacity to monitor industrial pollution, hazards & waste & to enforce environmental excellence & standards.

On top of the above mentioned policy deficiencies, Yemen legislation has evolved in a fragmented manner, leading to overlapping and conflicting legislation, rules and regulations associated with deficiency in regulatory frameworks, laws, by-laws standards advocating the promotion clean & efficient energy. This deficiency coupled with weak enforcement capacity of policy, legislation and standards, and lack of climate change mitigation plans in development sectors have been cited as key drivers triggering GHG emission from all local sectors.

To address the policy and legislative issues, there is a need for policy and legislative reforms with aim to mainstream mitigation concepts and into development policies. Mainstreaming mitigation concept into sectoral policies and plans will be achieved through three strategic reforms, as outlined in the bullets below.

- Strategic option 1 seeks to introduce a Payment scheme against pollution caused by the sector, and this will be realized through introduction and enforcement of polluter-pays-principle (emission tax) and tradable pollution permits scheme.
- Strategic option 2 focuses on promoting the green economy and sustainable development strategies within industry, mining, manufacturing and energy production. The enforcement of green economy will be met by through applying fiscal measures and economic incentives advocating sustainable production and consumption and adhering to environmental excellence. To this end, it is critical to put in place an incentives and subsidy scheme against the compliance of environmental excellence. This scheme is to ensure compliance with environmental excellence via several green policy options such as the diffusion of green-tech, EIA enforcement, prevention of pollution, efficient use of energy, control of hazards and waste and promotion of recycling. It further will encourage pollution free industries, industrial compliance, adoption of and use of recycled materials. The scheme will be enforced via the introduction of fiscal incentives and tax exemption for reducing the use of raw materials high carbon energy and waste water disposal, including the introduction of financial incentives conducive for clean energy such as the adopting of custom and tax exemption for small scale renewable energy systems and provision of fiscal incentives on tariffs to promote energy efficiency. The enactment of incentives and tax exemption schemes will be realized through designating an entity along with establishing certification mechanism by which environmental excellence as regard energy-efficiency, materials use -efficiency, and water-efficiency will be verified, registered and certified. The establishment of certification mechanism will include the existence of an effective domestic system for Measuring, Reporting and Verifying (MRV)

to be managed by a designated body, whose mandate and overall structure is later in this section.

- Strategic reform 3 seeks to reform policy and legislations with aims to remove current policy distortion and introduce new ones conducive promoting green energy. Specific legislation reform will focus on upgrading RE legal frameworks, removal of fuel subsidies for water pumping, enforcement of the renewable energy law, promulgation of by-laws for renewable energy & energy efficiency, and developing and implementing a Nationally Appropriate Mitigation Actions (NAMAs) to demonstrate commitments to shift towards greener economy promotion of and Renewable Energy and energy efficiency. Another key element of regulatory reform is to promote efficiency via introduction and enforcements of norms, benchmarks and standards via the development of energy efficiency standards, labels protocols, codes for energy efficiency, grid code for energy efficiency, *standards* for efficient household lighting, and air quality and waste management standards among others. To further addresses environmental policies deficit, it critical to readjust sectoral policies through two restructuring options, whereas the first is devoted to encouraging private sectors involvement in energy production/supply, and the second is dedicated for mainstreaming mitigation concepts into sectoral policies of energy, manufacturing industry, mining agriculture and waste sectors.

### 4.3. Inadequate Government and Donor Funding for developing Mitigation policies

In Yemen climate change mitigation issues are not considered among most pressing concerns compared with social issues such as poverty, health and education. Consequently, government funding for climate mitigation concerns is inadequate to promote green energy and mitigation of GHG emission. This funding inadequacy is further triggered by low levels of Official Development Assistance (ODA) associated with low level awareness of decision makers on available international funding mechanisms and funding eligibilities.

Yemen's inability to access and mobilize financial resources from international and national donor agencies is attributed to many reasons, including political unrest, security situation, associated with low national absorption capacities under the absence of National Climate Funds (NCF) as a designated national entity responsible for coordinating, mobilizing and administrating of climate change polices and strategies, including the supervision of project and programme implementation. Additionally, Yemen weak capacity to tap to international financing opportunities is constrained by weak planning capacities of the Environmental Protection Authority (EPA), Climate Change Unit (CCU) and Designated National Authority (DNA) in charge of CDM registration.

