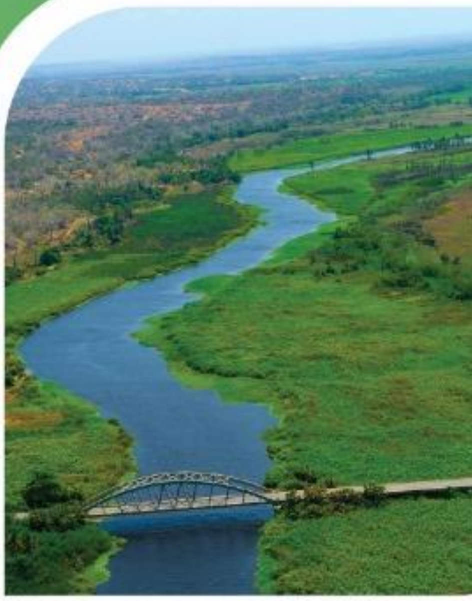
ANGOLA'S FIRST BIENNAL UPDATE REPORT TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

NOVEMBER 2024



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ABSTRACT

Article 12 of the United Nations Framework Convention on Climate Change states that all Parties shall communicate to the Conference of the Parties (COP) information relevant to the implementation of the Convention, including on greenhouse gas emissions and removals, in accordance with Article 4 (4). This will enable the Convention to have reliable, transparent and comprehensive information on greenhouse gas emissions, actions and support, thereby raising awareness of current emission levels and the extent of existing efforts and progress made, both nationally and internationally.

Through national communications and biennial reports, Parties must provide information to the Conference of the Parties (COP), via the Secretariat, on the actions taken or to be taken to implement the Convention. This is considered to be a fundamental task for the implementation of the Convention, as it allows Parties to be informed about national actions, which serve as a basis for evaluating the level of implementation of the Convention by COP member countries.

More demanding reporting requirements have been set for developing countries, namely the obligation to prepare National Communications every four years and BURs every two years, which means that the National Emission Inventory has to be prepared every two years.

Angola ratified the United Nations Framework Convention on Climate Change (UNFCCC) in May 2000 and the Kyoto Protocol in March 2007, thereby reaffirming its commitment to implement policies and programmes to stabilise greenhouse gas (GHG) emissions. In the same year, the first climate change strategy was approved ("National Strategy for the Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol", tasks carried out by the Ministry of Environment in 2007).

The lack and/or limitation of concrete data from some sectors, such as energy, industry, waste, agriculture and forestry, contributes to the existence of limitations on CO2, CH4 and N2O emissions, which means that each inventory to be prepared is limited to the data and information contained in previous reports. For this reason, the compilation of GHG inventories has been quite difficult and sometimes costly. Many sectors have structured data, others have estimated data but no real data. Still others don't consider the data that facilitates GHG inventories to be important. In most sectors, the people responsible for collecting and storing data are not able to link this data to the needs of the software. Time and again, data is missing.

These difficulties, coupled with bureaucratic issues and the lack of a legal institutional mechanism, mean that carrying out inventories is still a difficult process.

Training needs - Given the complexity of the GHG inventory, the process began with training for the technicians involved in its preparation, opting for institutional involvement to ensure the sustainability of the process. Experts from Brazil and the IPCC have been involved in the capacity building process for the preparation of the inventories, although there is also a quality control workshop organised in partnership with the Secretariat of the United Nations Framework Convention on Climate Change.

Methodology - A number of combined methodologies have been used to compile the National Greenhouse Gas Inventory. Given the great difficulty in using the software correctly, the spreadsheets and emission factors included in the software were used, as Angola does not yet have its own emission

factors. All instructions for filling in the spreadsheets, analysing the data and calculating emissions were taken from the IPCC manuals that guide the preparation of greenhouse gas inventories.

The methodologies used to quantify and compile this greenhouse gas (GHG) inventory followed the following Intergovernmental Panel on Climate Change (IPCC) guidelines

The Level 1 calculation method was used to calculate national greenhouse gas emissions in the energy sector. The information required for the calculation was collected from the consolidated activity reports of the oil and gas sector. GHG emissions are calculated using the activity data (fuel consumption or combustion) for each source and its respective emission factor, according to the following formula E=DA * FE

Where:

- E: greenhouse gas emissions;
- DA: Activity data (consumption or fuel consumption);
- FE: emission factor.

For the other sectors, with the exception of land use change, the same approach to collecting sectoral information was used, supplemented with some specific information from primary sources. For the land-use change and forestry sector, also known as LULUCF, it was decided to follow the guidelines for the use of three IPCC approaches to land classification and stratification. Approach 1 identifies the total area of each land use category, but does not provide detailed information on the nature of conversions between land uses. Approach 2 introduces the tracking of conversions between land use categories, and Approach 3 extends the information available in Approach 2 to track land use conversions in a spatially explicit way.

In this method, a combination of approaches can be used for different regions over time, trying to make the best use of available data and reducing possible overlaps and omissions in the reports. It is important to emphasise that the methodology proposed in this third inventory differs from that presented in the first inventory (2000-2005 inventory), which used a different approach provided by the 1996 IPCC that does not use explicit representation, i.e. the 1/approach method.

For the energy sector, gas emissions were inventoried using the bottom-up (or sectoral) approach, where greenhouse gas emissions are calculated from final energy consumption. The sectoral approach made it possible to identify where and how emissions occur.

CO2 emissions depends on the carbon content of fuels and can be estimated at a high level of aggregation and with reasonable accuracy. For non-CO2 gases, the IPCC default values have been used. In addition to CO2, the gases CH4 and N2 O are estimated.

The top-down method ("reference approach") was also used, which estimates CO2 emissions by considering only the supply of energy, without detailing how this energy is consumed. In this approach, estimates are based on a balance sheet that includes domestic production of primary fuels, imports and exports of primary and secondary fuels, international bunkers and the internal variation in stocks of these fuels. In the case of secondary products, domestic production is not taken into account as they come from the primary source already discussed. The use of this approach is considered good practice as it allows the results obtained to be compared with the bottom-up results and possible problems to be identified (IPCC, 2006).

The industrial sector in Angola accounts for about 8% of gross domestic product, which is estimated to be around US$100 billion in 2019. The main industries are the processing of oilseeds, cereals, meat, cotton and tobacco. Sugar, beer, cement, timber and oil refining are also important. The industrial park is powered by hydroelectric plants, whose energy potential is greater than their consumption capacity due to the fact that there are still distribution limitations.

The sector is responsible for some of the CO_2 emissions caused by the combustion of fossil fuels. This phenomenon occurs, for example, in cement production. This issue is also addressed in the Energy Sector. There are other sources of greenhouse gas emissions from the industrial sector, such as ceramics, glass and steel production. The expansion of the sector to include petrochemicals, fertilisers, electrical equipment and agro-industry is also mentioned.

The main greenhouse gases in the agriculture sector are CO_2, N_2O and CH_4. The agriculture sector includes all emissions related to enteric fermentation, manure handling, rice cultivation, agricultural waste burning, agricultural soils and liming.

The subcategory Greenhouse gas emissions from biomass burning in agricultural crops, which refers to the category Aggregate sources and sources of non-CO_2 gases on land, has not been included in the inventory of GHG emissions by sources and removals by sinks in Angola due to the low representativeness of these activities in the territory.

The inventory includes information on forests, land use and land use change. In terms of classification, area and sampling data representing different land use categories are needed to estimate carbon stocks, emissions and removals of greenhouse gases associated with activities grouped together as Agriculture, Forestry and Other Land Use and Land Use Change (AFOLU) in the IPCC 2006 Guidelines. The classification provided the basis for estimating GHG emissions and removals using different types of data to represent land use categories and conversions between land use categories so that they could be applied as appropriately and consistently as possible in inventory calculations.

The IPCC classification considers land use together with agricultural activities. This economic activity should present its inventory calculations separately, treating the agriculture sector in isolation, autonomously, and not as a component sub-sector of the forestry and land use sector.

For this inventory, we have endeavoured to update the data in a way that is as consistent as possible with the material in the 1st National Inventory of Angola (2000 and 2005). The first inventory was prepared according to the guidelines of the 1996 IPCC Guidelines. However, in order to apply the 2006 IPCC Guidelines, it is necessary to contextualise it, as the methodologies are very different. Countries use a variety of data collection methods to conduct their inventories, including annual inventories, ten-year forest inventories, periodic surveys and remote sensing. Each of these data collection methods produces different types of information (e.g. maps or tables), with different reporting frequencies and attributes, which have allowed the sector's emissions to be calculated.

In Angola, the waste sector includes emissions of CH_4, CO_2 and N_2O resulting from the final disposal and incineration of solid waste and wastewater treatment. This classification has been established in the country for the period from 2005 to 2018, based on the application of the 2006 Methodological Guidelines of the Intergovernmental Panel on Climate Change.

Calculations of emissions from solid urban waste management were primarily based on national data, and where this was not available, IPCC default data were used.

The parameters used for the calculation were: population, degradable organic carbon, gravimetric composition of waste, waste generation rate per inhabitant, oxidation factor, methane recovery and IPCC default data.

The majority of greenhouse gas emissions in Angola from 2005 to 2020 were CO_2 (carbon dioxide), followed by CH_4 (methane) and N_2O (nitrous oxide). The total value of emissions by gas for each year of the inventory is presented in the following tables by emissions with and without the Land Use, Land Use Change and Forestry (LULUCF) sector.

CO_2 accounts for more than 83 % of emissions in all the years covered by the inventory, taking into account emissions and removals from the Land Use, Land Use Change and Forestry sectors, and between 2005 and 2020 there was an increase in carbon dioxide emissions of more than 37,658 Gg CO_2 (an absolute increase of 81.92 %).

In the area of mitigation, we would like to highlight the mitigation actions undertaken in Angola, as part of the commitments made when joining the United Nations Framework Convention on Climate Change and the Paris Agreement, and, on the other hand, as part of its ambitious programme to expand the electricity sector, improve the provision of general services, energy transition and human capital development. Given the limitations of Angola's information and tools for planning and monitoring mitigation, projections are made in the following thematic areas:

- Energy;
- Industrial processes;
- Agriculture, Forestry and Other Land Uses (AFOLU);
- Land Use, Land Use Change and Forestry (LULUCF);
- Solid waste.

BUR Angola's GHG inventory estimates emissions from the energy, industrial processes, agriculture, forestry, land use and waste sectors from 2005 to 2020. GHG emissions in 2005 are estimated to be around 63.5 Mt CO_2 eq.

MEASUREMENT for developing countries refers to both efforts to address climate change and the effects of these efforts, including the level of greenhouse gas (GHG) emissions by sources and removals by sinks, emission reductions and other benefits. This measurement is done at the national level. Prior to COPs 16 and 17, the measurement of GHG emissions by sources and removals by sinks was mainly contained in national GHG inventories, which are part of national communications. Based on the decisions taken at COPs 16 and 17, measurement methodologies are not defined in the Convention; therefore, Parties rely on methodologies developed externally, including by the Intergovernmental Panel on Climate Change (IPCC) and other organisations. Whenever possible, the COP identifies and endorses the methodologies to be used by Parties.

REPORTING for developing countries takes place through National Communications (NCs), Biennial Update Reports (BURs) and Nationally Determined Contributions (NDCs). Parties are required to report on their climate change actions in their National Communications, which include information on GHG inventories, adaptation, mitigation actions and their effects, constraints and gaps, support required and received, and other information deemed relevant for achieving the objectives of the Convention. National Communications are to be submitted every four years and are to be prepared in accordance with guidelines approved by the Conference of the Parties. BURs should be submitted every two years and should provide an update of the information presented in the national communications, in particular on national greenhouse gas inventories, mitigation actions, limitations and gaps, including support needed and received. NDCs derive from the commitments of the Paris Agreement and must be submitted every 5 years.

VERIFICATION is addressed at the international level through the International Consultation Analyse (ICA) in relation to BURs, which is a process to increase transparency on mitigation actions and their effects, as well as support needed and received. National communications are not subject to ICA. At the national level, verification is carried out through national MRV mechanisms established by non-Annex I Parties, the general guidelines for which were adopted at COP 19 in 2013. Provisions for verification at the national level that are part of the national MRV framework must be reported in the BURs. Specific provisions have been adopted for the verification of REDD+ activities.

The process of implementing the Convention has shown that strengthening and consolidating institutional capacity is fundamental to the whole process of implementing the Convention and responding to adverse climate change phenomena. This process is taking place at a rather slow pace compared to the country's own context, which is quite dynamic in many respects. In contrast to the implementation process, Angola is focusing its attention on economic, developmental and social integration issues, without neglecting the link between climate change and these factors, including survival.

The need to adapt is an important issue, but it is highly dependent on the technical, financial and technological capacity and requires a concerted commitment so as not to jeopardise the survival of future generations.

The National Adaptation Action Programme aims to contribute to reducing the country's vulnerability to the effects of climate change and to creating the conditions for adaptation, in accordance with the urgent and priority sectoral actions identified.

The specific objectives are:

- To serve as a simplified and direct channel for communicating information on Angola's urgent and immediate adaptation needs;
- Strengthen the national capacity of Angolan experts in the field of vulnerability and adaptation to climate change, thereby ensuring an enabling environment for the implementation of the UNFCCC; and,
- Facilitate capacity building for the preparation and implementation of the adaptation actions contained in the First National Communication and identify urgent and immediate adaptation needs.

The country is aware that natural resources such as oil, coal and natural gas are finite, i.e. they will not last forever, which is why it has invested in the energy transition in order to stabilise the energy sector and ensure Angola's sustainable development.

The energy transition can be a solution that contributes to changing the current scenario, which aims to diversify the sources of energy production, with a focus on reducing emissions and achieving the national and international targets reported to the United Nations Framework Convention on Climate Change.

The process of assessing Angola's energy production potential is a fundamental aspect of the country's journey towards sustainability and energy transition.

In terms of renewable energy potential, the following stand out:

- Hydropower potential, which could generate up to 18 gigawatts;
- Wind potential, which could generate around 3.9 gigawatts;
- Solar potential, which could reach up to 17.3 gigawatts;
- Biomass potential, 3.7 gigawatts.

For the ongoing energy transition process, the energy mix is the most appropriate, as it ensures the use of biofuels, the use of solar and wind energy, the improvement of energy efficiency in various sectors such as housing, industry, waste, etc., the expansion of rural electrification, the modernisation of infrastructure, among others.

Angola has natural resources that allow the country to diversify energy sources, reduce greenhouse gas emissions, promote socio-economic development and harmoniously develop the territory, creating a surplus for the sustainability of the region.

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AC – Climate Change

AD – Activity Data

AFOLU – Agriculture, Forestry and Land Use

AfDB – African Development Bank

ANPG – National Agency of Petroleum, Gas and Biofuels

BUR – Biannual Update Report

CH4 – Methane

CO2 – Carbon Dioxide

CO2 e – Carbon Dioxide Equivalent

COP – Conference of the Parties

DNSP – National Department of Public Health

DOC – Degradable Organic Carbon

DW – Development Workshop

EDAs – Agricultural Development Stations

EF (FE) – Emission Factor

EFDB – Database of Emission Factors

ENDE – National Electricity Distribution Company

ELISAL – Luanda Sanitation and Cleaning Company

FAO – Food and Agriculture Organisation

FAOSTAT – FAO Statistics

FOLU – Forests and Land Use

GCF – Green Climate Fund

GDP – Gross Domestic Product

GHG – Greenhouse Gases

GEF – Global Environment Facility

Gg – Giga Gram

GWP – Global Warming Potential

HFC – Hydrofluorocarbons

ICH – Human Capital Index

IEA – International Energy Agency

INBAC – National Institute of Biodiversity and Conservation Areas

IPCC – Intergovernmental Panel on Climate Change

IPPU – Industrial Processes and Product Use

KCA – Key Category Analysis

Ktoe – Kilo tonne oil equivalent

LBA – Basic Environmental Law

LPG – Liquefied Petroleum Gas

LNG – Liquefied Natural Gas

LULUCF – Land Use, Land Use Change and Forestry

MINAMB – Ministry of Environment

MIREMPET – Ministry of Mineral Resources, Oil and Gas.

MINEA – Ministry of Energy and Water

MINFIN – Ministry of Finance

MINAGRIF – Ministry of Agriculture and Forestry

MINPESMAR – Ministry of Fisheries and the Sea

MIND – Ministry of Industry

MESCTI – Ministry of Higher Education, Science and Technology.

MoU – Memorandum of Understanding

Mt – One Million Tonnes

MRV – Monitoring, Reporting and Verification

MW – Megawatt

N_2O – Nitrous Oxide

NAMAs – Nationally Appropriate Mitigation Measures

NDC – Nationally Determined Contributions

NMVOCs – Non-methane Volatile Organic Compounds

NOx – Nitrogen Oxide

PEM – Macroeconomic Stabilisation Programme

PFC – Perfluorocarbons

PRODESI – Programme to Support Production, Export Diversification and Import Substitution

PROPIV – Privatisation Programme

QA/QC – Quality Control/Quality Assurance

UNFCCC – United Nations Framework Convention on Climate Change

UPDN – United Nations Development Programme

REDD+ - Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

RNT – National Electricity Transmission Network

SDGs – Sustainable Development Goals

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INTRODUCTION

Climate change is an alteration of the climate over time, either due to natural variability or as a result of human activities. These changes continue to affect populations and territories. Its causes remain an active area of research, although the scientific consensus points to the increasing concentration of carbon dioxide, which causes the greenhouse effect by trapping more heat. A rise in global temperatures can in turn cause other changes, such as rising sea levels and changes in rainfall.

The Republic of Angola is located on the west coast of southern Africa, between the Democratic Republic of Congo to the north, the Republic of Zambia to the east and the Republic of Namibia to the south. It is the fifth largest country in sub-Saharan Africa, with a total area of 1,246,700 square kilometres, a land border of 5,198 kilometres and a coastline of 1,600 kilometres. Administratively, Angola is divided into 18 provinces, 164 municipalities and 539 communes, which vary considerably in terms of geoFigurey, population, physical and cultural characteristics.

Angola is located in the intertropical and subtropical zones of the southern hemisphere:

- Changes in the cold Benguela Current could affect coastal fisheries, fishing communities and the fishing industry;
- Changes in river hydrology or water temperature may affect river and lagoon fisheries;
- Rising temperatures could affect livestock production by changing the geoFigureical distribution of diseases (such as sleeping sickness) or the availability of water in the pastoral regions of southern Angola;
- Rising temperatures may adversely affect agricultural production due to increased evaporation and transpiration;
- Changes in rainfall and hydrology affect rainfed and irrigated agriculture.

The impact of climate change depends on the area of the country, the farming systems in each area and the current vulnerability. In the Central Plateau, for example, rainfall is not increasing or decreasing, but there are years when prolonged drought affects production. As a result, lower yields are recorded during the rainy season. The effects of the war and the low fertility of the soil are also factors that reduce the ability to manage climatic risks in this area. Further south, there is evidence of a reduction in rainfall and an increase in rainfall variability. Difficulty in accessing seeds adapted to local conditions and climate variability is a factor of general vulnerability.

Rising temperatures also affect human health by changing the geoFigureical distribution of diseases such as malaria and others associated with urban heat waves, which are exacerbated by the difficulty of sleeping and working in high temperatures. Similarly, frequent flooding can increase the risk of diseases associated with poor or inadequate sanitation.

In 2009, the country established the Designated National Authority (DNA) for the Kyoto Protocol mechanisms and began developing its National Adaptation Programme of Action (NAPA), which was submitted to the UNFCCC Secretariat in 2011. The following year, it submitted its 1st National Communication, a document containing a national emissions inventory for the years 2000 and 2005. In 2015, the State prepared its National Contribution to the Reduction of GHG Emissions, in which it set itself the target of unconditionally reducing its GHG emissions. In 2021, it submitted its second national communication and national contributions to the Conference of the Parties, after ratifying the Paris Agreement in 2020.

The signing of the Paris Agreement at COP 21 was one of the most important events on the international political scene regarding climate change in 2015, and was the culmination of many years of negotiations between the parties. Angola was one of the countries that participated in the high-level ceremony to sign the agreement at the UN headquarters in New York in April 2016. One of the main novelties of the Paris Agreement is the objective of limiting the increase in global surface temperature to 2°C, with an ideal target of no more than 1.5°C above pre-industrial levels. Against the backdrop of the provisions of the Paris Agreement and the 17 Sustainable Development Goals (SDGs), the National Climate Change Strategy naturally emerged from the need to integrate climate change into Angola's development policies.

METHODOLOGY

The methodology for the preparation of this Biennial Update Report (BUR) consisted of integrated approaches to the development of the other components of the report. First, we emphasised the engagement of independent advisors, the engagement of staff from institutions relevant to achieving the objectives of the BUR, the engagement of specialised staff for the methodological review and adaptation process, the biblioFigureic review, and compatibility with other documents produced for the reporting process.

The GHG inventory was based on the IPCC 2006 methodology and the biomass inventory was based on Landsat imagery and additional field research.

Ongoing review and updating of the information contained in the report are the cornerstones of the final version that is now being made available to society and to the Conference of the Parties to the Framework Convention on Climate Change. Expert consultations and sectional conferences were also part of the methodology used to prepare this BUR.

A number of technical, individual and institutional shortcomings have been identified in the process of drawing up the BUR, which should be the subject of a work plan to overcome them and thus make the BUR quick and sustainable.

The lack and/or limitation of concrete data from some sectors, such as energy, industry, waste, agriculture and forestry, contributes to the existence of limitations on CO2, CH4 and N2O emissions, which means that each inventory to be prepared is limited to the data and information contained in previous reports. For this reason, the compilation of GHG inventories has been quite difficult and sometimes costly. Many sectors have structured data, others have estimated data but no real data. Still others don't consider the data that facilitates GHG inventories to be important. In most sectors, the people responsible for collecting and storing data are not able to link this data to the needs of the software. Time and again, data is missing.

These difficulties, coupled with bureaucratic issues and the lack of a legal institutional mechanism, mean that carrying out inventories is still a difficult process.

A number of combined methodologies have been used to produce the National Greenhouse Gas Inventory. Given the great difficulty in using the software correctly, the spreadsheets and emission factors included in the software were used, as Angola does not yet have its own emission factors. All the guidelines for filling in the spreadsheets, analysing the data and calculating emissions were taken from the IPCC manuals that guide the preparation of greenhouse gas inventories.

The methodologies used to quantify and compile this greenhouse gas (GHG) inventory followed the following Intergovernmental Panel on Climate Change (IPCC) guidelines.

2006[1] IPCC Guidelines for National Greenhouse Gas Inventories (Intergovernmental Panel on Climate Change).

The Level - 1 calculation method was used to calculate national greenhouse gas emissions in the energy sector. The information required for the calculation was collected from the consolidated activity reports of the oil and gas sector. GHG emissions are calculated using the activity data (fuel

[1] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf
https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_03_Ch3_Representation.pdf

consumption or combustion) for each source and its respective emission factor, according to the following formula: *E=DA * FE*[2]

Where:

- E: GHG emissions;
- DA: activity data (fuel consumption or combustion);
- FE: emission factor

For the other sectors, with the exception of land use change, the same approach was used to collect sectoral information, supplemented with some specific information from primary sources. For the Land Use Change and Forestry sector, also known as LULUCF, it was decided to follow the guidelines for the use of three approaches to land classification and stratification. Approach 1 identifies the total area of each land use category, but does not provide detailed information on the nature of conversions between land uses. Approach 2 introduces the tracking of conversions between land use categories, and Approach 3 extends the information available in Approach 2 to allow land use conversions to be tracked in a spatially explicit way.

- **Training needs**

Given the complexity of the GHG inventory process, the first step was to train the technicians who would be involved in its preparation, opting for institutional involvement to ensure the sustainability of the process. Experts from Brazil and the IPCC have been involved in the capacity building process for the preparation of the inventories, although there is also a quality control workshop organised in partnership with the Secretariat of the United Nations Framework Convention on Climate Change.

This method allows a combination of approaches to be used for different regions over time, and attempts to make the best use of available data and reduce possible overlaps and omissions in the reports. It is important to emphasise that the methodology proposed in this third inventory differs from that presented in the first inventory (2000-2005 inventory), which used a different approach provided by the 1996 IPCC that does not use explicit representation, i.e. the 1/approach method.

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CHAPTER 1 – NATIONAL CONTEXT

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CHAPTER 1 – NATIONAL CONTEXT

Angola is a developing country in South-West Africa. Its economy is heavily dependent on the exploitation of oil, but agriculture, especially family farming, plays a fundamental role for Angolans.

Although Angola experienced very high rates of economic growth between 2005 and 2013 as a result of the increase in the price and production of oil, the country's development has not kept pace with this economic growth and today Angola is facing a serious economic and financial crisis. It must therefore respond to the urgent and enormous challenges of diversifying its economy, combating high unemployment and guaranteeing its population access to basic services such as health, education, drinking water, energy and basic sanitation.

Table 1: Angola's parameters

Parameters	Description
Territory	**1,246,700 km²** and is the 23rd largest country in the world in terms of surface area.[2]
Political and administrative division	It is divided into **18 provinces** and **164 municipalities**, and the country's capital is **Luanda**.
Population	**29,250,009 inhabitants**, making it the 46th most populous country in the world.
Population density	**20.7 inhabitants per km** [3]
Weather	Rainy tropical, arid steppe, arid desert and temperate.
Water Resources	Angola has large water resources, with the largest river basins being the Congo, Zambezi, Kwanza, Queve, Cunene and Cubango rivers.[4]

- **PHYSICAL FRAMEWORK**

GeoFigureical situation - Angola is an African country surrounded by the Atlantic Ocean. These two aspects have marked its history over the last five centuries, even before it became a political and administrative entity, as it has been since the 19th century, as a Portuguese colony and then as an independent country.

The territory of the Republic of Angola lies between the equator and the Tropic of Capricorn, between parallels 4° 22' and 18° 02' in the south and meridians 11° 41' and 24° 05' in the east. Its land area is 1,246,700 square kilometres, with 1,650 kilometres of coastline and 4,837 kilometres of land border. The maximum distance from north to south is 1,277 kilometres and from west to east 1,236 kilometres.

Politically and administratively, the country is divided into provinces. The provinces are subdivided into municipalities, which in turn are subdivided into communes. The lowest territorial administrative unit is the neighbourhood in cities and the village in rural areas. According to the 2014 census, the country consists of 18 provinces, 44 municipalities, 164 municipalities and 518 communes.

Relief – From an orographic point of view, the Angolan territory can be roughly divided into three main compartments. The first is the coastal plain, which varies in length. In the north and around Luanda, this coastal strip extends up to 200 kilometres, narrowing to 25 kilometres in the central region, around Benguela.

[2] Angola is Now" Investor Guide, AmCham and AIPEX, 2018.
[3] National Statistics Institute.
[4] Angola is Now" Investor Guide, AmCham and AIPEX, 2018.

Towards the east, abrupt cliffs appear, marking the second compartment, which is actually a transition zone to the very rugged sub-plateau and plateau zones. In the centre of the territory, this section is known as the Marginal Mountain Chain, where Angola's highest point, Morro do Moco, stands at 2,619 metres. It is in this transitional area that some of the most important waterfalls, cascades and rapids of important rivers, such as the Kwanza, Lucala, Queve, Mbridge, among others, naturally appear.

To the east is the plateau compartment, the most important of which is the Bié Plateau, known as the Central Plateau. Its altitude often exceeds 1,500 metres and even reaches 2,000 metres. Also worth mentioning are the Congo and Malanje plateaus in the north, and the Huíla plateau or highlands as you move south. These plateaus are characterised by vast peneplains where majestic granite Island Mountains (inselbergs) dominate the landscape, most notably the Pedras Negras de Pungo Andongo in Malanje.

To the east, the plateaus gradually descend, and this is how the fourth compartment reaches the border. With altitudes ranging from 500 to 1,000 metres, this inconspicuous plateau covers about two-thirds of Angola's territory.

Climate – With the exception of the south-west and, more generally, the whole of the south, Angola's territory is almost entirely integrated into the zone of alternating humid and dry climates of the intertropical trade-wind regions, due to the strong desert influence of the tropical equatorial zone, which is felt down to relatively low latitudes, combined with the action of the cold Benguela current.

The cold Benguela Current and the variations in relief are the two local climatic factors with the greatest influence on temperature.

Angola's climate is strongly influenced by a number of factors, including latitude, altitude, relief, the cold Benguela Current and the Zaire, Zambezi, Cuanza, Cubango, Cuando and Cunene River basins. The average annual temperature decreases with increasing latitude and altitude, and with increasing distance from the sea. The range of annual temperature variation is very small and increases with latitude. The lowest values (15 to 20ºC) are found in the highest regions or in the extreme southwest, while the highest values (25 to 27ºC) are found on the banks of the Zaire River and along the northern coast. Frost is relatively common in the higher and colder regions.

Annual rainfall decreases with latitude and increases with distance from the sea and altitude. The highest rainfall (1500 to 1700 mm) occurs in Maiombe (north of Cabinda), in the highlands of Uíge, in Lunda Norte and in the central massif of the Marginal Mountains; the lowest (less than 300 mm) is in the coastal strip south of Luanda, and the worst situation is in the Namib Desert, where rainfall is around 50 mm.

The distribution of rainfall throughout the year determines a wet period or rainy season, which lasts from four to seven months (from October to April), followed by a transitional period of about one month to the dry season (June to August) and another transitional month in September.

In the plateau and sub-plateau regions, there can be a period of two to four weeks without rain, a small dry season, between the end of December and the end of February. The rainy season generally corresponds to the hottest period with the highest relative humidity. It is most intense in the north and along the coast.

According to the Köppen classification, Angola has the following climate types Aw - tropical rainy, with a distinct winter dry season; BSw - dry steppe, with a winter dry season; BWw - dry desert, with a dry winter; Cw - temperate, without regular snowfall, with a dry winter. According to the Thorn Thwaite classification, the climate varies from arid to humid, with each climate zone developing in bands roughly parallel to the coast and the southern edge of the country, with the climate becoming wetter and colder with increasing altitude.

Hydrography – The plateaus in the centre of Angola act as the country's main watershed. Most of the rivers originate in this region and flow west to the Atlantic Ocean, north to the Congo or Zaire rivers, or south-east where they seep into the interior of the continent.

Of the rivers that flow into the Atlantic, two stand out: the Kwanza and the Cunene. The Kwanza is the largest river, at around 1000 kilometres long. It rises on the Bié plateau and flows north until it meets the escarpment of the plateau and the Malanje, from where it flows west to the sea. It flows entirely within Angola's borders. The Cunene River also rises in the centre of the country and flows south until it turns sharply west, marking the border between Angola and Namibia.

Of the rivers that flow north, the most important are the Cuango and the Chicapa, both of which also originate in the central highlands. The south-eastern rivers are the Cuando and Cubango.

Angola's hydrographic configuration is closely linked to its relief. Rivers originate in the mountains and plateaux of the interior and flow into the lowlands. Most of the riverbeds are irregular - there is no shortage of waterfalls, cascades and rapids - with wider banks in the coastal areas. They are usually not navigable, which makes them difficult to use as communication routes, except for the stretch of the Cuanza from Dondo and some in Cuando Cubango.

The main river basins are (from north to south and west to east) the Congo, Zambezi, Kwanza (the largest), Queve, Cunene and Cubango.

There are many lakes and lagoons, the largest being Lake Dilolo in the province of Moxico, followed by the Panguila and Muxima lagoons near Luanda.

Vegetation - In keeping with its orographic and climatic diversity, Angola has a wide range of vegetation types, from forests of various types (dense, humid, dry, open) to deserts and various grasslands, as well as various mosaics (forest-savannah, woodland), savannahs and steppes.

This vegetation has been under immense pressure, accelerated by foreign settlement throughout the 20th century and even more so by the economic boom between the early 1960s and the country's independence, especially with the increase in agricultural and livestock activities.

This pressure took on new forms with the wars that Angola experienced, especially with the displacement of the rural population, which concentrated on the outskirts of the urban centres. Later, with the advent of peace, the pressure on forest resources increased with a new upsurge in agricultural and livestock activities, but also with the exploitation of forests for commercial purposes.

Another type of pressure is exerted by family farming and charcoal burning, both for subsistence and commercial purposes, to which must be added at least 200,000 hectares of deforestation. All this because Angola's two million family farmers cultivate between 1 and 1.5 hectares a year. Since the production systems used require an increase in land of an average of 0.5 hectares per year in order to maintain productivity, deforestation is the result of this compensation.

Finally, it is important to mention the loss of biomass due to burning, which takes place every year during the dry season. There are three reasons why the rural population burns: to hunt small animals for their own consumption and for sale, to open up new pastures before the rains start and, as already mentioned, to open up new areas for cultivation.

The loss of vegetation has led to a phenomenon that causes very serious damage, such as the appearance of ravines in both rural and urban areas. There are no studies on this subject, but they are absolutely necessary for the preservation of the environment.

1.1. ENVIRONMENT: POLITICAL AND INSTITUTIONAL FRAMEWORK

The Ministry of Environment (MINAMB) is the central government department responsible for the coordination, formulation, and implementation and monitoring of environmental policies, particularly in the areas of biodiversity, environmental technologies, prevention and impact assessment, and environmental education.

Under the aegis of MINAMB, the Angolan government has established a number of regulatory frameworks and management tools to implement the Primary Environmental Law (LBA) and a number of international conventions, in particular the United Nations Framework Convention on Climate Change (UNFCCC), as well as the objectives of the African Union's Agenda 2063.

Historically, the adoption of the Primary Environmental Law in 1998 marked the laying of the first stone in the building of an environmental legal system, which has since been consolidated with the drafting and entry into force of dozens of other laws on environmental or related issues. In this way, it fulfils and reinforces the provisions of the aforementioned laws.

The LBA establishes four types of instruments for the different forms of environmental protection: formative (environmental education), preventive (environmental protection zones; environmental impact assessment; environmental licensing), repressive (audits; environmental offences and penalties) and reparative (civil liability and environmental insurance).

The 2010 Constitution introduced new and particularly important dimensions to environmental protection. It has become clear that the protection of the environment and natural resources is a "fundamental task of the State", according to Article 21(m). It should also be emphasised that this task is shared between the State and the municipalities under Article 219. However, the two most significant changes are the addition of the "duty to defend and preserve the environment" and the "right to live in a healthy and unpolluted environment" - Article 39. The inclusion of a provision dedicated to popular action gives full meaning to environmental protection.

In order to pursue environmental policies and programmes, the Angolan government has defined a series of measures and objectives to be achieved, which are included in the National Development Plan (PDN). According to this planning instrument, environmental issues are a cross-cutting concern in Angola's long-term strategy. They are practically present in the various policies and also constitute a fundamental option of the country's strategy. In fact, these policies and programmes can be summed up in the following overall objective: "To ensure the existence and maintenance of the quality of natural resources (natural capital), guaranteeing their healthy use for present and future generations, through an appropriate legal and institutional framework and adequate management, with the strong participation of society".

The Ministry of Environment (MINAMB) is the body responsible for implementing environmental policy, both in terms of formulating policy and developing the regulatory framework, as well as monitoring and ensuring its implementation. It also involves other public administration bodies and the civil society including the private sector. With regard to the marine environment, the Ministry of Fisheries and Marine Resources (MINPERMAR) is responsible for formulating and implementing marine policy, in particular to ensure the preservation of the quality of marine waters and the sustainable exploitation of marine resources.

In addition to MINAMB and MINPESMAR, the implementation of these policies requires the cooperation of several other bodies: the Ministry of Construction and Public Works (MINCOP) for coastal protection and river regulation works, the Ministry of Energy and Water (MINEA) and the Ministry of Agriculture and Forestry (MINAGRIF) in the context of the strategy to combat drought and desertification, and the Ministry of Mineral Resources, Oil and Gas (MIREMPET) for issues relating to the production and extraction of minerals, oil and gas. It also liaises with the country's local government bodies.

In the specific case of the Climate Change Programme, the National Development Plan aims to:

- Prevent and control air, soil and water pollution.
- Implement the Climate Change Strategy.
- Implement the environmental quality system.
- Implement the Strategic Plan for New Environmental Technologies.
- Improve resilience against environmental risks.

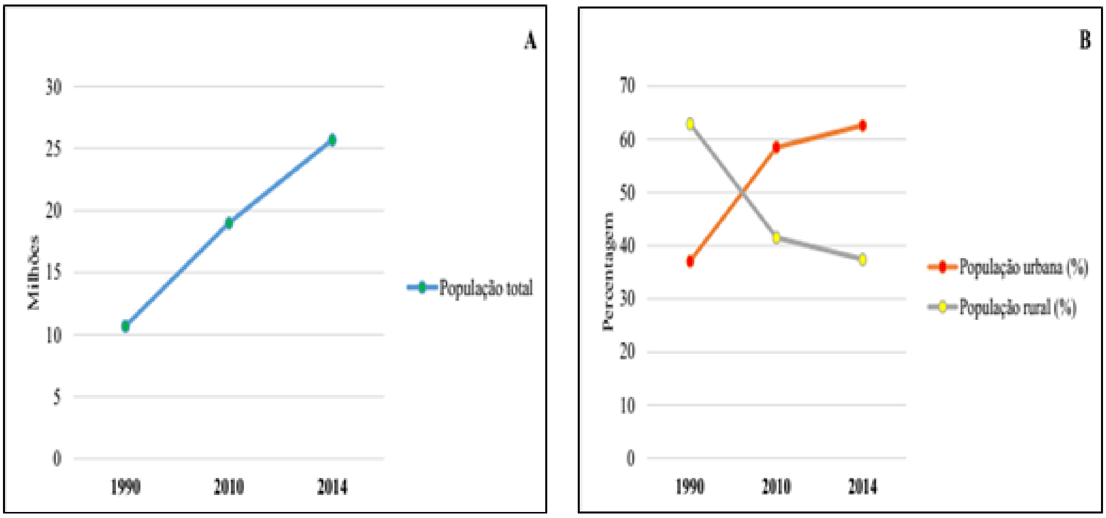
1.2. DEMOGRAPHIC FRAMEWORK

Demographic Framework - Existing demographic data for the period between 1975 and 2013 are unreliable due to the lack of a census covering the entire territory. An attempt was made to carry out a general census after independence, but the long period of war that followed and lasted until peace was achieved in 2002 meant that the country was unable to carry out a general census. Between 1983 and 1984, INE carried out provincial censuses in Cabinda, Luanda, Zaire and Namibe, and in the municipalities of Uíge, Negaje, Lubango, Huambo and Benguela, which, together with various studies and surveys also carried out, provided some information considered sufficiently reliable to allow population projections and the calculation of various demographic indices.

With the completion of the Integrated Population Welfare Survey (IBEP) in 2008, the country now has somewhat more reliable statistical information than previous national statistics.

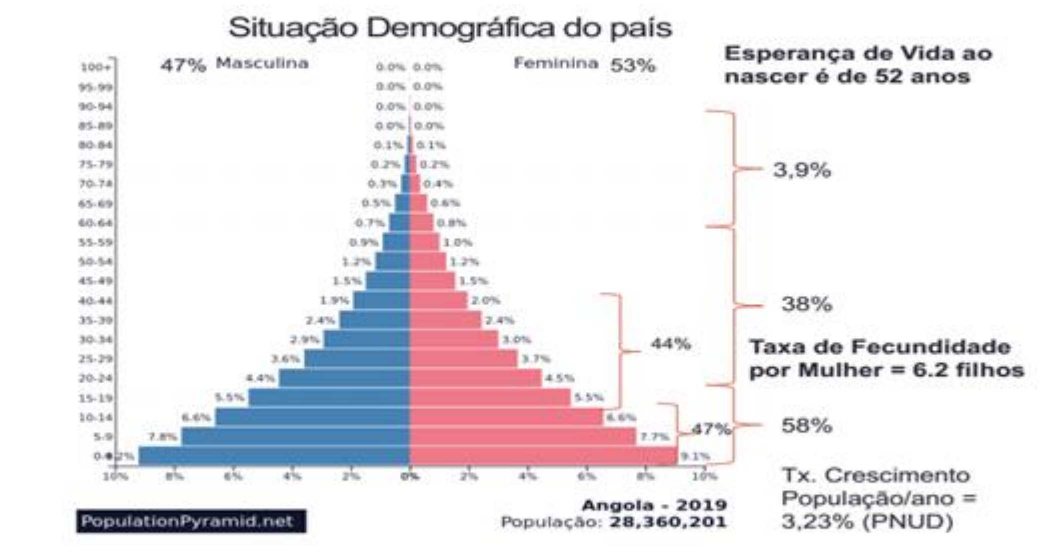
A general population and housing census was carried out in 2014, covering the entire territory. Data from INE (2016) show that Angola's population is growing strongly. According to Figure 1 A and B, it can be said that the population is growing strongly, especially in urban areas. A comparison of rural and urban population figures between 1990 and 2014 shows an almost complete reversal. In other words, in 1990 about 62.9% of the population lived in rural areas, and in 2014 this figure is almost equal to the urban population. This situation has several social implications. It should also be noted that in 2014, more than half of the country's population was concentrated in the provinces of Luanda (27%), Huila (10%), Benguela (9%) and Huambo (8%).

Chart 1: Population Growth



According to final data from the 2014 census, the natural growth rate is 2.7%, and UPDN data indicate an annual population growth rate of 3.23% and a fertility rate of 5.7 children per woman. It is believed that one aspect that has contributed to this situation is the high illiteracy rate (66% at national level, with 80% for men and 53% for women) (INE, 2016), combined with the poor dissemination of contraceptive methods, problems with sex education, low levels of education and religious beliefs. These circumstances lead to unplanned pregnancies and unwanted children.

Chart 2: Countries Demographic Situation



As a result of high birth and death rates, average life expectancy in Angola is low (60.2 years). It is 57.5 years for men and 63 years for women.

As the Figure below shows, the Angolan population is quite young, with an average age of 21. The proportion of inhabitants under the age of 15 represents 47 % of all inhabitants and the elderly only 2 % (INE, 2016). It can therefore be seen that the economically active population is less than 50 %, with a large number of people dependent on the state and their families.

1.2.1. Angola's Human Development Index

The country's age pyramid reveals a structural population model based on high fertility and birth rates. According to IIMS data for 2015-2016, the fertility rate is 6.2 children per woman. There are diverging statistics on this indicator, as the 2014 General Population and Housing Census shows a fertility rate of 5.7 children per woman. However, the difference is very small and does not affect the interpretation of the indicator. Although quite high, the fertility rate has been declining and was estimated at 7.2 children per woman in 2005. The average household consists of five persons and one in five households is headed by a woman. The proportion of women of reproductive age (15-49) is around 44%.

Angola's Human Development Index (HDI) has average values that still place the country at the bottom of the world rankings. In 2018, the index stood at 0.581, placing Angola in one hundred and forty-seventh place out of 189 countries in the world. This figure represents an increase of three positions compared to 2015, and places the country in the category of countries with average human development.