The Environmental Protection Authority (EPA), as the national focal point of UNFCCC in charge of coordinating donor finance for climate change interventions, lacks the technical expertise needed for identification, planning and formulation of nation-wide investment programs and sectotal projects as per national priorities and pursuant to the international eligibility requirements. Given this fact and recalling that the availability of documented projects & programmes in line with international standards is a key prerequisite to access international climate finance, it is therefore strongly needed to build EPA planning capacity with specific focus on identification, assessment and prioritization of related national climate- needs,

including identification of capital investment needs and hence formulating the needed funding documents. Also, it is necessary that EPA has in place operational management capacities to implement and execute project, programme, and coordinate implementation in order to be qualified for international climate finance. As the EPA lack for reporting, monitoring evaluation system to relay on while assessing and reporting on state of progress towards realization of intended results, it is highly needed to establish a reporting, monitoring and evaluation system in EPA so as to help the government accessing the international climate finance.

Given that the Climate Change Unit, DNA Secretariat and EPA focal point are not fully able to conduct detailed examination of the project proposals in terms of their eligibility to access CDM funding, priority focus should be given to strengthening the CCU evaluation capacity on CDM valuation and formulation of project proposals in line with international funding requirements. The CCU and the DNA Secretariat in this context needs to be trained on CDM methodologies and other quantification methodologies of mitigation impacts. More importantly, the CCU needs to be furnished with data base, electronic copies of CDM methodologies and adequate national expertise to act as auditors in charge of verification of mitigation projects. Through the establishment of reporting, monitoring and evaluation system coupled with the acquisition of data base along with trained expertise, the EPA will be able to conduct objective assessment of mitigation impacts and hence provide project developers with concrete advice on whether the nominated projects are fulfilling donor's financing criteria or not. Conversely, if such capacity needs are not met, the country absorptive capacity of climate finance will continue be weak, leading to continuing loss of funding from donor pledges, as well as the loss of CDM financial opportunities of highly accredited project for CDM finance.

In this context, it worth-mentioning that the country has failed to access CDM financing opportunities though it has successfully implemented a number of mitigation interventions, which are highly accredited for CDM certification. Government failure in registering these initiatives as CDM projects has resulted in the loss of substantial financial resources, and this fact can be visualized by the implementation of Ma'rib natural gas generation plant phase I and II. The Ma'rib-II power plant resulted in emission reductions of 680,000 tons per year, which is equivalent to US$13.6 million per year or over US$100 million as a lump sum over the crediting period. Similarly, Marib- Gas Turbine powered energy generation plants(Ma'rib-I) would have resulted into substantial CDM finance potential, but this facility has not been nominated as CDM project.

Yemen's capacity to tap to and mobilize financial resources from international sources is weak, resulting in low level of Official Development Assistance (ODA) for funding climate change issues. The country, over the past 15 years, has received about USD 187 million for climate change related activities, which has been mainly invested for adaptation & biodiversity conservation (76%); capacity building and improving environmental management (11%) and only 13% for GHG mitigation activities. The main partners contributed to this amount during this period are the World Bank, GEF, UNDP, GIZ, Netherlands and Italy. Table 4.1 provide a summary of completed and active Projects by the aforementioned donors.

**Table 4.1: Summary of Climate Change Donors' Projects for the period 2000-2015**

| Donors | | Project Title | Approval date/ Duration | Status | Budget (Million) US$ |
|---|---|---|---|---|---|
| WB | Mitigation | Mocha Wind Park Project | 2014-2017 | N/A | 20.0 |
| WB | Adaptation | Agro-biodiversity and Adaptation | May 27, 2010 | N/A | 4.0 |
| WB | Mitigation | RURAL ELECTRIFICATION & REN. EGY DEV | February 4, 2005 | Closed | 1.0 |
| GEF/UNDP | Capacity building | Third National Communication and First Biennial Update Report to the UNFCCC | 2014- 2017 | Active | 0.942 |
| WB | Capacity building | Climate Information System and PPCR Coordination | 2013-2017 | Active | 19.0 |
| WB | Mitigation | Biogas Digesters: An Integrated Solution for Poverty Alleviation and Climate Change Mitigation in Yemen | 2012-2014 | Closed | 2.61 |
| WB | Adaptation | Pilot Program for Climate Resilience Phase I (PPCR I) | August 22, 2010 | Closed | 1.5 |
| EU/UNDP | Adaptation | Enhancing Resilience and Self-reliance in Crisis Affected Yemeni Communities | | Active | 5 |
| WB | Adaptation | Taiz Municipal Development and Flood Protection Project | 2001-2005 | Closed | 50 |
| WB | Adaptation | Taiz Municipal Development and Flood Protection Project | January 29, 2008 | Closed | 20.0 |
| GEF | Adaptation | Conservation and Sustainable Use of the Biodiversity of Socotra Archipelago | 1996 -2003 | Closed | 1.3 |
| Netherland | Capacity building | Support to the Environmental Protection Authority (EPA) | N/A | Closed | N/A |
| Netherland | Capacity building | Support to Socotra | N/A | Closed | N/A |
| UNDP/ Gov. of Italy | Adaptation Capacity building | Sustainable Development and Biodiversity Conservation for the People of Socotra Island, YEM/03/004 | 2003 – 08 | N/A | 5 |
| GEF/UNDP | Adaptation | National Adaptation Programme of Action, YEM/03/G37 | 2003 – 04 | Closed | 0.2 |
| GEF/UNDP | Mitigation | National Recovery and Recycling Programme for Refrigerators in the Commercial and MAC Sectors in Yemen, YEM02/G61 | 2002 – 05 | Closed | 1.47 |
| GEF/UNDP | Adaptation | Protection of the Marine Ecosystems of the Red Sea Coast Yemen, YEM/97/G32 | 1997 – 04 | Closed | 2.8 |
| GIZ | Adaptation Capacity building | Conservation and sustainable use of biodiversity | 2011- 2016 | Active | 6 |
| WB | Adaptation | FLOOD PROTECTION AND EMERGENCY RECONSTRUCTION ADDITIONAL FINANCING II | March 24, 2009 | N/A | 35.0 |
| UNDP | Adaptation/ capacity Building | Sustainable Natural Resources Management, I | 2004 – 08 | Closed | 1.6 |
| GEF/UNDP | Capacity Building | National Capacity Self-Assessment | 2004 – 05 | Closed | 0.200 |
| UNDP | Adaptation/ capacity Building | Sustainable Natural Resources Management, II | 2009-2013 | Closed | 1.398 |
| UNDP/GEF | Adaptation/ capacity Building | Strengthening Socotra policy and regulatory framework for mainstreaming biodiversity | 2008-2013 | | 1.807 |
| GEF/UNDP | Adaptation | **Yemen** Geothermal Development Project | 2008- 2012 Approved | N/A | 1 |
| GEF/WB | Adaptation | Adaptation to Climate Change using agro biodiversity resources in the Rain fed Highlands | 2010- 2015 Approved | N/A | 4 |
| GEF/WB | Adaptation | Protected Areas Management | 1999- 2005 | Closed | 0.74 |
| | | | | **Grand Total** | 186.567 |

As for support received for the preparation of the BUR, the Government mobilized about USD 852,000 from the Global Environment Facility (GEF) and US$ 100,000 from the United Nations Development Programme (UNDP) in order to prepare the Third National Communication

(TNC) under which the Biennial Update Reports (BURs) is an important component. The government has provided in-kind contributions amounting to US$ 40,000 in order to fulfill its obligations under the UNFCCC requirement. Overall implementation of the BUR has been completed via commissioning a national expert assisted by five local consultants to facilitate data collection, processing and validation as well as to review draft National GHG Inventory Report and current mitigation policies and initiative, and subsequently prepare a draft BUR which is then consulted with national climate stakeholders for feed backing and guiding the editor of the BUR to develop final draft in line with their comments.

To improve the country readiness for climate change funding, there is urgent needs to tackle current barriers through three strategic options, as briefly outlined in the bullets below.

- Option1 focuses on creating an appropriate coordination mechanism known as National Climate Fund (NCF) to act as coordination body responsible for mobilizing funding resources to meet national mitigation needs, including the funding of nationally appropriate mitigation actions (NAMA) with ultimate aims to reduce GHG emissions through multiple actions including the shift to renewable energy (RE) & energy efficiency (EE), the promotion of smart agricultural practices and the introduction of bio-energy production especially from solid waste and wastewater among others. Primarily, it is proposed to materialize on infrastructural and institutional capacities available to EPA focal point to establish the coordination mechanism at EPA after being intuitionally restructured and Mandated through appropriate legislative framework and by- law for the functioning of mechanism.
- Option2 focuses on improve EPA operational management capacities to implement and execute project, programme through supporting the CCU with adequate qualified staff, and to train them on identification, planning and formulation of investment projects as per international documentation standard, they also should be trained implementation, monitoring, evaluation of the projects, including reporting of project performance
- Option3 focuses on creating monitoring, evaluation and reporting (MER) system under the CCU to help the EPA in examining projects eligibility for CDM financing, and subsequently monitoring and evaluating projects mitigation impacts. The proposed system should include data base containing ,as appropriate, emission reduction Methodologies, emission factors, indicators on project performance and other information needed for monitoring, evaluation of the projects implementation. It also should include reporting system and templates to report on status and progress of implementation of the mitigation projects, as well as for developing BUR and NC reports among others.