Population

Population: peri-urban and urban 55%; rural 45%.

Household - average 4.8 people; 1/3 head of household are women; 27% household ≥ 1 orphan or adoptee (IIMS 2015-16).

Human Development Index =0.581 (UNDP 2018); Angola 147th place/189 countries.

Around 36 % of the population lives below the poverty line and has difficulty accessing basic public services (water; sanitation; energy; health; education; housing).

Despite the fact that the country has improved its position in the HDI, the figures are still a cause for concern, which is why the government has shown interest in investing in a series of public policies, set out in the National Development Plan, aimed at improving the population's living conditions, availability and access to water, health, quality education, as well as the population's income and gross domestic product (GDP).

UPDN data also shows that between 2000 and 2017, Angola's HDI increased from 0.387 to 0.581, an increase of 50.2 %. Between 1990 and 2017, life expectancy at birth in Angola increased by 20.1 years and expected years of schooling increased by 8 years. In addition, the average number of years of schooling increased by 0.7 years between 1999 and 2017. On the other hand, Angola's gross national income (GNI) per capita increased by 182.4 % between 1990 and 2017.

Also, according to UPDN (2018), when Angola's HDI value (0.581) is adjusted for inequality, the HDI falls to 0.393, a loss of 32.4%, due to inequality in the distribution of the HDI dimension indices. Angola loses two positions in the HDI ranking when GNI per capita is adjusted for inequality. The average loss due to inequality is 25.1% for countries with an average HDI and 30.8% for sub-Saharan Africa.

Life expectancy at birth is 52 years, 51 for men and 53 for women. The low number of older people in the country could be a serious problem for the country, given that Angola, like most African countries, has a predominantly oral tradition, which strongly influences the way knowledge is produced and passed on. On the other hand, these indicators may reflect the poor quality of life of the population and, consequently, the country's level of development. Given that the population continues to grow and that living conditions have hardly improved, the social problems that the country is currently facing (poor medical care and medication, inadequate basic sanitation, unemployment, social inequality between the extremely rich and the extremely poor, delinquency, etc.) have worsened in the face of the economic crisis that the country has been experiencing since 2014.

1.3. SOCIAL FRAMEWORK

Poverty – The Angolan government has made great efforts to produce statistical information on poverty in the country. The INE's Multidimensional Poverty Index is one of these efforts, supported by its international partners, such as the UPDN.

The Multidimensional Poverty Index goes beyond the concept of monetary poverty, i.e. poverty measured in terms of consumption of goods and services. Data from the index show that multidimensional poverty, based on deprivation, requires people to consume certain goods and services, such as access to water, electricity, education and health.

The production of statistics on poverty in Angola plays an important role in the design of anti-poverty policies and the monitoring of existing policies and programmes, such as those set out in the Long-Term Development Strategy and the National Development Plan. These are the main planning and management instruments of the Angolan state. Through these instruments, the government outlines its policies based on the indicators that will lead to medium-term development.

According to the Multidimensional Poverty Index, 36 % of the Angolan population is poor, with three out of ten people living in extreme poverty, below the national poverty line.

According to a study by the United Nations Development Programme (UPDN), Angola's multidimensional poverty rate fell to 51.2 in 2018, compared to 77.4 % in 2011. Although the data contradict the Angolan government's indicators, the reduction shown is satisfactory, given that in reality the social situation deteriorated significantly in 2018-2019.

Multidimensional poverty is mainly based on deprivations that limit people's access to certain goods and services, such as access to water, sanitation, energy, education and health, among others. With these dimensions in mind, for the five-year period 2018-2022, the Angolan government, through the PDN and the Integrated Programme for Local Development and Poverty Reduction (PIDLCP), has planned to reduce the poverty rate from 36% to 25% and to lift the greatest number of people out of extreme poverty. To this end, in order to improve the well-being and quality of life of Angolan families and reduce inequalities and poverty, the PDN's Local Development and Poverty Reduction Programme outlined a series of short and medium-term actions, focusing on the following programmes:

- Municipalisation of social action services through the promotion and creation of integrated social centres (CASIS);
- Carrying out vulnerability diagnostics in Angola;
- Establishing a vulnerability database and registering social action beneficiaries, with information on beneficiaries, the nature and profile and dimensions of local vulnerability;
- Promote the inclusion of people in situations of vulnerability and poverty with the capacity to work in socio-economic projects to generate income (productive inclusion);
- Supporting the creation of sustainable economic activities based on cooperatives and solidarity-based associations for local development and economic and social integration, with a focus on ex-servicemen and their families;
- Provide social benefits in cash or in kind to families living in extreme poverty;

- Promote targeted assistance with a focus on improving the housing conditions of potential beneficiaries;
- Implement the national programme for the demarcation and subsequent allocation of land and rural land titles;
- Promote the construction of health and education facilities and improve communications;
- Ensure primary health care in all communities;
- Ensure the supply of drinking water and electricity to the population and the productive sector (water and electricity for all).

Education – The age structure of the Angolan population indicates that the majority is young, estimated at 47 % of the total population, according to the age pyramid. The average age of the population is 20.6 years. This situation puts increased pressure on the national education system.

It is important to emphasise that, after Angola's independence, the government's main objective was to create a new society, which would only be possible by educating the "new man". Everything that reminded of colonisation had to be changed. The new country had to have a new political, economic and social structure, different from the colonial structure that excluded the majority of the population from exercising their citizenship. The new education system had to be different from the colonial one.

Article 79 of the Constitution of the Republic of Angola, adopted in February 2010, recognises that the State promotes access to education and literacy for all citizens within the framework of their economic and social rights. Accordingly, the Basic Law of the National Education System establishes two principles - compulsory education and free education. Thus, unlike in the colonial period, education became compulsory and accessible to the entire Angolan population. Only the state was responsible for the educational process (leaving the churches out of this responsibility, as had been the case). Free education and easy access, combined with the fact that education was prioritised as one of the state's tasks, led to an explosion of schools (large numbers of pupils in the face of a glaring lack of infrastructure, teachers and school materials).

Free education means no payment for enrolment, attendance and school materials. Compulsory education means the obligation of the state, society, families and companies to ensure and promote access to education and the teaching system for all persons of school age.

The education system is unified and consists of six subsystems and four levels. The subsystem of general education is divided into primary and secondary education. Primary education is the foundation of general education and its completion is a prerequisite for secondary education.

The country currently has a literacy rate of 66%, which affects people aged 15 and over (80% men and 53% women). In Angola, around 4,676,900 people over the age of 15 (34% of the population) were unable to read and write at the time of the 2014 census. It's likely that this number has increased since then, due to cuts in services and a reduction in literacy tutors as a result of the economic crisis since 2014.

It's difficult to estimate the need for catch-up education. But given that only 19.9 % of the population aged 18 and over have completed primary school, the need must be extremely high. The 2018-2019 PDN aims to increase literacy, with a focus on women, particularly in rural areas. The Sustainable Development Goals for 2030 include targets to ensure that all young people and a significant proportion of adults are literate and have basic skills in mathematics. In fact, Angola is far from achieving this goal.

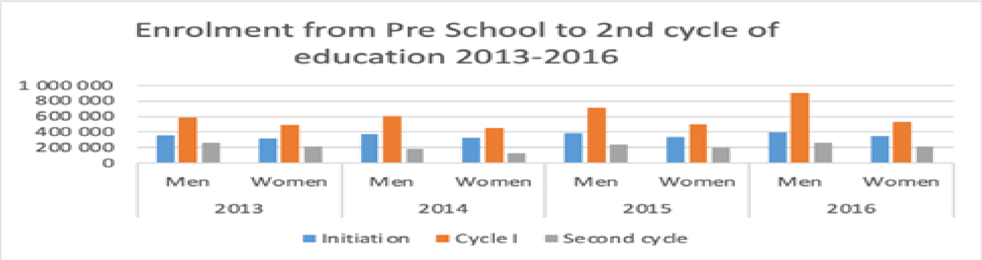
Primary and secondary education - According to the 2015-2016 IIMS, seventy-one % (71%) of children aged 6-11, of both sexes, attended primary school in the reference year of the survey.

There are significant gender disparities in secondary school attendance: only 37% of 12–18-year-olds who have attended secondary school are women. The Gender Parity Index (GPI) is 1.02 in primary education and 0.85 in secondary education. This means that there is one girl for every boy in primary school and eight girls for every ten boys in secondary school.

Children in urban areas are more likely to attend primary school (78% versus 59%) and Secondary school (50% versus 14%) than children in rural areas.

The chart above shows the difference between the number of pupils enrolled at the different levels of education (beginners, first and second cycle), which highlights the high number of drop-outs.

Chart 3: Number of students enrolled at different levels of education



Source. Ministry of Education report (2017)

Secondary school (50% versus 14%) than children in rural areas.

The chart above shows the difference between the number of pupils enrolled at the different levels of education (beginners, first and second cycle), which highlights the high number of drop-outs.

As the statistics on education in Angola show, the country still faces a great challenge in achieving the goals set at national (PDN) and international level. The goals set by the State demonstrate its will to improve education for all. The importance of education is reflected in the 2019-2022 PDN, which provides for a gradual increase in the allocation to the education sector from 12.4 % to 20 % of total expenditure. The GSB proposal for 2020 already indicated a clear intention to improve the allocation to the education sector, especially for the investment heading.

Health – governments, with priority given to the construction and rehabilitation of health infrastructure, confirming the commitment to improving indicators. This was followed by other programmes aimed at decentralising actions and transferring responsibilities to the municipalities. In this context, hospitals were given the status of budgetary units and thus gained autonomy.

The Municipal Rural Development and Poverty Reduction Programmes (PMIDRCP) have helped to reduce maternal and infant mortality and improve primary health care in rural communities. Closely linked to the PMIDRCPs is the municipalisation of health services, which consists of revitalising the health system at the community level, based on primary health care, using locally managed funds.

Despite the progress made in recent years, the health sector's challenges remain focused on reducing maternal and child mortality, controlling communicable diseases and improving healthcare delivery.

Employment and training – The employment rate is still very low, with only 53% of people of working age having a job, including in the informal sector of the economy, which is dominated by agriculture and commerce. This phenomenon implies a high real dependency ratio, where for every 100 citizens who produce goods and services, there are 150 who depend on them. As the dependency ratio for the elderly is very low, at only two for every 100-working people, the pressure on social security is not very high. However, there are concerns about the high rates of unemployment and informal employment, which mean that there are few contributions to the system. As the vast majority of the population is young, the sustainability of education, health, maternal and child protection, job creation and the fight against poverty are highly relevant issues today.

Rural environment and agriculture – Following the end of the civil war in 2002, the Angolan state faced new challenges, including the creation of policies and programmes aimed at rebuilding the country and ensuring security throughout the country. Measures have been taken to extend and re-establish state administration throughout the country, with an increased focus on rural areas. Among the various national priority programmes, the National Programme for Demining Potentially Affected Areas, programmes to encourage people to return to their areas of origin and the creation of a rural development and extension programme are the most notable.

With the end of the war, the country experienced significant economic growth, but some of the problems identified in rural areas have not been overcome. Despite efforts to implement these measures, such as the expansion of state administration, mine clearance and the rehabilitation of infrastructure, the rural reality is still characterised by many challenges to their implementation.

With regard to investment in the agricultural sector, the government is trying to move the sector from sub-system to market production. The limited economic infrastructure (roads and bridges), social infrastructure and services in general in rural areas do not facilitate trade or encourage agriculture, especially family farming. On the contrary, this situation has led people to seek other opportunities in urban areas, which is why the government is promoting employment and rural development to increase production and reduce rural depopulation. The population of some of the main agricultural provinces is tending to decline.

One of the instruments of the country's development strategies is the National Development Plan (PDN). The PDN is the Angolan state's main medium-term policy and governance instrument. Through this instrument, the Angolan government outlines its policies based on indicators that will lead to development in the medium term. The aim of this instrument is to promote the sustainable, equitable and prosperous development of Angola, and to enable the creation of fundamental policies and actions for all sectors of the country's economic and social life.

The PDN prioritises the construction of economic and social infrastructures that can guarantee the stability and diversification of the economic structure and the balanced development of the national territory. The plan also includes fundamental programmes and actions to boost the non-oil sector in order to accelerate economic diversification.

For the agricultural sector, the plan states that the general objective is to promote the integrated and sustainable development of the sector, making use of the resources and natural potential of each region. Given the current conditions in the agricultural sector, which is characterised by uncompetitive, quasi-subsistence agriculture in most regions of the country, the plan prioritises actions aimed at developing competitive agriculture, based on the reorientation of family production towards the market and the revitalisation of agribusiness, the rehabilitation and expansion of infrastructure to support livestock production, the promotion of job creation and the increase of incomes in family and entrepreneurial agriculture.

The family farming sub-sector has gained prominence because it employs most of the labour force in Angola. It is estimated that there are two million family farms in Angola and that family farming accounts for 80% of production.

Given the importance of family farming for job creation and family livelihoods, the PND provides for an increase in the capacity of the Agricultural Development Stations (EDAs) and other rural development partners to provide technical assistance to family producers.

The period in which the country experienced accelerated GDP growth was after the civil war. Agribusiness projects emerged, although they contributed little to large-scale agricultural production and processing. However, the plan is for the growth of agribusiness to go hand in hand with the development of family farming. Greater investment in the family farming sub-sector can take it to the next level. This would ensure food security for both rural and urban populations, while having a positive impact on the national economy by reducing imports and increasing exports.

In terms of food security, 2021 saw the creation of the Strategic Food Reserve (REA), a government initiative aimed at regulating the market and reducing the prices of products that make up the basic food basket. In 2022, the REA handled USD 500 million, equivalent to 600,000 tonnes of basic food basket products, and is expected to handle 1.2 billion tonnes in 2023. Although the REA has partly contributed to reducing the prices of basic food basket products, the recent context of sharp currency depreciation has made it difficult to curb price increases. In this context, strengthening the operational model of the REA could not only increase its effectiveness as a market regulation and price control mechanism, but also ensure food security in situations of food shortages, which is why it is an absolute priority in this five-year period. In addition, mechanisms will continue to be developed to bring the REA closer to local producers without jeopardising the stability of the "laws" of the market. In addition to the creation of the REA, educational campaigns have helped to raise citizens' awareness of the importance of healthy and sustainable food choices.

1.4. ECONOMIC FRAMEWORK

Having moved from the maize, coffee and diamond cycle to the oil cycle by 1973, the Angolan economy is still heavily dependent on this commodity, despite its many potentialities. Dilolwa (1978) identifies this last cycle as the period of capitalist exploitation of Angola.

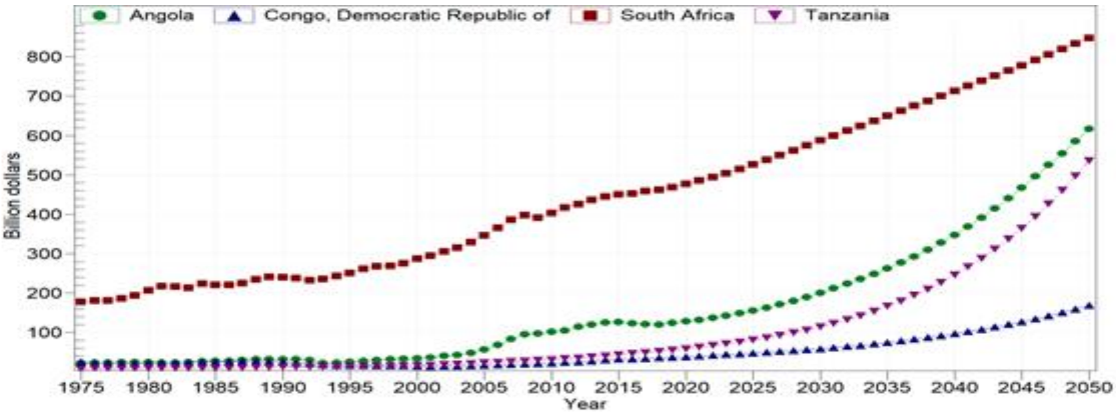
According to Dilolwa, this is the period in which a new logic crystallised in the economic field, with the establishment of a modern sector in the economy whose main function was the solvency of a demand located abroad.

In a logic of continuity, the "oil cycle" began in 1973, the year in which this commodity became the main export product. Independent Angola is therefore still intertwined with the "oil cycle". The economy is highly dependent on the oil sector, which accounts for around 33% of GDP, more than 65% of government revenue (average for 2012-2018) and more than 95% of exports.

Diamonds contribute a further 2.8% to exports. The rural economy is largely subsistence and the country imports a large proportion of its food.

Angola's GDP was estimated at US$121.2 billion in 2018, making it the 6th largest economy in Africa, but it ranks 15th in terms of average income. Among lower-middle-income countries, Angola is the fourth largest economy in Africa and the second largest in SADC after South Africa (although only the seventh largest in terms of average income in the SADC region). See figure 15a.

Chart 4: GDP, four largest SADC economies



Source: Institute for Security Studies, Report - The Current Path: Angola to 2050, 2019, page 25.

The decline in investment in the oil sector, observed between 2015 and 2017, continues to have an impact on production in the sector and has led to an economic recession since 2016. During the period in question, the variation was USD 15,829.5 in 2015 and reached USD 5,967.3 in 2017, as we will see later in the analysis of foreign direct investment in Angola during the period (2012 to 2018).

For some time, there have been negative real growth rates of around 2.6% in 2016, 0.1% in 2017 and 1.2% in 2018. For 2019, despite efforts in the non-oil sector, all forecasts point to a continued recession for Angola. The General State Budget for 2019, after its revision, estimated a real GDP growth rate of 0.3%, 2.5 pp lower than projected in the initial version of the State Budget, but the latest estimates pointed to a GDP contraction of 1.1%.

The non-oil sector, on the other hand, performed well, despite the significant influence of the oil sector on the non-oil sector. Non-oil GDP is estimated to grow by 0.6% by the end of 2019. Table 2 shows the growth trend of the different activities in the non-oil sector.

Table 2: Sectorial GDP Growth Rates (%)

Indicators	2017	2018	2019 Proj.
1. Agriculture	2,4	5,9	1,8
2. Fisheries and derivatives	2,4	2,2	-0,2
3. Mining of Diamonds, Metallic Minerals and Other Minerals	-0,6	0,8	17,9
4. Manufacturing	10,3	1,8	3,6
5. Construction	3,7	3,1	3,5
6. Energy	-3,0	30,0	10,7
7. Commercial services	-3,1	1,9	0,5
8. Other (Public Administrative Sector)	-22,1	0,0	-3,1

Source: *MEP*

The sectors of activity that make up non-oil GDP are expected to grow at a faster rate than the average growth rate of the sector, with the exception of "energy" and "trade services". Diamond mining, metallic minerals and other minerals were expected to perform best in 2019, with a growth rate of 17.9%, followed by energy with 10.7% and manufacturing with 3.2%.

The sectors of activity that make up non-oil GDP were expected to grow at a rate of higher than the average growth rate of the sector, with the exception of "Energy" and "Trade". Diamonds, metal and other mineral products were expected to perform best in 2019, with a growth rate of 17.9%, followed by energy with 10.7% and manufacturing with 3.2%.

Given the rapid population growth, economic growth forecasts for the coming years are not impressive. In April 2019, the IMF published its forecasts for Angola's GDP growth rates. According to the international organisation, growth would be 0.4% in 2019, 2.9% in 2020, 2.2% in 2021, 3% in 2022, 3.8% in 2023 and 3.9% in 2024. When it published its forecast in August 2019, the Economist Intelligence Unit predicted two more years of recession, with rates of -2.2% in 2019 and -1.9% in 2020. For 2021, it estimated it would be 2.5%, followed by 4.1% in 2022 and 5% in 2023, based on the conviction that the reforms introduced in the oil sector would attract more investment in exploration.

Angola is currently experiencing annual population growth of around 3.4%, which means that average incomes have actually been falling since 2014. At this rate, and with this economic performance, it will take many years for the country to return to the average income levels recorded between 2008 and 2015. The risks to the recovery of economic growth are exacerbated by the increase in poverty due to rising unemployment, low wages, a still large informal sector and an unchanged income redistribution model that has already shown itself to be neither effective nor efficient. GDP per capita remains low. More seriously, however, the annual increase in this figure has been declining year on year, suggesting that economic growth is not generating enough income to redistribute and improve the living conditions of the population.

A country's level of economic growth depends, among other things, on its ability to attract investment. Foreign direct investment in Angola has been growing in recent years, but still very slowly. In 2012, the value of this investment was USD 41.8 billion, and by the end of 2018 it had fallen by almost half to USD 23.7 billion, mainly in the oil sector, leading to a decline in production. Thus, from a peak of 1.78 million barrels per day between 2013 and 2017, it fell to 1,488,000 barrels per day in 2018, with a tendency to fall further in 2019 and 2020.

Table 3: Foreign Direct Investment in Angola (2012-2018)

FOREIGN DIRECT INVESTMENT							
Years	2012	2013	2014	2015	2016	2017	2018
Entry	14.853,7	14.345,9	16.543,2	16.176,4	11.062,3	6.208,1	7.650
Non-oil sector	486,4	227,5	155,3	346,9	282,1	240,9	647,8
Oil sector	14.367,3	14.118,4	16.387,9	15.829,5	10.780,2	5.967,3	7.002,2
Output	16.318,3	21.465,9	12.885,7	6.148,2	11.241,8	13.605,4	13.382,5
Non-oil sector	0,0	612,9	764,0	518,0	340,0	344,9	462,4
Oil sector	16.318,3	20.853,0	12.121,7	5.630,1	10.901,8	13.260,5	12.920,1
Liquid	-1.464,6	-7.120,0	3.657,5	10.028,2	-179,5	-7.397,3	-5.732,5
International Investment Position	41.810,6	34.690,6	25.478,6	32.311,6	29.184,1	29.436,3	23.703,8

Source: CEIC, Economic Report 2018, page 89.

The table above shows the sectoral breakdown of foreign direct investment in Angola and, as can be seen, the majority was allocated to the oil sector. Over the period under review, an average of 97% went to the oil sector and only 3% to the non-oil sector. Data from 2016 and 2017 show that of the amount allocated to the non-oil sector, approximately 86 % went to the diamond sector, with the remainder going to industry, construction, trade and transport. It should be noted that the sectors with the greatest potential to generate employment and income for people are those that have received the least FDI, such as agriculture and industry.

The stock of foreign direct investment (by Angolan residents) increased from USD 2.6 billion in 2012 to USD 5.1 billion. Measures need to be taken to reverse this situation and to encourage Angolan residents to invest in the country, instead of this investment potential "fleeing" to other countries.

To reverse this situation, it is recognised that the private sector must be the main generator of employment. The government remains committed to taking measures to improve the business environment and thus attract more foreign investment, but it is also strongly committed to training citizens, preparing them for the labour market and entrepreneurship. In 2019, the Action Plan for the Promotion of Employability (PAPE) was approved, which aims to train more than 250,000 young people in 3 years. The PAPE is based on micro-credits, entrepreneurship courses and vocational training and the distribution of professional kits.

To stimulate the private sector, the government has intensified the clearance of domestic arrears and will continue to support the diversification of the economy through the National Production Support Programme, export diversification and import substitution, credit and various economic stimuli. This programme will be implemented through the strengthening of the credit support programme and the incentives provided by the Angola National Bank (BNA) for credit for the production of basic goods.

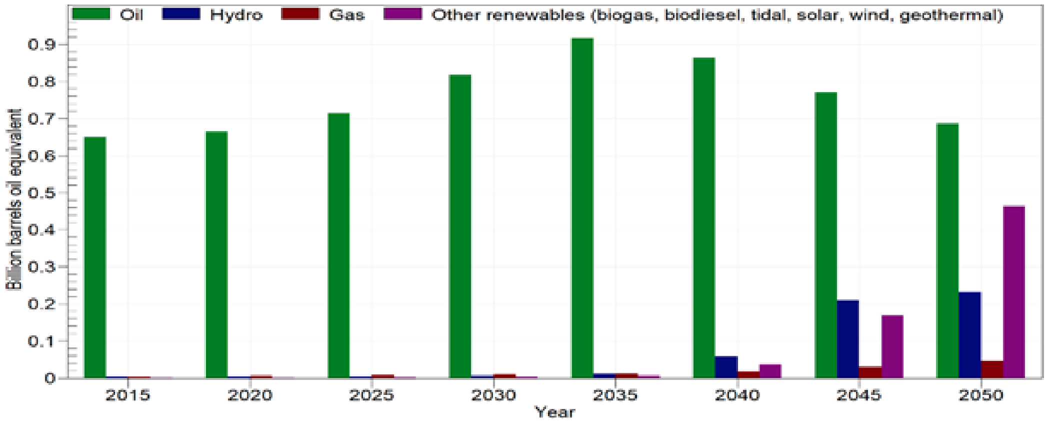
Oil and gas production - As one of Africa's two giant oil exporters, Angola relies heavily on its oil and gas resources (and to a lesser extent diamonds) for almost all of its foreign exchange. President João Lourenço has been restructuring the sector to better manage oil price volatility, attract new investment, and revitalise and boost the sector. In 2018, the president introduced taxes on gas and oil production and reforms to the licensing process.

Total oil production grew steadily between 2013 and 2017, peaking at 1.78 million barrels per day (b/d). In 2018, oil production fell to 1,488,000 b/d due to the depletion of some wells and, above all, a lack of investment. Production was expected to decline further in 2019 and 2020. According to OPEC rules, Angolan production has been limited to 1.67 million b/d since November 2016 due to the cartel's price control policy, and the reduction was expected to increase to 1,481 b/d.

Around 75% of oil production comes from offshore fields. As of 2018, Angola's proven crude oil reserves stood at 9.5 billion tonnes. Crude natural gas production totalled 413 billion cubic feet in 2016, of which about 60% was vented and flared, 20% was reinjected into oil fields to improve recovery, and 15% was commercialised.

According to the Energy Information Agency, Angola produced an estimated 0.653 billion barrels of oil equivalent (BBOE) in the IFs. In 2018, 0.004 BBOE each from hydropower and gas production and 0.001 BBOE from biodiesel, tidal, solar, wind and geothermal combined (see figure). Renewables are expected to increase dramatically around 2030, reaching more than 0.5 BBOE by mid-century.

Chart 5: Production by type, Angola



Source: Institute for Security Studies, Report - The Current Path: Angola to 2050, 2019.

Agriculture - As the third largest country in sub-Saharan Africa, with large areas of arable land, Angola's agricultural sector is still performing well below its potential and offers perhaps the greatest opportunity for sustainable development. The government estimates that the majority of Angolans (between 60% and 75% of the population) depend on agriculture for their livelihoods, while the World Bank gives a lower estimate of 45%.

According to the IFs, only about 17.2% of Angola's arable land is currently cultivated (15 million ha out of a total of 88.105 million ha). Furthermore, less than 1 million ha of land is equipped for irrigation and only about 11,600 ha is actually irrigated. It is therefore not surprising that Angola is heavily dependent on food imports.

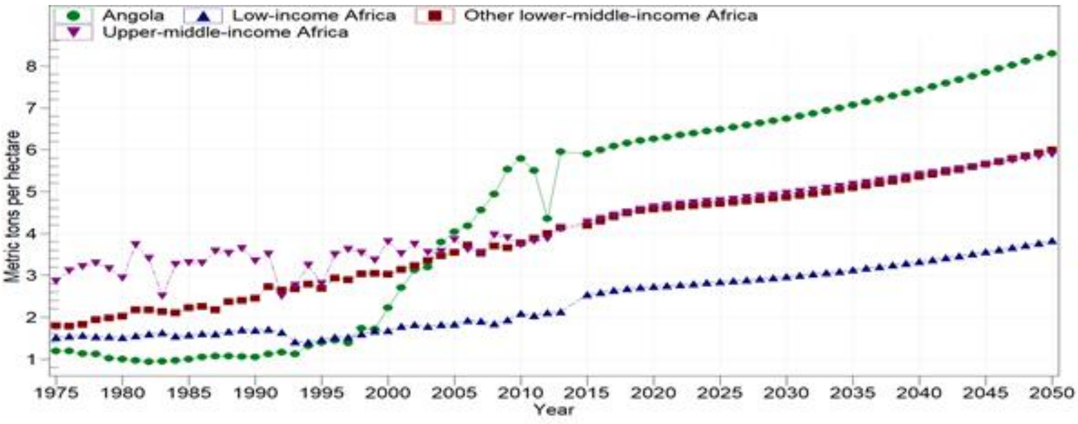
Table 4: Land use in Angola, %, 2018 and 2050

Year	Cultures	Pasture	Forests	Other uses	Urban	Total
2018	4,4	43,9	45,8	5,1	0,8	100,0
2050	4,6	48,5	40,5	4,3	2,1	100,0

Source: Institute for Security Studies, Report - The Current Path: Angola to 2050, 2019

According to the IFS, using data from the UN's Food and Agriculture Organisation, Angola's average yields increased by around five times between 1990 and 2010, which seems unlikely. It seems clear that the rapid growth of the sector was followed by a severe drought from 2012 to 2014, with particularly poor agricultural yields in 2012. These figures put average incomes in Angola well above the averages for Africa's low-income, upper-middle-income and lower-middle-income countries, which seems unlikely.

Chart 6: Agriculture Income



Source: Institute for Security Studies, Report - The Current Path: Angola to 2050, 2019

The growth rate for this sector, according to the national accounts, was 1.77% in 2016 and 1.41% in 2017. In 2018, for the first time, the sector recorded a recession of 2%, i.e. a negative growth rate. For 2019, the CEIC predicts stagnation or even continued recession. As for the sector's weight in GDP, the average between 2002 and 2017 is 4.5%, but if we look only at the years 2013 to 2017, its weight was 5.5%.

The analysis of the sector continues to be hampered by the quality of the information available, but there has been a significant improvement in the preparation, content and dissemination of the results report for the 2017-2018 agricultural year (RRAA), as well as in methodological aspects, in line with the progress made in previous years.

As mentioned previously, Angola's agriculture is based on family farming. This is represented by 2,846,743 family farms (EAF), a figure projected by MINAGRIF on the basis of the final results of the 2014 population and housing census. The number of business-type farms (EAE) reported in 2016 was 12,892, the same number reported in 2014. However, a more in-depth analysis is clearly needed, as small family farms account for about 90% of all cultivated land, while commercial farms account for the remaining 10%.

The government has focused on increasing agricultural production, especially cereals and vegetables, in order to reduce dependence on food imports and generate foreign exchange. However, there are many obstacles to the development of the sector, including climate-related pressures.

Manufacturing - Industrialisation is a process by which the value added of the economy is increased over time through the transformation of its natural resources. Economic growth is closely linked to the ability to generate domestic value added in conditions that create jobs, maximise efficiency and increase exports.

The manufacturing industry in Angola is still unable to take its rightful place in the Angolan economy, linking upstream with agriculture (fishing, forestry and logging), providing them with arguments to encourage production (expectations of its transformation and an increase in national added value) and improve the wage rate, and projecting downstream, producing goods and services to satisfy the growing demand from trade, construction, transport, agriculture and private consumption in general.

According to the government, various obstacles to increasing production, raising productivity and improving competitiveness have been identified. The various official programmes are full of such observations. While it is true that some of the constraints have been reduced, the most radical ones remain. The most important of these are the stable and competitively priced supply of basic electricity, gas and water services, access to finance loans, etc.

The contribution of the manufacturing sector to economic growth has been small and, since 2002, has been overtaken in absolute terms by the construction sector (not surprisingly, given the public investment effort to rebuild the upstream sector and its high import content).

1.5. DEVELOPMENT PRIORITIES

Strategy 2050 and PDN 2023-2017 **-** The Long-Term Development Strategy for Angola, also known as Angola 2050, is a multidimensional and sustainable response to the major challenges facing the country in 2050 and has the following global objectives:

- To promote human development and the well-being of Angolans, eradicate hunger and poverty, and improve the level of education and health of the population;
- To promote equitable and sustainable development, ensuring the efficient use of natural resources and the equitable distribution of national income, with macroeconomic stability and structural diversity;
- Ensure a high rate of economic development with macroeconomic stability and structural diversity.

Macroeconomic framework and diversification of the economy - The macroeconomic framework for the period 2023-2027 is characterised by a period of correction of the macroeconomic imbalances caused by the financial, economic and exchange rate crisis, by creating the necessary framework for restoring confidence, a necessary condition for the Angolan economy to resume its growth trajectory and the process of development on a diversified basis, ensuring the sustainability of the public and external accounts.

This framework was based on the diagnosis of the macroeconomic and social situation, which assessed the main factors influencing economic growth, such as inflation, the fiscal system and monetary and exchange rate policies, the balance of payments, the social sector and the medium-term plan. The diagnosis concluded that the Angolan economy had reached a state of "near stagflation" as a result of ineffective expansionary monetary and fiscal policies, a segmented foreign exchange market and a concentrated and inefficient banking system.

This diagnosis led to the ***Interim Plan***, which set out policies and actions to improve Angola's economic and social situation, and the **Macroeconomic Stabilisation Programme (PEM)**, which set out objectives and initiatives for exchange rate policy, government expenditure and revenue, debt, monetary policy, investment and diversification, and the financial sector.

It is also important to take into account the ***agreement signed between Angola and the International Monetary Fund*** (**IMF**) in December 2018. The agreement was for three years and was established under the Extended Fund Facility (EFF) in the amount of SDR 2,673 billion (approximately USD 3.7 billion, or 361% of Angola's quota) to support the country's economic reform programme and improve governance, reduce risks associated with public enterprises, address structural impediments to competitiveness, and expand access to finance. These are some of the key elements for accelerating private sector-led economic growth.

The programme, supported by the EFF agreement, should help Angola to restore external and fiscal sustainability and lay the foundations for sustainable, private sector-led economic diversification. The main pillars of the programme include fiscal consolidation to bring debt to safer levels, greater exchange rate flexibility to restore competitiveness, and a supportive monetary policy to reduce inflation. Other pillars include strengthening the banking system, improving the business environment, updating the CBC/FT legal framework and strengthening governance.

One of the conclusions of the review, according to the IMF's First Deputy Managing Director, is that "the Angolan authorities have demonstrated a strong commitment to the policies of the Fund-supported programme. However, a much weaker external environment, with increased volatility in international oil prices, has stalled reform efforts. The authorities have responded decisively by adopting a conservative supplementary budget for 2019" (David Lipton).

However, structural adjustment programmes, by focusing on macroeconomic stabilisation and fundamental economic reforms (liberalisation, privatisation, openness to the outside world, deregulation of markets), can in theory produce positive results in the short term. These programmes can be relevant instruments, particularly in the budgetary and monetary fields.

In order to speed up the process of diversifying the economy, the government has defined a prioritised set of products, based on these priority production sectors and clusters. Necessarily, in the current national context, the priority productions, rows and clusters are closely related to import substitution and the promotion and diversification of exports, as well as aiming to increase the tax collection base for the sustainability of public accounts.

In this context, the government has established the Programme to Support Production, Export Diversification and Import Substitution (PRODESI), an Executive programme aimed at accelerating, in a targeted and effective way, the diversification of national production and wealth generation in a series of specific products and sectors to be integrated into clusters with greater potential for value creation, exports and import substitution.

Another specific feature of PRODESI is that it emphasises a strategic alliance between the State and the private sector to achieve its objectives, ensuring that its coordination and implementation structure includes representatives of the business sector and those sectors of society linked to education and research aimed at productive activity.

Deconcentration, decentralisation and local authorities – the issue of deconcentration and decentralisation has been on the agenda in Angola practically since the declaration of independence. Because of its geographical size, the diversity of local realities and the impossibility of the central level to respond to all the problems, including those of the lower levels of state administration, Angola has made deconcentration, decentralisation and the establishment of local authorities a national priority. The current deconcentration and decentralisation strategy dates back to 2002, and since then much progress has been made in its preparation, although some of its objectives have yet to be achieved.

On the other hand, there have been profound changes in the Angolan context in recent years that have forced a rethink of this important strategy. General elections have been held, the constitution has been approved, the extension of state administration to the entire national territory has been consolidated, the census has been carried out and Luanda's administrative organisation has been reorganised.

To make de-concentration and decentralisation a reality, one of the measures to be taken is the gradual municipalisation of new sectors, learning from the experience of the health sector. There has been some progress recently, such as the experience of municipalising social action, but we need to make rapid progress with the municipalisation of agriculture and education, for example. However, in order to achieve results, we must not forget the immense need for trained staff at local government level, and it may be necessary to transfer staff from the provincial to the municipal level, and even from the central level.

1.6. POLICIES AND LEGISLATION

The Republic of Angola has developed policies and legislation relating to the environment and the rational use of natural resources. Some of this legislation relates to Angola's adherence to international treaties, such as the United Nations Framework Convention on Climate Change (UNFCCC), national policy on climate change and the establishment of climate-related institutions, as well as the adoption of laws and regulations for the protection of the environment and natural resources, with the aim of assuring a better quality of life for all Angolans.

Constitution of the Republic of Angola - 2010, of 27 January – The Constitution of the Republic of Angola establishes a series of guarantees for the defence and protection of the environment and natural resources. Article 21 establishes the "Fundamental Tasks of the State" and, in particular, paragraph (m) describes the fundamental task of the State as "promoting harmonious and sustainable development throughout the national territory, protecting the environment, natural resources (...)". In the "Title" on "Fundamental rights, freedoms and guarantees", Article 39 of the CRA defines the "right to the environment" as one of these fundamental rights.

In "Title III", Article 89 (h), the protection of the environment is mentioned as a fundamental principle of the economic, financial and fiscal organisation of Angola. Article 91 (Planning), paragraph 2 defines that "Planning.

Throughout the CRA, issues of environmental protection and natural resources are also mentioned as part of other issues, namely in articles 46 (freedom of residence, movement and emigration), 74 (right of popular action).

In addition to the existing constitutional guarantees, Angola has a structuring legal instrument in the form of the Basic Law on the Environment. Approved in 1998, Law 5/98 of 19 June, the "Primary Environmental Law", establishes the basic concepts and principles for the protection, conservation and preservation of the environment, the promotion of the quality of life and the rational use of natural resources.

Primary Environmental Law - Law 5/98 of 19 June – As its name suggests, this is the law that lays the foundations for the entire environmental legal system, the State's environmental policy and the forms and limits of the use of natural resources, defends the country's environmental heritage and guarantees the quality of life of all Angolans.

It also defines, in a global and concrete way, collective and individual responsibility for environmental and ecological crimes and violations.

It establishes the conditions for cooperation and collaboration with other environmental legislation.

Law 3/04, of 25 June, on Regional Planning and Urbanism – Legal instrument that establishes the regional planning and urbanism system and its political action through the implementation of the appropriate instruments.

Establishment and Statute of the Environmental Fund – Presidential Decree 9/11 of 7 January – The Fund is a body that finances research, education, studies and programmes for the enhancement of natural resources.

The legislator defined the objectives of the Environment Fund as the support of activities related to the management, promotion and conservation of the environment, the promotion of activities related to the management of the environment and the rehabilitation of degraded areas, the support of technical and scientific activities related to clean energy and sustainable development, and the support of the activities of environmental associations and other civil society organisations as partners in the management of the environment.

United Nations Framework Convention on Climate Change - Resolution 12/98 – Rectification of the accession of the Republic of Angola to the above-mentioned international convention outlines the policies and objectives to combat climate change at the global level.

United Nations Convention to Combat Desertification - Resolution 12/00 – The rectification of the accession of the Republic of Angola to the international convention establishes policies and measures to combat desertification at the global level.

United Nations Framework Convention on Climate Change - Kyoto Protocol - Resolution 14/07

The ratification of the accession of the Republic of Angola to the international convention outlines new policies, measures and objectives to be achieved in relation to climate change, taking into account new scientific knowledge and the evolution of climate and environmental problems.

Mining Code - Law 31/11 – Regulates all activities in the mining and extractive sector, including the establishment of obligations and good practices for the defence and conservation of the material, historical, cultural and environmental heritage.

National Strategy for implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol (2008 – 2012) – Coordinate the implementation of the Convention and the Kyoto Protocol by promoting adaptation and mitigation measures.

Angola Initial National Communication, 2010 – This document was developed to establish a national GHG inventory; to create the conditions for the implementation of appropriate measures to facilitate the adaptation to the adverse impacts of climate change and to mitigate emissions of GHGs consistent with the sustainable development objectives of Angola; to initiate processes of transfer of environmentally sound technologies, systematic observation and integration of climate change related issues into development plans and programs; and to evaluate the country's capacity to deal with external climate events.

National Adaptation Programme of Action (NAPA), 2011 – Inform the country's immediate needs of adaptation.

National Strategy on Climate Change (ENAC 2022-2035), Presidential Decree 216/22 - Strategic vision - Angola adapted to the impacts of climate change and with low carbon development that also contributes to the eradication of poverty.

National Climate and Environmental Observatory, Presidential Decree 8/22 - Coordinate climate research, compile environmental, social and economic data to include adaptation consideration into the national development strategies.

National Climate Policy Monitoring, Reporting and Verification System (MRV), Presidential Decree 8/22 - Inform the UNFCCC on the implementation of the Convention, regarding greenhouse gas emissions.

Nationally Determined Contribution (NDC) of Angola 2021 - This document outlines Angola's commitment to reducing emissions and adapting to climate change.

Angola Second National Communication, 2021 – This document aims to present a set of actions at national level within the framework of the various commitments assumed with the implementation of the United Nations Framework Convention on Climate Change. The document brings the second national inventory on greenhouse gases, the creation of conditions for the establishment of appropriate measures to facilitate adequate adaptation and mitigation of climate change, the process of environmental technology transfer, research and systematic observation and the integration of climate change issues into sectoral plans and programs, as well as carrying out capacity assessment to deal with extreme climate events.