### 4.4. Measuring, Reporting and Verification system

To date, Yemen has not developed and submitted any Nationally Appropriate Mitigation Actions (NAMAs) to the UNFCCC registry, which reflects the fact that the country lacks a Measurement, Reporting and Verification (MRV) system to quantify and track the emission reductions impacts of national mitigation interventions. Furthermore, Yemen has not yet identified specific institutional arrangements for mitigation assessment and MRV application, including the sustainable production of GHG inventory, BURs and national communications.

Under this situation, Climate Change Unit (CCU) of EPA developed these reports on an ad-hoc basis through outsourcing national exerts with limited contribution of EPA staff. This implies that the EPA capacity to monitor implementation of mitigation measures is by far weak, and the country reporting, verification, quantification of mitigation impact is made subjectively with high degree of uncertainty.

Precise accounting and reporting of the overall effectiveness of Yemen mitigation measures pursuant to the UNFCCC reporting standards is still hampered by numerous constraints and gaps which needs to be overcome in order to have comprehensive quantifiable report. This include among others: the lack of a Measurement, Reporting and Verification (MRV) system to quantify and track the emission reductions impacts of national mitigation interventions; the absence of specific institutional arrangements for mitigation assessment and MRV application; lack of financial resources to implement the MRV system; and low awareness on mitigation policy options, which in turn is attributable to weak information base, and limited research capacity. The following sections presents these constraints and gaps with identification of priority needs to overcome these constraints

### *4.4.1. Information base*

The information base for monitoring and verification is hampered by inadequate information networks, a shortage of information technology (IT), limited research capacity, and an absence of monitoring indicators for better understanding and planning energy and mitigation issues. This status is further deprived by lack of technical capacity on methodological approach on quantification of mitigation impacts, poor expertise on development GHG inventories, including data collection, quality control and quality assurance; lack of systematic GHG database for achieving raw activity data processing it and hence developing and updating GHG inventories. Specific information deficit is manifested by lack of activity data on installations, lack of emission factors and calculation methodologies To address information deficiency, standardization of data collection, processing and analysis formats in addition to automating and upgrading of data collection and processing facilities along with establishment of modern information systems in CCU to serve as data acquisition, processing and dissemination of environmental information, development of procedures and methodologies for measurement and evaluation, and establish systems to verify quality of data gathered, i.e., a source check.

### *4.4.2. Public Awareness on Renewable Energy and Mitigation Issues*

Currently, there is low public awareness about renewable energy and GHG mitigation issues. This is largely due to the lack of a communication strategy to promote renewable energy & energy efficiency and hence help decision makers public appreciation of renewable energy leading to mainstreaming mitigation concerns into decision making. To address public awareness weakness, there is an urgent need to develop and implement a Communications strategy, set-up an environmental communication units at PEC/EPA and to furnish the units with appropriate technologies for production and dissemination of environmental information and awareness and research products. To this end, each communication unit needs to be provided with adequate specialized training on information processing, and production and dissemination of awareness materials. Specific training will be given to

designing radio/TV programs, environmental campaigns and awareness raising educational materials addressing the economic benefits of prompting renewable energy and energy efficiency in industrial sectors, and Promoting Solar Home System (SHS) use in replacing electrical in urban households, hotels and restaurants.

### *4.4.3. National research capacity*

The national research capacity is inadequate to produce informative research on green energy because of the absence of specialized designated research center on renewable energy efficiency associated with low financial capacity to transfer and promote know- how, practices and green technologies. This weakness is accelerated by lack of Information base on cleaner energy , lack of specialized training center for renewable energy & energy efficiency combined with lack of networking with between national and regional research centers, and absence of designated body for licensing for renewable energy equipment and certification of energy efficient products. In the absence of licensing and certification system of renewable energy and efficient technology, current energy production facilities is reported to be largest polluting source in terms of GHG emission.

This fact is being broadly verified by the frequent country GHG inventories, however the verification of this issue as per each installation is constrained by lack of measuring equipment and techs on measuring GHG emission and measuring emission reduction impact at site level. More importantly, a precise quantification and assessment of mitigation impacts is constrained by lack of MRV System and none- existence of officially designated verification agency to be responsible for measuring, reporting and verification of mitigation projects/ initiatives. Further, unavailability of specialized national energy auditors and CDM experts to carry out Measurement and verification of mitigation actions are another key constraints.

Improving national research capacity is the most important first step towards producing purposeful research on viable green technologies needed for emissions reduction by source. Similarly, the development of an research and information base is vital to understand national emission by sources including their corresponding impact on environment. Improved research and knowledge base are important for developing calculation methodologies of emission reduction and development of specific national emission factor for various sectors contributing to national GHG emissions.

Therefore, research development needs is oriented for exploring methodologies and emission factor for quantification of mitigation impacts of measures undertaken locally. This is very critical for putting in place an effective domestic system for Measuring, Reporting and Verifying (MRV) and is an important step for monitoring GHG emission and monitoring emission reduction impact incurred by mitigation measures. Complimentary to research development, the creation of systematic database for monitoring GHG emission and monitoring emission reduction impact at EPA is an important integral part of the domestic MRV system. It will ensure data collection, achieving, processing, quality control and quality assurance of activity data needed for GHG inventory development and regular update. Further, the MRV will be an important tool to be used for systematic recording and registry of energy saving and emission reduction resulted from overall country mitigation measures. In other words, it will serve as information sharing platform to be accessed by national

partners while assessing, auditing & monitoring of environmental excellence, including the provision of energy saving certification and emission reduction certificates.

Research development needs in energy sectors is delineated for exploring viable policy option and technologies disseminating green technologies and efficient energy. This will be realized through establishment of research center on renewable energy efficiency under the MoEE and to support the research center with data base on cleaner energy combined with of specialized training center on Renewable Energy / energy efficiency.

### 4.5. Institutional Arrangements and MRV system

As presented above, Measurement, Reporting and Verification (MRV) is highly demanding process in terms of its requirements and funding needs. Given this fact and noting that these requirements are beyond the Government financial capacity under the current war, it is assumed that the establishment of a robust institutional arrangements is far reaching, and it is therefore proposed not to establish new entity for MVR management and to capitalize instead on existing domestic processes, arrangements or systems, including domestically available information, methodologies, experts and other aspects, for domestic measurement, reporting and verification. Capitalizing on MRV capacity of CCU is of most viable arrangement option and is consistence with EPA mandate as a national designated focal point responsible for the periodic preparation and submission of the BUR and national communications to UNFCCC. However, technical and financial assistance is needed to support the upgrading of the CCU to act as institutional arrangements for measuring, reporting, verification of mitigation impact incurred by mitigation projects. This include the following:

- Appointment of the CCU secretariat as officially designated agency responsible for MRV of mitigation projects/ initiatives.
- Appointment of specific specialized auditors under CCU to be in charge of verifying impact of mitigation actions
- Development of procedures and methodologies for measurement and quantification of mitigation impacts, including estimation of emission factors
- Establishment of information system for development of GHG inventories, data collection, quality control and quality assurance
- Creation of certification system to certify energy saving and emission reduction
- Formulate and approve a regulatory framework, authorizing the CCU to be responsible for MRV of mitigation projects/ initiatives
- Develop indicators to measure GHG reductions or other benefits.

In addition, there is need to conduct several studies and surveys to improve development of comprehensive GHG inventory covering all sources categories, as outlined by IPCC guidelines. Of major studies needed are the following:

- Conducting countrywide survey on the prevailing traditional biomass consumption practices.

- Specific study on forestland and grassland converted to croplands and uses over the last 30 years.
- Updating soil survey and state of abandonment of managed Lands
- Updated inventory on forestation, afforestation, tree plantation and removal.
- Development of data bases on land use, forestry and grasslands.
- Specific study with aim to develop country specific emission factor of national grid.
- Specific study with aim to develop country specific emission factors for methane and $N_2O$ from agriculture and from waste.
- Study on household energy use from biomass.
- Study on the use of fuels by vehicles.

Most importantly, it is highly recommended to conduct an immediate survey of household solar systems voluntary introduced by people as an important step for quantifying emission reduction form this source, which is anticipated to exceed the intended target planed by national strategies by 2025.