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CHAPTER 2 – GREENHOUSE GAS (GHG) INVENTORY

NOVEMBER 2024

With Support From:

UN environment programme

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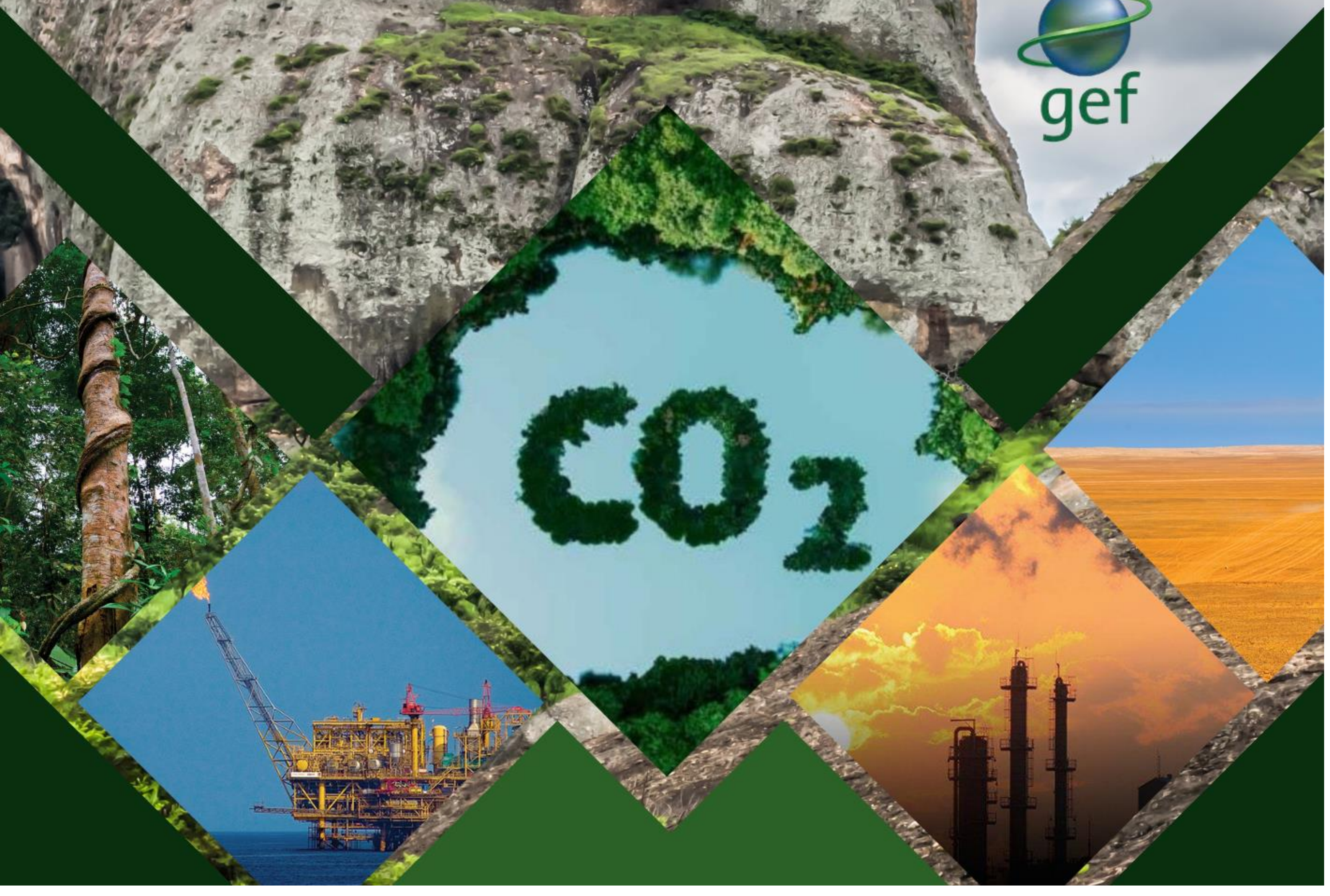


CHAPTER 2 – GREENHOUSE GAS (GHG) INVENTORY

By acceding to the Convention, the country has taken on a number of obligations related to its implementation at national level. The purpose of this greenhouse gas inventory and its quality control is to ensure the quality of the information contained in the various inventories to be submitted to the United Nations Framework Convention on Climate Change.

The greenhouse gas inventory is carried out using software developed by the Intergovernmental Panel on Climate Change (IPCC). For this inventory, some spreadsheets used in Brazil, which are easy to use and have a small margin of error, were also used for the following five main thematic areas.

- Energy - Fuels, energy, transport and biomass;
- Industry - Existing industries and their main characteristics;
- Agriculture - Agricultural activity in the country and its main characteristics;
- Deforestation - Deforestation rates and coal production;
- Waste - Production and treatment of waste and the sanitation system;

Some components of the inventory were developed using a set of spreadsheets from the 2006 software, as these appeared to be the simplest and most appropriate for the existing institutional capacity. The 2006 GHG Inventory Guidelines were developed using an evolutionary approach to ensure continuity and to incorporate the experience gained from the 1996 Guidelines and new scientific information to make the process more comprehensive, integrative and capable of providing more approximate answers in terms of estimating emissions. Angola used the 1996 guidelines for its first inventory and opted for the 2006 guidelines for its second inventory, even though they are more difficult to use, because they provide more reliable results.

The greenhouse gas emissions estimated in the first inventory for the years 2000 and 2005 are reflected in the energy, land use change and forestry, agriculture, waste and industry sectors. It should be noted that the Conference of the Parties adopted 1994 as the base year for the First National Communication and 2000 as the base year for the Second National Communication.

For the inventory years, emissions were calculated in gigagrams of carbon dioxide equivalent, which is obtained by multiplying CO2 emissions by 1, CH4 emissions by 21 and N2 O emissions by 310, according to the global warming potential (GWP) established by the IPCC and adopted for the inventories. For the inventory, CO2 emissions in 2000 were 13,243 Gg, methane 15,953.39 Gg CO2 Gg and nitrous oxide 13,944.01 Gg CO2 eq. In 2005, CO2, CH4 and N2 O emissions were 29,261, 20,158.32 and 14,098.37 Gg CO2 Gg respectively. For 2020, the emissions of CO2, CH4 and N2 O were 190,501.22, 18,226.389 and 2,800.278 Gg CO2 eq.

Table 5: Greenhouse Gas Emissions from land use change and forestry

Total with LULUCF	CO2	CH4	N2O	Total	CO2	Land Use, Land Use Change and Forestry
Year	thousand tonnes CO2 eq				%	thousand tonnes CO2 eq
2005	45 966,604	8 698,434	1 405,844	56 070,883	81,98%	40 062,605
2006	46 783,347	8 435,315	1 366,358	56 585,021	82,68%	39 907,397
2007	47 811,803	8 840,216	1 469,092	58 121,110	82,26%	40 153,357
2008	50 496,175	6 899,419	1 287,518	58 683,112	86,05%	40 065,406
2009	51 687,901	9 983,113	1 662,230	63 333,244	81,61%	40 233,866
2010	52 907,198	7 623,838	1 353,546	61 884,581	85,49%	40 189,886
2011	82 867,171	8 344,765	1 437,237	92 649,173	89,44%	70 552,361
2012	85 968,610	8 945,308	1 538,210	96 452,129	89,13%	70 392,155
2013	88 370,118	10 906,890	1 753,230	101 030,238	87,47%	70 417,382
2014	90 015,648	8 824,184	1 594,648	100 434,481	89,63%	70 432,479
2015	88 801,782	9 542,122	1 711,869	100 055,773	88,75%	70 360,442
2016	90 581,605	8 821,502	1 603,209	101 006,315	89,68%	70 430,964
2017	82 973,608	8 608,853	1 569,478	93 151,938	89,07%	70 406,684
2018	83 624,948	14 585,581	2 338,529	100 549,058	83,17%	70 409,590
2019	200 412,126	18 736,610	2 880,878	222 029,614	90,26%	186 281,537
2020	190 501,221	18 226,389	2 800,278	211 527,889	90,06%	178 173,775

Source: Author's calculations

The responsibility for carrying out the GHG inventory is coordinated by the Ministry of Environment, through the National Department for Climate Change and Sustainable Development, with the active and direct participation of the Ministry of Natural Resources, Oil and Gas, Ministry of Agriculture and Forestry, Ministry of Industry and Trade, Ministry of Transport, Ministry of Planning, Ministry of Finance, Agostinho Neto University, independent consultants and some private sector companies.

This third inventory differs from the previous one only in the Energy and Land Use Change and Forestry components, where emissions have been updated and calculated for the period 2005/2020.The Land Use Change and Forestry component uses satellite images, which improves the accuracy of the information and gives a smaller margin of error.

The Second National Greenhouse Gas Inventory added a process of data and information collection that did not cover all the dimensions of the previous inventory, which made it possible to include emissions in the third inventory.

Outlook - The outlook for the preparation of greenhouse gas inventories continues to be one of continuous improvement, focusing on the technical and institutional training of the people and institutions involved, improving the quality and sustainability of the whole process, which includes archiving the information in solid databases. The aim is also to contribute to the country's commitment to climate change; to help consolidate a national inventory system; to enrol and integrate Angolan technicians into the Convention's expert system and enable Angolan technicians to carry out inventory reviews in other countries; to improve effectiveness and efficiency and facilitate the preparation of subsequent inventories; to increase the availability of information to the public on greenhouse gas emissions, their sources and sectors.

Another objective is to obtain detailed emissions in order to facilitate the most appropriate mitigation measures, as well as to move towards greenhouse gas emission neutrality by maintaining the continuity of the inventories, which can serve as a basis for decision-making in relation to Angola's commitments to implement the Convention and the Paris Agreement.

Finally, the objective is to develop an action plan to progressively overcome the shortcomings in the GHG inventory. This action plan should include the strengthening of technical and institutional capacities, the improvement of data collection and the institutional integration of the different sectors with specific responsibilities through the implementation of the Monitoring, Reporting and Verification Mechanism (MRV).

The main sources of greenhouse gas (GHG) emissions in Angola are related to the country's economic activities, in accordance with national circumstances and the set of exercises carried out as part of medium and long-term planning. Specifically, they are: the combustion of fossil fuels for energy production and transport; fugitive emissions associated with oil production; certain agricultural practices; deforestation and uncontrolled burning; and the use of firewood and coal for domestic energy. Non-industrial emission sources are related to land-use processes, land-use change and forestry, and contribute to deforestation and, in some cases, increased desertification. In addition to the sources mentioned above, agriculture (livestock, rice cultivation and fertiliser use) must also be considered. Waste production completes the picture of national greenhouse gas emissions.

2.1. INSTITUTIONAL ARRANGEMENTS FOR THE COMPILATION OF GREENHOUSE GAS INVENTORIES

In Angola, the Ministry of Environment (MINAMB) is the national organisation responsible for preparing the national greenhouse gas (GHG) inventory. It is also responsible for the official approval and endorsement of the inventory and its subsequent submission to the UNFCCC, in partnership with other institutions that make up the Interministerial Commission for Climate Change and Biodiversity. MINAMB acts as the national coordinating body, working with various public and private institutions to plan, implement and compile the inventory. Each institution has been assigned a specific task to carry out the inventory. As the national coordinating body, MINAMB works with the institutions contributing to the inventory to manage the data on activities and emission factors, as well as to compile estimates of emissions from the sectors, quality control, quality assurance and improvement planning, and to prepare reports.

The process of institutionalising the MRV mechanism is underway, which should result in the necessary arrangements to facilitate the data collection process and thus the compilation of the inventory.

Table 6: Functional entities for the GHG inventory and their roles/responsibilities

Inventory task	Responsible institution	Specific task
Approval and submission of the final report	Ministry of Environment and Interministerial Commission for Climate Change and Biodiversity	Review and approve the national inventory; Direct the institutions and compile the national inventory.
Implement	National Department for Climate Change and Sustainable Development	Guide and supervise all the work involved in drawing up the Inventory
National coordinator	National Department for Climate Change and Sustainable Development	Co-ordinate the day-to-day actions related to the drawing up of the inventory
Inventory Compiler	National Department for Climate Change and Sustainable Development	Key sectors whose activities contribute to greenhouse gas emissions, collecting information and compiling it
QA/QC	Coordinating the project and international Advisors	Review the report produced and make recommendations for its improvement
Documentation archive	National Department for Climate Change and Sustainable Development	Collecting all relevant documentation and storing it
Data providers	All the institutions that provide information to facilitate the drawing up of the inventory	Other institutions and private Advisors with experience and complementary information for carrying out the inventory

Energy sector – For the period under consideration, gas emissions from the energy sector have been calculated using the bottom-up (or sectoral) approach, which calculates greenhouse gas emissions based on final energy consumption. The sectoral approach makes it possible to identify where and how emissions occur. The calculation of emissions using this approach takes into account the different approaches.

CO2 emissions depend on the carbon content of fuels and can be estimated at a high level of aggregation and with reasonable accuracy. For non-CO2 gases, the IPCC default values have been used. In addition to CO2, the gases CH4 and N2O were also estimated.

On the other hand, the top-down methodology ("reference approach") was also used, which estimates CO2 emissions by considering only the energy supply, without sufficient detail on how this energy is consumed. In this approach, estimates are based on a balance sheet that includes domestic production of primary fuels, imports and exports of primary and secondary fuels, international bunkers and the internal variation in stocks of these fuels. In the case of secondary products, domestic production is not taken into account as they come from the primary source already mentioned. The use of this approach is considered good practice because it allows the results obtained to be compared with the bottom-up results and possible problems to be identified (IPCC, 2006).

The ideal top-down approach should use energy balance data. However, there is no energy balance for Angola and this should be a priority for the future development of energy sector planning.

This report quantifies the greenhouse gas emissions of the Angolan oil sector from 2005 to 2020.

Table 7: Categories included in Angola's GHG inventory - Energy Sector 2005-2020

SECTOR	CATEGORY	SUBCATEGORY	DESCRIPTION
Energy	Fuel utilisation activities	Energy Industries	Electricity generation.
		Transport	Civil aviation, rail, sea and road transport.
	Fugitive emissions from fuels	Oil and Natural Gas	Natural Gas
			Oil
			Flaring
			Venting
	Emissions from wood and charcoal consumption	Residential	Cooking
	Emissions from charcoal plants	Energy Industries	Charcoal Production

2.1.1. Sectors not included in the inventory

The following table shows the sectors not included in the energy inventory and the reasons for their exclusion.

Table 8: Category not included in the Energy Inventory

SECTOR	CATEGORY	SUB-CATEGORY	ACTIVITY	JUSTIFICATION FOR EXCLUSION
	Fugitive emissions from fuels	Solid fuels	Spontaneous combustion and burning of coal waste	No coal production in Angola
			Coal mining and handling - Underground mines	
			Coal mining and handling - Surface mines	
		Other emissions from energy production		
	Transport and storage of carbon dioxide	Injection and storage	Storage	There is no such activity
			Injection	
		Transport	Ships	
			Others	

2.1.2. Emission factors used in this inventory

As Angola does not yet have specific (national) emission factors, the default emission factors from the 2006 IPCC Guidelines were used to compile the GHG inventory (energy sector), as shown in the table below:

Table 9: Default emission factors for stationary combustion in the energy sector (kg of greenhouse gases per TJ of energy on a net calorific value basis)

Liquid Fuels	Energy consumption	CO2	CH4	N2O
	Conversion factor	Emission Factor	Emission Factor	Emission Factor
	(TJ/Gg)	(kg CO2/TJ)	(kg CH4/TJ)	(kg N2O /TJ)
Petrol	44,3	69.300,0	3,0	0,60
Aviation Kerosene	44,1	71.500,0	3,0	0,6
Other Kerosenes	43,8	71.900,0	3,0	0,6
Diesel	43,0	74.100,0	3,0	0,6
Fuel Oil	40,4	77.400,0	3,0	0,6
LPG	47,3	63.100,0	1,0	0,1
Lubricants	40,2	73.300,0	3,0	0,6
Other Oil Products	40,2	73.300,0	3,0	0,6
Firewood	15,6	112.000	30	4
Charcoal	29,5	112.000	200	4

Below are the values for the conversion factor and the default carbon content (from the IPCC guidelines) for the calculation of total carbon.

Table 10: Net calorific value (NCV) and carbon content by default

TYPES OF FUEL			Conversion factor	Carbon content
			(TJ/Gg)	(t C/TJ)
Liquid Fuels	Primary Fuels	Oil	42,3	20,00
		Liquid Natural Gas	44,2	17,50
	Secondary Fuels	Petrol	44,3	18,90
		Aviation Kerosene	44,1	19,50
		Other Kerosenes	43,8	19,60
		Diesel	43,0	20,20
		Fuel Oil	40,4	21,10
		LPG	47,3	17,20
		Nafta	44,5	20,00
		Bitumen	0,00	22,00
		Lubricants	40,2	20,00
		Other oils	40,2	20,00

For the analysis of the Inventory Reference Approach, the oxidised carbon fraction values were used by default due to the lack of national data. It should be noted that the net calorific value (NCV) values used to calculate domestic consumption (Abas Fuel Combustion) are the same as those used to calculate total carbon (Abas Reference Approach).

Table 11: Default Values for the oxidized carbon fraction

TYPES OF FUEL			Fraction of Oxidised Carbon
Liquid Fuels	Primary Fuels	Oil	1,00
		Liquid Natural Gas	0,99
	Secondary Fuels	Petrol	0,99
		Aviation Kerosene	0,99
		Other Kerosenes	0,99
		Diesel	0,99
		Fuel Oil	0,99
		LPG	0,99
		Nafta	0,99
		Lubricants	1,00
		Other oils	1,00

For the final calculation of the CO2 equivalent, the default global warming potential from the IPCC 4th Assessment Report for a 100-year horizon was used, as shown in the table below:

Table 12: Global warming potential (100-year horizon)

Nomenclature	Chemical Formula	Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	$N\ O_2$	310

Source: United Nations Framework Convention on Climate Change

The methodology used to calculate emissions in the Fuel Utilisation Activities category used data on the sales of delivered fuels, as shown in the table below.

The consumption data used in the different indicators represent the figures for imports and domestic production. From 2005 to 2015, the country increased its peak emissions, driven by economic development and increased domestic consumption of fossil fuels.

Table 13: Description of liquid fuel consumption indicators

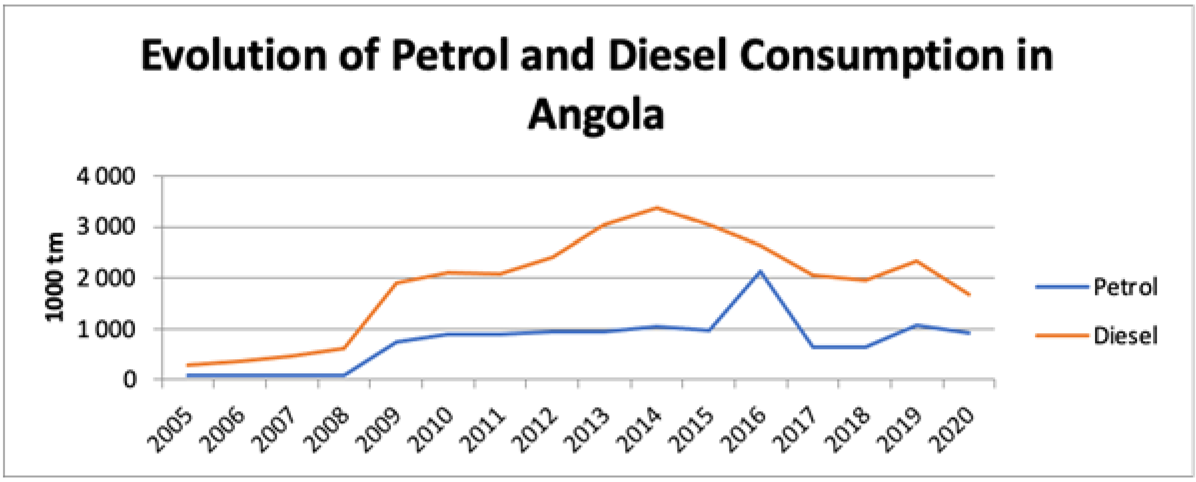
Liquid Fuels	Description
Petrol	Domestic petrol consumption data was taken into account (value of retail petrol sales at Sonangol Distribuidora, Sonagalp, Pumangol and artisanal fishing filling stations).
Aviation Kerosene	Fuel sales data for national airlines (Gas Aviation, Jet B and Jet A1) were taken into account.
Other Kerosenes	Kerosene sales data was taken into account (value of retail sales of illuminating petroleum for domestic use at the petrol stations of Sonangol Distribuidora, Sonagalp and Pumangol).
Diesel	Diesel consumption data was taken into account (value of retail sales at Sonangol Distribuidora, Sonagalp Pumangol petrol stations), sales of diesel for industrial and artisanal fishing and diesel for national bunker.

Fuel Oil	Data from Sonangol Distribuidora's sales of Fuel Oil 1500, Fuel Oil Heavy and Fuel Oil for the national bunker were taken into account.
Nafta	National Naphtha production data from the Luanda Refinery was taken into account.
LPG	Data on internal sales of gas for domestic use by the companies Sonagás, Saigás and Gástem and others were taken into account.
Other oils	Ordoil and Cut Back production data from the Luanda Refinery were taken into account.

Table 14: Evolution of consumption of the main oil derivates in Angola between 2005 and 2020. Consumption 1000 tm

Oil Products	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petrol	91,9	88,9	90,7	99,3	751,9	894,3	889	947,9	944,4	1047,3	963,1	2133,4	643,8	645,6	1081,4	909,5
Aviation paraffin	231,2	237	116,8	309	214,3	217,2	207,9	258,2	241,6	285,1	243,1	136	146,8	112,1	88,6	28,4
Other Kerosene	880,7	1057,5	1241,8	1654,4	63,1	51,3	51,3	89,5	68,2	35,6	40,3	54,8	36,5	24,8	33,7	39,1
Diesel	297,8	359,6	458,9	627,3	1905,5	2096,8	2090,2	2397,3	3045,3	3378,9	3041,6	2634,8	2064,6	1949,4	2325,3	1684,8
LPG	95,5	103,6	119,1	140,3	164,6	185	164,6	234,5	264,3	302,4	330,2	311,6	320,9	351,7	368,8	403
Fuel Oil	104,1	96,3	106,6	98,9	101,8	51,4	24,2	35,6	73,7	120,8	62,8	185,9	115,9	467,3	347,1	569,1

Chart 7: Evolution of petrol and diesel consumption in Angola, 2005-2020



Between 2005 and 2020, there was a significant increase in national hydrocarbon production, with growth of around 54%. The production of associated natural gas (natural gas in solution with crude oil) stood out significantly.

According to the national oil legislation in force in Angola, the flaring of natural gas in oil installations is prohibited (Law 10/04), but the flaring of natural gas volumes is authorised annually by the regulatory body (MIREMPET) so that the company can operate safely and carry out scheduled maintenance on gas compression equipment without affecting the annual production plan.

On the other hand, for operational safety reasons, the pilot flame in the flare must be maintained in order to minimise operational risks in crude oil processing plants. The data on oil and gas flaring refer to the combustion of natural gas during the hydrocarbon production process between 2015 and 2020.

These emissions will need to be reviewed because at time of closing the inventory there where no information that a good part of fuel that supposed to be utilised in Angola, was utilized illegally in countries like DRC, Zambia and Namibia and so far there are no calculations about quantities. The emissions in this chapter tent to be much lower.

Table 15: Description of the fugitive emissions indicator

Fugitive emissions	Description
Flaring	Data from natural gas flaring during the hydrocarbon extraction process was taken into account

Table 16a	2005	2006	2007	2008	2009	2010	2011
Flaring	0,357	0,471	0,585	0,699	0,813	0,926	1,040
Charcoal	33,192	28,430	28,540	2,165	37,150	2,165	9,567

Table 16b	2012	2013	2014	2015	2016	2017	2018	2019	2020
Flaring	1,154	1,268	1,382	1,496	1,292	0,811	0,577	0,545	0,506
Charcoal	17,476	43,392	3,852	8,877	0,039	0,056	85,321	270,340	259,560

The indicator data used to calculate the Reference Approach tabs refer to national production, imports and exports of oil and imports, exports and international bunkers of oil products in the years in question.

Table 16: Description of the indicators in the Reference Approach tables

Liquid Fuels	Description			
	Production	Import	Export	International bunkers
Oil	National crude oil production data was taken into account.	-	National crude oil export data was taken into account.	-
Natural Gas Liquids	National LNG production data was taken into account.	-	National LNG production data was taken into account.	-
Petrol		National petrol import data was taken into account.	National petrol export data was taken into account.	-
Aviation paraffin		National import data for aviation fuel was taken into account.	National export data for aviation fuel was taken into account.	Aviation fuel sales/supply data were taken into account for aircraft that travelled outside Angolan airspace.
Diesel		National diesel import data was taken into account.	National diesel export data was taken into account.	Diesel sales/supply data for vessels travelling outside Angolan waters were taken into account
Fuel Oil		National fuel oil import data was taken into account.	National fuel oil export data was taken into account.	Data on sales/supply of fuel oil to vessels travelling outside Angolan waters was taken into account.
LPG		National import data for propane and butane were taken into account.	National export data for propane, butane and condensates were taken into account.	-
Nafta		-	National Naphtha export data was taken into account.	-
Asphalt	Asphalt national consumption data was taken into account to determine excluded carbon	National import data for asphalt was taken into account.	-	-
Lubricants	National consumption data for lubricants was used to determine the carbon excluded.	Data on national imports of lubricants was taken into account .	-	-

The production of liquefied natural gas (LNG) by Angola LNG began in 2013, with the first export in the same year. It was suspended in 2014 and resumed in 2016. In 2017, gas flaring was reduced with the commissioning of 95% of the capacity of the Angola LNG plant, which increased the use of gas and led to a reduction in flaring. As for the other unfilled indicators, they are neither produced nor consumed in Angola. Other indicators in the different tables are not part of the oil sector.

To calculate the emissions, the emission factors were multiplied by the quantities of fuels used (formula) - IPCC 2006 default emission factors for each fuel.

GHG emissions, fuel = fuel consumption fuel x GHG emission factor, fuel

Where:

- *GHG emissions per fuel (t GHG)*
- *Amount of fuel used (TJ)*
- *Default GHG emission factor by fuel type (t GHG/TJ).*

In the period 2005-2015, there has been a significant increase in imports of oil derivatives, with a focus on imports of petrol and diesel to meet demand. Petrol and diesel are the fuels used for road transport in Angola. Diesel is also used mainly for electricity generation. An adequate and reliable supply of transport and electricity services is essential for economic development. On the other hand, households in both urban and rural areas use a variety of petroleum products, such as kerosene, which is used for lighting and cooking, and liquefied petroleum gas (LPG), which is mainly used for cooking. On the other hand, diesel is used in agriculture to power tractors and irrigation pumps.

The National Electricity Production Company (PRODEL) currently has 6,300 megawatts of electricity available. Up to 2016, PRODEL's production totalled 2,300 MW, but investments in the Laúca (Malange), Cambambe (Kwanza Norte), Luachimo (Lunda Norte) and Matala (Huila) dams and the Soyo combined cycle power plant have helped to increase PRODEL's production. Work has also been carried out on the interconnection of the North and Centre systems, allowing energy to reach the provinces of Bié, Benguela and Huambo, thus reducing the overuse of thermal power stations.

2.2. FUELWOOD CONSUMPTION AND CHARCOAL PRODUCTION AND CONSUMPTION

According to IPCC (2006), biomass is a special case where CO2 emissions from biomass fuels are estimated and reported in the LULUCF sector as part of the LULUCF methodology. In the tables of the report, emissions from the combustion of biofuels are reported as information items, but are not included in the sectoral or national totals to avoid double counting. In the emission factor tables presented in this chapter, the standard CO emission factors2 are presented to allow the user to estimate these information items. For biomass, only the part combusted for energy purposes should be estimated for inclusion in the energy sector information. However, CH4 and N2 O emissions are estimated and included in the sectoral and national totals as their effect is additional to the stock changes estimated in the LULUCF sector.

For fuelwood, activity data are available from the IEA or FAO (Food and Agriculture Organisation of the United Nations). These data come from national sources and the inventory compilers can gain a better understanding of the national situation by contacting the national statistical offices and organisations involved.

Therefore, this chapter estimates the emissions associated with the energy use of fuelwood and charcoal, as well as the emissions process associated with the production of charcoal as an energy input.

The following data and tables have been provided by the Angolan Forestry Development Institute (IDF) and show the annual data, planned and actual use in the reporting year. For the purposes of calculating emissions, the figure used has been taken as "realised".

It should be noted that, according to the table, the largest amount of charcoal produced in 2018 compared to each year in the period came from illegal activities.

Table 17: Charcoal production from 2005 to 2018

Charcoal production in (tonnes)from 2005 to 2018			
Product	Year	Planned	Realised
Charcoal	2005	183.486	360.543
Charcoal	2006	191.308	308.816
Charcoal	2007	0	310.020
Charcoal	2008	250.000	23.522
Charcoal	2009	300.000	403.537
Charcoal	2010	0	23.522
Charcoal	2011	33.000	103.918
Charcoal	2012	33.000	189.828
Charcoal	2013	0	471.348
Charcoal	2014	0	41.839
Charcoal	2015	0	96.430
Charcoal	2016	0	423
Charcoal	2017	0	605
Charcoal	2018	0	926.800

According to Table 17, the highest production of fuelwood was in 2005 compared to the other years from 2005 to 2018. However, the largest planned quantity was in 2008.

Table 18: Firewood production from 2005 to 2018

Firwood production in (steres) from 2005 to 2018			
Product	Year	Planned	Realised
Firewood	2005	39.432	58.208
Firewood	2006	18.099	31.770
Firewood	2007	0	35.400
Firewood	2008	40.400	15.681
Firewood	2009	20.400	29.402
Firewood	2010	0	15.681
Firewood	2011	20.400	24.573
Firewood	2012	23.000	8.175
Firewood	2013	0	5.101
Firewood	2014	0	7.261
Firewood	2015	0	35
Firewood	2016	0	13.579
Firewood	2017	0	70
Firewood	2018	0	1.210

2.3. CHARCOAL PRODUCTION EMISSIONS

To calculate the methane emissions from charcoal production, the following formula was used, which has already been used by the Angolan project called "Sustainable Charcoal Promotion Project in Angola, Through a Value Chain Approach" - GEF/UPDN. This is the same formula used for small projects in developing countries approved by the CDM Executive Board.

- $M = 139.13 - 313.80 * Y$

Where:

- *M = Methane emission factor (kg CH_4 /tonne of charcoal)*
- *Y = Gravimetric carbonisation yield (tonne of charcoal/tonne of wood, dry basis).*

The charcoal production yield is defined as the ratio between the weight of charcoal produced and the weight of firewood used for this purpose. This yield depends on a number of factors, which are summarised below:

Species. Each species has certain characteristics of its wood which are related to its calorific value and therefore to its charcoal production yield. These characteristics are:

- Chemical and physical structure and composition
- Apparent density
- Ashes
- Used wood (part of the tree used to make charcoal)
- Moisture

Moisture in the harvested wood. Treated wood has a higher charcoal yield than untreated wood. Therefore, charcoal production yields are generally higher in the dry season than in the wet season.

The type of kiln used. In general, the traditional kilns used in Angola have a very low yield (10-15% according to different authors).

The charcoal production yield is estimated using the following formula:

$$Yield\ (\%) = \frac{Weight\ of\ Charcoal\ produced\ (Kg)}{Weight\ of\ wood\ used\ (Kg)} \times 100$$

Based on this equation, in order to determine the charcoal production yield at the national level, it is necessary to have the data on the charcoal produced at the national level (dividend) and the data on the wood used to realise this production (divisor), expressed in kg.

The data provided for 2018 in the Partial Report on Angola's Forestry Sector (2015-2018) (IDF, 2020) are data on the production (weight) of charcoal produced, namely 926,800 tonnes (926,800,000 kg), to which must be added the 366,350 tonnes (336,350,000 kg) corresponding to illegal seizures, giving a total value of 1,263,150 tonnes (1,263,150,000 kg). So, we have the dividend of the equation. However, there is no data on the wood used to produce this charcoal (the divisor of the equation).

Satellite images can be used to obtain data on deforestation in hectares (ha), but in order to 'convert' this data from hectares of deforestation to weight, which is only approximate, we need data from the following sources:

Structure of each type of forest: density of each type of forest, since this density is a key piece of information to know roughly how many trees there are per hectare of forest (each type of forest is different);

Species type: because each species has an average volume (assuming that all trees felled are adult and more or less similar, which is not the case);

Specific density of the species, since the conversion of volume into weight depends very much on the specific density of each species.

On this basis, it is impossible to estimate yields from official data. The yield of coal used in traditional kilns in Angola is no more than 10-15%. Therefore, a higher charcoal production in 2018 does not mean a higher charcoal production yield in that year, but rather a higher deforestation. The problem is that the deforestation associated with that year is not much greater than the rest of the years, at least not to make a very big difference compared to the other years.

2.4. ENERGY BIOMASS GREENHOUSE GAS EMISSIONS

The IPCC default factors and the gravimetric yield of charcoal production observed in Angola were used to calculate GHG emissions from charcoal production and energy biomass consumption (fuelwood and charcoal).

It should be noted that CO2 emissions are already accounted for in the Land Use, Land Use Change and Forestry section and are therefore only reported as information on total emissions from energy biomass. For accounting purposes in the total energy sector, only CH4 and N2O emissions are calculate.

Table 19: Emission from charcoal production

	Charcoal Production	Equivalent dry wood	Conversion factor	Firewood consumption	Charcoal consumption	CO Emission Factor$_2$	CO_2	CH Emission Factor$_4$	CH emissions$_4$	CH emissions$_4$	Total Emissions
Year	Tonnes	Tonnes	TJ/Gg	TJ	TJ	(kg CO_2 /TJ)	(Gg CO)$_2$	(kg CH_4 /t Coal)	(Gg CH)$_4$	(Gg CO2e)	(Gg CO2e)
2005	360.543	2.403.620	15,6	374.964,72	106.360,19	112000	30.083,71	92,06	33,19	697,02	30.780,73
2006	308.816	2.058.773	15,6	321.168,64	91.100,72	112000	25.767,61	92,06	28,43	597,02	26.364,63
2007	310.020	2.066.800	15,6	322.420,80	91.455,90	112000	25.868,07	92,06	28,54	599,35	26.467,42
2008	23.522	156.813	15,6	24.462,88	6.938,99	112000	1.962,68	92,06	2,17	45,47	2.008,15
2009	403.537	2.690.247	15,6	419.678,48	119.043,42	112000	33.671,13	92,06	37,15	780,14	34.451,27
2010	23.522	156.813	15,6	24.462,88	6.938,99	112000	1.962,68	92,06	2,17	45,47	2.008,15
2011	103.918	692.787	15,6	108.074,72	30.655,81	112000	8.670,92	92,06	9,57	200,90	8.871,82
2012	189.828	1.265.520	15,6	197.421,12	55.999,26	112000	15.839,25	92,06	17,48	366,99	16.206,24
2013	471.348	3.142.320	15,6	490.201,92	139.047,66	112000	39.329,28	92,06	43,39	911,24	40.240,52
2014	41.839	278.927	15,6	43.512,56	12.342,51	112000	3.491,05	92,06	3,85	80,89	3.571,93
2015	96.430	642.867	15,6	100.287,20	28.446,85	112000	8.046,12	92,06	8,88	186,42	8.232,54
2016	423	2.820	15,6	439,92	124,79	112000	35,30	92,06	0,04	0,82	36,11
2017	605	4.033	15,6	629,20	178,48	112000	50,48	92,06	0,06	1,17	51,65
2018	926.800	6.178.667	15,6	963.872,00	273.406,00	112000	77.332,19	92,06	85,32	1.791,75	79.123,94

The data for 2019 and 2020 was not qualitative due to some limitations in its processing and treatment, but taking into account the dynamics and growth of the population and the country, it shows an upward trend in charcoal consumption, the following table shows methane and nitrous oxide emissions:

The following table shows methane and nitrous oxide emissions for fuelwood consumption.

Table 20: Greenhouse gas emissions by firewood consumption

Year	Meters 3	Meters / t green wood	t green wood	t green wood / t dry wood	t dry wood	TJ/Gg	TJ
2005	58.208	0,34	19.791	0,80	15.833	15,6	246,99
2006	31.770	0,34	10.802	0,80	8.641	15,6	134,81
2007	35.400	0,34	12.036	0,80	9.629	15,6	150,21
2008	15.681	0,34	5.332	0,80	4.265	15,6	66,54
2009	29.402	0,34	9.997	0,80	7.997	15,6	124,76
2010	15.681	0,34	5.332	0,80	4.265	15,6	66,54
2011	24.573	0,34	8.355	0,80	6.684	15,6	104,27
2012	8.175	0,34	2.780	0,80	2.224	15,6	34,69
2013	5.101	0,34	1.734	0,80	1.387	15,6	21,64
2014	7.261	0,34	2.469	0,80	1.975	15,6	30,81
2015	35	0,34	12	0,80	10	15,6	0,15
2016	13.579	0,34	4.617	0,80	3.693	15,6	57,62
2017	70	0,34	24	0,80	19	15,6	0,30
2018	1.210	0,34	411	0,80	329	15,6	5,13

Table 21: GHG Emission

	CO Emission Factor$_2$	CO_2	CH Emission Factor$_4$	CH emissions$_4$	N Emission Factor O_2	Emissions N O_2	CH emissions$_4$	Emissions N O_2	Total Emissions
Year	(kg CO_2 /TJ)	(Gg CO)$_2$	(kg CH_4 /TJ)	(Gg CH)$_4$	(kg N_2 O /TJ)	(Gg N_2 O)	(Gg CO2e)	(Gg CO2e)	(Gg CO2e)
2005	112000	27,66	300	0,074	4	0,0010	1,556	0,31	29,52
2006	112000	15,10	300	0,040	4	0,0005	0,849	0,17	16,11
2007	112000	16,82	300	0,045	4	0,0006	0,946	0,19	17,96
2008	112000	7,45	300	0,020	4	0,0003	0,419	0,08	7,95
2009	112000	13,97	300	0,037	4	0,0005	0,786	0,15	14,91
2010	112000	7,45	300	0,020	4	0,0003	0,419	0,08	7,95
2011	112000	11,68	300	0,031	4	0,0004	0,657	0,13	12,46
2012	112000	3,89	300	0,010	4	0,0001	0,219	0,04	4,15
2013	112000	2,42	300	0,006	4	0,0001	0,136	0,03	2,59
2014	112000	3,45	300	0,009	4	0,0001	0,194	0,04	3,68
2015	112000	0,02	300	0,000	4	0,0000	0,001	0,00	0,02
2016	112000	6,45	300	0,017	4	0,0002	0,363	0,07	6,89
2017	112000	0,03	300	0,000	4	0,0000	0,002	0,00	0,04
2018	112000	0,58	300	0,002	4	0,0000	0,032	0,01	0,61

Emissions are included in the Land Use, Land Use Change and Forests section and are therefore only reported as information on the total emissions from biomass energy use. Only CH4 and N2 O emissions are included in the energy sector total.

Table 22: Total emission

Year	Total					Total			Total			
	Firewood					Charcoal			Biomass			
	CO_2 Emissions	CH_4 Emissions	N O_2 Emissions	Total Emissions	CO_2 Emissions	CH_4 Emissions	N O_2 Emissions	Total Emissions	CO_2 Emissions	CH_4 Emissions	N O_2 Emissions	Total Emissions
	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)	(Gg CO_2 e)
2005	30.111,37	1,56	0,31	30.113,23	11.912,34	1.143,74	131,89	13.187,96	42.023,71	1.145,29	132,19	43.301,20
2006	25.782,71	0,85	0,17	25.783,72	10.203,28	979,64	112,96	11.295,89	35.985,99	980,49	113,13	37.079,61
2007	25.884,89	0,95	0,19	25.886,02	10.243,06	983,46	113,41	11.339,93	36.127,95	984,41	113,59	37.225,95
2008	1.970,13	0,42	0,08	1.970,63	777,17	74,62	8,60	860,39	2.747,29	75,04	8,69	2.831,02
2009	33.685,10	0,79	0,15	33.686,04	13.332,86	1.280,12	147,61	14.760,60	47.017,96	1.280,91	147,77	48.446,64
2010	1.970,13	0,42	0,08	1.970,63	777,17	74,62	8,60	860,39	2.747,29	75,04	8,69	2.831,02
2011	8.682,60	0,66	0,13	8.683,38	3.433,45	329,65	38,01	3.801,12	12.116,05	330,31	38,14	12.484,50
2012	15.843,13	0,22	0,04	15.843,39	6.271,92	602,18	69,44	6.943,54	22.115,05	602,40	69,48	22.786,93
2013	39.331,70	0,14	0,03	39.331,86	15.573,34	1.495,24	172,42	17.241,00	54.905,04	1.495,37	172,45	56.572,86
2014	3.494,50	0,19	0,04	3.494,73	1.382,36	132,72	15,30	1.530,39	4.876,86	132,92	15,34	5.025,12
2015	8.046,14	0,00	0,00	8.046,14	3.186,05	305,90	35,27	3.527,22	11.232,18	305,90	35,27	11.573,36
2016	41,75	0,36	0,07	42,18	13,98	1,34	0,15	15,47	55,72	1,70	0,23	57,66
2017	50,51	0,00	0,00	50,52	19,99	1,92	0,22	22,13	70,50	1,92	0,22	72,65
2018	77.332,77	0,03	0,01	77.332,81	30.621,47	2.940,05	339,02	33.900,55	107.954,24	2.940,08	339,03	111.233,35
	Note: CO2 emissions are only informative because they are included in Land use, Land use change and Forests.											

2.4.1. Energy Sector GHG Emissions in Angola

For the energy sector, the results were CO2 (carbon dioxide), CH4 (methane) and N2 O (nitrous oxide), with CO2 emissions dominating throughout the period from 2005 to 2018.

Emissions from the energy sector in Angola increased by 103.66% between 2005 and 2018. CO2 emissions account for about 99% of all energy sector GHG emissions over the entire period.

Table 23: GHG Emission in Energy

Year	CO2	CH4	N2O	Total Emissions	% CO2 in Total
2005	5 929,402	2 302,596	406,892	8 638,891	68,64%
2006	6 878,800	1 976,022	375,744	9 230,566	74,52%
2007	7 667,500	1 986,688	382,566	10 036,754	76,39%
2008	10 362,100	172,453	183,628	10 718,181	96,68%
2009	11 397,100	2 587,452	470,225	14 454,777	78,85%
2010	12 505,100	178,959	197,251	12 881,310	97,08%
2011	12 479,800	691,732	261,782	13 433,315	92,90%
2012	14 348,300	1 239,438	329,399	15 917,137	90,14%
2013	16 678,000	3 029,623	547,408	20 255,030	82,34%
2014	18 539,100	307,753	241,842	19 088,695	97,12%
2015	17 176,678	655,074	283,867	18 115,620	94,82%
2016	19 176,101	44,601	204,169	19 424,871	98,72%
2017	11 783,372	29,184	171,003	11 983,559	98,33%
2018	12 083,017	5 900,977	836,391	18 820,386	64,20%
2019	13 794,723	9 338,938	1 113,515	24 247,176	56,89%
2020	11 874,375	8 964,948	1 065,339	21 904,662	54,21%

Source: Authors' calculations. Includes fugitive emissions from oil extraction.

The following figures show emissions by gas for the period 2005 to 2018 and illustrate the dominance of CO2 emissions in the energy sector.