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# Annex – GHG inventory tables, 2012

| Table 1 : Yemen's GHG Emissions Summary (by Sector and Gas) for the Year 2012 | | | | |
|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | Subtotal |
| | (Gg) of CO2 Equivalent | | | |
| **Total National Emissions & Removals** | **23,312** | **7,713** | **6,864** | 37,889 |
| **1 Energy** | 21,914 | 1,545 | 66 | 23,525 |
| **A Fuel Combustion (Sectoral Approach)** | 21,113 | 117 | 66 | 21,295 |
| **1 Energy Industries** | 4,296 | 4 | 11 | 4,310 |
| **2 Manufac. Industries & Construction** | 3,464 | 2 | 8 | 3,473 |
| **3 Transport** | 5,696 | 28 | 15 | 5,739 |
| **4 Other Sectors** | 7,657 | 84 | 32 | 7,773 |
| **B Fugitive Emissions from Fuels** | 801 | 1,429 | | 2,230 |
| **Oil and Natural Gas** | 801 | 1,429 | | 2,230 |
| **2 Industrial Processes** | 1,398 | 0 | 0 | 1,398 |
| **A Mineral Products** | 1,398 | | | 1,398 |
| **D Food and Drink** | 0 | 0.0000 | 0.0000 | 0.0000 |
| **4 Agriculture** | | 4,354 | 6,415 | 10,769 |
| **A Enteric Fermentation** | | 4,154 | 0 | 4,154 |
| **B Manure Management** | | 183 | 23 | 206 |
| **D Agricultural Soils** | | 0 | 6,386 | 6,386 |
| **F Field Burning of Agricultural Residues** | | 17 | 7 | 23 |
| **5 Land-Use Change & Forestry** | -1,540 | 0.00 | 0.00 | -1,540 |
| **A Changes in Forest & Biomass Stocks** | -11,235 | | | -11,235 |
| **B Forest and Grassland Conversion** | 0 | 0.00 | 0.00 | 0 |
| **C Abandonment of Managed Lands** | -132 | | | -132 |
| **D $CO_2$ Emissions & Removals from soil** | 9,827 | | | 9,827 |
| **6 Waste** | | 1813.91 | 382.34 | 2,196 |
| **A. Solid waste disposal on land** | | 1261.50 | | 1,262 |
| **B. Waste-water handling** | | 552.40 | 382.34 | 935 |
| **Memo Items** | | | | |
| **International Bunkers** | 335 | 0.009629 | 0 | 335 |
| **Aviation** | 52 | 0.000179 | 0 | 52 |
| **Marine** | 282 | 0.00945 | 0 | 282 |
| **$CO_2$ Emissions from Biomass** | 538 | | | 538 |

| Table2: Summary report for national greenhouse gas Source and Sink, 2012 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category Sources** | **$CO_2$ emissions (Gg)** | **$CO_2$ removals (Gg)** | **$CH_4$ (Gg)** | **$N_2O$ (Gg)** | **$NO_x$ (Gg)** | **CO (Gg)** | **NMVOCs (Gg)** | **$SO_x$ (Gg)** |
| **Total national emissions and removals** | **23,312** | **-1,540** | **367** | **22** | **105** | **594** | **111** | **4** |
| **1. Energy** | **21,914** | **0** | 74 | **0** | **104** | **577** | **107** | **3** |
| A. Fuel combustion (sectoral approach) | 21,113 | | 6 | 0 | 104 | 577 | 103 | 0 |
| 1. Energy Industries | 4,296 | | 0.17 | 0 | 12 | 1 | 0 | 0 |
| 2. Manufacturing industries/ construction | 3,464 | | 0.08 | 0 | 8 | 0 | 0 | 0 |
| 3. Transport | 5,696 | | 1.31 | 0 | 50 | 508 | 95 | 0 |
| 4. Other sectors | 7,657 | | 3.98 | 0 | 34 | 68 | 7 | 0 |
| B. Fugitive emissions from fuels | 801 | | 68 | | 0.2 | 0.3 | 4.0 | 3.3 |
| 1. Solid fuels | | | 0 | | 0 | 0 | 0 | 0 |
| 2. Oil and natural gas | | | 68 | | 0.2 | 0.3 | 4.0 | 3.3 |
| **2. Industrial processes** | **1,398** | **0** | **0** | **0** | **0** | **0** | **4** | **1** |
| A. Mineral products | 1,398 | | | | 0 | 0 | 3 | 1 |
| B. Chemical industry | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| C. Metal production | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| D. Other production | 0 | | 0 | 0 | 0 | 0 | 2 | 0 |
| **3. Solvent and other product use** | **0** | | | **0** | | | **0** | |
| **4. Agriculture** | | | **207** | **21** | **1** | **17** | **0** | **0** |
| A. Enteric fermentation | | | 198 | | | | | |
| B. Manure management | | | 9 | 0 | | | 0 | |
| D. Agricultural soils | | | | 21 | | | 0 | |
| F. Field burning of agricultural residues | | | 1 | 0 | 1 | 17 | 0 | |
| **5. Land-use change and forestry** | **0** | **-1,540** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| A. Changes in forest and other woody biomass stocks | 0 | -11,235 | | | | | | |
| B. Forest and grassland conversion | 0 | 0 | 0.000 | 0.000 | 0.000 | 0.000 | | |
| C. Abandonment of managed lands | | -132 | | | | | | |
| D. $CO_2$ emissions and removals from soil | 9,827 | 0 | | | | | | |
| **6. Waste** | | | **86** | **1** | **0** | **0** | **0** | **0** |
| A. Solid waste disposal on land | | | 60 | | 0 | | 0 | |
| B. Waste-water handling | | | 26 | 1 | 0 | 0 | 0 | |
| C. Waste incineration | | | | | 0 | 0 | 0 | 0 |
| **Memo items** | | | | | | | | |
| **International bunkers** | **335** | | **0** | **0** | **0** | **0** | **0** | **0** |
| Aviation | 52 | | 0 | 0 | 0 | 0 | 0 | 0 |
| Marine | 282 | | 0 | 0 | 0 | 0 | 0 | 0 |
| **$CO_2$ emissions from biomass** | **538** | | | | | | | |

| TABLE 3 SECTORAL REPORT FOR ENERGY, 2012 (Gg) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
| **Total Energy** | **21,914** | **73.59** | **0.29** | **103.98** | **577.20** | **106.67** | **3.28** |
| **A Fuel Combustion Activities** (Sectoral Approach) | **21,113** | **5.55** | **0.21** | **103.77** | **576.88** | **102.64** | **0.00** |
| **1 Energy Industries** | **4,296** | **0.173** | **0.03** | **11.52** | **0.86** | **0.29** | **0.000** |
| **2 Manufacturing Industries and Construction** | **3,464** | **0.08** | **0.03** | **8.38** | **0.42** | **0.21** | **0.00** |
| **3 Transport** | **5,696** | **1.31** | **0.05** | **49.64** | **507.86** | **95.45** | **0** |
| a Civil Aviation | 71 | 0.00 | 0.00 | 0.31 | 0.10 | 0.05 | |
| b Road Transportation | 5,625 | 1.31 | 0.05 | 49.34 | 507.76 | 95.40 | |
| **4 Other Sectors** | **7,657** | **3.98** | **0.10** | **34.23** | **67.74** | **6.70** | **0.00** |
| a Commercial/Institutional | 1,195 | 0.16 | 0.01 | 1.63 | 0.33 | 0.08 | |
| b Residential | 5,267 | 3.73 | 0.09 | 13.04 | 51.12 | 3.36 | |
| c Agriculture/Forestry/Fishing | 1,195 | 0.08 | 0.01 | 19.56 | 16.30 | 3.26 | |
| **B Fugitive Emissions from Fuels** | **801** | **68.04** | **0.08** | **0.21** | **0.32** | **4.03** | **3.28** |
| **2 Oil and Natural Gas** | **800.94** | **68.04** | **0.08** | **0.21** | **0.32** | **4.03** | **3.28** |
| a Oil | 0.33 | 2.13 | 0.00 | 0.21 | 0.32 | 4.03 | 3.28 |
| b Natural Gas | 800.61 | 51.35 | 0.00 | | | | |
| c Venting and Flaring | | 14.56 | 0.08 | | | | |
| **Memo Items** [(1)] | | | | | | | |
| **International Bunkers** | **335** | **0** | **0** | **0** | **0** | **0** | **0** |
| Aviation | 52 | 0 | 0 | 0 | 0 | 0 | 0 |
| Marine | 282 | 0 | 0 | 0 | 0 | 0 | 0 |
| **$CO_2$ Emissions from Biomass** | **538** | | | | | | |

| TABLE 4: SECTORAL REPORT FOR INDUSTRIAL PROCESSES, 2012, (Gg) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
| **Total Industrial Processes** | **1,398** | **0** | **0** | **0** | **0** | **4.19** | **0.84** |
| **A Mineral Products** | **1,398** | **0** | **0** | **0** | **0** | **2.53** | **0.84** |
| 1 Cement Production | 1,395.80 | | | | | | 0.84 |
| 2 Lime Production | 1.26 | | | | | | |
| 3 Limestone and Dolomite Use | 1.32 | | | | | | |
| 6 Road Paving with Asphalt | | | | | | 2.528 | |
| **D Other Production** | **0** | **0** | **0** | **0** | **0** | **1.66** | **0** |
| 1 Pulp and Paper | | | | 0 | 0 | 0.00 | 0 |
| 2 Food and Drink | | | | | | 1.66 | |