Chart 8: Greenhouse Gas Emissions 2005

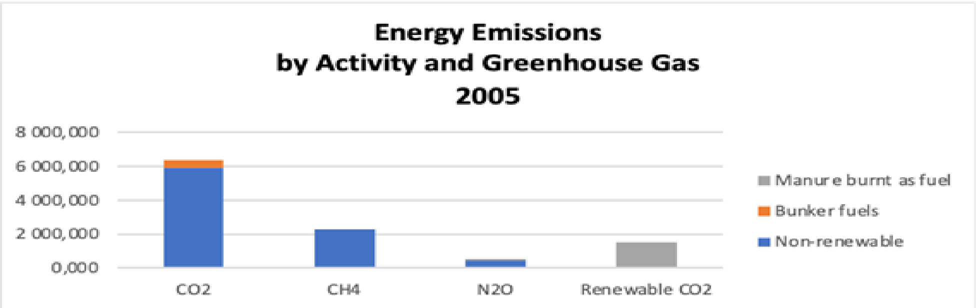
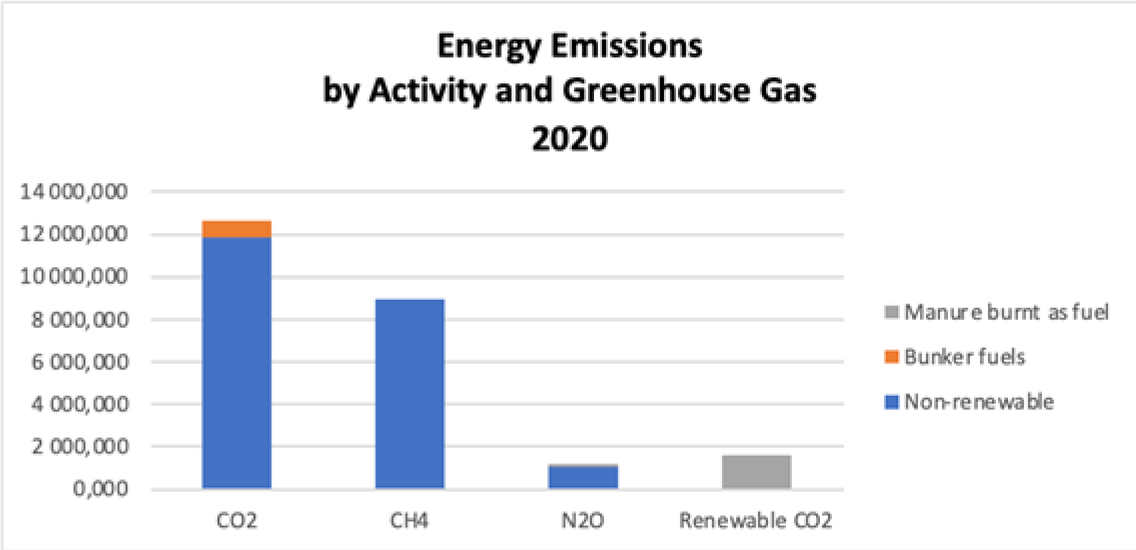


Chart 9: Emissions by GHG in 2020



Source: Author's calculations.

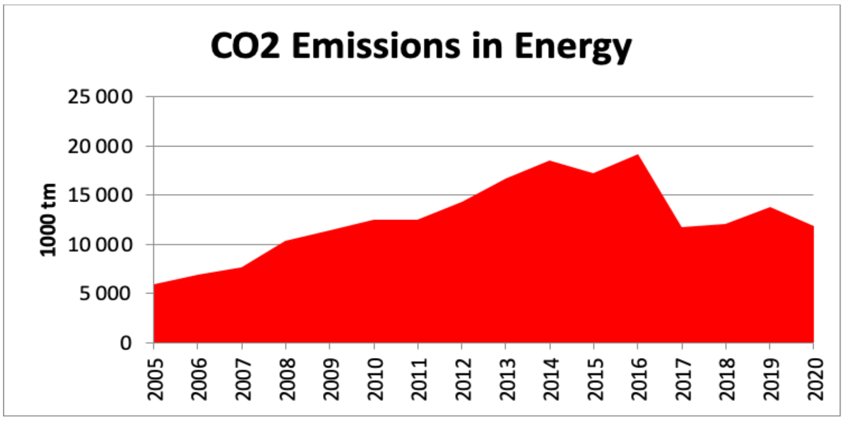
2.4.2. GHG emissions

The following figures show emissions by gas in CO2 equivalent for the period 2005 to 2018 and illustrate the predominance of CO2 emissions in the energy sector.

Emissions from renewable fuels and emissions from bunker fuels (exports) related to international flights are not included in the inventory, in accordance with the guidelines of the United Nations Convention on Climate Change (UNFCCC).

Emissions from biomass (fuelwood and charcoal) are calculated in the Land Use, Land Use Change and Forests sector and reported in the Energy sector for information purposes only.

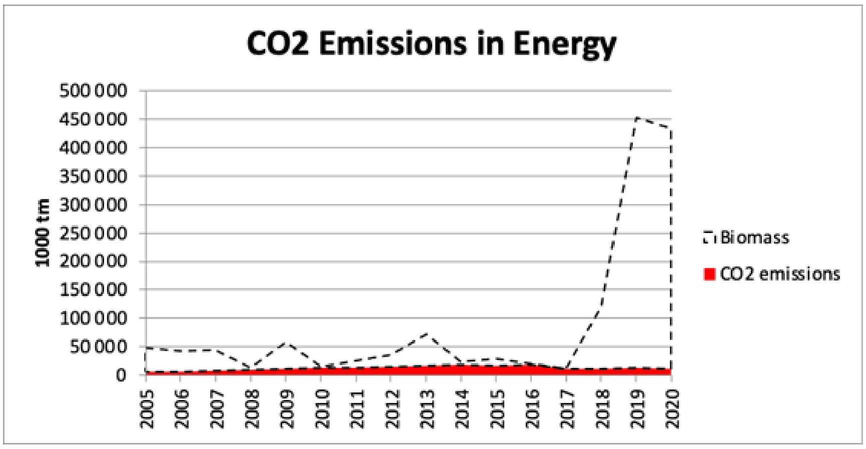
Chart 10: CO2 emissions in the period 2005 - 2020



Source: Author's calculations. Includes fugitive emissions from oil extraction.

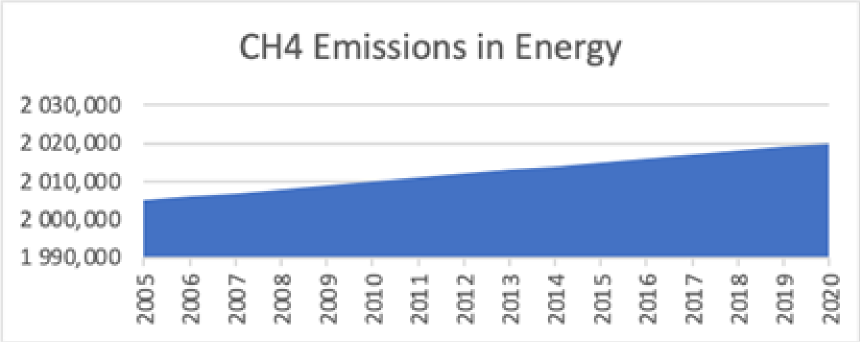
In the figure below, biomass emissions are shown as dashed lines as they are not calculated in this sector.

Chart 11: CO2 Emissions



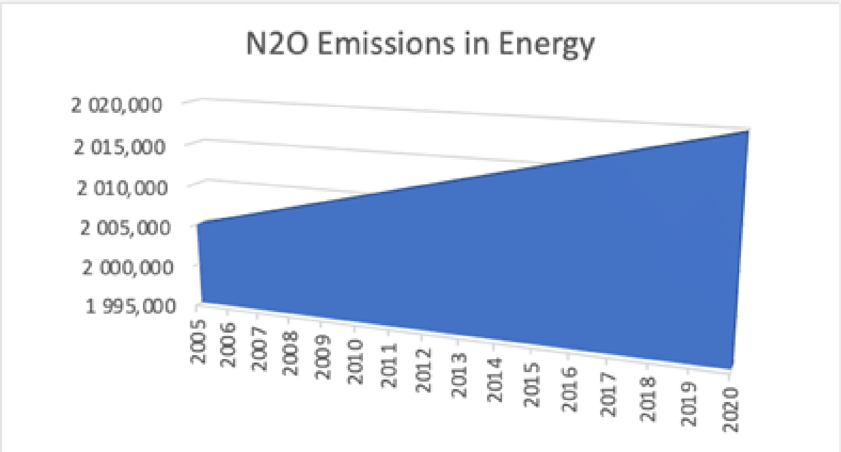
Source: Author's calculations.

Chart 12: CH4 Emissions 2005 - 2020



Source: Author's calculations. Includes biomass and fugitive emissions from oil production.

Chart 13: N2O emissions in the period 2005-2020



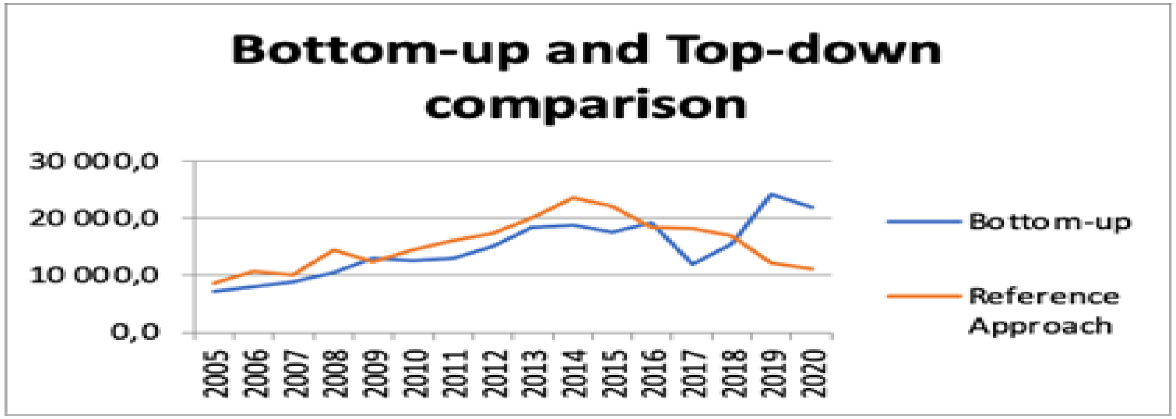
Source: Author's calculations.

The CO2 emissions from domestic consumption and the CO2 emissions from the reference method (apparent consumption) are compared below to illustrate the amount of carbon available in the country in a given year:

Table 24: Comparison of Bottom-up and Top-down Methods

	2005													2018	2019	2020
CO2	81,95%												CO2	78,39%	56,89%	54,21%
CH4	16,00%												CH4	19,21%	38,52%	40,93%
N2O	2,05%												N2O	2,40%	4,59%	4,86%
Total	100,0%												Total	100,0%	100,0%	100,0%
Bottom-up																
													Gg			
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
CO2	5929,402	6878,800	7667,500	10362,100	11397,100	12505,100	12479,800	14348,300	16678,000	18539,100	17176,101	19176,101	11783,372	12794,017	13794,723	11874,375
CH4	1157,304	995,528	1002,278	97,416	1306,542	103,922	361,420	637,036	1534,248	174,835	349,172	42,897	27,263	2960,894	9338,938	8964,948
N2O	148,511	132,524	134,849	36,768	179,885	41,428	71,757	110,913	68,285	68,285	85,772	52,795	31,305	369,558	1113,515	1065,339
Total	7235,217	8006,852	8804,626	10496,284	12883,527	12650,450	12912,977	15096,249	18433,601	18782,219	17611,623	19271,792	11841,940	15413,470	24247,176	21904,662
Reference Approach																
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
	8554,579	10 757	10 100	14 495	12 426	14 428	16 015	17 385	19 949	23 632	22 153	18 448	18 146	16881,241	12138,876	11192,710
		,857	,326	,295	,253	,481	,750	,251	,607	,308	,418	,969	,481			
		CO2 Equivalent											Gg			
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Bottom–up	7235,2	8006,9	8804,6	10496,3	12883,5	12650,5	12913,0	15096,2	18433,6	18782,2	17611,6	19271,8	11841,9	15413,5	24247,2	21904,7
Reference Approach	8554,6	10757,9	10100,3	14495,3	12426,3	14428,5	16015,7	17385,3	19949,6	23632,4	22153,4	18449,0	18449,0	16881,2	12138,9	11192,7

Chart 14: Emissions by bottom-up and top-down methods: period 2005-2020



Source: Author's calculations.

Emissions by Fuel

All emissions from the energy sector in Angola come from the use of fuels. The emission results show a predominance of emissions from gasoline in the period 2005 to 2020.

The largest reduction in fuel consumption was in other kerosene, with a reduction of 97.18%, followed by aviation kerosene, with a reduction of 51.57%.

Table below:

Table 25: Evolution of emissions from oil products. Gg t CO2e

Gg CO2 equivalent emissions																
Oil Products	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Petrol	282,36	273,11	278,71	305,21	2316,70	2754,22	2738,12	2922,03	2911,23	3227,54	2968,63	6572,95	1983,58	1989,18	3298,62	2 774,27
Aviation Paraffin	732,71	751,03	371,82	978,34	679,63	688,53	659,23	817,83	765,53	902,84	770,23	430,42	464,44	354,85	270,26	86,63
Other Kerosene	2782,12	3341,92	3923,26	5227,12	199,01	161,71	161,71	282,53	215,63	112,42	127,42	172,96	115,42	78,57	102,80	119,27
Diesel	952,80	1149,85	1466,66	2006,68	6092,35	6702,27	6681,17	7663,61	9736,19	10802,40	9724,49	8423,42	6600,70	6232,17	7 092,91	5139,18
LPG	285,25	309,36	355,81	419,16	491,82	552,57	491,82	700,47	789,48	903,33	986,03	930,40	958,20	1050,36	1 124,96	1229,28
Fuel Oil	326,71	302,03	334,34	310,03	319,23	161,22	76,17	111,59	231,33	378,95	197,09	583,43	363,52	1465,71	1 058,77	1735,94
Total	5361,95	6127,30	6730,60	9246,54	10098,74	11020,52	10808,22	12498,07	14649,39	16327,47	14773,88	17113,57	10485,85	11170,83	12948,31	11084,56
Flaring	595,78	785,93	976,02	1166,02	1356,11	1546,21	1736,30	1926,30	2116,39	2306,49	2496,56	2156,29	1353,95	963,52	909,00	844,54
Charcoal	697,02	597,02	599,35	45,47	780,14	45,47	200,90	366,99	911,24	80,89	186,42	0,82	1,17	1791,75	5 677,15	5450,76
Firewood	1,86	1,02	1,13	0,50	0,94	0,50	0,79	0,26	0,16	0,23	0,00	0,43	0,00	0,04	0,12	0,12
Charcoal	578,60	495,59	497,52	37,75	647,60	37,75	166,77	304,64	756,42	67,14	154,75	0,68	0,97	1487,33	4 712,60	4524,68
Bottom-up	7235,217	8006,852	8804,626	10496,284	12883,527	12650,450	12912,977	15096,249	18433,601	18782,219	17611,623	19271,792	11841,940	15413,470	24247,176	21904,662

Source: Authors calculation

2.5. INDUSTRIAL PROCESSES AND PRODUCT USES

Despite significant progress in macroeconomic stability and structural reforms, Angola continues to suffer from the effects of falling oil prices and production levels, with gross domestic product (GDP) estimated to contract by around 1.2% in 2018, according to the World Bank. The oil sector accounts for a third of GDP and more than 90% of exports.

Angola's industrial sector accounts for around 8% of the country's gross domestic product, which is estimated at around US$100 billion in 2019. The country's main industries are related to oilseeds, cereals, meat, cotton and tobacco. The production of sugar, beer, cement, wood and oil refining are also noteworthy. In the same sector, the tyre, fertiliser, cellulose, glass and steel industries stand out. The industrial park is powered by five hydroelectric plants, which have an energy potential greater than their consumption.

The industrial sector is responsible for some of the CO emissions2 from burning fossil fuels. For example, cement production. The emissions from this activity are covered in the energy sector.

However, there are other sources of greenhouse gas emissions from the industrial sector. The two tables below present three relevant sub-sectors identified in this inventory, as well as the categories of IPPU sector sources that were excluded from Angola's inventory and the respective justifications for the exclusion.

Table 26: Categories included in the GHG inventory - IPPU Sector 2005 - 2018

SECTOR	SUB-SECTOR	CATEGORY	DESCRIPTION
Industrial processes and product use	Mineral Industry	Cement production	Cement production.
		Lime production	Production of Dolomitic Limestone and Virgin Lime.
		Glass production	Glass production
		Ceramic production	Brick and tile production.
	Metal Industry	Production of Iron and Steel Alloys	Production of Iron and Steel Alloys

Source: Author's calculations

2.5.1. CO2 emissions from cement production

Cement is essentially a mixture of clinker and gypsum. Clinker is the main constituent of Portland cement. Gypsum (or plaster) ($CaSO_4\ 2H_2O$) is added in quantities generally less than 3% of the mass of the clinker and has the function of extending the setting time (time for the cement to begin to set). Without this addition, the setting time of the cement would be only a few minutes, making the product unusable. For this reason, gypsum is a mandatory addition and has been present since the first types of Portland cement. In the clinker production process, lime (CaO) is obtained from the calcination of limestone (CACO3), a process that generates CO2 emissions. Therefore, CO2 emissions in the cement industry are estimated from clinker production and not necessarily from cement production. The table below shows the evolution of cement production in Angola from 2005 to 2018.

For this inventory, the production of the plants was taken into account: Nova Cimangola I and II, Bom Jesus cement plant (CIF), which started operations in November 2011. In this case, emissions were counted for 2012. The Kwanza Sul cement plant started operations in 2013, Secil Lobito and Cimafort Benguela.

In cement production, emissions occur during the clinker production process. The emission estimates are based on the content of limestone oxide produced by burning $CaCO_3$ (limestone) according to the following equation:

$$CaCO_3 + \text{heating} \dashrightarrow CaO + CO_2$$

Approximately 90% of the cement produced in Angola is blended with other compounds, as the clinker content in cement (67%) is lower than the world average. The IPCC standard for clinker content in cement is 98%.

CO_2 emissions occur during clinker production, not cement production. Emissions estimates are based on clinker production, taking into account its calcium oxide content. The IPCC default value of 0.52 tCO_2 /t clinker was used.

2.5.2. Glass production

The glass production process also produces CO_2. Angola has only one glass industry, Vidrul, located in the municipality of Cacuaco, Luanda province. This industry produces bottles, jars and glass containers for packaging, brewing and soft drinks.

2.5.3. Lime production

In this sector, emissions from quicklime and dolomitic lime (used to correct agricultural soils) were estimated.

The production processes for quicklime and hydrated lime are calcined in a kiln. This kiln is fired with wood and has a capacity of 18 to 25 tonnes per firing.

Hydrated lime is made from fresh lime obtained by calcining limestone in a kiln, a process that emits CO_2. After cooling, water is added, which in turn causes an exothermic reaction that absorbs CO_2 and, after cooling, produces hydrated lime. In this process the net emission is zero.

The estimated emissions are based on the types of lime mentioned above, which occurred between 2012 and 2018. It should be noted that the data analysis covers the years mentioned below because the factory, Calcareous from Huila LDA, was established in 2011.

There are other industries in the country, such as Biaconstroe, which uses lime as a raw material for the production of cement glue and gypsum. It should also be noted that much of the lime used by these industries is imported.

In the tables below, the production figures fluctuate and ultimately affect the CO_2 emission factors. According to the Calcareous from Huila factory, this fluctuation is due to the lack of equipment and electricity supply, and also because lime production is very sensitive to market downturns.

2.5.4. Production of ceramics

The red ceramics industry in Angola includes the production of bricks and tiles. The most important production is red coloured perforated bricks.

The ceramics production process also generates CO_2 emissions. The industrial units are located in the country's 18 provinces, many of which are paralysed for various reasons.

Emissions associated with the ceramic process result from the calcination of carbonates in the clay and the addition of additives. Similar to the production of cement and lime, the carbonates are heated to high temperatures in a kiln, producing oxides and CO_2. Most ceramic products are made from one or more different types of clay. The raw materials are collected and finely ground in successive grinding operations. The ground particles are then fired in a kiln to produce a powder (which can be liquefied). Additives are then added and the ceramic is shaped or moulded and 'worked' to smooth the edges and achieve the desired characteristics of the ceramic.

CO_2 emissions result from the calcination of raw materials (mainly clay, limestone and dolomite) and the use of limestone as a flux. To calculate the CO_2 emissions from the production of ceramic products, the weight of carbonate in the limestone used to make bricks and tiles was estimated.

The variety of chemical and mineralogical compositions of the clay raw materials used in the brick and tile industry in different European countries shows that, for Greece, the dolomite carbonate content ranges from 0.5 to 31% of the clay.

The emission factor presented by the IPCC is 0.47732 t CO_2/t dolomite carbonate. The factor of 0.2 t CO_2/t ceramics used in this inventory implies a dolomite carbonate content of 42% in the clay used to make ceramics, which is higher than in Greece. Using the maximum value for Greece and the IPCC emission factor for dolomite carbonate, the emission factor for brick and tile ceramics would conservatively be 0.15 t CO_2/t ceramics.

2.5.5. Production of iron-alloys

Ferro-alloys consist of iron mixed with one or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten. These alloys can be used to deoxidise and modify the physical properties of steel. Ferro-alloy plants produce concentrated compounds that are taken to the steelworks to be incorporated into the various steel alloys. The production of ferroalloys involves the reduction of metals, which can result in CO_2

In this process, ore is melted together with coke and slag at high temperatures. During the smelting of ferroalloys, carbon absorbs oxygen from the metal oxides to form CO_2 in the reduction reaction that takes place. The following data were obtained from the industrial units: Siderurgia Nacional, Fabrimetal, Delta Stel, Best-Angola, ZW, (SU), LDA, Karam industry in the province of Luanda and ADA, Lda. in Bengo.

2.5.6. Emissions from industrial processes and product use

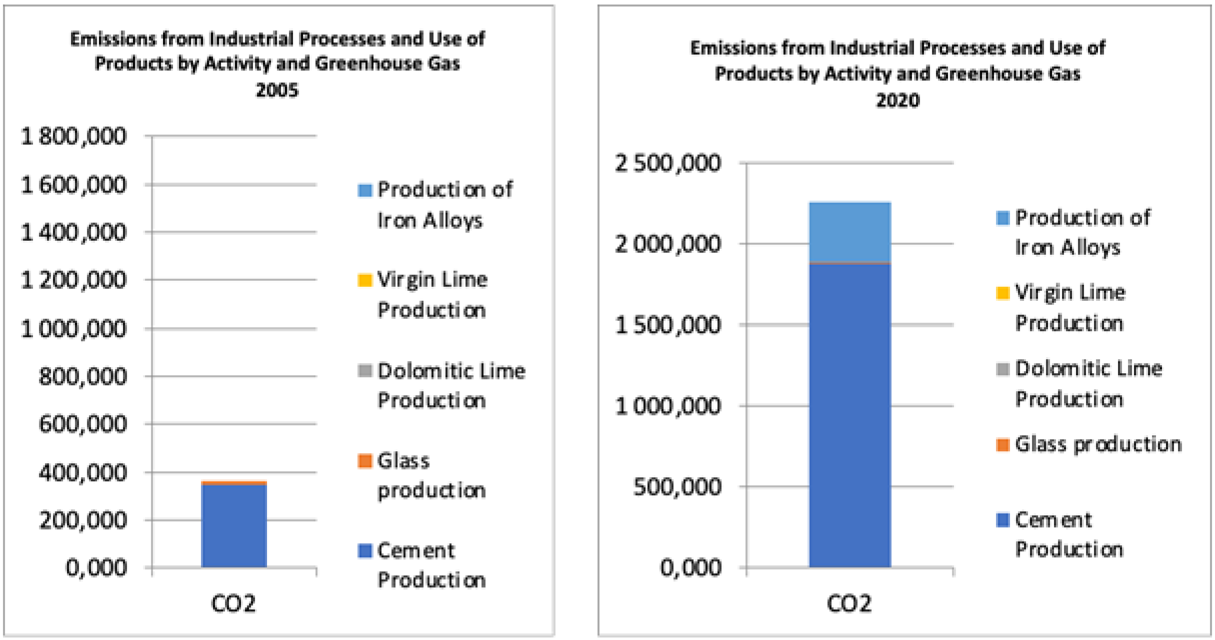
The following table shows the emissions results for each greenhouse gas in each year of the inventory, as well as the total value of emissions in each year.

The calculation of emissions for the IPPU sector resulted in the emission of gases, with CO2 being the only gas inventoried in the industrial sectors between 2005 and 2020. Emissions of the gases CH4 (methane), N2 O (nitrous oxide), HFCs (hydrofluorocarbons) and PFCs (perfluorocarbons) were not inventoried.

The results of emissions by IPPU sector category show a predominance of emissions from the cement production category (mineral industry subsector).

Emissions from cement production accounted for more than 95% of the sector's annual emissions between 2005 and 2014. From that year onwards, the main emissions from the ferro-alloys industry reduced the share of cement emissions in the total IPPU sector, but it still remains above 74.5% until 2020.

Chart 15: GHG Emissions from Industrial Processes and Product Use



Source: Author's calculations

The figures show the representativeness of each category analysed, with the cement production category (shown in blue) having the highest representativeness of emissions over the entire period from 2005 to 2020, reaching a maximum in 2013.

2.6. AGRICULTURE, FORESTRY AND LAND USE SECTOR (AFOLU)

In the agricultural sector, the main greenhouse gases of interest are CO2, N2 O and CH4. Agriculture includes all emissions related to enteric fermentation, manure handling, rice cultivation, agricultural waste burning, agricultural soils and liming.

Table 27: Categories included in Angola's 2010/2020 GHG inventory

SECTOR	CATEGORY	SUBCATEGORY	DESCRIPTION
AGRICULTURE	Aggregate sources and sources of non-CO_2 gases on earth	Liming	Applying lime to agricultural soil
		Rice cultivation	CH emissions$_4$ from rice production in general (Irrigated and Upland/sequel).
		N_2 O emissions from soil management	Includes direct and indirect emissions of N_2 O in managed soils. E.g. fertiliser application. Organic fertilisers (from agricultural and animal waste), which have not been inventoried, and inorganic fertilisers, which are fertilisers obtained from mineral extraction or oil refining), synthetic fertilisers (compound fertilisers (NPK, ammonium sulphate and urea), simple fertilisers (sulphate, carbonate and chloride), limestone (used to correct the soil). [5]
	Flock	Enteric fermentation	CH emissions$_4$ from enteric fermentation in cattle, sheep, goats, horses, donkeys, pigs and poultry.
		Handling animal manure	Emissions of CH_4 and N_2 O in the management of livestock manure Bovine/beef; Ovine/sheep; Equine/horses; Caprine/goats; Asinine/mules; Swine/pigs; and Poultry/poultry.

Source: Author's calculations

Table 28: Categories not included in Angola's 2010/2019 GHG inventory

SECTOR	CATEGORY	SUBCATEGORY	DESCRIPTION
AGRICULTURE	Aggregate sources and sources of non-CO_2 gases on earth	GHG emissions from burning biomass in agricultural crops	At a national level, the main crops that involve burning waste are sugar cane and herbaceous cotton. As these crops are not significant in Angola, emissions from burning agricultural waste will not be considered in this inventory.

Source: Author's calculations.

The subcategory GHG emissions from biomass burning in agricultural crops, which refers to the category Aggregate sources and non-CO gas sources2 on land, has not been included in Angola's inventory of GHG emissions by sources and removals by sinks due to the low representativeness of these activities in the country.

CH4 emissions from enteric fermentation

To calculate CH4 (methane) emissions from enteric fermentation, the total number of animals in each type of herd was multiplied by the appropriate emission factor, according to the equation below:

[5] Note: Only synthetic fertilisers (used in EAF) have been inventoried by IDAR.

$$Emissions_{CH_4} = \sum_T EF_T \cdot N_T \cdot 10^{-6}$$

Number of poultry and annual population

The data on the number of animals in the different flocks (N_T) have been obtained from the Ministry of Agriculture and Fisheries (annual reports of the Office for Studies, Planning and Statistics (GEPE), the Institute for Agricultural Development (IDA), Family Farming (EAF)) and the National Statistics Institute (INE).

Table 29: Herd numbers in Angola from 2005 to 2011

Effective	2005	2006	2007	2008	2009	2010	2011
Cattle (Ox/Cow)	-	-	-	-	-	-	4.586.570
Sheep	-	-	-	-	3.740.977	-	1.009.756
Goats	-	-	-	-	-	3.844.786	3.948.595
Pigs	-	-	-	-	-	-	2.135.979
Equines (Horses)	-	-	-	-	-	-	-
Mules	-	-	-	-	-	-	-
Poultry	-	-	-	-	14.260.000	17.119.000-	19.977.427

Source: Report of the Ministry of Agriculture and Fisheries (GEPE) on the 2011/2012 agricultural year.

Table 30: Herd numbers in Angola from 2012 to 2018

Effective	2012	2013	2014	2015	2016	2017	2018
Cattle (Ox/Cow)	4.499.605	-	-	4.916.862	-	-	3.859.401
Sheep	1.222.206	-	-	1.335.558	-	-	1.089.396
Goats	4.777.871	4.055.207	4.277.150	5.220.925	4.433.656	4.512.098	6.697.057
Pigs	2.000.025	-	-	2.185.500	-	-	2.996.289
Equines (Horses)	14.939	-	-	16.353	-	-	5.987
Mules	9.007	-	-	9.871	-	-	11.681
Poultry	19.622.300	23.314.000	31.750.000	21.441.833	35.700.000	36.500.000	14.136.786

Source: 2012 and 2015 Agricultural Campaign Report from the National Statistics Institute (INE).
Source: FAO (Faostat) data for the years 2013; 2014; 2016; 2017 and 2018.

Note: The years with missing data are those for which no information was provided in the annual reports of the respective institutions (Ministry of Agriculture and Fisheries (GEPE, IDA), National Institute of Statistics, FAO) that provided the data presented in these tables.

In order to estimate the stock, interpolation was made between the existing data in the case of missing data and, for birds, an annual life span of 60 days was assumed and the average annual population of the herd was calculated according to equation 10.1. For missing data from the beginning of the period, the per capita flock value of the first available data in the series was used and is shown as hatched values in the table below.

Table 31: Staff used to calculate emissions

Effective	2005	2006	2007	2008	2009	2010	2011
Cattle	3.810.624	3.928.405	4.050.348	4.172.537	4.305.346	4.443.203	4.586.570
Sheep	3.311.105	3.413.447	3.519.406	3.625.577	3.740.977	2.375.367	1.009.756
Goats	3.297.403	3.399.322	3.504.842	3.610.574	3.725.496	3.844.786	3.948.595
Pigs	1.774.618	1.829.469	1.886.259	1.943.163	2.005.012	2.069.212	2.135.979
Horses	12.021	12.393	12.777	13.163	13.582	14.017	14.469
Asses	7.248	7.472	7.704	7.936	8.189	8.451	8.724
Poultry	2.127.129	2.192.875	2.260.945	2.329.152	2.403.288	2.814.082	3.283.961
Effective	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Cattle	4.499.605	4.638.691	4.777.776	4.916.862	4.564.375	4.211.888	3.859.401
Sheep	1.222.206	1.259.990	1.297.774	1.335.558	1.253.504	1.171.450	1.089.396
Goats	4.777.871	4.055.207	4.277.150	5.220.925	4.433.656	4.512.098	6.697.057
Pigs	2.000.025	2.061.850	2.123.675	2.185.500	2.455.763	2.726.026	2.996.289
Horses	14.939	15.410	15.882	16.353	12.898	9.442	5.987
Asses	9.007	9.295	9.583	9.871	10.474	11.078	11.681
Poultry	3.225.584	3.832.438	5.219.178	3.524.685	5.868.493	6.000.000	2.323.855

Note: Poultry = Staff * 60/365

Note: Hatchlings are kept as head/inhabitant of the first year available.

2.6.1. CH4 emissions from enteric fermentation

Emissions were calculated using the IPCC Tier 1 methodology (IPCC, 2006), using IPCC default factors (Tier 1) according to the regional characteristics of livestock species, which range between 19ºC and 20ºC. Therefore, the emission factors in Table 10.10 (page 10.28) / V4_10ch10 that are acceptable for developing countries have been adopted, as well as those in Table 10.11 (page 10.29) / V4_10ch10 that refer to "Africa and the Middle East": Dairy products marketed in the pasture-based sector with low production per cow. Most cattle are multipurpose, providing draught power and some milk within agricultural regions. Some cattle graze very large areas. Cattle are smaller than in most other regions. As we don't have specific data for their approach, we have considered "other livestock" - 46 kg CH4 head-1 year-1. Average milk production of 475 kg head-1 year-1. Includes multi-purpose cows, bulls and young cattle".

In line with the above approach, we have chosen to consider the emission factor (46 kg CH4 head-1 year-1) for cattle, as these are other livestock with dual or multiple functions. This is also because it is more in line with the reality on the African continent and in particular in Angola, where most cattle are multipurpose with a maximum weight (300 kg) and a minimum weight (150 kg) depending on their age, while beef cattle weigh up to 450 kg. On average, cattle were assumed to weigh 300 kg, provide energy for animal traction, some milk within regions or agricultural areas and still graze large areas, including multi-purpose cows, bulls and young cattle.

The table below shows the emission factors used in the calculations.

Table 32: Emission factors assumed for enteric fermentation

TYPE OF CATTLE	EMISSION FACTOR ADOPTED FOR ENTERIC FERMENTATION
Cattle (Ox/Cow)	Emission factor (46 kg CH_4 head^{-1} year^{-1}) acceptable for developing countries weighing 300kg.
Sheep	Emission factor (5 kg CH_4 head^{-1} year^{-1}) acceptable for developing countries weighing over 65 kg.
Goats	Emission factor (5 kg CH_4 head^{-1} year^{-1}) acceptable for developing countries weighing over 150 kg.
Pigs	Emission factor (1 kg CH_4 head^{-1} year^{-1}) acceptable to developing countries, with the weight above the
Equines (Horses)	Emission factor (18 kg CH_4 head^{-1} year^{-1}) acceptable for developing countries weighing over 300 kg.
Mules	Emission factor (10 kg CH_4 head^{-1} year^{-1}) acceptable for developing countries weighing more than 200 kg

Source: Author's calculations

2.6.2. CH4 emissions from manure handling

To calculate CH4 (methane) emissions from manure handling, the total number of animals in each type of herd was multiplied by the appropriate emission factor, as shown in the equation below:

$$\boldsymbol{Emissions_{CH_4} = \sum_{T} EF_T \cdot N_T \cdot 10^{-6}}$$

As for the enteric fermentation emissions, the herd data for the different herds (N_T) were obtained by Research in consultation with the database of the Ministry of Agriculture and Fisheries (GEPE) and the National Statistics Institute (INE). Emissions were calculated using the IPCC Tier 1 methodology (IPCC, 2006). (IPCC, 2006) and the IPCC default factors (Tier 1).

Therefore, the emission factors in table 10.14 (page 10.39) / V4_10ch10, which refer to "Africa": Most animal manure is managed as solid on pastures and fields. A smaller but significant proportion of manure is burned as fuel". Based on this approach, we consider the average annual temperature (AAT) prevailing in Angola;

Africa, according to the regional characteristics of the livestock species, which is between 19º and 20ºC. Therefore, the value of 1 kg CH4 Head yr-1-1 was assigned to the cattle and pig species listed in Table 10.14 (page 10.39) / V4_10ch10 from countries in Africa, since these species are all found in the same area of the African continent, where the temperature does not very much.

Taking into account the regional characteristics of the livestock species Sheep, Goats, Horses, Mules and Horses and Poultry, we applied CH emission factors4 (kg CH4 head yr-1-1) per annual average temperature (°C) from Table 10.15 (page 10.40) / V4_10ch10 of developing countries, we considered the annual average temperature (AAT) acceptable for developing countries, in the case of Angola.

Table 33: Emission factors for manure handling

TYPE OF CATTLE	EMISSION FACTOR ADOPTED FOR MANURE MANAGEMENT
Cattle (Ox/Cow)	Emission factor (1 kg CH_4 head^{-1} year);$^{-1}$
Sheep	Emission factor (0.15 kg CH_4 head^{-1} year);$^{-1}$
Goats	Emission factor (0.17 kg CH_4 head^{-1} year);$^{-1}$
Pigs	Emission factor (1 kg CH_4 head^{-1} year);$^{-1}$
Equines (Horses)	Emission factor (1.64 kg CH_4 head^{-1} year);$^{-1}$
Mules	Emission factor (0.90 kg CH_4 head^{-1} year);$^{-1}$
Poultry	Poultry: emission factors (0.02 kg CH_4 head^{-1} year);$^{-1}$

Source: Author's calculations

Elimination rate

The standard excretion rate, N, has been selected from Table 10.19 (page 10.59) / V4_10ch10 in order to find the standard excretion rate of animals of domesticated species, acceptable for developing countries such as Angola, which are given in the following table in kg N (1000 kg animal mass)-1 day:-1

Table 34: Excretion rate assumed for manure handling

TYPE OF CATTLE	EXCRETION RATE ADOPTED BY MANURE HANDLING (N)
Cattle (Ox/Cow)	Excretion rate 0.63kg N (1000 kg animal mass)$^{-1}$ day .$^{-1}$
Sheep	Excretion rate 1.17 kg N (1000 kg animal mass)$^{-1}$ day .$^{-1}$
Goats	Excretion rate 1.37 kg N (1000 kg animal mass)$^{-1}$ day^{-1}
Pigs	Excretion rate 1.47 kg N (1000 kg animal mass)$^{-1}$ day .$^{-1}$
Equines (Horses)	Excretion rate 0.46 kg N (1000 kg animal mass)$^{-1}$ day .$^{-1}$
Mules	Excretion rate 0.46 kg N (1000 kg animal mass)$^{-1}$ day .$^{-1}$
Poultry	Excretion rate 0.82 kg N (1000 kg animal mass)$^{-1}$ day .$^{-1}$

Source: Author's calculations

2.6.3. Emissions from manure management2

The equation below is used to calculate nitrous oxide (N2 O) emissions from manure handling:

$$\boldsymbol{Emission_{N_2O}^{direct}} = \left[\sum_S \left[\sum_T \left(N_T \cdot Nex_T \cdot MS_{T,S}\right)\right] \cdot EF_{3,S}\right] \cdot \frac{44}{28}$$

Animal population data (herd numbers) were obtained from the Ministry of Agriculture and Livestock (GEPE) and the National Statistics Institute.

In terms of time span, data from 〖MS〗(T, S) are presented on an annual basis for the years 2005 to 2018 as shown in the tables. For the Angola region, data from Table 10 A-5 have been used for cattle and Table 10 A-7 for pigs. Table 10 A-8 (new) was used for sheep and goats and Table 10 A-9 (new) for poultry, both tables from the updated version of the 2019 IPCC guideline. The 2019 IPCC guideline suggests using the value for goats as a proxy for horses and donkeys. It should also be noted that nitrogen losses have been considered in manure management systems for cattle ("dry lot" system with 40% losses, Table 10.22), sheep and goats ("dry lot" system with 30% losses and "solid storage" with 12% losses, Table 10. 22), pigs ("liquid manure" system with 48% losses, "solid storage" with 50% losses and "pit <1 month" with 25% losses, Table 10.22) and poultry ("manure with litter" system with 40% losses, Table 10.22), according to IPCC default values. (IPCC, 2006). As an Excel spreadsheet system was used, the appropriate correction was made in these cases.

The percentage of total annual nitrogen excreted in manure management systems (MMS) for each species/livestock category was taken from Tables 10A-4 - 10A-7 (p. 10.78) / V4_10ch10, "Manure Management System Utilisation (MS%)". Table 10A-5 (p. 10.78) / V4_10ch10 was used to apply the average annual temperature (°C) for livestock species, taking into account the acceptable levels for developing countries in the African region for cattle and Table 10 A-8 for pigs. For these tables, the values for the average annual temperature (°C) of animals of the breeding and market species of cattle and pigs were used. Taking into account other purposes (manure production) for the characteristics of other livestock, Tables 10A-8 (new) and 10A-9 (new) (p. 10.124 / 10.126) / V4_10ch10 (new) were used for animals of other species, taking into account the acceptable levels for developing countries in the African region. The table below shows the results by species.

Table 35: Total annual nitrogen excretion for each manure handling system used

TYPE OF CATTLE	MANAGEMENT SYSTEM	FRACTION OF TOTAL ANNUAL NITROGEN EXCRETION FOR EACH MANURE HANDLING SYSTEM USED
Cattle (Ox/Cow)	Dry lot	1,00%
	Pasture/Range/Paddock	95,00%
	Daily spread	1,00%
	Burned as fuel	3,00%
Pigs	Liquid Slurry	6,00%
	Pasture/Range/Paddock	87,00%
	Solid storage	6,00%
	Pit <1 month	1,00%
Sheep and Goats;	Dry lot	3,00%
Equines (Horses) and Asinines (Mules) equal Caprines as proxy	Pasture/Range/Paddock	80,00%
	Solid storage	17,00%
Poultry	Manure with litter	100,00%

Source: Author's calculations

It should be noted that cattle manure (3% of the total nitrogen excreted) is used as fuel. These figures have been calculated but should be reported in the energy section. The CO_2 emissions are given for information as they are renewable energy and the N2O emissions should be added to the N emissions2 O in the energy sector.

Regarding the emission factor for direct emissions of N2O-N from the MMS, Table 10.21 (page 10.78) / V4_10ch10 has been used to find the default emission factors for direct emissions of N2O from the management of livestock manure, taking into account the acceptable levels for developing countries in the African region, applicable to Angola for cattle. Table 10.21 (page 10.63) / V4_10ch10 was used according to the type of system, definition, EF3 [kg N2 O-N (kg nitrogen excreted)-1], uncertain EF3 ranges and source. It can be seen that this corresponds to the reality of manure management in Angola for pigs and poultry. Finally, for sheep, goats, horses and donkeys, Table 10.21 (page 10.62) / V4_10ch10 was used according to the type of system, definition, EF3 [kg N2O-N (kg nitrogen excreted)-1], uncertainty ranges of EF3 and source. The table below shows the results by animal species.

Table 36: Emission factor for direct emissions of N20-N from Mms Kg N2O-N

TYPE OF CATTLE	HANDLING SYSTEM	EMISSION FACTOR FOR DIRECT EMISSIONS OF N_2 O-N FROM MMS kg N O-N_2 (kg Nitrogen excreted)-1
Cattle (Ox/Cow)	Dry lot	0,01
	Pasture/Range/Paddock	0,01
	Daily spread	0,01
	Burned as fuel	0,01
Pigs	Liquid Slurry	0,005
	Solid storage	0,005
	Pit <1 month	0,002
Sheep and Goats;	Dry lot	0,02
Equines (Horses) and Asinines (Mules) equal Caprines as proxy	Solid storage	0,005
Poultry	Manure with litter	0,001

Source: Author's calculations

2.6.4. Direct emissions of nitrogen$_2$ from treated soils

Emissions of N2 O from treated soils are the result of four different ways of adding nitrogen to the soil:

- Synthetic fertilisers applied to soil;
- Nitrogen in livestock manure applied as fertiliser;
- Nitrogen in livestock manure applied directly to pasture; and
- Nitrogen returned to the soil as crop residues.

Direct emissions of N2 O from soil management were calculated using the following equations[6]:

$$Emission_{N_2O}^{direct} = \frac{44}{28} \cdot \left(EF_1 \cdot N_{inputs} + EF_{3PRP,CPP} \cdot F_{PRP,CPP} + EF_{3PRP,SO} \cdot F_{PRP,SO}\right)$$

where:

$$N_{inputs} = F_{SN} + F_{ON} + F_{CR}$$

The were taken from the agricultural campaign report of the Agricultural Development Institute (EAF) of the Ministry of Agriculture and Fisheries.

The kg N/ha consumption data for Angola were taken from the agricultural campaign reports of the Agricultural Development Institute (EAF) of the Ministry of Agriculture and Fisheries and are only available for the period 2011 to 2018.

To obtain, F_{ON},$F_{PRP,CPP}$ e $F_{PRP,SO}$ the same references were used as for the manure management emissions estimates - data on the number of animals in the different herds presented and data on live weight and nitrogen excretion rate used in the manure management calculations for the different types of animals. Again, there were differences with the IPCC software, which does not calculate according to the above formula. As Excel spreadsheets were used, the correct calculation was made.

2.6.5. Indirect emissions of nitrogen2 from treated soils

Indirect emissions of N2 O from treated soils result from four different ways of adding nitrogen to the soil:

- Synthetic fertilisers applied to soil;
- Nitrogen in livestock manure applied as fertiliser;
- Nitrogen in livestock manure applied directly to pasture;
- Nitrogen returned to the soil as crop residues.

These emissions are the result of two different processes that nitrogen applied to land undergoes: volatilisation of nitrogen compounds and subsequent deposition to soil and water, and leaching of these compounds and loading to surface or groundwater. The methodologies used to calculate indirect N2 O emissions from volatilised and leached nitrogen are described below.

Volatilised nitrogen

The calculation of N2 O emissions resulting from the volatilisation of nitrogen compounds added to the cultivated soil was done according to the IPCC guidelines using the following equation.

EF_1 = N emission factor$_2$ O of Nitrogen added to the soil (0.01 kg N_2 O-N/kg N added - *default* IPCC 2006)

[6] where: $Emissões_{N_2O}^{diretas}$ = Direct emissions of N_2 O from managed soils per year [kg N O/year] $_2$

F_{SN} = Nitrogen (N) applied to the soil in the form of synthetic fertilisers [kg N/year]

F_{ON} = Nitrogen (N) applied to the soil from manure used as fertiliser [kg N/year]

F_{CR} = Nitrogen (N) that returns to the soil as crop residue [kg N/year]

$EF_{3PRP,CPP}$ = N emission factor$_2$ O of Nitrogen from cattle, poultry and pig manure deposited directly on pasture (0.02 kg N_2 O-N/kg N added - IPCC 2006 *default*).

$EF_{3PRP,SO}$ = N emission factor$_2$ O of Nitrogen from sheep manure deposited directly on pasture (0.01 kg N_2 O-N/kg N added - IPCC *default* 2006)

$F_{PRP,CPP}$ = N from cattle, poultry and pig manure deposited directly on pastures [kg N/year].

$F_{PRP,SO}$ = N of sheep waste deposited directly on pasture [kg N/year]

$$\boldsymbol{Emissions_{N_2O,volatilisation}^{indirects} = \frac{44}{28} \cdot [F_{SN} \cdot Frac_{GASF} + (F_{ON} + F_{PRP}) \cdot Frac_{GASM}] \cdot EF_4}$$

Leached nitrogen

The calculation of N2 O emissions resulting from the leaching of nitrogen compounds added to the cultivated soil was done according to the IPCC guidelines using the following equation.

$$\boldsymbol{Emissions_{N_2O,leaching}^{indirects} = \frac{44}{28} \cdot (F_{SN} + F_{ON} + F_{PRP} + F_{CR}) \cdot Frac_{LEACH} \cdot EF_5}$$

Limescale

The main aims of liming are to remove acidity from the soil and to supply calcium and magnesium to the plants. Calcium stimulates root growth, so liming increases the root system and increases the use of water and nutrients in the soil, helping the plant to tolerate drought.

In Angola, liming is not a common agricultural practice, mainly due to a lack of technical information, policies to promote its use and the high cost of limestone.

The main aims of liming are to remove acidity from the soil and to supply calcium and magnesium to the plants. Calcium stimulates root growth, so liming increases the root system and increases the use of water and nutrients in the soil, helping the plant to tolerate drought.

It was assumed that limestone production in Angola is of the dolomitic type. To calculate the CO2 emissions from liming agricultural soils, the apparent consumption of dolomitic limestone in Angola was taken into account. This information comes from the Ministry of Agriculture and Fisheries Institute for Agrarian Development (IDA) - Family Farm (EAF).

Angola has a dolomitic limestone plant in Huíla. The default factor of 0.13 suggested by the IPCC was used. Therefore, this factor was used for dolomitic limestone in the liming calculation.

The total amount of carbon contained in the limestone applied to the soil was obtained using the Huíla value and the IPCC default of 0.13 t C/t limestone. Assuming that all the carbon applied is converted to CO2, the emissions from liming were calculated by multiplying the estimated total carbon in the limestone applied by the mass conversion factor from C to CO2 (44/12).

Urea application - The addition of urea to soils during fertilisation results in the loss of CO2 sequestered during the industrial limestone production process. Urea (CO (NH) 22) is converted into ammonia (NH4 +), hydroxyl ion (OH-) and bicarbonate (HCO3 -) in the presence of water and enzymes. The bicarbonate formed is converted into CO2 and water in the same way as the reaction in the soil after the addition of lime.

This nitrogen fertiliser is the most widely used nitrogen source in Angola due to its high N concentration, high solubility, low cost and ease of production and blending with other nitrogen sources. To calculate the CO2 emissions from the use of urea in agricultural soils, the apparent consumption of urea in Angola, as reported by the IDA (annual reports of family farming campaigns (EAF)), was taken into account.

The total amount of carbon contained in the urea applied to the soil was obtained using the IPCC default value of 0.2 t C/t urea (20% for CO (NH) 22). Assuming that all the applied carbon is converted to CO2, the emissions from the urea activity were calculated by multiplying the estimated total carbon in the limestone applied by the mass conversion factor from C to CO2 (44/12).

Rice cultivation - The anaerobic decomposition of organic matter in flooded rice fields produces methane (CH4), which is emitted to the atmosphere mainly through the transport of nutrients by the rice plants.

The annual amount of CH4 emissions4 in a given rice-growing area depends on: a) the growing season (days); b) the water regime (before and during the growing season); c) the organic amendments applied to the soil; d) other factors (soil type, temperature, rice variety). However, it is important to note that rice fields in upland areas do not produce significant amounts of CH4.

Calculations of methane emissions in Angola have therefore followed the Tier 1 pathway, according to Equation 5.1 of the 2006 IPCC Guidelines. Thus, CH emissions4 from rice cultivation are given by

$$CH_{4\ Rice} = \sum_{i,j,k} (EF_{i,j,k} \bullet t_{i,j,k} \bullet A_{i,j,k} \bullet 10^{-6})$$

Where:

CH4 Rice = annual methane emissions from rice cultivation, Gg CH4 yr -1

EFijk = daily emission factor for conditions i, j and k, kg CH4 ha-1 day-1

tijk = rice growing period for conditions i, j and k, days

Aijk = annual rice area harvested for conditions i, j and k, ha year-1 i, j and k = represent different ecosystems, water regimes, type and number of organic amendments and other conditions under which CH4 emissions4 from rice may vary.

The IPCC Guidelines therefore suggest the following steps for estimating emissions from rice cultivation:

Due to the complexity and variability of management practices for rice production, it is good practice to stratify the total harvest area into sub-units according to conditions i, j and k, as well as the cropping period and emission factor (e.g. harvest areas under different water regimes).

For each sub-unit, it would be ideal to calculate the emissions by multiplying the respective emission factor by the cultivation period (t) and the annual harvest area (A).

It would then be ideal to add up the emissions for each sub-unit of crop area to determine the total annual emissions from rice cultivation at the national level.

Thus, the emission factor EFi is calculated by multiplying a baseline emission factor EFc by several adjustment factors (SF).

Thus, Equation 5.2 of the 2006 IPCC Guidelines was followed for the standard values and methods needed to calculate the daily emission factors.

$$EF_i = EF_c \bullet SF_w \bullet SF_p \bullet SF_o \bullet SF_{s,r}$$

Where:

EFi = daily emission factor adjusted for a given harvested area

EFc = baseline emission factor for continuously flooded fields without organic corrections

SF = adjustment factor to account for differences in water regime during the growing season

SFp = adjustment factor to explain differences in water regime in the pre-season, before the growing season

SFo = adjustment factor must vary according to the type and amount of organic correction applied

SFs,r = adjustment factor for soil type, rice variety, etc., if available as shown above, the base emission factor is for continuously flooded fields without organic corrections, in the case of upland cultivation, emissions would be negligible. In any case, the default value for EFc (emission factor) can be found in Table 5.11 of the 2006 IPCC Guidelines, where the emission factor of 1.30 is applied. This variable is used as a starting point and is adjusted according to the adjustment factors. The adjustment factor to explain the differences in the water regime during the growing season, this number is essential to calculate the emission factor applied, in the specific case of Angola, the default factor was applied in Table 5.12 of the 2006 IPCC Guidelines, which is 0.78.

Another essential part of the calculation is the application of the adjustment factor to account for differences in water regime in the pre-season before the growing season. In this case, we applied the default factor in Table 5.13 of the 2006 IPCC Guidelines for the scaling factor to account for differences in water regime in the pre-season before the growing season, which is 1.22. This value is applied to areas where fields are not flooded for less than 180 days prior to rice cultivation and are continuously flooded during rice cultivation, without ecological corrections, which is the standard case in Angola presented by experts from the Ministry of Agriculture.

Finally, the adjustment factor must be applied to take into account the type and quantity of organic corrections applied. The organic corrections applied to rice include: compost, livestock waste, green manure and rice straw. In this case, the default factor in Table 5.14 of the 2006 IPCC Guidelines was applied, which is 1.00. With respect to the adjustment factor to account for soil type, rice variety, etc., these can be calculated from experiments or local knowledge, but due to the large variation in available data, the IPCC does not define reasonably accurate default values. The IPCC guidelines suggest that country-specific adjustment factors should only be used if they are based on well-researched and documented measurements, stratified at least by soil type and rice variety. Therefore, only the factor of 1 was used.

To arrive at the final emission factor, it is then necessary to stratify the activity data. The difficulties in identifying data were considerable, and the calculations are based mainly on the harvested area statistics provided by the IDA/Ministry of Agriculture team, supplemented by the statistics published by the FAO for rice cultivation in Angola.

Thus, following the IPCC 2006 guidelines, the harvested area has been divided into three basic water regimes, as shown below:

Irrigated Plateau Storm and deep water

As no type 3 areas were identified, the distribution of rice areas was split between type 1 and type 2 areas as described above. As the number of cultivated hectares was presented on a consolidated basis, the same information was used to calculate methane emissions from rice cultivation as published in Angola's initial national communication to the UNFCCC. This indicated that about 43% of Angola's rice-growing area is irrigated. Therefore, a rate of 57% of the total cultivated area was used for the Type 2 (Plateau) category. As shown above, these upland areas do not have significant emissions according to the IPCC 2006 guidelines.

Therefore, the results of methane emissions in irrigated rice production areas, as well as in the other categories of the agricultural sector, are presented below.

2.6.6. Greenhouse gas emissions

This chapter presents the results of Angola's greenhouse gas (GHG) inventory by sources and removals by sinks for the agricultural sector. All emissions are reported in GgCO e.2

The following table shows the emission results for each greenhouse gas in each year of the inventory, as well as the total value of emissions in each year. According to the results obtained, total emissions from the agriculture and livestock sector show a relatively upward trend over the period covered by this inventory, from 2005 to 2020.

The calculation of emissions for the agricultural sector resulted in the emission of the gases CO2 (carbon dioxide), CH4 (methane) and N2 O (nitrous oxide), with CH4 being the most representative gas in all years from 2005 to 2020, with the highest emissions occurring in 2015, and N2 O being the second most representative gas.

2.6.7. Emissions by category

The following tables show the absolute emissions by category for the agricultural sector in Angola and the percentage emissions by category for the years 2005 to 2020. The results of the emissions by category show a predominance of emissions from the Enteric Fermentation category

Table 37: Emissions in Gg CO2 by agricultural sector category from 2005 to 2020

Agriculture	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Enteric fermentation	4418,289	4554,852	4696,242	4554,852	4991,903	4995,776	5003,410	5026,165	5090,147	5253,312	5492,269	5064,984	4728,598	4613,397	4290,459	4050,194
Rice cultivation	31,268	19,532	22,730	41,745	59,794	62,922	65,674	70,375	74,431	75,838	63,543	190,839	166,008	198,401	200,3851	209,6028
Direct Emissions Handled Soils	120,785	124,519	128,384	132,257	136,467	126,601	116,852	127,772	121,576	128,455	139,463	130,682	129,212	147,952	137,595	129,890
Waste Handling	206,534	212,923	219,497	226,189	233,537	226,453	214,847	226,233	223,262	230,556	252,046	240,033	236,552	253,949	256,4884	268,2869
Indirect emissions Managed soils	546,076	562,954	580,429	597,939	616,971	601,258	585,697	604,708	597,474	619,259	660,737	615,341	594,562	634,718	590,288	557,232
Urea	0,000	0,000	0,000	0,000	0,000	0,000	0,154	1,953	0,974	0,323	0,396	0,086	1,420	0,298	0,277	0,261
Liming	0,000	0,000	0,000	0,000	0,000	0,000	0,562	0,545	0,000	0,000	0,000	0,083	0,717	0,305	0,284	0,268
Total	5322,952	5474,780	5647,282	5552,982	6038,672	6013,010	5987,196	6057,751	6107,864	6307,743	6608,453	6242,049	5857,070	5849,020	5475,776	5215,734

Source: Author's calculations

Enteric Fermentation was the most prevalent category with an average representation of 82.44% over the period. The second category with the highest prevalence of emissions was Indirect Emissions from Managed Soils. These categories reflect the significant increase in livestock production in Angola, with emissions peaking in 2015.

Emissions by gas and category - The following tables show the representativeness of greenhouse gases for each category in the agriculture and livestock sector from 2005 to 2018. There is a predominance of CH4 (methane) in the Enteric Fermentation category (with a predominance of emissions from cattle, with an average of 85.27% over the period). Indirect emissions of N2 O in cultivated soils were the dominant emission over the whole period.

2.7. LAND USE, LAND USE CHANGE AND FORESTS

The methodology includes data from the second inventory, covering the years 2005 to 2019, and additional data collection for 2019 and 2020.

Inventories of emissions in tonnes of CO2 equivalent were calculated using the method of gains and losses and differences in stocks within annual periods, as recommended in the IPCC 2003 good practice guide. The land use and land cover classification of the MODIS Land Cover Type Product (MCD12Q1) with a resolution of 500 metres pixels, accessible through the Google Earth Engine platform, was used. This set of classifications can be used to analyse emissions and removals inventories from 2000 to 2020 or to date.

The matrices of land use and land cover transitions between the pairs of years 2018 to 2019 and 2019 to 2020 were evaluated. For each land use and land cover change, the corresponding emissions or removals were evaluated using data from anthropogenic activities and emission factors related to biomass stock or annual biomass growth.

For activities with a change in cover from native formations to anthropogenic use, i.e. areas with forest loss, emissions were calculated by multiplying the difference in biomass carbon stocks by the area of transition with anthropogenic deforestation. For activities with an increase in forest area, removals were calculated by multiplying the average annual increase in biomass in tonnes of carbon per hectare over the annual period of the activity. In this way, the calculations are more conservative or underestimate the value of carbon removal from the atmosphere in cases of native forest regeneration in annual mapping periods.

For the years 2019 and 2020, emissions caused by burning disturbances or environmental changes, removal of firewood, changes in organic soil types or other factors were not assessed. Maps of burned areas and their respective burn factors for activities related to burning are not available. The stock values of wood harvested from forest management were also not available, nor were maps of organic soils for sites with anthropogenic impacts. It was concluded that all forests are located in areas under human influence and therefore all areas are considered to be managed by anthropogenic influences, even conservation or protected and indigenous units.

In general, the sector is known for collecting information on forests, land use and land use change, also known by its acronym LULUCF (Land Use, Land Use Change and Forestry). In terms of classification, area and sampling data representing different land use categories are needed to estimate carbon stocks, emissions and removals of greenhouse gases associated with the activities that the IPCC 2006 Guidelines group together as the Agriculture, Forestry and Other Land Use (AFOLU) sector. It is important to emphasise that this classification provides the basis for estimating GHG emissions and removals using different types of data to represent land use categories and conversions between land use categories, so that they can be applied in the most appropriate and consistent way in inventory calculations.

The IPCC classification considers land use together with agricultural activities. According to the UNFCCC, this economic activity should be reported separately in inventory calculations, as well as the agriculture sector, and not as a component sub-sector of the forestry and land use sector.

For this sectoral inventory, we have endeavoured to update the data so that it is as consistent as possible with the material in Angola's first national inventories (2000 and 2005). The first inventory was prepared according to the guidelines of the 1996 IPCC guidelines. However, in order to apply the 2006 IPCC Guidance, it is necessary to contextualise it, as the methodologies are very different. Countries use a variety of data collection methods to conduct their inventories, including annual censuses, decadal forest inventories, periodic surveys and remote sensing. Each of these data collection methods produces different types of information (e.g. maps or tabulations), at different reporting frequencies and with different attributes.

Therefore, for the presentation of the LULUCF sector in this section, it was decided to adopt the guidelines provided for the use of three approaches to land classification and stratification. Approach 1 identifies the total area of each land use category separately, but does not provide detailed information on the nature of conversions between land uses. Approach 2 introduces the tracking of conversions between land use categories and Approach 3 extends the information available in Approach 2 to allow land use conversions to be tracked in a spatially explicit way.

This method allows a combination of approaches to be used for different regions over time and attempts to make the best use of available data and reduce possible overlaps and omissions in the reports. It is important to emphasise that the methodology proposed in the second inventory differs from that presented in the first inventory (2000-2005 inventory), which used a different approach provided by the 1996 IPCC that does not use explicit representation, i.e. the 1/approach 1 method.

IPCC 2006 defines some broad categories of land use. The methodological documentation points out that some of these categories refer to land cover (e.g. forests), while others represent land use (e.g. cropland).

In order to determine land use and its changes according to the categories listed in the table below, the transition matrices constructed from the visual analysis of satellite images of the Angolan territory were interpreted according to the IPCC 2006 methodology in order to expertly determine the areas corresponding to the different land use categories.

The analysis carried out in the first inventory did not use the same methodology. Thus, both would be in line with the approach adopted in the national GHG inventories, but with different precision approaches, the first being in line with the 1996 IPCC guidelines and the current one with those presented in the 2006 IPCC guidelines.

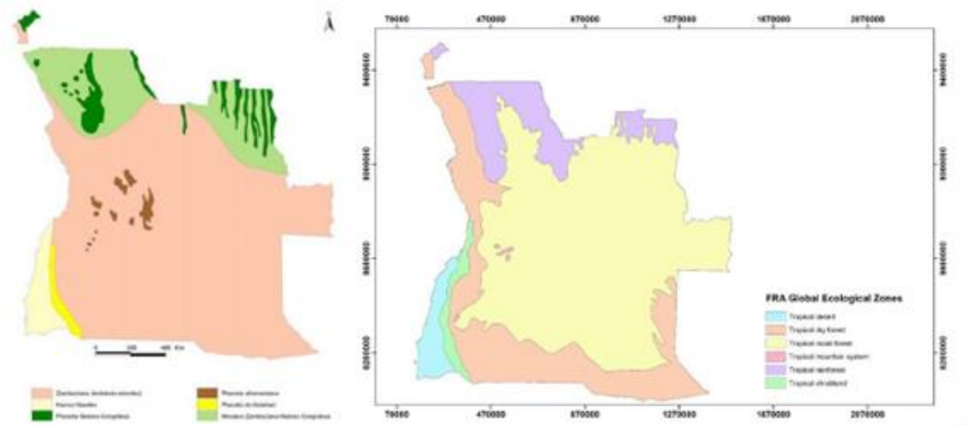
Angola's territory is located entirely in the tropical zone of the African continent. The only national forest inventory (IFN) was carried out in 2015 and published in 2018. It includes data from only 124 of the 591 sampling units originally planned, and these data are not available in digital format, so it is not possible to geo-spatially identify the different types of vegetation at the national level.

Based on these limitations, research was carried out into the different classifications at national and international level in order to identify an appropriate classification for the work to be carried out, depending on the methodologies used at international level and the availability of national data.

At international level, there is more or less consensus on the division of the world into 14 terrestrial biomes. Of these, 9 biomes are present in Africa, 7 of which are in Angola: 1) tropical and subtropical moist forests, 2) mountain grasslands and shrublands, 3) tropical and subtropical grasslands, savannahs, scrublands and forests, 4) tropical and subtropical dry and deciduous forests, 5) deserts and xeric scrublands, 6) mangroves and 7) grasslands and flooded savannahs.

At national level, however, it is accepted that there are six biomes in Angola, defined by biological composition and soil, climatic and physiognomic factors: 1) Guineo-Congolese forest, 2) Congolese savannah forest mosaic, 3) Zambezi including miombo woodland, 4) Afromontane Forest, 5) Karoo-Namibe and 6) Kalahari - plateau transition zone and escarpment zone. Thus, at this first level of classification, there is no correspondence between the international and national classifications. A very similar classification, but with some differences. For this reason, the FAO's Global Assessments of World Forest Resources and the specific reports for each country are presented here. The mapping, carried out in 2000 and updated in 2010, is based on the Global Ecological Zones (GEZ) and presents 6 extracts, grouping the ecological zones established in the Global Assessment for Angola. This classification was developed for the distribution of the IFN sampling units.

Figure 1: Map of Angola biomes (left) and global ecological zones for Angola (right)



Source: Taken from MINUA, 2006 and created by the authors from the Global Ecozones Map 2010

The classification of vegetation units (classes) in the Angolan phytogeographic map had the advantage of being recognised at national and international level, and the classification is presented in most strategic documents, policies, laws and institutional reports. However, the main disadvantage of the 1970 classification is that, with the advances made in recent decades in the fields of phytosociology, community ecology, etc., it may be outdated and does not meet current criteria for grouping plant communities, which is why its use has also been discouraged.

Biomass classification has been discouraged from the outset because I) it is very general, with only one classification of a small number of units, which could lead to the loss of relevant information, and II) there is no correspondence between the international and national classifications, since one defines 7 biomes in Angola and the other, the Global Ecozones Classification, defines 6, but they do not coincide with the national classification.

For all these reasons, the classification chosen to define the smallest units for the GHG inventory was the Modis Land Cover Satellite, as it provides not only vegetated areas, but also classifications of urban areas, grassy areas, water bodies, cultivated areas and different types of forest formation.

In order to determine how to apply the 2006 IPCC guidelines to the Angolan reality, a calculation test was carried out using the transition matrix method within the IPCC TIER 1 framework, i.e. using the default values available in the IPCC guidelines. For the classification of the transition matrix, the IPCC approach 3 was applied, with geo-referencing of the transitions, using the years 2005, 2010 and 2015 as intermediate estimation points for the construction of calculations of average annual emissions for the period 2003 to 2018.

The Angolan territory has thus been divided into 15 types, presented below, with the corresponding stocks of Mg of carbon contained in one hectare, as shown in the table below.

Table 38: Classification types and carbon content per hectare

TYPES OF CLASSIFICATION	MG/HECTARE
Grasslands	2,8
Evergreen Needle leaf Forests	141
Permanent Wetlands	2,8
Croplands	4,1
Urban and Built-up Lands	0
Cropland/Natural Vegetation Mosaics	4,1
Barren	0
Water Bodies	0
Evergreen Broadleaf Forests	141
Deciduous Broadleaf Forests	61,1
Mixed Forests	84,6
Closed Shrub lands	32,9
Open Shrub lands	6
Woody Savannas	65,8
Savannas	49,35

Source: Lusophone Group Mission, 2020, Source: based on IPCC, 2006

For the inventory, we used the specialised information contained in the Modis database and the images of the maps in Figures 1 to 3, which show the land use classification for the analysis years 2005, 2010 and 2015.

The emissions results are summarised in the main categories of maintenance and change in six classes: Forests, Grasses, Urban or Settlement, Water, Crops, Deserts and Other. The results can be visualised on the maps in Figures 1 and 2. Emissions and removals are summarised in Table 1 for the years 2018 and 2019 and in Table 2 for the years 2019 and 2020. The total net value of human emissions is 182 Mt CO2 eq for 2019 and 174 Mt CO2 eq for 2020.

The activities classified and calculated as carbon emitters are spatially detailed on maps and in tables. The detailed values in the land use and land cover transition matrix are broken down into areas per hectare in Table 3 for the years 2018 and 2019 and in Table 4 for the years 2019 and 2020. The values for emissions and removals in tonnes CO2 equivalent are detailed in Table 5 for the years 2018 and 2019 and in Table 6 for the years 2019 and 2020. The results of emissions and removals by land use and land cover for each transition are specifically delineated in the map archives.

For spatial analyses of land use and land cover changes with potential environmental impacts, they have been classified as degraded and deforested areas. Degraded areas are non-forest areas that have been converted to other uses, i.e. deserts. Areas classified as deforestation were forest areas converted to crops, grasses, urban and other uses. Only deforestation was taken into account in the calculation of emissions.

Other changes can also be observed, with changes in land use and land cover potentially emitting carbon, but their emissions have not been calculated. These areas were classified as dryland, as land with water was considered to have been converted to other uses. The area of other water uses was considered as flooded. The total area of urbanisation was retained and the total area of the other class was also retained on the maps for visual assessment of the total area with potential for anthropogenic emissions. Cropped areas that are now considered to be grassland were considered to be pasture, as they may be in some form of fallow or crop rotation with grass cover.

Maps of the areas considered under the main changes in use and cover with emission potential are shown in Figure 3 for the years 2018 to 2019, Figure 4 for the years 2019 to 2020 and Figure 5 for the years 2018 to 2020.

2018-2019

Table 39: Amount of land use and land cover change between 2018 and 2019 in terms of tCO2 equivalent emissions or removals

Transition		Activity Data	Total (ha)	tCOeq
1	**FF**	Forests that remain forests	79,630,975	**-12,204,108**
	TF	Land converted into forests	1,135,950	**-5,216,993**
2	**GG**	Grasselands kept as grasselands	46,739,725	3,592,350
	TG	Land converted to grassland	1,396,375	193,493,575
3	**CC**	Croplands kept as croplands	457,500	-
	TC	Land converted to crops	68,100	2,760,166
4	**AA**	Water kept as Water	344,900	-
	TA	Land converted into water	14,350	-
5	**OO**	Others kept as Others	1,874,375	-
	TO	Land converted to Other	75,300	-
6	**UU**	Urban maintained Urban	104,775	-
	TU	Land converted to urban	725	-
Total			**131,843,050**	**182,424,989**

2019-2020

Table 40: Amount of land cover change between 2019 and 2020 in terms of tCO2-equivalent emissions or removals

Transition		Activity Data	Total (ha)	tCOeq
1	**FF**	Forests that remain forests	79,537,450	-11,998,046
	TF	Land converted into forests	1,216,200	-5,384,080
2	**GG**	Grasselands kept as grasselands	46,832,900	4,455,219
	TG	Land converted to grassland	1,294,375	184,771,652
3	**CC**	Croplands kept as croplands	461,975	-
	TC	Land converted to crops	48,675	2,626,268
4	**AA**	Water kept as Water	346,300	-
	TA	Land converted into water	34,875	-
5	**OO**	Others kept as Others	1,916,275	-
	TO	Land converted to Other	47,725	-
6	**UU**	Urban maintained Urban	105,500	-
	TU	Land converted to urban	800	-
	Total		**131,843,050**	**174,471,012**

Table 41: Matrix of areas in hectares of land use and land cover transitions between 2018 and 2019

	2018	2019															Area (ha)
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	
1	**Evergreen Needleleaf Forests**	**375**						25	25		50						**475**
2	**Evergreen Broadleaf Forests**	25	**6,762,400**	66,950	153,400	1,325		537,025	39,525	4,150	1,650						**7,566,450**
3	**Deciduous Broadleaf Forests**		63,975	**1,364,275**	55,075	23,575	2,450	112,775	201,475	11,025							**1,834,625**
4	**Mixed Forests**		58,850	156,725	**2,617,250**	1,025	825	341,825	218,600	1,425							**3,396,525**
5	**Closed Shrublands**		75	50	650	**1,877,600**	13,075	6,575	19,575	307,300	25	100					**2,225,025**
6	**Open Shrublands**			150	1,200	30,325	**1,938,025**	2,650	41,325	316,725		150	25	325	41,075		**2,371,975**
7	**Woody Savannas**		318,350	81,550	220,650	7,450	2,950	**19,822,575**	803,325	81,800	925			75			**21,339,650**
8	**Savannas**		17,475	115,100	131,500	146,650	81,725	761,475	**42,523,850**	795,600	4,600	9,175	275	7,275		1,625	**44,596,325**
9	**Grasslands**		350	25		204,575	256,750	120,150	710,325	**44,228,225**	3,700	37,450	400	13,550	33,575	1,625	**45,610,700**
10	**Permanent Wetlands**		900				75	1,250	6,525	52,275	**231,525**				175	825	**293,550**
11	**Croplands**					25			8,775	21,425		**288,325**	25	2,750			**321,325**
12	**Urban and Built-up Lands**												**104,775**				**104,775**

13	**Cropland/Natural Vegetation Mosaics**						500	150	7,200	17,375		5,150		**161,275**			**191,650**
14	**Barren**					25	850		25	1,500	75				**1,874,375**	75	**1,876,925**
15	**Water Bodies**									50	300				475	**112,250**	**113,075**
	Grand Total	**400**	**7,222,375**	**1,784,825**	**3,179,725**	**2,292,575**	**2,297,225**	**21,706,475**	**44,580,550**	**45,838,875**	**242,850**	**340,350**	**105,500**	**185,250**	**1,949,675**	**116,400**	**131,843,050**

Table above:

Table 42: Matrix of areas in hectares of land use and land cover transitions between 2019 and 2020

	2019	**2020**															**Area (ha)**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	
1	**Evergreen Needleleaf Forests**	**350**						25	25		50						**400**
2	**Evergreen Broadleaf Forests**		**6,603,075**	64,750	108,825	1,375	25	406,225	35,025	1,575	1,500						**7,222,375**
3	**Deciduous Broadleaf Forests**		44,475	**1,339,075**	105,525	600	200	123,025	171,650	275							**1,784,825**
4	**Mixed Forests**		47,200	83,500	**2,400,650**	2,800	2,500	436,950	205,850	275							**3,179,725**
5	**Closed Shrublands**		250	7,775	275	**1,909,375**	5,450	3,075	58,775	307,500	25	75					**2,292,575**
6	**Open Shrublands**			1,475	375	51,850	**1,748,550**	1,650	74,675	385,550	75	25		500	32,500		**2,297,225**

7	**Woody Savannas**		319,075	81,725	197,550	17,550	5,025	**20,104,500**	875,425	104,050	1,275			300			**21,706,475**
8	**Savannas**	75	31,700	131,175	119,250	56,975	38,400	715,925	**42,726,025**	737,425	7,825	10,850	250	4,500		175	**44,580,550**
9	**Grasslands**		575	3,650	250	243,575	142,100	94,125	726,625	**44,556,700**	21,375	28,175	500	4,250	15,175	1,800	**45,838,875**
10	**Permanent Wetlands**	50	1,225					1,850	3,425	6,350	**228,725**				25	1,200	**242,850**
11	**Croplands**					25			5,075	29,275		**302,600**	50	3,325			**340,350**
12	**Urban and Built-up Lands**												**105,500**				**105,500**
13	**Cropland/Natural Vegetation Mosaics**						175	100	5,625	23,300		8,950		**147,100**			**185,250**
14	**Barren**						14,700			17,875	75				**1,916,275**	750	**1,949,675**
15	**Water Bodies**										25				25	**116,350**	**116,400**
	Grand Total	**475**	**7,047,575**	**1,713,125**	**2,932,700**	**2,284,125**	**1,957,125**	**21,887,450**	**44,888,200**	**46,170,150**	**260,900**	**350,675**	**106,300**	**159,975**	**1,964,000**	**120,275**	**131,843,050**

Table below:

Table 43: Matrix of areas in amounts of tons of CO_2 equivalent from land use and cover transitions between the years 2018 and 2019

2018		2019														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Evergreen Needleleaf Forests**	-						-	-		-					
2	**Evergreen Broadleaf Forests**	-	-	-	-	-		-	-	2,102,943	-					
3	**Deciduous Broadleaf Forests**		-694,797	-	-76,500	-	-	-816,265	-	2,356,777						
4	**Mixed Forests**		-639,137	-	-	-	-	-	-	427,405						
5	**Closed Shrublands**		-815	-81	-903	-	-	-47,590	-94,456	33,915,677	-	10,560				
6	**Open Shrublands**			-242	-1,667	-73,164	-	-19,181	-199,407	3,716,240		1,045	-	2,264	-	
7	**Woody Savannas**		-3,457,423	-	-306,484	-	-	-	-	18,895,800	-			16,967		
8	**Savannas**		-189,786	-185,661	-182,654	-	-	-5,511,556	-	135,795,660	-	1,522,285	-	1,207,044		-
9	**Grasslands**		-3,801	-40		-493,571	-123,890	-869,646	-3,427,555	-	-	-	-	-	-	-
10	**Permanent Wetlands**		-9,774				-36	-9,048	-31,485	-	-				-	-
11	**Croplands**					-60			-42,342	-		-	-	-		
12	**Urban and Built-up Lands**												-			
13	**Cropland/Natural Vegetation Mosaics**						-241	-1,086	-34,742	-		-		-		
14	**Barren**					-60	-410		-121	-	-				-	-
15	**Water Bodies**									-	-				-	-

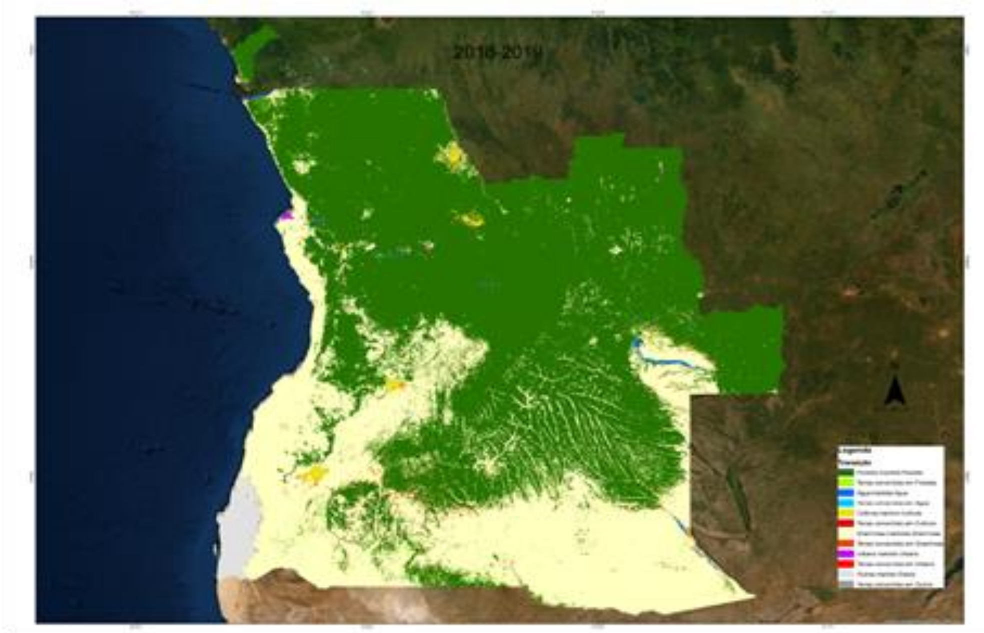
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Grand Total	-	-4,995,534	-186,024	-568,208	-566,856	-124,578	-7,274,371	-3,830,108	197,210,502	-	1,533,890	-	1,226,275	-	-

Table 44: Matrix of areas in tones of C02 equivalent of land cover transitions between 2019 and 2020

2019		**2020**														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Evergreen Needleleaf Forests**	-						-	-							
2	**Evergreen Broadleaf Forests**		-	-	-	-	-	-	-	798,105	-					
3	**Deciduous Broadleaf Forests**		-483,018	-	-146,575	-	-	-890,455	-	58,786						
4	**Mixed Forests**		-512,613	-	-	-	-	-	-	82,482						
5	**Closed Shrublands**		-2,715	-12,541	-382	-	-	-22,257	-283,609	33,937,750	-	7,920				
6	**Open Shrublands**			-2,379	-521	-125,097	-	-11,943	-360,332	4,523,787	-	174		3,483	-	
7	**Woody Savannas**		-3,465,297	-	-274,398	-	-	-	-	24,035,550	-			67,870		
8	**Savannas**	-815	-344,276	-211,591	-165,639	-	-	-5,181,865	-	125,866,157	-	1,800,196	-	746,625		-
9	**Grasslands**		-6,245	-5,888	-347	-587,665	-68,568	-681,277	-3,506,208	-	-	-	-	-	-	-

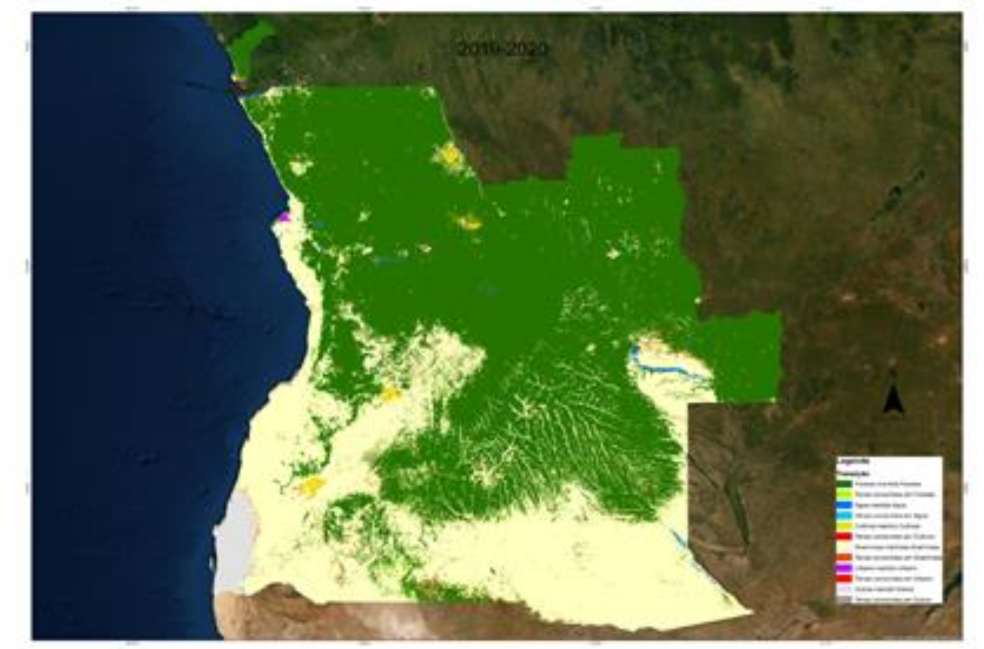
10	**Permanent Wetlands**	-543	-13,304					-13,390	-16,527	-	-				-	-
11	**Croplands**					-60			-24,489	-		-	-	-		
12	**Urban and Built-up Lands**												-			
13	**Cropland/Natural Vegetation Mosaics**						-84	-724	-27,143	-		-		-		
14	**Barren**						-7,093			-	-				-	-
15	**Water Bodies**										-				-	-
	Grand Total	-1,358	-4,827,469	-232,399	-587,862	-712,822	-75,746	-6,801,911	-4,218,306	189,302,616	-	1,808,290	-	817,978	-	-

Figure 2: Land use and land cover transition map for 2018 and 2019



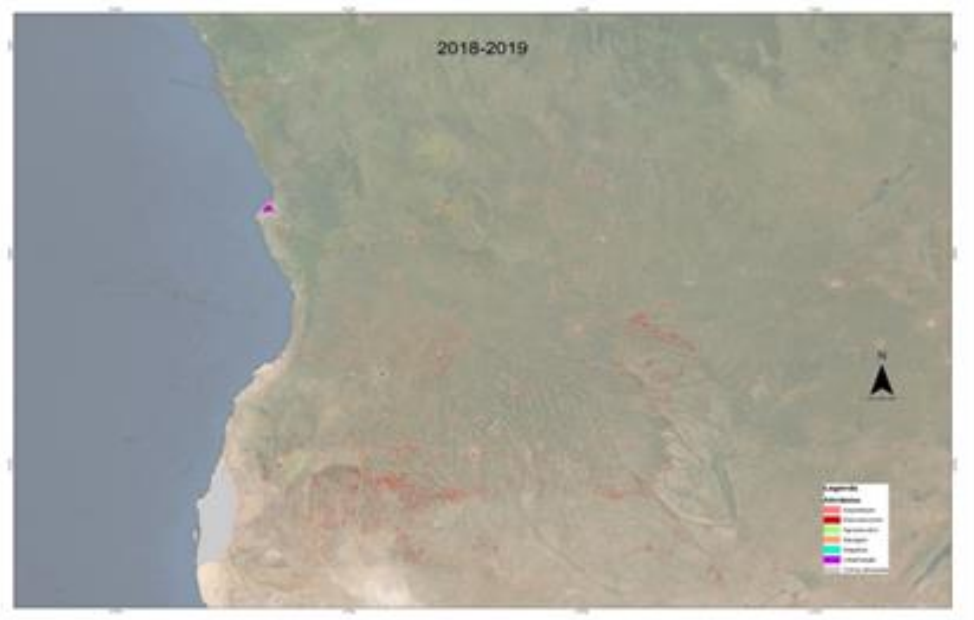
Source: Author's calculations

Figure 3: Land use and land cover transition map for 2019 and 2020



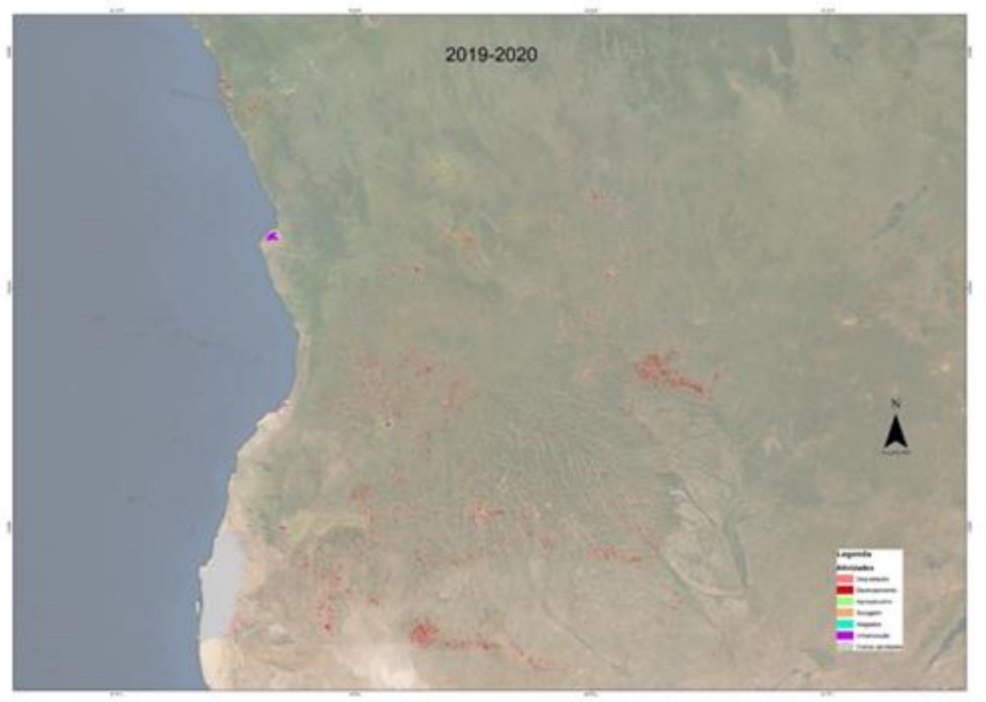
Source: Author's calculations

Figure 4: Map of the main sources of emissions from land use and land cover change between 2018 and 2019



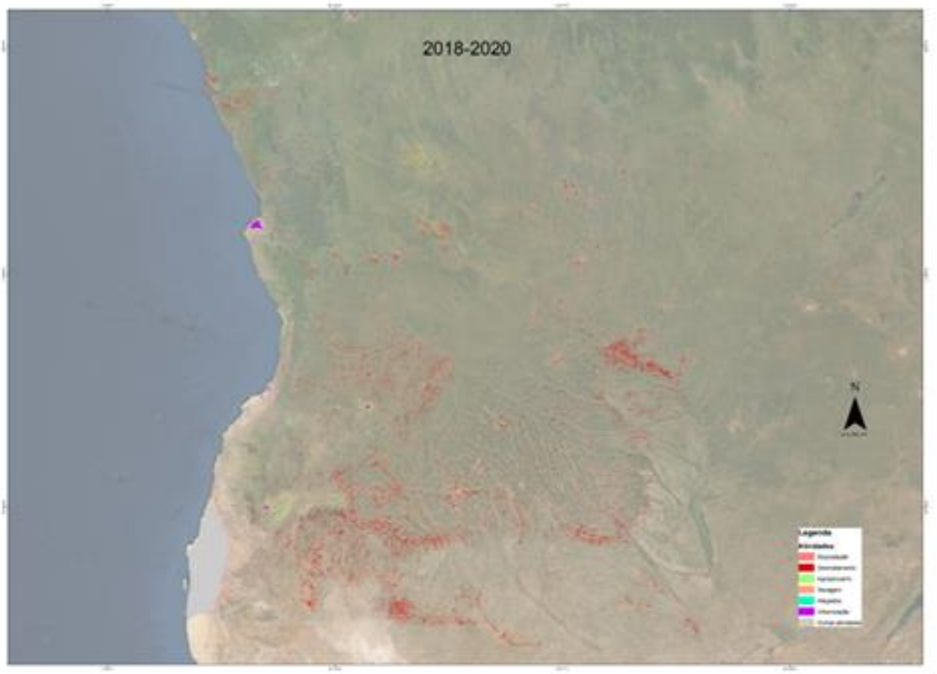
Source: Author's calculations

Figure 5: Map of the main sources of emissions from land use and land cover change between 2019 and 2020



Source: Author's calculations

Figure 6: Map of the main sources of emissions from land use and land cover change between 2018 and 2020



Source: Author's calculations

From there, the classification adopted in this inventory update was applied, which increased the number of classifications, or rather the 15 classifications mentioned above, and from there the transition matrices were applied. Therefore, following the IPCC 2006 methodology, 6 land use classes are required.