| TABLE 5: SECTORAL REPORT FOR AGRICULTURE,2012 Gg | | | | | |
|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC |
| **Total Agriculture** | **207** | **21** | **1** | **17** | **0** |
| **A Enteric Fermentation** | **198** | | | | |
| 1 Cattle | 61 | | | | |
| 3 Sheep | 57 | | | | |
| 4 Goats | 55 | | | | |
| 5 Camels and Llamas | 20 | | | | |
| 7 Horses , Mules and Asses | 5 | | | | |
| **B Manure Management** | **9** | **0** | | | |
| 1 Cattle | 3 | | | | |
| 3 Sheep | 2 | | | | |
| 4 Goats | 2 | | | | |
| 5 Camels and Llamas | 1 | | | | |
| 7 Horses , Mules and Asses | 1 | | | | |
| **B Manure Management (cont...)** | | | | | |
| 10 Anaerobic | | 0.000 | | | |
| 11 Liquid Systems | | 0.000 | | | |
| 12 Solid Storage and Dry Lot | | 0.071 | | | |
| 13 Other (please specify) | | 0.002 | | | |
| **D Agricultural Soils** | | **21** | | | |
| **E Prescribed Burning of Savannas** | **0.00** | **0.00** | **0.00** | **0.00** | |
| **F Field Burning of Agricultural Residues** [1] | **0.79** | **0.02** | **0.80** | **16.59** | |

| TABLE 6: SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (Gg), 2012 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$-eq Emissions | | $CO_2$ Removals | | $CH_4$ | $N_2O$ | $NO_x$ | CO |
| **Total Land-Use Change and Forestry** | (1) | **0** | (1) | **-1,540** | **0.000** | **0.000** | **0** | **0** |
| **A Changes in Forest and Other Woody Biomass Stocks** | (1) | **0** | (1) | **-11,235** | | | | |
| **C Abandonment of Managed Lands** | | | | **-132** | | | | |
| 1 Tropical Forests | | | | -132 | | | | |
| **D CO2 Emissions and Removals from Soil** | (1) | **9,827** | (1) | **0** | | | | |

| Table 7: GHG Emissions Trends, 1995, 2000, 2012 | | | | | |
|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | 1995 | 2000 | 2012 | Emission increase Between 1995-2012 | Percentage Change (%) from base Year to 2012 |
| | Gg CO2 eq | | | | 1995-2012 |
| **Total National Emissions & Removals** | 19,346 | 25,684 | 37,889 | 18,543 | 96 |
| **1 Energy** | 13,173 | 17,795 | 23,525 | 10,352 | 79 |
| **Fuel Combustion (Sectoral Approach)** | 11,608 | 15,871 | 21,295 | 9,687 | 83 |
| **Energy Industries** | 3,782 | 4,943 | 4,310 | 528 | 14 |
| **Manufac. Industries & Construction** | 1,017 | 1,711 | 3,473 | 2,456 | 242 |
| **Transport** | 4,014 | 4,956 | 5,739 | 1,725 | 43 |
| **Other Sectors** | 2,795 | 4,261 | 7,773 | 4,978 | 178 |
| **Fugitive Emissions from Fuels** | 1,565 | 1,924 | 2,230 | 665 | 42 |
| **Oil and Natural Gas** | 1,565 | 1,924 | 2,230 | 665 | 42 |
| **2 Industrial Processes** | 544 | 734 | 1,398 | 854 | 157 |
| **Mineral Products** | 544 | 734 | 1,398 | 854 | 157 |
| **4 Agriculture** | 4,976 | 5,941 | 10,769 | 5,794 | 116 |
| **Enteric Fermentation** | 1,706 | 2,144 | 4,154 | 2,449 | 144 |
| **Manure Management** | 96 | 122 | 206 | 110 | 115 |
| **Agricultural Soils** | 3,160 | 3,660 | 6,386 | 3,225 | 102 |
| **Field Burning of Agricultural Residues** | 14 | 15 | 23 | 10 | 72 |
| **5 Net Land-Use Change & Forestry** | -2,033 | -1,501 | -1,540 | 493 | -24 |
| **A Changes in Forest and Other Woody Biomass Stocks** | -11,156 | -11,357 | -11,367 | -211 | 2 |
| **$CO_2$ Emissions and Removals from soil** | 9,123 | 9,856 | 9,827 | 704 | 8 |
| **6 Waste** | 653 | 1,214 | 2,196 | 1,543 | 236 |
| **Solid waste disposal** | 547 | 1,097 | 1,262 | 715 | 131 |
| **Wastewater Treatment and Discharge** | 106 | 116 | 935 | 828 | 778 |