The following table shows a comparison of the 15-land use and land cover categories for the LULUCF sector used to construct the transition matrices and those provided by the IPCC 2006 methodology.

Table 45: Comparison between the classifications of the 15 categories and the 6 IPCC 2006 land use classes

CATEGORY IN THIS UPDATE	DESCRIPTION	SUB-CATEGORIES[7]
FORESTLANDS	Angola follows the FAO definition of forest, which is "an area equal to or greater than 0.5 hectares dotted with trees, with a height equal to or greater than 5 metres at maturity and a canopy cover equal to or greater than 10%, or trees capable of reaching that height in situ".	Evergreen Needleleaf Forests
		Evergreen Broadleaf Forests
		Deciduous Broadleaf Forests
		Mixed Forests
		Closed Shrublands
		Woody Savannas
		Savannas

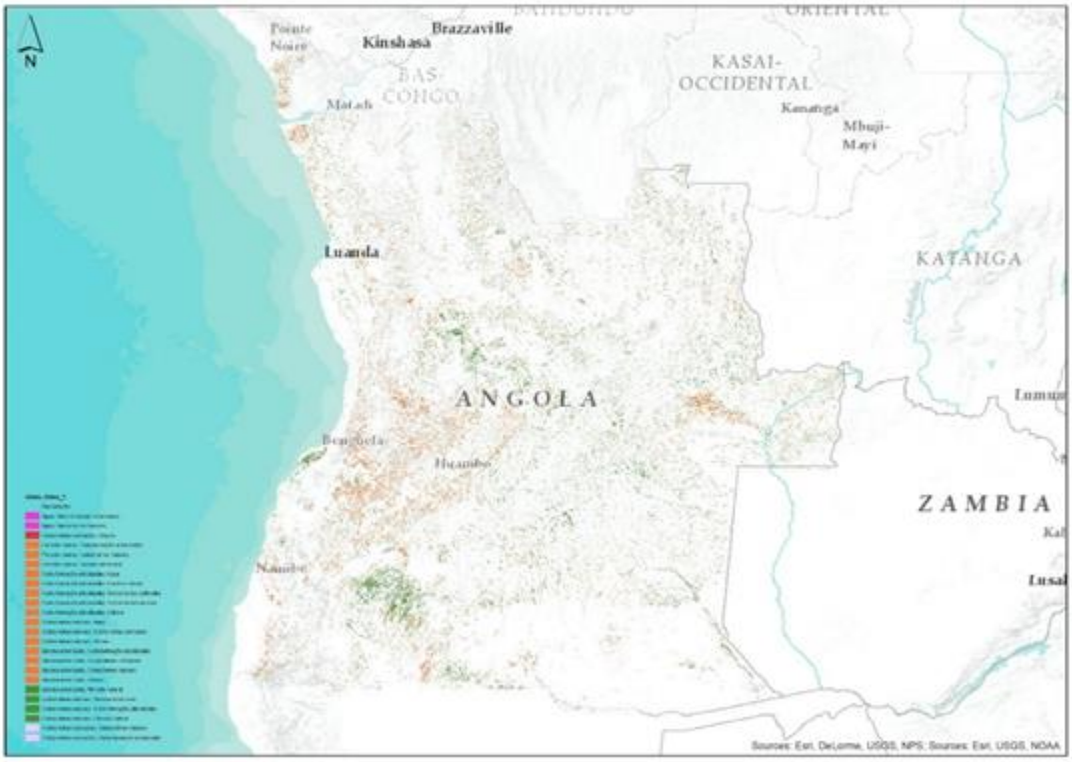
[7] Estimates of CO emissions and removals were made for each of the subcategories

CROPLANDS	Areas cultivated with temporary and permanent agriculture.	Cropland/Natural Vegetation Mosaics Croplands
GRASSLANDS	Areas intended for grazing and established by planting. It also refers to field areas at an early, medium or advanced stage, but which are not characterised by forests.	Grasslands Open Shrublands
Water/Wetlands	All water bodies, permanent and temporary, natural or artificial, which can be continental waters, rivers, lakes, lagoons, dams or reservoirs.	Water Bodies Permanent Wetland
Urban *Settlements*	An area defined by law, characterised by continuous buildings and the existence of social facilities (housing, recreation, circulation, etc.), which can be a city, district, town or village.	Urban and Built-up Lands
Other Lands	Area of rock formations, mining, clouds, cloud shadows or any other landscape feature that cannot be interpreted or classified.	Barren

Source: Author's calculations

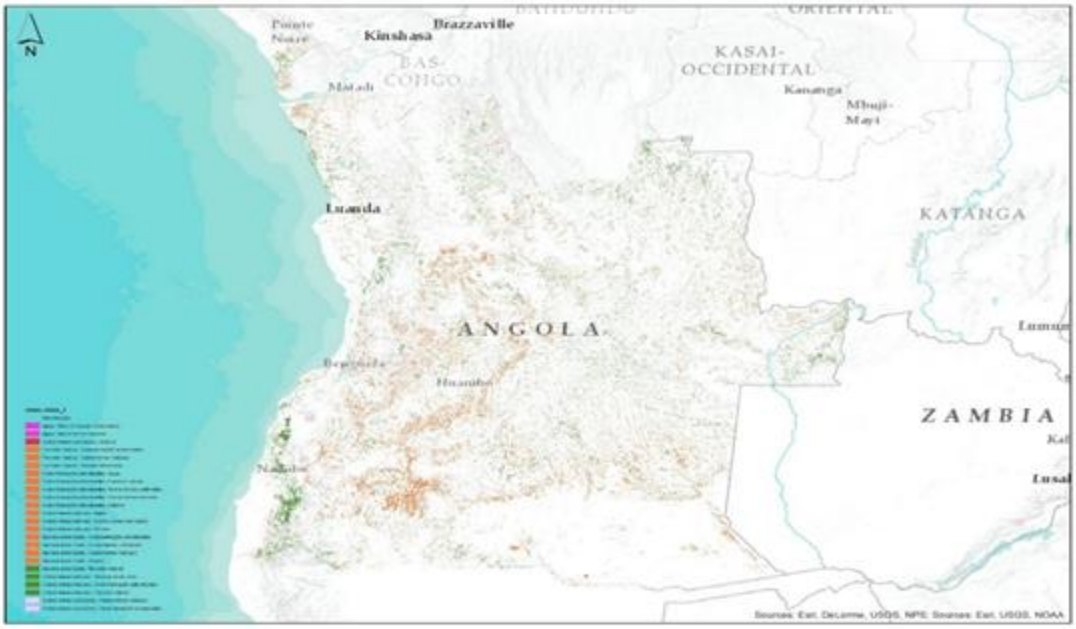
For each transition between 2005 and 2010 and from 2010 to 2015, there are new maps showing the areas that have changed. For each type of change, called a land use transition, there are associated factors to help calculate emissions.

Figure 7: Land use transitions between 2005 and 2010



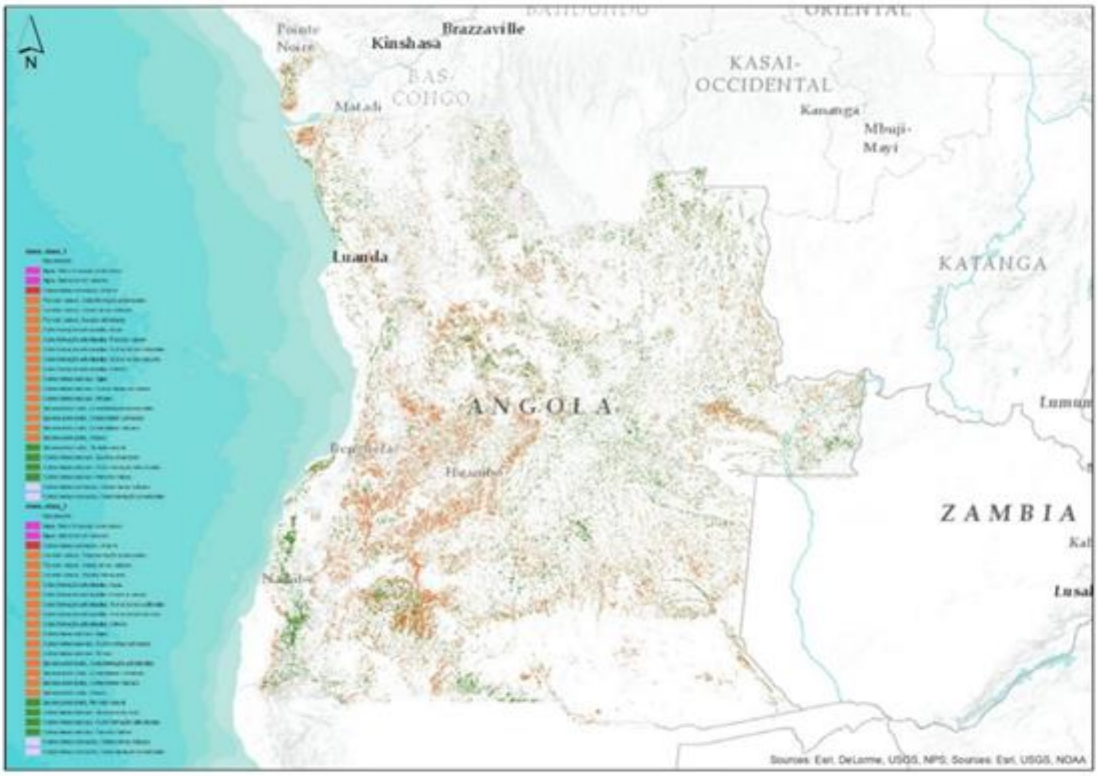
Source: Author's calculations

Figure 8: Land use transitions between 2010 and 2015



Source: Author's calculations

Figure 9: Overlapping transitions between 2005 and 2015



Source: Author's calculations

A first look at the overlapping transition areas shows that the region to the north and east of Namibe has higher CO2 removals, while the regions around Huambo have higher emissions, due to the land-use changes identified.

In simple terms, the results show that the sum of the emissions and removals of the 15 classifications for the period 2003 to 2010 totals 314,232,178 tCO2, or an annual average of about 39,279,022.25 tCO2, and that for the period 2010 to 2018 there is an increase in emissions, totalling 553,516,255 tCO2, with an annual average of 69,189,531.875 tCO2.

Table 46: Results of CO2 Emissions

Result of the transition matrix	tCO_2 Annual Average	tCO_2 Period
2003	39.279.022,25	314.232.178
2004	39.279.022,25	
2005	39.279.022,25	
2006	39.279.022,25	
2007	39.279.022,25	
2008	39.279.022,25	
2009	39.279.022,25	
2010	39.279.022,25	
2011	69.189.531,875	

2012	69.189.531,875	553.516.255
2013	69.189.531,875	
2014	69.189.531,875	
2015	69.189.531,875	
2016	69.189.531,875	
2017	69.189.531,875	
2018	69.189.531,875	

Author's calculations: Mission of the Lusophone Group, 2020
Source: Modis database, geo-referenced for the years 2005-2010-2015

As can be seen, there is a dynamic of substantial change, in particular an increase in the percentage of urban areas of 3.3% since 2003 compared to 2018. The agricultural area has increased by 5% over this period. Forests experienced a net loss of 200 000 ha, while grassland increased by 200 000 ha. There was a 7% loss of flooded areas over the period.

2.7.1. Emissions and removals from the land use, land use change and forestry (LULUCF) Sector

According to the IPCC (2006), cropland includes arable land, cultivated land, rice fields and agroforestry systems where the vegetation is below the thresholds used for the forest land category and is not expected to exceed these thresholds. Arable land includes all annual and perennial crops as well as temporary fallow land (i.e. land left fallow for one or more years before being cultivated again).

Annual crops include cereals, oilseeds, vegetables, roots and forage. Perennial crops include trees and shrubs in combination with herbaceous plants, crops (e.g. agroforestry) such as orchards and plantations of cocoa, coffee, tea, oil palm, coconut, rubber trees and bananas, except where such land meets the criteria for classification as woodland. Areas normally used for the production of annual crops but temporarily used for fodder crops or grazing as part of an annual rotation between crops and pastures (integrated system) are included in arable land.

The amount of carbon stored and emitted or removed in each of the land consolidation and land use categories, including forests, crops, grasslands, water and wetlands, urban areas and other land, depends on the type of genetic material, management practices and soil and climate variables. For example, annual crops (cereals, vegetables) are harvested every year, sometimes twice a year. These have not been included in the calculation of the long-term carbon stock of biomass.

However, in the case of forests, as well as the woody parts of grasslands or even pastures, vegetation can store significant carbon in biomass throughout the life of such uses, but the amount depends on species type, density, growth rates and management practices.

Carbon stocks in soils can be significant and changes in stocks can occur in relation to soil characteristics and management practices, including crop type and rotation, tillage, timber harvesting, drainage, residue management, organic management and amendments. The burning of crop residues produces significant non-CO2 greenhouse gases and calculations and methodologies are provided. However, for Angola, no information was provided on residue burning practices, so they were not included in the calculations nor in Angola's first inventory. If this data is included in the next review, the values may be different from those found.

Next, the tables consolidating the results of greenhouse gas emissions and removals are presented, taking into account that, unlike in the first inventory, they have been calculated annually for the period of all transitions and, as the tables are quite large, it has been decided to consider only two synthesis subcategories for each of the 6 land categories.

For the sake of transparency, the notation keys for gases other than CO2 are Externally Estimated (EE); Not Estimated (NE); and Not Occurring (NO). In the first inventory, emissions and removals from Harvested Wood Products (HWP) were not estimated.

Table 47: Emissions not found

GHG emissions by sources and removals by sinks	CH4	N2O	NOx	CO	NMVOC
	Tones				
Total LULUCF - Net CO2 emissions (emissions and removals) (1)	NE	NE	NE	NE	NE
A. Forests (F) tCO_2	Dear	Dear	NE	NE	NE
1. maintained forests Forests (FF) tCO_2	Dear	Dear	NE	NE	NE
2. land converted to forest (TF) tCO_2	Dear	Dear	NE	NE	NE
B. Crops (C) tCO_2	NE	NE	NE	NE	NE
1. crops kept in Cultivation (CC) tCO_2	NE	NE	NE	NE	NE
2. land converted into crops (TC) tCO_2	NE	NE	NE	NE	NE
C. Grasses (G) tCO_2	NE	NE	NE	NE	NE
1. maintained grasses (GG) tCO_2	NE	NE	NE	NE	NE
2. land converted to grass (TG) tCO_2	NE	NE	NE	NE	NE
D. Waters/Flooded areas (A)(2) tCO_2	NE, NO	NE, NO	NE	NE	NE
1. waters/wetlands maintained as wetlands (AA) tCO_2	NE	NE, NO	NE	NE	NE
2. land converted to water/wetlands (TA) tCO_2	NE	NE, NO	NE	NE	NE
E. Urban settlements (U) tCO_2	NE	NE, NO	NE	NE	NE
1. urban settlements maintained as urban settlements (UU) tCO_2	NE	NO	NE	NE	NE
2. land converted into urban settlements (TU) tCO_2	NE	NE, NO	NE	NE	NE
F. Other Land (O) (3) tCO_2	NE, NO	NE, NO	NE	NE	NE

1. other land held as other land (OO) tCO_2			NE	NE	NE
2. land converted into other land (TO) tCO_2	NO	NO	NE	NE	NE
G. Harvested wood products (HWP) (4) tCO_2	NE	NE	NE	NE	NE
(1) For reporting purposes, the signs for removals are always negative (-) and for emissions positive (+).					
(2) Parties may decide not to prepare estimates for CH emissions$_4$ from flooded areas, contained in Appendix 3 of volume 4 of the 2006 IPCC Guidelines, although they may do so if they wish.					
(3) This category includes bare soil, rock, ice and all areas of the earth that don't fall into any of the other five categories. It allows the total of identified areas to correspond to the total area.					
(4) Non-CO emissions$_2$ from HWP are covered in the energy sector or the waste sector.					

Source: Author's calculations: Mission of the Lusophone Group, 2020

The tables below consolidate the results of CO2 emissions and removals.

Table 48: CO_2 emissions by sources and removals by sinks (in tonnes)

	2003	2004	2005	2006	2007	2008	2009	2010
Total LULUCF	39 499,303	39 530,990	39 670,813	39 515,605	39 761,566	39 673,614	39 842,075	39 798,095
A. Forest (F) tCO2	-1 881,557	-1 849,870	-1 710,046	-1 865,255	-1 619,294	-1 707,245	-1 538,785	-1 582,765
1. Forests maintained Forests (FF) tCO2	-3 432,562	-3 432,562	-3 432,562	-3 432,562	-3 432,562	-3 432,562	-3 432,562	-3 432,562
2. Land converted to forest (TF) tCO2	1 330,724	1 330,724	1 330,724	1 330,724	1 330,724	1 330,724	1 330,724	1 330,724
3. Burning (non-CO2)	220,281	251,968	391,791	236,583	482,543	394,592	563,053	519,073
B. Crops (C) tCO2	488,110	488,110	488,110	488,110	488,110	488,110	488,110	488,110
1. Crops kept in Cultivation (CC) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted to crops (TC) tCO2	488,110	488,110	488,110	488,110	488,110	488,110	488,110	488,110
C. Grasses (G) tCO2	40 201,097	40 201,097	40 201,097	40 201,097	40 201,097	40 201,097	40 201,097	40 201,097
1. Maintained grasses Grasses (GG) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted to grass (TG) tCO2	580,675	580,675	580,675	580,675	580,675	580,675	580,675	580,675
D. Water/Wetlands (A)(2) tCO2	8,946	8,946	8,946	8,946	8,946	8,946	8,946	8,946
1. waters/wetlands maintained as	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

wetlands (AA) tCO2								
2. Land converted to water/wetlands (TA) tCO2	8,946	8,946	8,946	8,946	8,946	8,946	8,946	8,946
E. Urban settlements (U) tCO2	102,033	102,033	102,033	102,033	102,033	102,033	102,033	102,033
1. Urban settlements maintained as urban settlements (UU) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted into urban settlements (TU) tCO2	580,675	580,675	580,675	580,675	580,675	580,675	580,675	580,675
F. Other Land (O) (3) tCO2	8,946	8,946	8,946	8,946	8,946	8,946	8,946	8,946
1. Other Land held as Other Land (OO) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted into Other Land (TO) tCO2	102,033	102,033	102,033	102,033	102,033	102,033	102,033	102,033
G. Harvested wood products (HWP) (4) tCO2								

Source: Author's calculations, 2020

Table 49: CO2 emissions by sources and removals by sinks (in tones)

	2013	2014	2015	2016	2017	2018	2019	2020
Total LULUCF	**69 803,457**	**69 811,005**	**69 774,987**	**69 810,248**	**69 798,108**	**69 799,561**	**184 353,264**	**176 322,394**
A. Forest (F) tCO2	6 541,121	6 548,669	6 512,651	6 547,912	6 535,772	6 537,225	-15 492,827	-15 530,745
1. Forests maintained Forests (FF) tCO2	-3 432,533	-3 432,533	-3 432,533	-3 432,533	-3 432,533	-3 432,533	-12 204,108	-11 998,046
2. Land converted to forest (TF) tCO2	2 584,663	2 584,663	2 584,663	2 584,663	2 584,663	2 584,663	-5 216,993	-5 384,080
3. Burning (non-CO2)	613,925	621,473	585,455	620,716	608,576	610,029	1 928,274	1 851,381
B. Crops (C) tCO2	385,792	385,792	385,792	385,792	385,792	385,792	2 760,166	2 626,268
1. Crops kept in Cultivation (CC) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted to crops (TC) tCO2	385,792	385,792	385,792	385,792	385,792	385,792	2 760,166	2 626,268
C. Grasses (G) tCO2	62 201,650	62 201,650	62 201,650	62 201,650	62 201,650	62 201,650	197 085,925	189 226,871
1. Maintained grasses Grasses (GG) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	3 592,350	4 455,219
2. Land converted to grass (TG) tCO2	62 201,650	62 201,650	62 201,650	62 201,650	62 201,650	62 201,650	193 493,575	184 771,652
D. Water/Wetlands (A)(2) tCO2	519,148	519,148	519,148	519,148	519,148	519,148	0,000	0,000

1. waters/wetlands maintained as wetlands (AA) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted to water/wetlands (TA) tCO2	519,148	519,148	519,148	519,148	519,148	519,148	0,000	0,000
E. Urban settlements (U) tCO2	11,144	11,144	11,144	11,144	11,144	11,144	0,000	0,000
1. Urban settlements maintained as urban settlements (UU) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted into urban settlements (TU) tCO2	11,144	11,144	11,144	11,144	11,144	11,144	0,000	0,000
F. Other Land (O) (3) tCO2	144,601	144,601	144,601	144,601	144,601	144,601	0,000	0,000
1. Other Land held as Other Land (OO) tCO2	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2. Land converted into Other Land (TO) tCO2	144,601	144,601	144,601	144,601	144,601	144,601	0,000	0,000
G. Harvested wood products (HWP) (4) tCO2								

Source: Author's calculations, 2020

As can be seen, the emissions identified using this methodology are much higher than those identified in Angola's first inventory. The figures above show in more detail the sources and sinks of the two main sub-categories that account for more than 80% of emissions and removals from the LULUCF sector: Forests and grasslands.

When analysed in more detail, the two main sources are the forest-to-forest transitions, which move from a situation where forests were net sinks in 2005 to a situation where they are sources of emissions in 2015. Together, these transitions account for more than 95% of the sector's emission sources. The emissions found are about 50 times higher than those estimated in the first inventory.

2.7.2. Greenhouse gas emissions from biomass combustion

In order to estimate the area deforested by fires, different methodologies were evaluated and finally a methodology was selected, which is explained in this sub-section. The data sources used to estimate the area of forest loss were:

Annual forest area loss data provided by the GFC (Hansen et al., 2003).

FireCCI51 Burned Area dataset https://www.esa-fire-cci.org/FireCCI51

https://www.esa-fire-cci.org/node/1

There are several global burned area products available, but after a comparative review of the different data sources, we used the FIRECCI51 derived product from the European Space Agency's FIRE CCI project (https://www.esa-fire-cci.org). This approach aims to improve data consistency by using better algorithms in the pre-processing phase as well as for the detection of burned areas, while incorporating the FRAMEWORK of errors into its product.

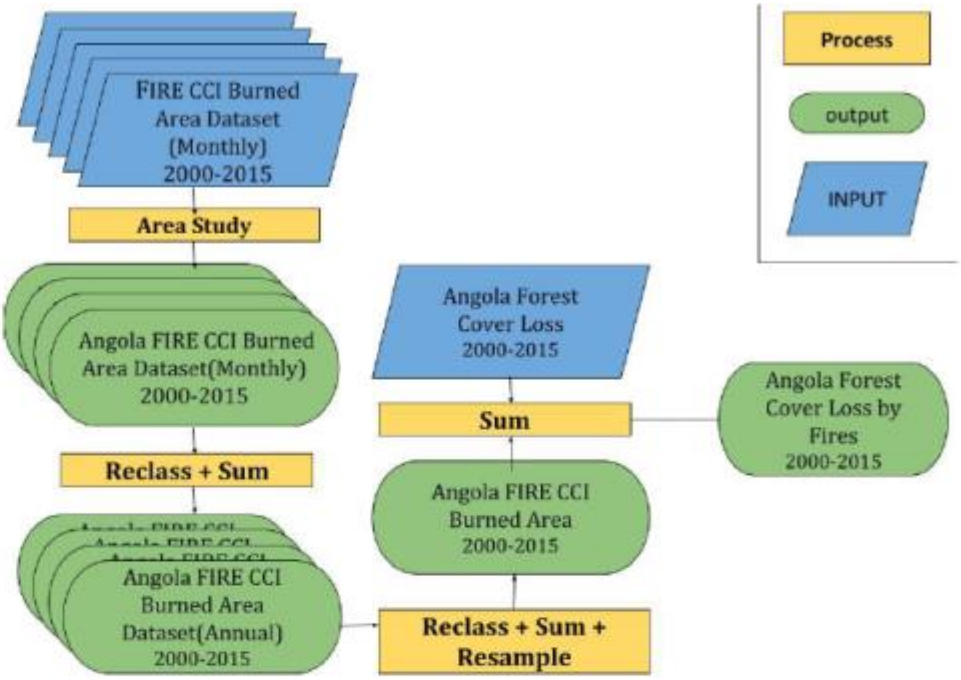
The FIRECCI51 product was obtained by combining different data from the MODIS (Moderate Resolution Imaging Spectroradiometer) sensor, located on the Terra (EOS a.m.) and Aqua (EOS p.m.) satellites of the National Aeronautics and Space Administration (NASA). These satellites cover the Earth's surface from north to south (Terra) and from south to north (Aqua) every 1-2 days, acquiring data in 36 spectral bands that, when combined (multispectral), provide information on two types of radiation from fires: infrared radiation and thermal radiation. The spatial resolution varies between 250 metres and 1 kilometre, depending on the spectral band used.

Specifically, there is combined information between MODIS spectral information with a resolution of 250 metres and thermal information from MODIS active fire products.

Specifically, to estimate the area affected by fires in Angola during the period 2000-2015, the FIRECCI51 pixel product with a resolution of 250-300 metres was used. A 5-year moving average was then applied to complete the data estimates for 2016, 2017 and 2018. The output of this survey includes the date of detection, the confidence level and the land cover corresponding to the burned pixel. The information is available for each month analysed.

The workflow after obtaining the FIRECCI51 product, summarised in the figure below, is briefly explained.

Figure 10: Fire activity data calculation workflow



Source: University of Córdoba, Spain.

The main processing steps are:

1. The data obtained from the burned area dataset (FIRE CCI) were "clipped" to the study area (Angola). In this way, a large amount of monthly burned area data was obtained for the 15 years of the reference period.

2. To work with the data, it was reclassified using the QGis software and added together to obtain only annual data for the reference period, which were then reclassified again to obtain the accumulated fire data for the reference period (2000-2015).

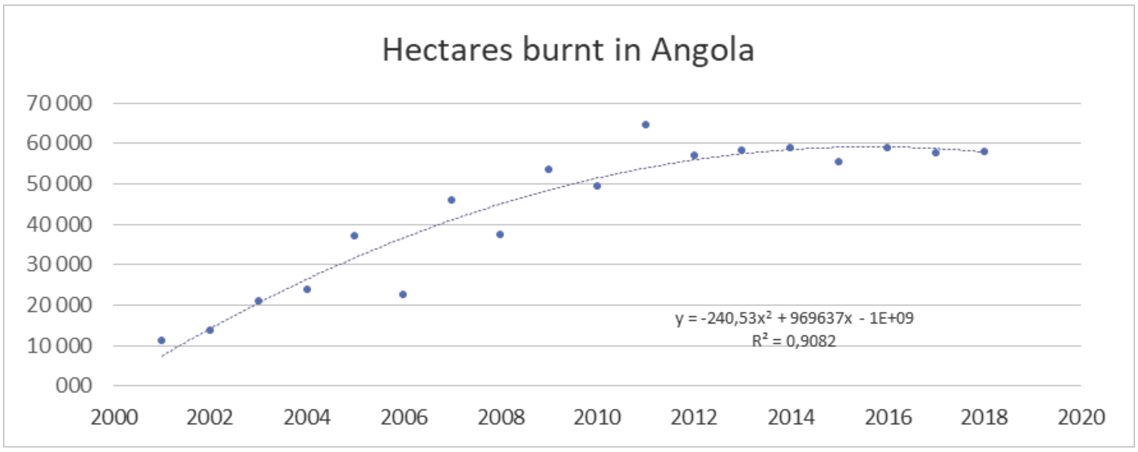
3. The model file of the resulting data was combined with the model file of Angola's forest area loss data, previously generated from data provided by the GFC (Angola Forest Loss 2000-2015), to obtain the result.

The result is a csv file of forest cover loss in Angola during the period in question (Angola Forest Cover Loss by Fires 2000-2015), with an associated model file that can be transformed into a map of accumulated forest cover loss caused by fires.

Thus, the area deforested by fires in the period in question was 609,157.53 ha (2000-2015), and by expanding the estimates by calculating the 5-year moving averages for 2016, 2017 and 2018, the total was 783,500.76 ha, with an annual average of 43,527.82 ha.

As the data on CO2 emissions and removals have already been calculated in the transition matrices, the emissions of non-CO2 greenhouse gases, namely CH4 and N2 O from forest fires, were estimated separately in this case. For this purpose, data on the areas (ha) affected by forest fires were used according to the information collected. The following figure shows the figures in hectares per year.

Chart 16: Hectares burnt in Angola



Source: University of Córdoba study and calculations by experts from the Lusophone Group.

Once the parameters and data were obtained, the calculations were carried out for each year of the reference period, using the equations adjusted for methane and nitrous oxide:

Logo = (A * (MB * Cf) * Gef)/1000

Being,

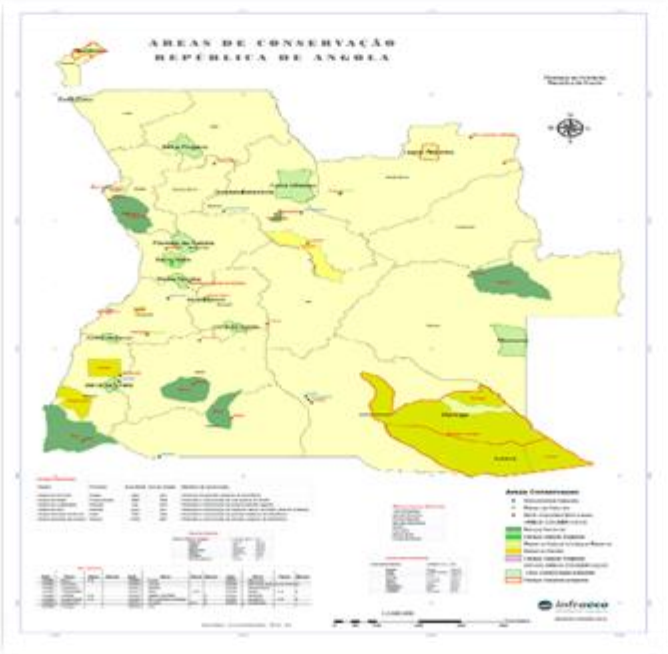
- A = the number of hectares concerned
- MB x Cf (t/ha) = mass of biomass burnt by carbon fraction, taken into account in the calculation in tonnes of carbon per hectare affected (42.2).
- Gef-N2 O = specific factor for the calculation of nitrous oxide emissions (0.2);
- Gef-CH4 = specific factor for the calculation of methane emissions (6.8)

2.7.3. Critical analysis and improvement points for future inventories

It's worth noting that the results described above are more accurate than those found in the first inventory and were developed during the training process supported by the Lusophone Centre. In order for the next version of the national inventory to be able to calculate emissions more accurately, it is necessary to know the types of transitions as well as the conversion factors based on more accurate imagery. The land use examples presented reflect the granularity of satellite data with a pixel size of 250 metres (Modis). It should be noted that the definition of forest used by Angola is quite small, i.e. a minimum of 0.5 hectares, with only 10% canopy cover and a potential height of 5 metres. The use of more detailed satellite imagery and geoprocessing with field data can improve the information and determine the benefits of forest production, afforestation and reforestation.

Other relevant information includes the division of the country by type of land use, burned areas by type of land use and type of vegetation. A quick look at Google Maps shows that there are large areas of protected land spread across the country. For each management unit, emissions can be calculated without transitions, as these can be caused by natural management. The following figure shows the areas that have been identified as nature reserves.

Figure 11: Conservation areas



Source: Author’s calculations.

2.8. WASTE SECTOR

The waste sector includes emissions of CH4, CO2 and N2 O, resulting from the final disposal and incineration of solid waste and wastewater treatment in the Republic of Angola, for the period 2005 to 2018, based on the application of the 2006 Methodological Guidelines of the Intergovernmental Panel on Climate Change (IPCC).

Table 50: Categories included in the waste sector

SECTOR	SUB-SECTOR	CATEGORY	DESCRIPTION
Waste and wastewaters	Solid waste disposal	Waste disposal on unmanaged sites	Dumps
		Waste disposal on managed sites	Landfill sites
	Incineration and open burning of waste	Incineration of waste	Incineration of waste
	Wastewater treatment and disposal	Treatment and disposal of domestic wastewater	Treatment and disposal of domestic wastewater
	Wastewater treatment and disposal	Treatment and disposal of industrial wastewaters	Treatment and disposal of industrial wastewaters

Table 51: Categories not included in the waste sector

SECTOR	CATEGORY	DESCRIPTION	JUSTIFICATION FOR EXCLUSION
Waste and wastewaters	Biological treatment of solid waste	Production of organic waste compost	NE- Not estimated. Emissions of CH_4 and N_2O in this section were not estimated due to difficulties in obtaining significant data from the country on the biological treatment of waste, composting and flaring of gas generated in landfills.

2.8.1. Methodological comments on the categories included in this inventory

Management of solid waste (5A)

Calculations of emissions from the disposal of solid urban waste were primarily based on national data from Angola, and where these were not available, IPCC default data were used.

The parameters used for the calculation were: population, degradable organic carbon, gravimetric composition of waste, waste generation rate per inhabitant, oxidation factor, methane recovery and IPCC default data.

The method used to estimate emissions from landfills (SWDS) was First Order Decay (FOD), from the IPCC 2006 Methodological Guidelines, Tier 1.

The equation used to calculate CH emissions4 according to the 2006 IPCC guidelines is described below:

$$CH_4 Emissions = \left[\sum_x CH_4 generated_{x,T} - R_T \right] * (1 - OX_T)$$

Where:

- T: year of inventory
- X: waste category or type of waste/material
- R: CH4 recovered in year T, Gg
- OX: oxidation factor in year T, %.

CH4 emissions were estimated using the data described below.

Population - The official population statistics were obtained from the National Statistics Institute (INE), in particular the projections for the period 1950-2014, which are the result of estimates from some censuses. According to the INE, the factors that contribute to the projections are the birth rate, the death rate and the migration rate.

Table 52: Population of Angola 1950-2019

Year	1950	1960	1970	1975	1980	1985	1990	1995	2000	2005	2006	2007
Population (thousands)	7, 241	7, 466	7, 695	7, 928	8, 200	8, 409	9, 625	11, 102	12, 870	14, 948	15, 410	15, 889
Source: INE, Population Census.												
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Population (thousands)	16, 368	16, 889	17, 430	17, 992	18, 577	19, 184	25, 789	26, 682	27, 504	28, 360	29, 250	30, 176
Source: INE, Population survey.[8]												

Degradable Organic Carbon - The DOCx was obtained from the default value in the IPCC 2006 Guidance, Section 2.3.1 Table 2.4, using the waste composition in Table 1, resulting in a value of 0.1894.

Gravimetric waste composition - The last waste FRAMEWORK in Luanda was carried out in 2012 (as shown in the table) by UAN in partnership with the Luanda Sanitation Company (ELISAL). The two partners, ELISAL and UAN, are currently working on a new waste FRAMEWORK to be carried out at a later date for all Angolan provinces.

Table 53: Municipal solid waste generations by waste category (Angola)

Annual production	4,482,179	4,836,830	5,202,675	5,579,714	5,967,947	6,367,373
Organic matter	1,120,544	1,209,207	1,300,668	1,394,928	1,491,986	1,591,843
Plastic	672,326	725,524	780,401	836,957	895,192	955,106
Paper and cardboard	717,148	773,892	832,428	892,754	954,871	1,018,779
Textiles	358,574	386,946	416,214	446,377	477,435	509,389
Glass	313,753	338,518	364,187	390,580	477,435	445,716
Metals	313,753	338 .518	364,187	390,580	477,435	445,716
Other inorganic materials	313,753	338,518	364,187	390,580	477,435	445,716
Sand and earth	672,327	725,524	780,401	836,957	895,192	955,106

Source: Agostinho Neto University and Elisal

Table 54: Composition of Municipal Solid Waste

MSW production	Organic matter	Plastic	Paper and cardboard	Textiles	Glass	Metals	Other inorganic materials	Sand and earth
%	25%	15%	16%	8%	7%	7%	7%	15%

Source: Agostinho Neto University and Elisal.

[8] https://www.ine.gov.ao/images/Populacao_Sociedade/ANUARIO_ESTATISTICA_SOCIAIS_2011_2016.pdf (1990 to 2016) and https://www.ine.gov.ao/indicadores-estatisticos/populacao from 2016 to 2019

2.8.1.1. Waste generation rate

Data on the rate of solid waste generation per inhabitant (RSD rate) were estimated based on the number of inhabitants in the country. These data were taken from the Strategic Plan for Urban Solid Waste Management (PESGRU). For the years 2006-2011, the per capita waste value (kg/cap./year) was calculated using the interpolation method.

According to the Strategic Plan for the Management of Municipal Solid Waste (PESGRU), the generation of municipal solid waste in Angola is estimated at 0.46 kg/cap./day, which is higher in the areas with the highest urban concentration in 2012.

The generation per inhabitant varies between 0.5 and 0.8 kg/inhab.day.

Table 55: Average solid waste generation per inhabitant per day

UP TO 100,000 INHAB.	0.5KG / INHAB. / DAY
From 100,0 01 to 500,000 inhab.	0.6kg / inhab. / Day
From 500,001 to 1,000,000 inhab.	0.7kg / inhab. / Day
More than 1,000,000 inhabitants	0.8kg / inhab. / Day

Source: Presidential Decree No. 196/12 - Strategic Plan for Urban Waste Management (PESGRU)

PESGRU carried out these variation calculations based on these data and the urban population of the municipalities in the Republic of Angola. As a weighting factor, a municipal solid waste generation rate was obtained for the inventory years for this report (2006-2018).

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Generation per inhabitant varies between 0.5 and 0.8kg/inhab.day

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Up to 100,000 inhab.	0.5kg / inhab. / Day
From 100,0 01 to 500,000 inhab.	0.6kg / inhab. / Day
From 500,001 to 1,000,000 inhab.	0.7kg / inhab. / Day
More than 1,000,000 inhabitants	0.8kg / inhab. / Day

Source: Presidential Decree No. 196/12 - Strategic Plan for Urban Waste Management (PESGRU)

PESGRU carried out these variation calculations based on these data and the urban population of the municipalities in the Republic of Angola. As a weighting factor, a municipal solid waste generation rate was obtained for the inventory years for this report (2006-2018).

Emissions from solid waste disposal on unmanaged sites accounted for 70% of the sites.

Table 57: Methane emissions from solid waste treatment

Methane emissions					
Solid Waste Treatment					
Sites					
Not Handled		Not Handled		Not Handled	Not Handled
Not Handled depth <5m	Not Handled depth >5m	Handled	Handled semi-aerobically		
25%	30%	25%	5%	15%	100%
MCF					
0.4	0.8	1.0	0.5	0.6	0.7

Source: Presidential Decree No. 196/12 - Strategic Plan for Urban Waste Management;

Table 58: Estimated waste generation based on population and average waste generation rate from the Strategic Plan for Urban Waste Management (PESGRU)

Year	Projected Population (people)	Waste generation rate (kg/cap./year)	Total MSW (Gg)
1950	7,241,000	109.50	792,890
1960	7,465,959	109.50	817,523
1970	7,695,474	109.50	842,654
1975	7,927,525	109.50	868,064
1980	8,200,381	109.50	897,942
1985	8,408,710	109.50	920,754
1990	9,624,775	109.50	1,053,913
1995	11,102,110	109.50	1,215,681
2000	12,870,494	109.50	1,409,319
2005	14,948,178	127.75	1,909,630
2006	15,410,205	132.84	2,047,033
2007	15,888,562	138.13	2.1 94.608
2008	16,367,880	143.62	2,350,825
2009	16,888,858	149.34	2,522,226
2010	17,429,637	155.29	2,706,622
2011	17,992,033	161.47	2,905,195
2012	18,576,568	167.90	3,119,006
2013	19,183,590	233.69	4,483,018
2014	25,789,024	186.75	4,816,105
2015	26.68 1,590	195.00	5,202,985
2016	27,503,526	202.90	5,580.429
2017	28,359,634	210.51	5,969,975
2018	29,250,009	217.69	6,367.375

Source: Presidential Decree No. 196/12 - Strategic Plan for Urban Waste Management; First National Communication Report; INE Angola: Statistical Yearbook 2011/Population Projection 2014-2050.

Type of waste treatment

The following table describes the type of waste treatment for each province of the Republic of Angola in the inventory years and the estimated future waste production (unit: tonne/day).

Table 59: Type of waste treatment by province and estimated waste generation in tones/day

Province	Type of treatment	Quantities produced (Tonnes/year)	Quantities produced (Tonnes/year)
		1st phase	2nd phase
		(2010 - 2015)	(2016 - 2020)
		2015	2020
Bengo	Open bin	630	916
Benguela	Controlled rubbish dump	2,892	4,146
Bié	Waste bin	2,459	3,525
Cabinda	Landfill	362	519
	Controlled rubbish dump		
Cuando Cubango	Waste bin	910	1.305
Kwanza Norte	Waste bin	895	1.283
Kwanza Sul	Waste bin	2,283	3,274
Cunene	Open bin	942	1.35
Huambo	Landfill	3,048	4.37
	Open bin		
Huila	Controlled rubbish dump	2,135	3,062
Luanda	Landfill	5,893	8.45
	Open bin		
	Incineration		
Lunda Norte	Waste bin	959	1,376
Lunda Sul	Controlled/open dump	717	1,028
Malanje	Waste bin	1,366	1959
Moxico	Waste bin	511	733
Namibe	Waste bin	429	615
Uige	Waste bin	3,559	5.103
Zaire	Waste bin	496	711

Source: National Solid Waste Management Plan (PNGRS)

Oxidation factor (OX)

The OX reflects the amount of methane from landfills that is oxidised in the soil or other material used to cover the deposited waste. The default value from the IPCC 2006 Guidance was used, which considers the oxidation factor to be 0 for landfills serving Angola.

Methane recovery - Methane recovery was assumed to be zero due to the lack of concrete data on recovery activity.

2.8.1.2. IPCC standard data

Some of the data used were derived from the IPCC default values (IPCC, 2006):

- Dissimilated degradable organic carbon (DOCf) fraction (0.5);
- Methane fraction in biogas (0.5);
- Methane correction factor - The MCF value is given in the table above for the different types of site conditions, resulting in a factor of 0.7;
- Decay constant - k (0.17). Based on humid tropical climate and bulk waste, according to IPCC 2006;
- Incineration and open burning of waste (5C);
- Incineration of waste (5C1);

To calculate emissions from waste incineration, data on the total amount of solid medical waste incinerated from 2005 to 2018 was obtained from the Luanda Sanitation Company (ELISAL).

There are currently two private companies in the province of Luanda that collect and incinerate hospital waste from private clinics and public services.

Incineration is a radical method of waste disposal that destroys the waste and eliminates its hazardousness, thus limiting the transmission of diseases through hospital waste. However, incineration is not the best way to treat and dispose of waste as it produces fumes and ashes that cause environmental and public health problems.

The estimated production of hospital and healthcare waste represents about 0.3% of the estimated production of municipal waste in Angola.

Despite being a waste stream with little quantitative expression, the hospital waste stream requires proper management as a priority, given the risk it poses to public health and environmental sustainability.

According to the Hospital Waste Management Plan, there will be an opportunity to establish ecologically viable waste processing and disposal units and to extend these initiatives to as many health units as possible. The control of all hospital waste throughout the country should be achieved in a phased manner, taking advantage of "good practices" acquired over time.

In general, the incineration category includes hospital and healthcare waste (HCW) and hazardous industrial waste (HIW). However, for the inventory years (2013-2018), only CW incineration was considered as it was the only waste for which information was available from official data (ELISAL). CW incineration is carried out in Angola to destroy pathogenic micro-organisms, but on a small scale.

To calculate the estimates, mass values for hospital and health care waste were obtained from information from the landfill in Luanda province. For the other parameters, standard values from the IPCC 2006 guidelines were used.

We were able to collect some information on hazardous waste from the Mulenvos landfill (ELISAL) and the AES operator (a company providing services to the oil and gas industry).

The AES operator receives waste from industries within and outside Luanda Province and has a high temperature incinerator (HTIU) on its premises at the Sonils base.

Table 60: Incinerated waste data

Year	Total Incinerated Waste (tonnes)
2005	351,179.64
2006	388. 094.20
2007	403,590.19
2008	432,343.65
2009	463,846.10
2010	517,762.33
2011	534,495.43
2012	573,694.15
2013	844,740.11
2014	904,301.62
2015	974,279.20
2016	1,058,694.36
2017	1,124,278.39
2018	1,205,695.60

The equations used to calculate emissions from waste incineration were those given in the IPCC Guidelines (2006), Volume 5, Chapter 5.

Equation for estimating CO2 emissions from waste incineration:

$$CO_2 Emissions = \sum_i (SW_i \bullet dm_i \bullet CF_i \bullet FCF_i \bullet OF_i) \bullet 44/12$$

Where:

- CO2 emissions: CO2 emissions in the inventory year, Gg / year
- SWi: total quantity of solid waste type i (wet weight) incinerated or burned in the open, Gg/year
- dmi: dry matter content in the residue (wet weight) incinerated or burned in the open (fraction)
- CFi: carbon fraction in dry matter (total carbon fraction)
- FCFi: fraction of fossil carbon in total carbon (fraction)
- OFi: oxidation factor (fraction)
- 44/12: conversion factor from C to CO2

i: Type of waste burned/incinerated in the open air, such as municipal solid waste (MSW), industrial solid waste (ISW), sewage sludge, hazardous waste, clinical waste, etc.

Equation to estimate CH emissions4 from incineration:

$$\text{CH emissions4} = \sum (IWi \bullet EFi) \bullet 10^{-6}$$

IWi = quantity of solid waste type i incinerated or burned in open air, Gg / year

EFi = total CH_4 emission factor, kg CH_4 / Gg waste

10^{-6} = conversion factor from kilograms to gigagrams

i = category or type of waste incinerated or burned in the open air, specified as follows

MSW: municipal solid waste; ISW: industrial solid waste; HW: hazardous waste,

CW: clinical waste, SS: sewage sludge, other (to be specified)

Equation for the estimation of N_2O emissions from incineration:

N_2O emissions = $\sum (IW_i \bullet EF_i) \bullet 10^{-6}$.

N_2O emissions: N_2O emissions in the inventory year, Gg/year

IW_i: quantity of type i waste incinerated/burnt, Gg/year

EF_i: N_2O emission factor (kg N_2O/Gg waste) for type i waste

10^{-6}: conversion from kilograms to gigagrams

i: category or type of waste incinerated/burnt in the open (municipal solid waste, industrial solid waste, hazardous waste, clinical waste, sewage sludge, etc.)

2.8.2. Open burning of waste (5C2)

The burning of residues in the soil contributes to changes in the levels of some essential mineral elements. The action of fire on the soil can increase the levels of N, P, K, Ca and Mg due to their mineralisation after burning, making high concentrations of these minerals available in the ash.

Most provinces do not have a landfill site and waste is disposed of in the open. People also use the practice of burning waste. Burning waste under less-than-ideal combustion conditions produces harmful particles and gases, typically called a "smoke screen", including carbon monoxide (CO), methane (CH_4) and other light hydrocarbons, volatile organic compounds (VOCs) such as benzene, and semi-volatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs). Depending on the source, varying amounts of metals, such as lead (Pb) or mercury (Hg), can be emitted, as well as polychlorinated dibenzenedioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) or polychlorinated biphenyls (PCBs) (US EPA, 2002).

There was great difficulty in finding official information for this area. However, part of the population, which doesn't benefit from the waste collection system (especially in hard-to-reach areas), has two options: burn or bury.

Burning is also done after collection, in the rubbish tip or "landfill"

The mass of MSW burnt in the open (MSW) was estimated using equation 5.7 (IPCC, 2006; V.5, Ch5, p.5.16). This formula is normally used when data on the quantity of waste is not available.

$$MSW_B = P \bullet P_{frac} \bullet MSW_P \bullet B_{frac} \bullet 365 \bullet 10^{-6}$$

Where:

- MSWB: total quantity of municipal solid waste burnt in the open,
- Gg/year
- P: population (per capita)
- Pfrac: fraction of the population burning waste, (fraction)
- MSW: per capita waste generation, kg of waste/per capita/day
- Bfrac: fraction of the amount of waste that is burnt in the open in relation to the total amount of waste treated.

365: number of days in the year.

10-6 : conversion factor from kilogram to gigagram.

Therefore: the fraction of the population was obtained from the 2014 census data on solid waste and wastewater. Of the total of 5,544,835 households, 1,108,967 (20 %) burn their waste due to a lack of collection or disposal sites. The average number of people per household is 4.6. The fraction of the amount of waste that is burnt in relation to the total amount of waste treated is approximately 20 % (Source: Elisal).

According to the Ministry of Environment's technical note, 20 % of the Angolan population burns their waste due to a lack of access to a waste management and treatment system in the areas where they live. However, there are some provinces in the Republic of Angola where sporadic burning takes place in controlled rubbish dumps, due to the lack of landfill sites.

Once the value for the total amount of waste burnt in the open was found, the standard values from the IPCC 2006 guide were added to obtain the emissions.

2.8.3. Waste water treatment and disposal (5D)

2.8.4. Domestic waste water treatment and disposal (4.D.1)

Domestic wastewater is produced after water is used in the home, whether for washing clothes, washing dishes, bathing or flushing toilets, or for commercial and industrial activities. This wastewater can contaminate the environment and cause disease. It is therefore important that wastewater is collected and treated in appropriate facilities.

Wastewater with a high organic content, such as domestic wastewater and wastewater from the food and beverage and pulp and paper industries, has a high potential for CH4 emissions. Domestic sewage is also a source of N2 O emissions due to the nitrogen content of human food.

The estimation of emissions for this section was initially based on the calculation of total degradable organic matter in wastewater for each year of the inventory, using official population data from the Republic of Angola (RGPH 2014) and default values from the IPCC 2006 Guidelines (Volume 5, Chapter 6, Table 6.5, page 6.15) for the Federal Republic of Nigeria.

Following the guidance of the script, the team writing this report analysed and concluded that, in terms of sanitation and modus vivendi, our reality is similar to that of the Federal Republic of Nigeria, which is why the same Standard values were used.

Using the following equation TOW= P BOD-- 0.001 I-- 365

Where: TOW: total organic load of waste water in the inventory year, kg BOD/year

P: population of the country in the inventory year, (people)

BOD: country specific biochemical oxygen demand per capita in the inventory year, g/person/day 0.001: conversion from gram BOD to kg BOD

I: Correction factor for additional industrial BOD discharged to sewer (default is 1.25 for collected; default is 1.00 for uncollected).

BOD value= 37 for Africa

To calculate CH4 emissions, we used income distribution data from Nigeria and treatment types from Nigeria and TOW from Angola.

The following equation was used to estimate nitrogen in wastewater:

$$N_{EFFLUENT} = \left(P \bullet PROTEIN \bullet F_{NPR} \bullet F_{NON-CON} \bullet F_{IND-COM}\right) - N_{SLUDGE}$$

Where:

WASTEWATER: total annual amount of nitrogen in the wastewater effluent, kg N/year

P: human population

Protein: annual protein consumption per capita, kg/person/year

FNPR: fraction of nitrogen in protein (default = 0.16, kg N/kg protein)

FNON-CON: factor for unconsumed protein added to wastewater

FIND-COM: factor for industrial and commercial protein eliminated in the sewerage system

NSLUDGE: nitrogen removed with sludge (default = zero), kg N/year

Table 61: Protein consumption (g/capita/day) of domestic and industrial waste water

Year	Protein intake (g / cap. / day)
2005	45.4
2006	45.4
2007	47.55
2008	49.7
2009	53.4
2010	53.4
2011	54.7
2012	56
2013	56
2014	58.96
2015	60.5
2016	62

2017	63.5
2018	65.1

Source: FAOSTAT Angola

Table 62: Emission factor for domestic waste water treatment kg CH4 / kg BOD

Emission factors	Maximum methane production capacity B0	Methane correction factor for each system	Methane emission factor E_{FJ}
	KG CH4 / KG BOD	**MCFJ**	**KG CH4 / KG BOD**
Septic System	0.6	0.5	0.3
Discharge into the sea, river and lakes	0.6	0.1	0.06
Drains	0.6	0.1	0.06

Table 63: Types of domestic waste water treatment in Angola (2014 census)

Households connected to the public sewerage system	Households connected to septic tanks	Households connected to an open pit (ditch or river)	Homes without a toilet/outdoors	Others	Total households in the 2014 census
198092	3126278	256079	1964364	22	5544835
3.572%	56.38%	4.61%	35.42%	0.02%	100%

Table 64: Treatment and disposal of industrial waste water (5D2)

Waste	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Solid Waste Treatment	760, 425	789, 485	822, 294	858, 939	899, 575	944, 554	994, 126	1048, 628	1108, 286	1219, 168	1337, 365	1462, 867	1595, 665	1735, 751	1753, 109	1833, 752
Domestic Wastewater Treatment	905, 278	933, 757	970, 735	1008, 833	1056, 446	1090, 243	1131, 738	1174, 235	1212, 807	1656, 816	1716, 940	1779, 978	1845, 581	1915, 821	1934, 979	2023, 988
Industrial Wastewater Treatment	6, 688	6, 688	8, 401	6, 083	19, 808	22, 986	23, 076	22, 747	22, 747	44, 631	45, 975	47, 388	48, 853	50, 404	46, 876	44, 250
Biological Treatment of Solid Waste	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000	0, 000
Waste Incineration	13, 105	31, 244	15, 060	16, 133	17, 309	36, 647	19, 945	21, 408	48, 849	46, 143	51, 058	67, 225	64, 609	74, 504	75, 249	78, 711
															thousand tones CO2 eq	

Source: Author’s calculations.

Industrial wastewaters are liquid and gaseous wastes from industrial activities.

In its report, the Ministry of Industry and Trade considered some industries that are likely to emit greenhouse gases in their production processes, according to the IPCC 2006 classification. In this case, for Angola's specific situation, only the cement, brick and tile, lime, food and beverage industries can be singled out. Only the structural industries, such as the production of basic chemical products and basic minerals, emit greenhouse gases in their production processes. There are currently no such industries in the country due to a lack of major investment.

For this report, emissions from the brewing industry were calculated using annual production data (t/year) from the Ministry of Industry and Trade's GHG emissions report. For the others, default values from the IPCC 2006 Guidelines were used.

2.8.5. Results of the inventory of GHG emissions by sources and removals by sinks

All emissions are reported in GgCO e.2.

Greenhouse gas emissions.

The following table shows the emission results for each greenhouse gas in each year covered by the inventory, as well as the total value of annual emissions. According to the results obtained, the total emissions from the waste sector show a relatively increasing trend over the period covered by this inventory, from 2006 to 2018, with emissions totalling 718.3 GgCO2 e in 2005 and 1,948.2 GgCO2 e in 2018.

The calculation of emissions for the waste sector resulted in emissions of CO2 (carbon dioxide), CH4 (methane) and N2O (nitrous oxide). CH4 was the dominant gas over the period 2005 to 2018, accounting for more than 95% of emissions from the waste sector.

The following table shows the methane emissions from solid waste.

Table 65: Methane emissions from solid waste

Methane emissions														
Solid Waste Treatment														
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	760,425	789,485	822,294	858,939	899,575	944,554	994,126	1048,628	1108,286	1,219,168	1337,365	1462,867	1595,665	1735,751
Thousand tonnes CO2 eq														

Source: Author's calculations.

2.8.6. Waste incineration

Waste incineration in Angola covers hazardous waste or the open burning of solid waste. For the first case, data were collected for a few years, only for hazardous waste (2006) and clinical waste (2010 and 2013 to 2018). For the second case, the IPCC standard factors were applied, assuming that 20% of the population uses this practice. The results are shown below:

Table 66: CO2 emissions from burning hazardous waste

Year	Total Waste Incinerated thousand tonnes	dm dry matter content	CF Carbon fraction in dry matter	FCF Fraction of Fossil Carbon in Total Carbon	OF Oxidation fraction	Fossil CO_2
2005	0.000	1.0	0.6	0.4	1.0	0.000
2006	11,445	1.0	0.4	1.0	1.0	16,786
2007	0.000	1.0	0.6	0.4	1.0	0.000
2008	0.000	1.0	0.6	0.4	1.0	0.000
2009	0.000	1.0	0.6	0.4	1.0	0.000
2010	20,019	1.0	0.6	0.4	1.0	17,617
2011	0.000	1.0	0.6	0.4	1.0	0.000
2012	0.000	1.0	0.6	0.4	1.0	0.000
2013	20,019	1.0	0.6	0.4	1.0	17,617
2014	14,325	1.0	0.6	0.4	1.0	12.606
2015	16,987	1.0	0.6	0.4	1, 0	14,949
2016	32,027	1.0	0.6	0.4	1.0	28,184
2017	26,176	1.0	0.6	0.4	1.0	23,035
2018	34,099	1.0	0.6	0.4	1.0	30,007
Note: For 2006, the figure refers to hazardous waste.						
For the other years, it refers to clinical waste (Health Residues).						

Source: Author's calculations.

Table 67: CH4 and N2 emissions from incineration of hazardous waste

Year	Emission Factor kg CH_4 /Gg Wet waste	CH emissions$_4$ Gg	Emission Factor kg N_2O /Gg Wet waste	N emissions$_2$ O Gg
2005	200	0.000	60	0.000000
2006	200	0.002	100	0.001145
2007	200	0.000	60	0.000000
2008	200	0.000	60	0.000000
2009	200	0.000	60	0.000000
2010	200	0.004	60	0.001201
2011	200	0.000	60	0.000000
2012	200	0.000	60	0.000000
2013	200	0.004	60	0.001201
2014	200	0.003	60	0.000859
2015	200	0.003	60	0.001019
2016	200	0.006	60	0.001922
2017	200	0.005	60	0.001571
2018	200	0.007	60	0.002046

Source: Author's calculations.

Table 68: Inputs for calculating emissions from open burning

Year	Population millions	Fraction of the population burning waste	Waste generation per capita kg/cap/day	Fraction of burnt waste relative to total waste	Number of days in the year	Total Waste Burned Gg/year
2005	14.94	0.92	0.35	0.2	365	351,180
2006	15.41	0.92	0.3 6	0.2	365	376,649
2007	15.88	0.92	0.38	0.2	365	403,590
2008	16.36	0.92	0.39	0.2	365	432,344
2009	16.88	0.92	0.41	0.2	365	463,846
2010	17.42	0.92	0.43	0.2	365	497,743
2011	17.99	0.92	0.44	0.2	365	534,495
2012	18.57	0.92	0.46	0.2	365	573,694
2013	19.1 8	0.92	0.64	0.2	365	824,721
2014	25.9	0.92	0.51	0.2	365	889,977
2015	26.68	0.92	0.53	0.2	365	957,292
2016	27.5	0.92	0.56	0.2	365	1,026,667
2017	28.35	0.92	0.58	0.2	365	1,098,102
2018	29.25	0.92	0.60	0.2	365	1,171,597

Source: Author's calculations.

Table 69: CO2 emissions from open burning

Year	Dry matter content (dm)	Carbon fraction in dry matter CF	Fraction of fossil carbon in total carbon FCF	Oxidation factor	Fossil CO2 emissions Gg
2005	0.57	0.32	0.04	0.58	5.499
2006	0.57	0.32	0.04	0.58	5.844
2007	0.57	0.32	0.04	0.58	6.262
2008	0.57	0.32	0.04	0.58	6.708
2009	0.57	0.32	0.04	0.58	7.197
2010	0.57	0.32	0.04	0.58	7,723
2011	0.57	0.32	0.04	0.58	8.293
2012	0.57	0.32	0.04	0.58	8,902
2013	0.57	0.32	0.04	0.58	12,797
2014	0.57	0.32	0.04	0.58	13.809
2015	0.57	0.32	0.04	0.58	14,853
2016	0.57	0.32	0.04	0.58	15.930
2017	0.57	0.32	0.04	0.58	17.038
2018	0.57	0.32	0.04	0.58	18,179

Source: Author's calculations.

Table 70: CH4 and N2O emissions from open burning

Year	Emission Factor kg CH_4 /Gg Wet waste	CH emissions$_4$ Gg	Emission Factor kg N_2 O /Gg Wet waste	N emissions$_2$ O Gg
2005	300	0.105	50	0.018
2006	300	0.113	50	0.019
2007	300	0.121	50	0.020
2008	300	0.130	50	0.022
2009	300	0.139	50	0.023
2010	300	0.149	50	0.025
2011	300	0.160	50	0.027
2012	300	0.172	50	0.029
2013	300	0.247	50	0.041
2014	300	0.267	50	0.044
2015	300	0.287	50	0.048
2016	300	0.308	50	0.051
2017	300	0.329	50	0.055
2018	300	0.351	50	0.059

Source: Author's calculations.

Table 71: Total GHG emissions by incineration

Year	Fossil CO_2	CH emissions $_4$	N emissions O $_2$	Total
	Gg CO_2 equivalent			
2005	5.499	2,212	5,443	13.10 5
2006	22,630	2,421	6.193	31,244
2007	6.262	2,543	6.256	15,060
2008	6.708	2,724	6.701	16,133
2009	7.197	2.922	7.190	17,309
2010	25,340	3,220	8.087	36,647
2011	8.293	3,367	8.285	19,945
2012	8,902	3,614	8,892	21,408
2013	30,413	5.280	13,156	48,849
2014	26,415	5.677	14,061	46,143
2015	29,802	6.102	15,154	51,058
2016	44.114	6.603	16,509	67,225
2017	40,073	7.028	17,507	64,609
2018	48,186	7.524	18,794	74,504

Source: Author's calculations.

2.8.7. Domestic wastewater treatment

Greenhouse gas emissions from domestic wastewater in Angola are the most important in the waste sector, followed by emissions from solid waste. The main gases emitted in this activity are CH4 and N2 O, and the emissions of these gases are shown in the following tables.

Table 72: Degradable organic material in domestic waste waters

Year	Population	Degradable Organic Component	Degradable Organic Component	Correction factor for industrial BOD discharged into sewers	Degradable organic material in wastewaters TOW
	People	g BOD/cap/day	kg BOD/cap/year	L	kg BOD/year
2005	14,940,000	37	13,505	1	201,764,700
2006	15,410,000	37	13,505	1	208,112,050
2007	15,880,000	37	13,505	1	214,459,400
2008	16,360,000	37	13,505	1	220,941,800
2009	16,880,000	37	13,505	1	227,964,400
2010	17,420,000	37	13,505	1	235,257,100
2011	17,990,000	37	13,505	1	242,954,950
2012	18,570,000	37	13,505	1	250,787,850
2013	19,180,000	37	13,505	1	259,025,900
2014	25,900,000	37	13,505	1	349,779,500
2015	26,680,000	37	13,505	1	360,313,400
2016	27,500,000	37	13,505	1	371,387,500
2017	28,350,000	37	13,505	1	382,866,750
2018	29,250,000	37	13,505	1	395,021,250

Source: Author's calculations.

Table 73: Methane emissions in domestic waste waters

Year	CH_4 Emissions
	Gg CH_4
2005	35,068
2006	36,172
2007	37,275
2008	38,401
2009	39,622
2010	40,890
2011	42,228
2012	43.589
2013	45,021
2014	60,794
2015	62,625
2016	64,550
2017	66,545
2018	68,658

Source: Author's calculations.

Table 74: Nitrogen in the waste water discharged into the aquatic environment

Year	Population	Protein consumption per capita	Fraction of nitrogen in protein	Fraction of protein not consumed	Industrial and commercial protein fraction co-discharged	Nitrogen removed with sludge	Nitrogen in the wastewater discharged into the aquatic environment
							kg N/year
				Fnon-com	Find-com	Nsludge	Nwastewater
	People	kg/person/year	kg N/kg Protein	Fraction	Fraction	kg	kg N/yr
2005	14.940.000,00	16.57	0.16	1.4	1.25	0	69.319.807,20
2006	15.410.000,00	16.57	0.16	1.4	1.25	0	71.500.550,80
2007	15.880.000,00	17.36	0.16	1.4	1.25	0	77.170.606,80
2008	16.360.000,00	18.14	0.16	1.4	1.25	0	83.098.002,40
2009	16.880.000,00	19.49	0.16	1.4	1.25	0	92.122.262,40
2010	17.420.000,00	19.49	0.16	1.4	1.25	0	95.069.301,60
2011	17.990.000,00	19.97	0.16	1.4	1.25	0	100.570.216,60
2012	18.570.000,00	20.44	0.16	1.4	1.25	0	106.279.824,00
2013	19.180.000,00	20.44	0.16	1.4	1.25	0	109.770.976,00
2014	25.900.000,00	21.52	0.16	1.4	1.25	0	156.065.940,80
2015	26.680.000,00	22.08	0.16	1.4	1.25	0	164.965.108,00
2016	27.500.000,00	22.63	0.16	1.4	1.25	0	174.251.000,00
2017	28.350.000,00	23.18	0.16	1.4	1.25	0	183.982.995,00
2018	29.250.000,00	23.76	0.16	1.4	1.25	0	194.606.685,00

Source: Author's calculations.

Table 75: N2O emissions from domestic waste waters

Year	N2O emissions
	Gg NO_2
2005	0.545
2006	0.562
2007	0.606
2008	0.653
2009	0.724
2010	0.747
2011	0.790
2012	0.835
2013	0.862
2014	1,226
2015	1,296
2016	1,369
2017	1,446
2018	1.529

Source: Author's calculations.

2.8.8. Industrial wastewater treatment

The treatment of industrial waste water has been estimated for the brewing and malting industry. In fact, it is the main industry with significant industrial wastewater. With the available data it was possible to estimate the beer and malt production from 2005 to 2013. For the period from 2014 to 2015, consumption data of 59 litres/capita was used, and as Angola is self-sufficient in beer production, the estimate based on consumption is conservative, as beer imports must be small and would be an overestimate, as consumption would be slightly higher than production.

The calculation of waste water emissions in the brewing and malting industry is shown in the following tables:

Table 76: Degradable organic material in the brewing and malting industry

Year	Total production in the brewing and malting industry	Wastewaters generated	Chemical oxygen demand	Degradable organic material
	Pi	Wi	CODi	TOWi
	t / year	m3 / t	kg COD / m3	kg COD / year
2005	232,417	6.3	2.90	4,246,262.93
2006	232,417	6.3	2.90	4,246,262.93
2007	291,945	6.3	2.90	5,333,830.66
2008	211.407	6.3	2.90	3,862,401.09
2009	688,376	6.3	2.90	12,576,621.07
2010	798,826	6.3	2.90	14,594,547.50
2011	801,954	6.3	2.90	14,651,707.68
2012	790,496	6.3	2.90	14,442,358.34
2013	790,496	6.3	2.90	14,442,358.34
2014	1,551,022	6.3	2.90	28,337,162.81
2015	1,597,732	6.3	2.90	29,190,559.99

2016	1,646,838	6.3	2.90	30,087,721.13
2017	1,697,740	6.3	2.90	31,017,705.23
2018	1,751,636	6.3	2.90	32,002,394.29

Source: Author's calculations.

Table 77: Methane emissions in the brewing and malting industry

Year	CH4 emissions
	Gg CH 4
2005	0.318
2006	0.318
2007	0.400
2008	0.290
2009	0.943
2010	1,095
2011	1,099
2012	1,083
2013	1,083
2014	2,125
2015	2,189
2016	2,257
2017	2,326
2018	2,400

Source: Author's calculations.

2.8.9. GHG emissions by category

The results of the emissions by category in the waste and wastewater sector show a predominance of emissions from the Domestic Wastewater category, which accounts for 50.73% of emissions from the waste sector, followed by the Solid Waste Disposal in Unsupervised Sites category, which accounts for 45.96% of emissions from the waste sector.

The results highlight the importance of the solid waste disposal category compared to the other categories, as well as the growth of these emissions over the period analysed. As shown in Figures 3 and 4, this category accounted for more than 67% of total emissions from the waste and wastewater sector between 2005 and 2018.

Emissions from waste incineration accounted for about 2% and emissions from industrial waste water accounted for 1.34% of total emissions from the waste sector.

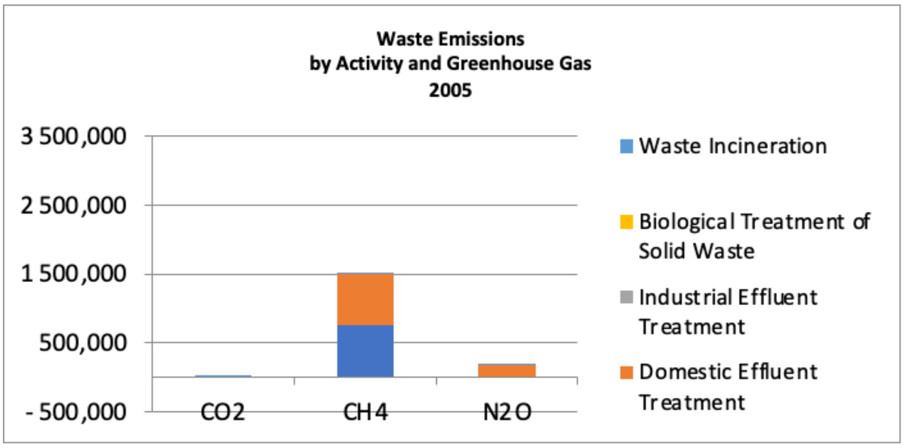
There was a continuous upward trend in emissions from the waste and wastewater sector over the period analysed, i.e. from 2005 to 2020, as shown in the table below.

Table 78: GHG emissions (Gg CO2e) from 2005 to 2020

Waste	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Solid Waste Treatment	760,425	789,485	822,294	858,939	899,575	944,554	994,126	1 048,628	1 108,286	1 219,168	1 337,365	1 462,867	1 595,665	1 735,751	1 753,109	1 833,752
Domestic Wastewater Treatment	905,278	933,757	970,735	1 008,833	1 056,446	1 090,243	1 131,738	1 174,235	1 212,807	1 656,816	1 716,940	1 779,978	1 845,581	1 915,821	1 934,979	2 023,988
Industrial Wastewater Treatment	6,688	6,688	8,401	6,083	19,808	22,986	23,076	22,747	22,747	44,631	45,975	47,388	48,853	50,404	46,876	44,250
Biological Treatment of Solid Waste	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Waste Incineration	13,105	31,244	15,060	16,133	17,309	36,647	19,945	21,408	48,849	46,143	51,058	67,225	64,609	74,504	75,249	78,711
Total	1 685,496	1 761,174	1 816,491	1 889,989	1 993,139	2 094,430	2 168,886	2 267,018	2 392,688	2 966,758	3 151,339	3 357,458	3 554,708	3 776,480	3 810,213	3 980,701

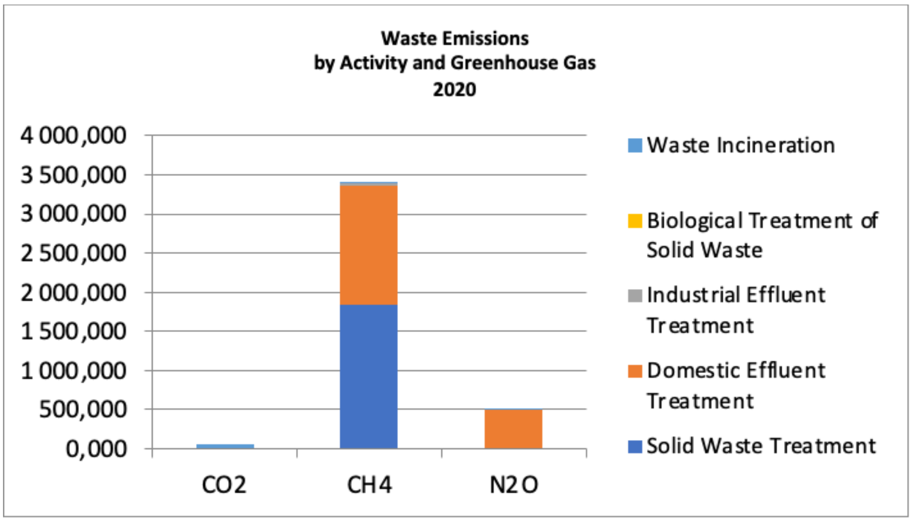
Source: Author's calculations.

Chart 17: Emissions from the waste and waste water sector by category in 2005



Source: Author's calculations.

Chart 18: Emissions form the Waste and Waste water sector by category in 2020



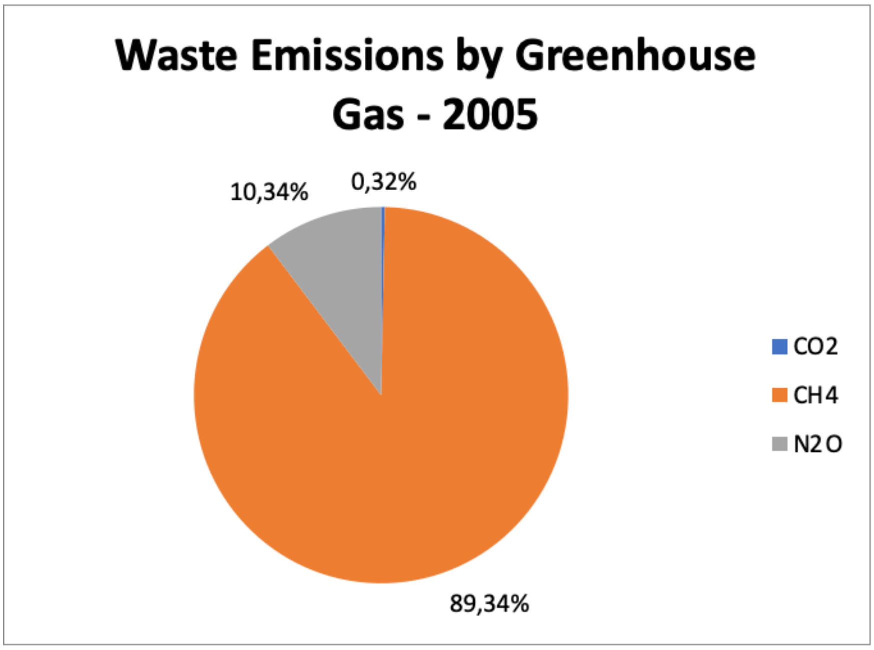
Source: Author's calculations.

2.8.10. Emissions from the waste and wastewater sector by GGE

The results of the emissions by category in the waste and wastewater sector show a predominance of methane gas emissions, which accounted for more than 85% of the sector's emissions over the whole period from 2005 to 2018, followed by nitrous oxide emissions, which accounted for more than 10% over the whole period.

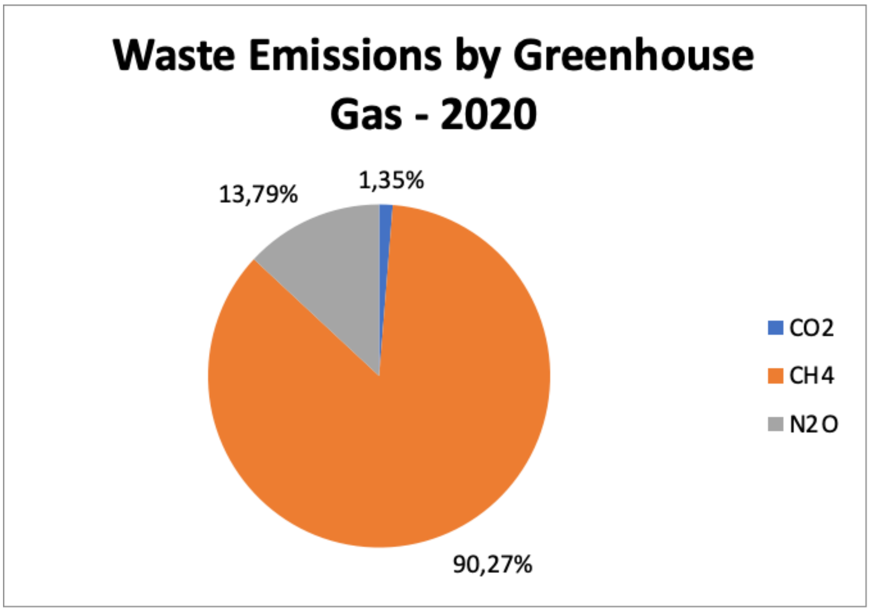
The results highlight the importance of methane emissions and the 114.87% increase in these emissions over the period. As shown in Figures 20 and 21, this gas accounted for the largest share of emissions from the waste and wastewater sector between 2005 and 2018.

Chart 19: Emissions from the waste and waste water sector by gas in 2005



Source: Author's calculations.

Chart 20: Emissions from the waste and waste water sector by gas in 2020



Source: Author's calculations.

CO2 emissions accounted for a share of less than 2% over the entire period. There was a continuous upward trend in emissions from the Waste and Effluent sector during the period analysed, from 2005 to 2018, as shown in the table below.

Emissions from Waste Treatment

Table 79: Emissions from the waste and waste water sector by GHG

	Gg CO2 equivalent						
YEAR	**CO2**	**%**	**CH4**	**%**	**N2O**	**%**	**Total**
2005	5.499	0.32%	1,505,760	89.34%	174,287	10.34%	1,685,496
2006	22,630	1.28%	1,558,196	88.47%	180,348	10.24%	1,761,174
2007	6.262	0.34%	1,616.007	88.96%	194,221	10.69%	1,816,491
2008	6.708	0.35%	1,674,177	88.58%	209,104	11.06%	1,889,989
2009	7.197	0.36%	1,754,369	88.02%	231,573	11.62%	1,993,139
2010	25,340	1.21%	1,829,441	87.35%	239,649	11.44%	2,094,430
2011	8.293	0.38%	1,907,348	87.94%	253,245	11.68%	2,168,886
2012	8,902	0.39%	1,990,357	87.80%	267,760	11.81%	2,267,018
2013	30,413	1.27%	2,081,748	87.00%	280,526	11.72%	2,392,688
2014	26,415	0.89%	2,546,150	85.82%	394,193	13.29%	2,966,758
2015	29,802	0.95%	2,704,575	85, 82%	416,962	13.23%	3,151.339
2016	44.114	1.31%	2,872,410	85.55%	440,935	13.13%	3,357,458
2017	40,073	1.13%	3,048.997	85.77%	465,637	13.10%	3,554.708
2018	48,186	1.28%	3,235,494	85.67%	492,800	13.05%	3,776,480

Source: Author's calculations.

2.9. INVENTORY OF GHG EMISSIONS BY SOURCES AND REMOVALS BY SINKS IN ANGOLA - TOTAL EMISSIONS

The results of emissions and removals are presented by IPCC sector (2006). This document presents the overall results of Angola's inventory of anthropogenic greenhouse gas (GHG) emissions and removals by gas, category, major emitting categories and annual emissions variability. All emissions are reported in GgCO2 e (thousand tonnes of CO2 equivalent).

2.9.1. Greenhouse Gas Emissions (GEE) - General

Most of Angola's greenhouse gas emissions from 2005 to 2018 were CO2 (carbon dioxide), followed by CH4 (methane) and N2 O (nitrous oxide). The total value of GHG emissions by gas for each year of the inventory is presented in the following tables with or without the Land Use, Land Use Change and Forestry (LULUCF, IPCC) sector.

CO2 accounted for more than 81% of emissions in all years covered by the inventory, including emissions and removals from LULUCF, and there was an increase in carbon dioxide emissions between 2005 and 2020.

Excluding the forestry sector, Angola's total emissions increased by 14,131 Gg CO2 between 2005 and 2020, with CO2 being the main greenhouse gas responsible for this increase. Taking into account CO2, the main greenhouse gas responsible for this increase in total greenhouse gas emissions, carbon dioxide emissions are on the rise.

Table 80: GHG emissions by gas in Angola (total emissions) 2005-2020, with land use, land use change and forestry - Emissions in GgCO2e

Total with LULUCF	CO2	CH4	N2O	Total	CO2	Land Use, Land Use Change and Forestry
Year	Thousand tones CO2 eq				%	Thousand tonnes CO2 eq
2005	45 966,604	8 698,434	1 405,844	56 070,883	81,98%	40 062,605
2006	46 783,347	8 435,315	1 366,358	56 585,021	82,68%	39 907,397
2007	47 811,803	8 840,216	1 469,092	58 121,110	82,26%	40 153,357
2008	50 496,175	6 899,419	1 287,518	58 683,112	86,05%	40 065,406
2009	51 687,901	9 983,113	1 662,230	63 333,244	81,61%	40 233,866
2010	52 907,198	7 623,838	1 353,546	61 884,581	85,49%	40 189,886
2011	82 867,171	8 344,765	1 437,237	92 649,173	89,44%	70 552,361
2012	85 968,610	8 945,308	1 538,210	96 452,129	89,13%	70 392,155
2013	88 370,118	10 906,890	1 753,230	101 030,238	87,47%	70 417,382
2014	90 015,648	8 824,184	1 594,648	100 434,481	89,63%	70 432,479
2015	88 801,782	9 542,122	1 711,869	100 055,773	88,75%	70 360,442
2016	90 581,605	8 821,502	1 603,209	101 006,315	89,68%	70 430,964
2017	82 973,608	8 608,853	1 569,478	93 151,938	89,07%	70 406,684
2018	83 624,948	14 585,581	2 338,529	100 549,058	83,17%	70 409,590
2019	200 412,126	18 736,610	2 880,878	222 029,614	90,26%	186 281,537
2020	190 501,221	18 226,389	2 800,278	211 527,889	90,06%	178 173,775

Source: Author's calculations.

Table 81: GHG emissions by gas in Angola (total emissions) 2005-2020, without land use, land use change and forestry - Emissions in GgCO2e

Total without LULUCF	CO2	CH4	N2O	Total	CO2
Year	Thousand tonnes CO2 eq				%
2005	6 295,791	8 400,046	1 312,441	16 008,278	39,33%
2006	7 267,742	8 255,133	1 309,957	16 832,832	43,18%
2007	8 050,237	8 472,711	1 354,054	17 877,001	45,03%
2008	10 822,561	6 598,898	1 193,447	18 614,905	58,14%
2009	11 845,826	9 554,292	1 527,998	22 928,116	51,67%
2010	13 109,103	7 228,512	1 229,799	21 567,414	60,78%
2011	12 996,225	7 825,799	1 274,788	22 096,813	58,81%
2012	16 177,767	8 487,349	1 394,858	26 059,974	62,08%
2013	18 566,661	10 439,325	1 606,871	30 612,857	60,65%
2014	20 204,643	8 350,870	1 446,489	30 002,002	67,34%
2015	19 026,795	9 096,239	1 572,297	29 695,331	64,07%
2016	20 771,357	8 348,765	1 455,230	30 575,351	67,93%
2017	13 175,500	8 145,361	1 424,393	22 745,254	57,93%
2018	13 825,388	14 120,983	2 193,098	30 139,468	45,87%
2019	16 058,863	17 268,037	2 421,177	35 748,077	44,92%
2020	14 178,827	16 816,377	2 358,909	33 354,113	42,51%

Source: Author's calculations.

Table 82: GHG emissions by gas in Angola (perceptual) 2005-2020, including the land-use, land-use change and forestry sector - emissions in GgCO2

Total without LULUCF	CO2	CH4	N2O	Total
2005	39,33%	52,47%	8,20%	100,00%
2006	43,18%	49,04%	7,78%	100,00%
2007	45,03%	47,39%	7,57%	100,00%
2008	58,14%	35,45%	6,41%	100,00%
2009	51,67%	41,67%	6,66%	100,00%
2010	60,78%	33,52%	5,70%	100,00%
2011	58,81%	35,42%	5,77%	100,00%
2012	62,08%	32,57%	5,35%	100,00%
2013	60,65%	34,10%	5,25%	100,00%
2014	67,34%	27,83%	4,82%	100,00%
2015	64,07%	30,63%	5,29%	100,00%
2016	67,93%	27,31%	4,76%	100,00%
2017	57,93%	35,81%	6,26%	100,00%
2018	45,87%	46,85%	7,28%	100,00%
2019	44,92%	48,30%	6,77%	100,00%
2020	42,51%	50,42%	7,07%	100,00%

Source: Author's calculations.

Table 83: GHG emissions by gas in Angola (perceptual) 2005-2020, excluding the land-use, land-use change and forestry sector - emissions in GgCO2

Total with LULUCF	CO2	CH4	N2O	Total
2005	81,98%	15,51%	2,51%	100,00%
2006	82,68%	14,91%	2,41%	100,00%
2007	82,26%	15,21%	2,53%	100,00%
2008	86,05%	11,76%	2,19%	100,00%
2009	81,61%	15,76%	2,62%	100,00%
2010	85,49%	12,32%	2,19%	100,00%
2011	89,44%	9,01%	1,55%	100,00%
2012	89,13%	9,27%	1,59%	100,00%
2013	87,47%	10,80%	1,74%	100,00%
2014	89,63%	8,79%	1,59%	100,00%
2015	88,75%	9,54%	1,71%	100,00%
2016	89,68%	8,73%	1,59%	100,00%
2017	89,07%	9,24%	1,68%	100,00%
2018	83,17%	14,51%	2,33%	100,00%
2019	90,26%	8,44%	1,30%	100,00%
2020	90,06%	8,62%	1,32%	100,00%

Source: Author's calculations.

2.9.2. Emissions by sector in Angola

The results of Angola's total emissions, considering the total with LULUCF by sector, show a predominance of emissions from the Land Use, Land Use Change and Forestry sector, followed by the Energy, Agriculture, Waste and Wastewater, and Industrial Processes and Product Use sectors. While the Land Use, Land Use Change and Forestry sector was responsible for the highest emissions over the whole inventory period, the Energy sector was the second largest emitter. Agriculture was the third largest sector, followed by Waste and Wastewater and Industrial Processes and Product Use (IPPU).

Table 84: GHG emissions by sector to Angola in the period 2005-2018 with and without the land use change and forests sector - emissions in GgCO2e

Sector with LULUCF	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Energy	8638,891	9230,566	10036,754	10718,181	14454,777	12881,310	13433,315	15917,137	20255,030	19088,695	18115,620	19424,871	11983,559	18820,386
Agriculture	5322,952	5474,780	5647,282	5552,982	6038,672	6013,010	5987,196	6057,751	6107,864	6307,743	6608,453	6242,049	5857,070	5849,020
Waste	1685,496	1761,174	1816,491	1889,989	1993,139	2094,430	2168,886	2267,018	2392,688	2966,758	3151,339	3357,458	3554,708	3776,480
Industrial Processes	360,940	366,312	376,475	453,752	441,529	578,663	507,415	1818,068	1857,274	1638,805	1819,919	1550,973	1349,917	1693,582
Land Use and Land Use Change	40062,605	39907,397	40153,357	40065,406	40233,866	40189,886	70552,361	70392,155	70417,382	70432,479	70360,442	70430,964	70406,684	70409,590
Total Angola	56070,883	56740,229	58030,358	58680,311	63161,982	61757,300	92649,173	96452,129	101030,238	100434,481	100055,773	101006,315	93151,938	100549,058
Renewables	43532,841	37541,762	37732,022	4399,755	48723,020	4506,947	13932,477	23897,040	56742,111	6769,011	13179,420	1863,364	1738,548	109482,687
Bunker Fuels	424,431	658,432	982,231	0,000	755,692	928,265	1224,346	1405,946	523,107	732,419	660,835	740,932	700,245	914,575

Source: Author’s calculations.

In terms of representativeness, when all sectors including LULUCF are added together, the LULUCF sector accounted for more than 63% of Angola's total emissions over the inventory period. In 2011, the year in which the Land Use, Land Use Change and Forestry sector accounted for the largest share, it was 76.15%, the highest over the period. The energy sector accounted for 22.89% of emissions in 2009. The IPPU sector, on the other hand, is the sector with the lowest share of greenhouse gas emissions in Angola, although it is growing over the period analysed.

Excluding the volatility of the forestry sector, the energy sector accounted for more than 52% of Angola's total emissions over the inventory period. Finally, taking into account the increase in emissions from the forestry sector, a new visualisation of the results makes it possible to compare the importance of the LULUCF sector in relation to the other sectors.

The figures below also illustrate the reduction achieved through the use of renewable energy (white background) and emissions from international aviation (bunker fuels, dashed line). Both emissions are excluded from the inventory in accordance with the United Nations Framework Convention on Climate Change. It should also be noted that the volatility of emissions increases with the inclusion of emissions and removals from forests, according to the annual pattern of land use by the different categories of this sector.

2.9.3. Comparative emissions by Gas and sector - General

The following figures show the representativeness of each greenhouse gas for each category by inventory sector. There is a predominance of CO2 in the energy sector (road and air transport categories), land use and land use change (CH4 and N2 O not yet estimated, but of minor importance and for CO2 removal and grass categories) and industrial processes and product use (cement production category); of CH4 in the waste sector (solid waste treatment category) and agriculture (enteric fermentation) and of N2 O in the agriculture sector (direct emissions from cultivated soils).

In addition, the categories of road transport (growth of 16.14%), air transport (growth of 79.92%), cement production (growth of 8.86%), direct emissions from land treatment (growth of 21.02%) and domestic waste water treatment (growth of 32.92%) are shown to have contributed most to the absolute growth of emissions, while relocations (growth of 27.16%) partially offset the growth of emissions that were negative.

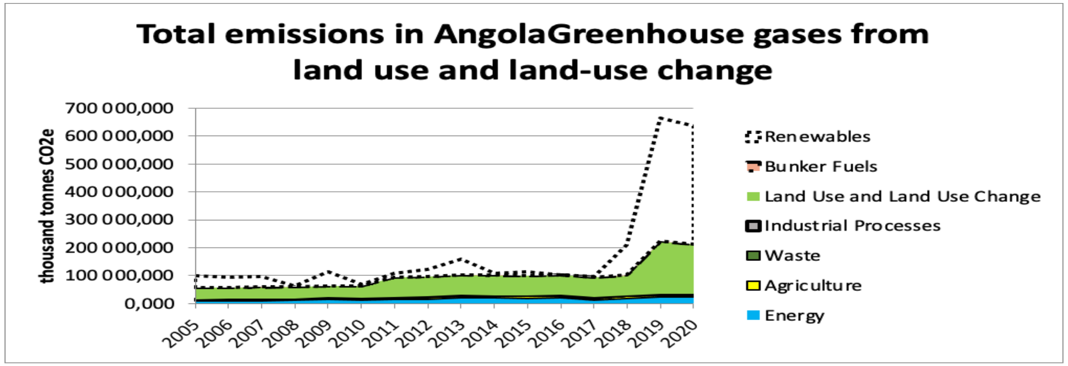
2.9.4. Emissions by category of activity in each sector and by GEO

2.9.4.1. For LULUCF, thousand tonnes of CO2 equivalent

Table 85: LULUCF thousand tones of CO2 equivalent

Sector with LULUCF	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy	8638,891	9230,566	10036,754	10718,181	14454,777	12881,310	13433,315	15917,137	20255,030	19088,695	18115,620	19424,871	11983,559	18820,386	24247,17571	21904,66159
Agriculture	5322,952	5474,780	5647,282	5552,982	6038,672	6013,010	5987,196	6057,751	6107,864	6307,743	6608,453	6242,049	5857,070	5849,020	5475,776	5215,734
Waste	1685,496	1761,174	1816,491	1889,989	1993,139	2094,430	2168,886	2267,018	2392,688	2966,758	3151,339	3357,458	3554,708	3776,480	3810,213	3980,701
Industrial Processes	360,940	366,312	376,475	453,752	441,529	578,663	507,415	1818,068	1857,274	1638,805	1819,919	1550,973	1349,917	1693,582	2214,911	2253,016
Land Use and Land Use Change	40062,605	39907,397	40153,357	40065,406	40233,866	40189,886	70552,361	70392,155	70417,382	70432,479	70360,442	70430,964	70406,684	70409,590	186281,537	178173,775
Total Angola	56070,883	56740,229	58030,358	58680,311	63161,982	61757,300	92649,173	96452,129	101030,238	100434,481	100055,773	101006,315	93151,938	100549,058	222029,614	211527,889
Bunker Fuels	424,431	658,432	982,231	0,000	755,692	928,265	1224,346	1405,946	523,107	732,419	660,835	740,932	700,245	914,575	862,824	801,640
Renewables	43532,841	37541,762	37732,022	4399,755	48723,020	4506,947	13932,477	23897,040	56742,111	6769,011	13179,420	1863,364	1738,548	109482,687	440620,869	423183,117

Chart 21: Total GHG emissions from land use and land use change in Angola



2.9.4.2. Excluding LULUCF, thousand tonnes CO2 equivalent

Table 86: Excluding LULUCF, thousand tones CO2 equivalent

Sector without LULUCF	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy	8638,891	9230,566	10036,754	10718,181	14454,777	12881,310	13433,315	15917,137	20255,030	19088,695	18115,620	19424,871	11983,559	18820,386	24247,176	**21904**,662
Agriculture	5322,952	5474,780	5647,282	5552,982	6038,672	6013,010	5987,196	6057,751	6107,864	6307,743	6608,453	6242,049	5857,070	5849,020	5475,776	5215,734
Waste	1685,496	1761,174	1816,491	1889,989	1993,139	2094,430	2168,886	2267,018	2392,688	2966,758	3151,339	3357,458	3554,708	3776,480	3810,213	3980,701
Industrial Processes	360,940	366,312	376,475	453,752	441,529	578,663	507,415	1818,068	1857,274	1638,805	1819,919	1550,973	1349,917	1693,582	2214,911	2253,016
Total Angola	16008,278	16832,832	17877,001	18614,905	22928,116	21567,414	22096,813	26059,974	30612,857	30002,002	29695,331	30575,351	22745,254	30139,468	35748,076	33354,113
Bunker Fuels	424,431	658,432	982,231	0,000	755,692	928,265	1224,346	1405,946	523,107	732,419	660,835	740,932	700,245	914,575	862,824	801,640
Renewables	43532,841	37541,762	37732,022	4399,755	48723,020	4506,947	13932,477	23897,040	56742,111	6769,011	13179,420	1863,364	1738,548	109482,687	440620,869	423183,117

Chart 22: Total emission in Angola greenhouse gases without use and land use change

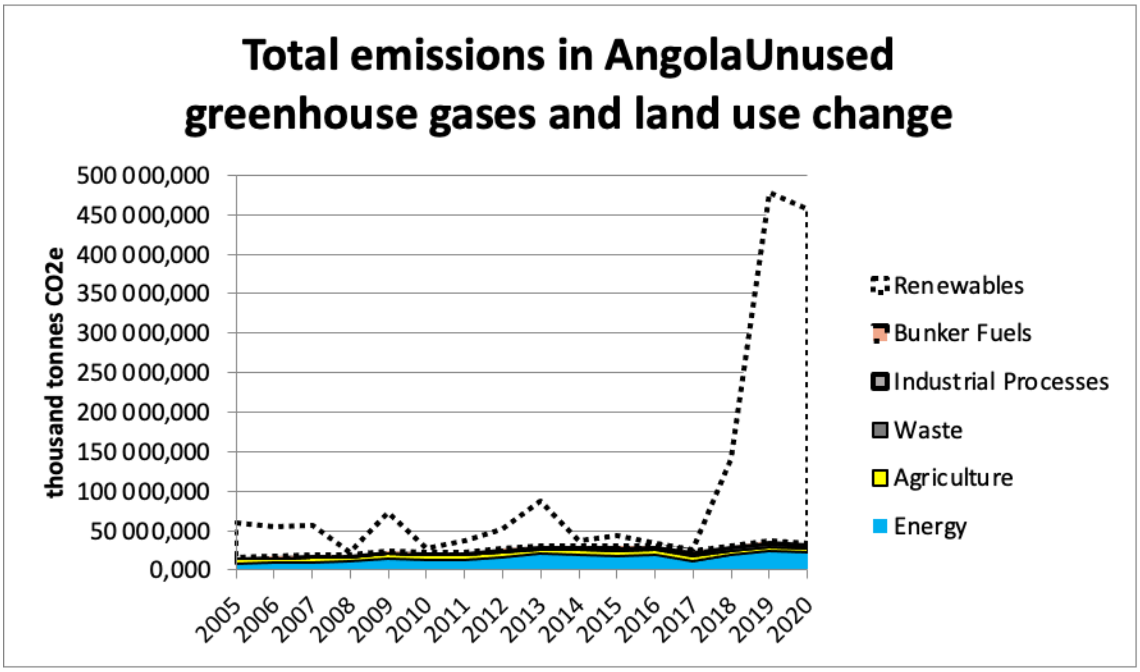


Chart 23: Angola's greenhouse gas emissions from land use, land use change and forestry

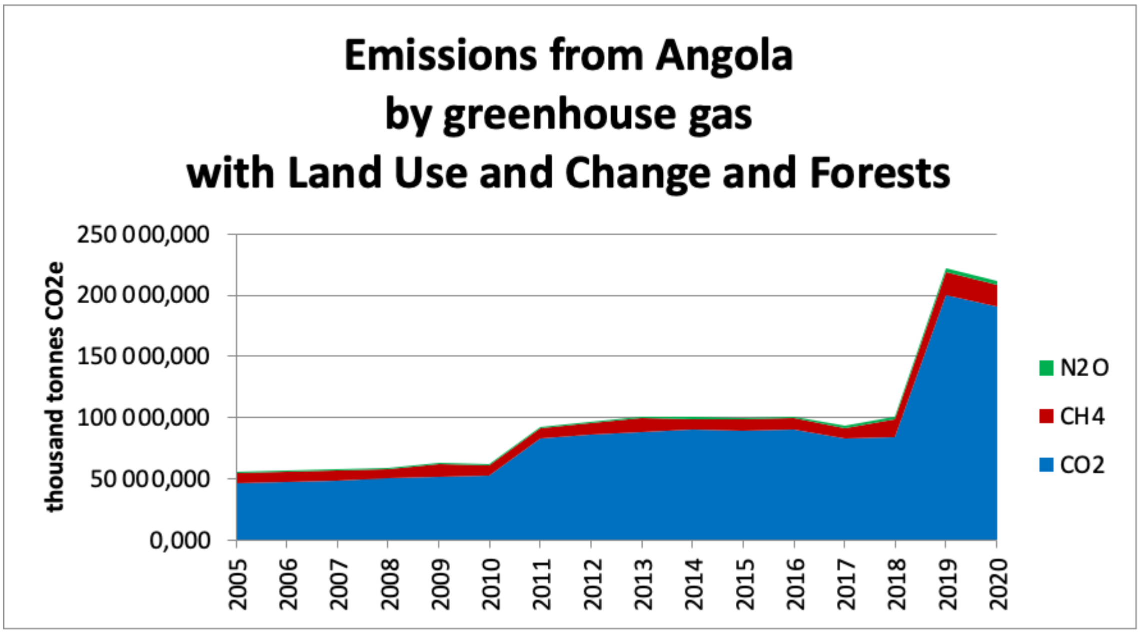
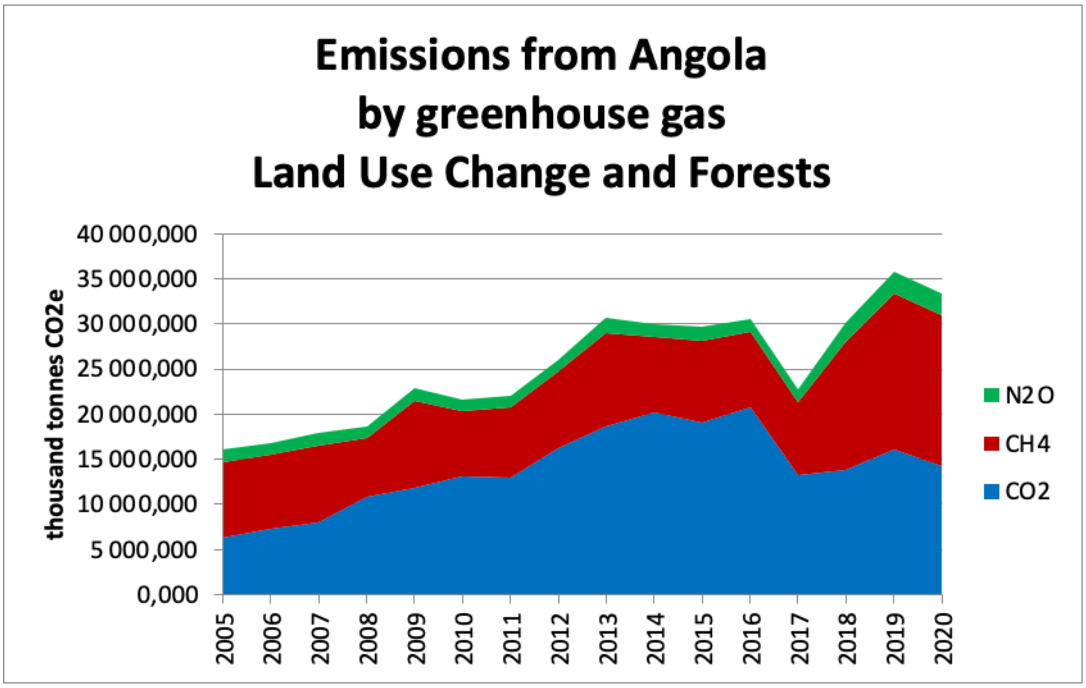


Chart 24: Angola's greenhouse gas emissions without land use and land use change and forests



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CHAPTER 3 – APPROPRIATE MITIGATION MEASURES

NOVEMBER 2024

CHAPTER 3 – APPROPRIATE MITIGATION MEASURES

Angola ratified the UNFCCC in May 2000 and the Kyoto Protocol in March 2007, reaffirming its commitment to implement policies and programmes to stabilise greenhouse gas emissions. In the same year, it approved its first climate change strategy ("National Strategy for the Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol"), which aims to "establish the framework for intervention in legal, technical and human terms to contribute to the stabilisation of GHG emissions and to the technological development of the country". In November 2015, Angola submitted its national contribution to reduce GHG emissions to the UNFCCC, in which it proposed to unconditionally reduce its GHG emissions by 35% by 2030 compared to the baseline scenario (base year 2005) and to reduce an additional 15% of its GHG emissions by 2030 with international finance. In 2020, it ratified the Paris Agreement and in 2021, it submitted an updated version of the Nationally Determined Contribution in which it renewed its key mitigation commitments at this level.

ENAC 2022-2035 replaced the first strategy of 2007 because it no longer corresponded to the new international climate context resulting from the Paris Agreement. It did not reflect the considerable progress Angola had made in social and economic terms. The ENAC 2022-2035 aims to position Angola in the face of the new commitments and challenges posed by the Paris Agreement, as well as to establish the vision of Angolan national policy for the 2030 horizon, taking into account the need to articulate national mitigation policy with adaptation to the impacts of climate change. The ENAC 2022-2035 has been structured around five main pillars: 1) mitigation, 2) adaptation, 3) capacity building, 4) financing and 5) research, systematic observation and analysis. The first three pillars - mitigation, adaptation and capacity building needs - are supported by a fourth pillar, climate finance, which is essential for the implementation of actions. At the same time, it is important to strengthen the national capacity to monitor the climate and subsequently analyse its impact on key sectors of the country's economic and social life. ENAC's fifth pillar focuses on climate research, systematic observation and analysis.

The PND 2023-2027 sets targets for the sectors covered by the National Greenhouse Gas Emission Plan: low-carbon pilot projects to be designed, sectoral and/or provincial strategies to implement the National Climate Change Adaptation Plan, sectoral/provincial/municipal climate databases to be created, construction of river crossings to be started, construction of earth dams for water retention to be started, planting of trees to increase the forest cover, creation of a windbreak curtain and soil protection, and mapping of land degradation zones in all provinces.

Objective 4 of the National Environmental Quality Programme (DP 138/20) is to promote the introduction of clean energies and technologies, including those compatible with the reduction of greenhouse gas emissions. The measures are Carrying out education and awareness-raising activities to promote the use of alternative energies, clean technologies and cleaner production in the various sectors; disseminating mechanisms for the adoption of clean energies and technologies, including those compatible with the reduction of greenhouse gas emissions, with priority given to the generation, distribution and energy efficiency and waste treatment sectors; promoting the MINAMB Science and Innovation Programme and its sub-programmes (in particular sub-programme 4, relating to climate change mitigation measures).

The 2nd National Communication, presented in 2021, aims to respond to mitigation actions by supporting the sectorial programmes and initiatives of the different government institutions, prioritising the sectors listed in the inventory and their respective emissions. Despite financial constraints, the government has made efforts in the area of clean energy and has drawn the attention of the international community to the financing of other mitigation actions.

Angola is a country with vast endogenous energy resources, including significant oil and gas reserves. The characteristics of its rivers and its relief mean that it has one of the greatest hydroelectric potentials on the African continent. The size of its territory and its geographical location give it exceptional solar potential.

According to the Renewable Energy Report 2022, forest resources, especially fuelwood, play an important role in the informal and subsistence economy of households, mainly in rural and peri-urban areas. The 2014 census for Angola identified a rural population of approximately 9.6 million, representing 37% of the total population. This population uses firewood and charcoal as a source of domestic energy and to generate income. This situation is due to the uncontrolled consumption of fuelwood for domestic use in rural areas, in addition to charcoal production. This situation exacerbates the problems of deforestation and desertification in most parts of the country, leading to an increase in soil erosion and the impact on people's health and safety.

Angola has enormous potential to gradually promote the replacement of firewood and coal consumption with clean energy sources that are adapted to the traditions and cultures of the local population. Currently, access to clean cooking facilities in sub-Saharan Africa is remarkable, thanks to government policies promoting LPG and natural gas.

This report therefore provides an overview of renewable energy. Angola intends to electrify 50% of the population by 2025 and therefore expects a relative growth in demand that could reach 7.2 GW, as a result of the increase in residential consumption, the growth in national wealth due to the increase in services and the industrialisation of the country. The long-term axes of the national energy security policy have thus been defined, namely:

- Growth of the generation park;
- Increasing the role of renewable;
- Expansion of electrification;
- Tariff review and economic and financial sustainability;
- Restructuring and strengthening of operators;
- Encouraging the entry of private capital and know-how.

The National Strategy for Climate Change 2022-2035 (ENAC) presents the main mitigation actions that the country is committed to. The ENAC presents the mitigation actions, grouped into initiatives, by sector (energy, agriculture, forestry and other land uses, industry and waste) and references to their main contributions to achieving the 17 Sustainable Development Goals.

Table 87: GHG emissions by sector in 2020

Sources of GHG Emissions	CO_2 eq – Gg
Energy - Fuel Burning	2190466159
Banker Fuels	801640
Industrial Processes	2253016
Agriculture	5215734
Land use change and forests	178173775
Waste	3960701
Total	**211527889**

In the energy sector, it is important to stress that the progress made has had a direct impact on the lives of Angolans, with an increase in electricity production and distribution capacity, with an emphasis on increasing clean energy production, with a focus on hydro and solar energy, a reduction in thermal sources, the introduction of natural gas power plants and hybrid energy. The country has an installed capacity of 6,283 megawatts to meet a current demand of 2,375 megawatts. Accordingly, it has focused on increased investment in energy transmission and distribution networks and household connections, with the aim of achieving rural electrification and reducing the use of biomass energy in these areas, which is around 80%.

The national electricity matrix consists of 59.79% hydro, 35.74% thermal, 3.81% solar and 0.57% hybrid energy.

For example, 63.6% of the energy produced in Angola is clean, from non-polluting sources, i.e. environmentally friendly, and represents appropriate mitigation measures, which are generally the responsibility of the government. In many cases, the government has gone into debt to achieve this goal.

The National Interconnection Project is designed to enable the distribution of existing generation capacity. This will reduce the production of electricity from fossil fuels, as well as operating, fuel and maintenance costs, thereby improving environmental sustainability.

The northern and central regions are currently connected, benefiting a total of ten provinces, while the project to connect the southern and eastern regions is underway.

To reach every household, the government is investing in distribution, household connections and rural electrification. In fact, the electrification rate has gradually and steadily increased in recent years, from 36% in 2017 to 43% in the first quarter of 2023. The target is to reach an electrification rate of 50% by 2027.

The Caraculo solar park in Namibe province has been completed with a production capacity of 25 megawatts and will soon be expanded to 50 megawatts. Five more solar parks are under construction in different provinces. A further 100 megawatts of clean energy will be available by 2025 with the completion of the Quilemba photovoltaic plant in Huila province. By 2027, the country hopes to complete a major rural electrification programme to bring electricity to rural areas using photovoltaic energy in several provinces, in a total of 126 locations, benefiting around 3 million people.

To further increase access to electricity, other projects are underway, notably the Caculo Cabaça dam in Kwanza Norte, which will produce 2,172 megawatts, and the Cunje dam in Bié, with 1,80 megawatts. The Matala dam in Huila province and the Luachimo dam in Lunda Norte will come on stream in 2024, generating 48.80 and 34 megawatts respectively.

According to the country's latest greenhouse gas inventory, the energy sector was responsible for 21904.66159 tonnes of CO_2 emissions in 2020.

Total emissions are shown in the table below. Most attention is focused on reducing greenhouse gas emissions, or simply mitigation.

Table 88: Total LULUCF emissions

Sector without LULUCF	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy	8638,891	9230,566	10036,754	10718,181	14454,777	12881,310	13433,315	15917,137	20255,030	19088,695	18115,620	19424,871	11983,559	18820,386	24247,176	**21904**,662
Agriculture	5322,952	5474,780	5647,282	5552,982	6038,672	6013,010	5987,196	6057,751	6107,864	6307,743	6608,453	6242,049	5857,070	5849,020	5475,776	5215,734
Waste	1685,496	1761,174	1816,491	1889,989	1993,139	2094,430	2168,886	2267,018	2392,688	2966,758	3151,339	3357,458	3554,708	3776,480	3810,213	3980,701
Industrial Processes	360,940	366,312	376,475	453,752	441,529	578,663	507,415	1818,068	1857,274	1638,805	1819,919	1550,973	1349,917	1693,582	2214,911	2253,016
Land Use and Land Use Change	40062,605	39907,397	40153,357	40065,406	40233,866	40189,886	70552,361	70392,155	70417,382	70432,479	70360,442	70430,964	70406,684	70409,590	186281,911	2253,016
Total Angola	56070,883	56740,229	58030,358	58680,311	63161,982	61757,300	92649,173	96452,129	101030,238	100434,481	100055,773	101006,315	93151,938	100549,058	186281,537	178173,775
Bunker Fuels	424,431	658,432	982,231	0,000	755,692	928,265	1224,346	1405,946	523,107	732,419	660,835	740,932	700,245	914,575	862,824	801,640
Renewables	43532,841	37541,762	37732,022	4399,755	48723,020	4506,947	13932,477	23897,040	56742,111	6769,011	13179,420	1863,364	1738,548	109482,687	440620,869	423183,117

3.1. LOW - CARBON ENERGY AND ENERGY EFFICIENCY IN THE CONTEXT OF GREENHOUSE GAS EMISSIONS

The energy sector is one of the most important contributors to greenhouse gas emissions. It is therefore important to implement mitigation measures by promoting the rational and efficient use of energy in the country. The implementation of renewable energy is also a mitigation measure, given the country's vast potential and the actions currently underway.

Approximately 680 projects have been studied, totalling more than 40 GW of renewable energy projects, of which about 4,000 MW (just to clarify, according to the latest data, Angola's total energy matrix is 6,283 MW and is made up of 3 sources: solar, thermal and hydro. In terms of generation technology, the energy matrix is divided into hydro (3,330.12 MW), thermal (1,878.7 MW) and hybrid (30 MW), representing 63.57%, 35.86% and 0.57% respectively, as shown in the following charts.

It should also be noted that the investments underway in the energy transition process, especially green carbon, will contribute to reducing the current level of greenhouse gas emissions if implemented in Angola.

Chart 25: Installed and available capacity in the energy sector 2018-2022 (1)

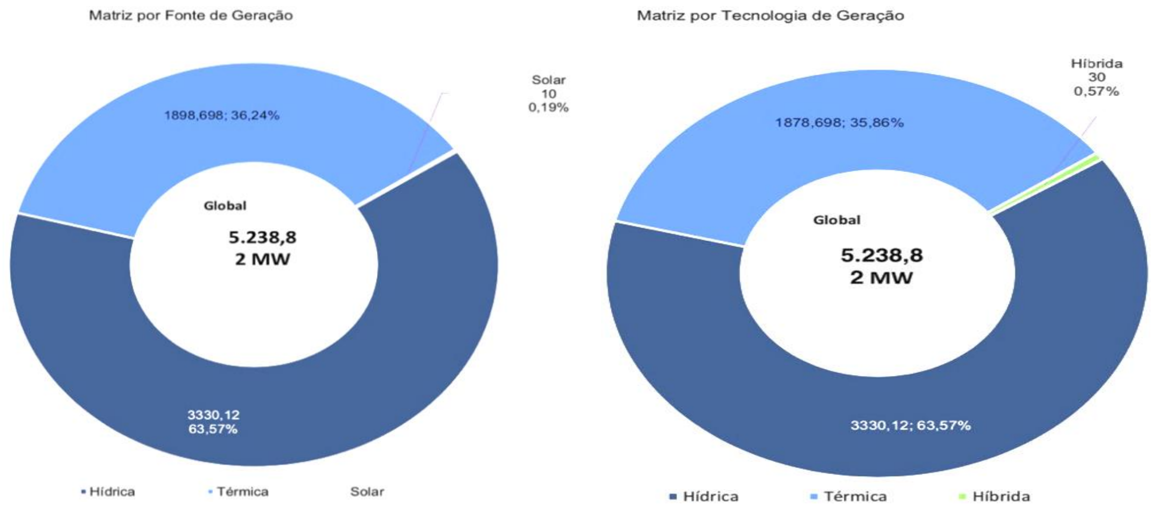
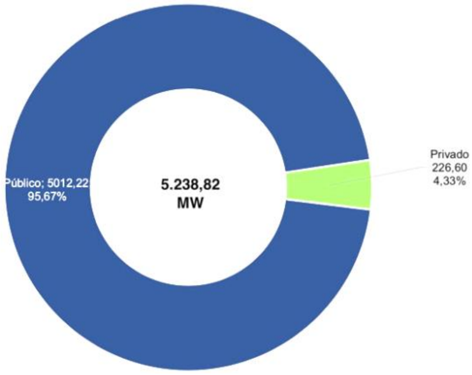


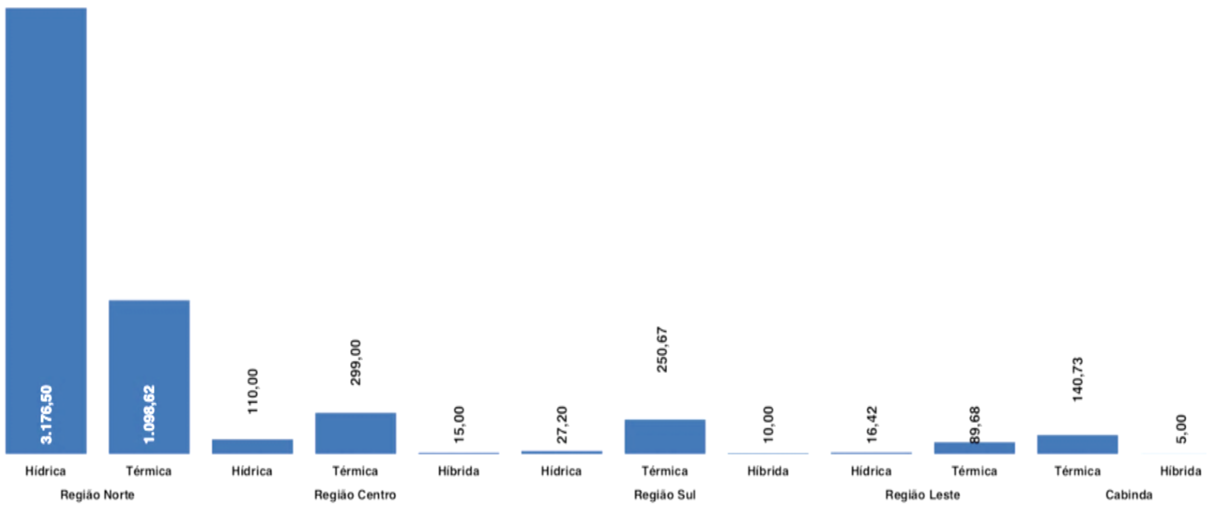
Chart 26: Energy matrix by generation source (left) and generation technology (right)



The vast majority of Angola's energy is generated by the public sector. It accounts for 95.67% of the total, or 6,283 MW, while the private sector contributes only 4.33%, or 226.60 MW of energy generation.

During the period 2010-2019, Angola's electricity generation will increase from 1,375.44 MW to 5,238.82 MW, which corresponds to about 16.02% (6,283 MW) in 2024. Thermoelectric generation increased from 594.94 MW to 1,878.70 MW, representing an increase of about 13.63%, and hydroelectric generation increased from 780.5 MW in 2010 to 3,330.12 MW in 2019, representing an increase of about 17.5% in Angola's hydroelectric generation over the same period.

Chart 27: Regional Installed capacity by technology (July 2019)



Angola's electricity system is divided into 4 regions: 2 interconnected systems (North and Centre) and 2 isolated systems (South and East).

3.2. ELECTRICITY SUB-SECTOR

During the period 2010-2024, Angola's electricity generation increased from 1,375.44 MW to 6,283 MW. Thermoelectric generation increased from 594.94 MW to 2,258.73 MW and hydroelectric generation increased from 780.5 MW to 3,342.12 MW. About 35 MW came from hybrid power plants. The table below shows the panorama in 2020.

Table 89: Installed and available capacity on 31 January 2020

Source	Power 31 January 2020			
	Installed [MW]	Percentage [%]	Available [MW]	Available [%]
Water	3.342,12	59,30	3.060,98	91,59
Thermal	2.258,73	40,08	1.692,69	74,94
Hybrid	35,00	00,62	34,22	97,77
TOTAL	**5.635,85**	**100,00**	**4.787,90**	**84,95**

Angola's public power generation park comprises 59 power plants in 17 provinces, including 43 thermal plants, 8 hydroelectric plants and 8 hybrid plants. The 2018-2022 PND foresees an installed capacity of 6.3 GW by 2022.

Angola's electricity system is divided into 4 regions: 2 interconnected systems (North and Centre) and 2 isolated systems (South and East). The Luanda region on the map is added to the northern region, as shown in the figure below. In addition to the development of major energy projects, it is important to promote the electrification of Angola, which currently covers only 30% of the country.

Production, 96.5% of which is guaranteed by the public company PRODEL, is distributed throughout the country as follows:

Table 90: Installed power, available power and energy produced from 31 July 2019 to 30 January 2020 (1)

Region	South	East	Centre	North	Cabinda	TOTAL
Installed Capacity [MW]	287,87	138,17	410,80	4 653,28	145,73	5 635,85
PRODEL	283,87	109,42	360,80	4 537,68	145,73	5 437,50
INDEPENDENT	4,00	28,75	50,00	115,60		198,35
Available Capacity [MW]	222,52	108,17	267,05	4 071,06	119,10	4 787,90
PRODEL	218,52	79,42	227,05	4 001,06	119,10	4 645,15
INDEPENDENT	4,00	28,75	40,00	70,00		142,75
Energy produced from 31 July 2019 to 31 January 2020						
Electricity Produced [MWh]	422 493,27	180 587,54	124 584,15	7 040 002,17	262 110,52	8 029 777,65
PRODEL	418 473,86	144 189,27	39 043,41	6 897 113,56	262 110,52	7 760 930,62
INDEPENDENT	4 019,41	36 398,27	85 540,74	142 888,61		268 847,03

To generate electricity from thermal sources, PRODEL uses fuels such as diesel, Jet B and, more recently, natural gas (see table below), supplied by the concessionaire SONANGOL and 100% subsidised by the Angolan government. The natural gas reserves exploited at the Angolan

LNG terminal in Soyo (Zaire Province) enabled the installation of a 720 MW combined cycle power plant (Soyo I), which began production in 2017-18.

Table 91: Evolution of fuel consumption in power generation centers

Year	Liquid fuel [l]	Natural gas [MMBTU]
2016	1 203 715 960,00	-
2017	716 017 750,69	-
2018	665 968 833,63	5 283 403,00
2019	539 496 644,00	14 220 113,85
2020	43 728 918,92	-

As mentioned above, the country's electrification rate is still low, at around 40%. Expanding the country's electrification will enable wealth and job creation and is an important vector for the country's industrial and human development, as well as the well-being of Angolans. Projections indicate that there will be a large increase in energy demand of around 7.2 GW by 2025.

According to the "Atlas and National Strategy for New Renewable Energies", Angola has a potential of 18 GW of electricity from hydropower (with mini-hydro plants of up to 10 MW having a potential of 800 MW) and 3.7 GW from biomass and municipal solid waste. Solar energy has a potential of 17.3 GW and wind energy has a potential of 3.9 GW.

About 86% of Angola's hydropower potential is located in the Kwanza, Queve, Catumbela and Cunene basins. A dam programme is underway that is expected to add another 60 MW and 117,400 customers, equivalent to about 704,400 people. Sites have been identified for the construction of dams that will bring the installed capacity to a further 4.2GW.

Solar energy is Angola's largest renewable resource and the most evenly distributed. Among Angola's provinces, Luanda, Kwanza Norte and Kwanza Sul have the most viable projects due to their greater capacity to absorb intermittent energy from the grid. A total of 122 projects, totalling 3.45GW, have been identified as suitable for grid connection. In a first phase, 10 priority solar projects have been identified, representing a total of 100 MW for the market and leading to the construction of solar parks in the provinces of Benguela, Cunene, Huíla and Namibe. The Aldeia Solar programme is also underway, with the aim of electrifying social infrastructures through the installation of autonomous photovoltaic systems, such as Schools; medical posts; police posts; administrative buildings and social yards, including public lighting posts.

For biomass, the provinces of Benguela, Malanje, Lunda Norte, Moxico, Huíla and Huambo have high potential. Luanda has a high potential for converting municipal solid waste into energy.

The wind potential is limited by efficiency and demographic constraints. However, it is greatest in the province of Namibe, followed by the provinces of Huíla, Cuanza-Sul, Malanje and

Moxico. Along the Atlantic escarpment, on a north-south axis, 13 projects with a total capacity of 604 MW have been identified and are ready to be connected to the grid.

The natural gas produced in Soyo makes it possible to install more power in this region or in any other part of the country, as long as the appropriate infrastructure is in place. The government plans to increase the amount of thermal power installed in the country, based on investments in more economical and less polluting combined-cycle thermal power plants. Natural gas will accompany the installation of renewable energy projects on the fossil side, as it is not only an endogenous source but also less polluting.

The electricity grid is undergoing major development, with plans to integrate the five main existing regional grids (North, Centre, East, South and Cabinda) and to increase the stability of electricity supply to the main centres of consumption, whether residential or industrial. In the near future, it is planned to extend the rural electrification networks to some localities in 12 provinces. This is an extensive programme, involving the construction of 31 substations of various voltages, 1,358 transformer stations of various capacities, around 1,000 km of 30 kV lines, 10 km of 15 kV lines, 2,000 km of low-voltage networks and 1,000 km of public lighting networks. The implementation of this programme will allow around 230,000 families (1,400,000 people) to be connected to the electricity distribution and supply system, increasing the electrification rate by 5%.

At present, Angola has not systematised the calculation of the emission factor (EF) of its electricity grid. It will be a priority to develop it in order to allow a more accurate and up-to-date calculation of emissions from fossil fuel combustion in the electricity sector and to serve as a tool for all participants in projects and programmes aimed at reducing emissions under the UNFCCC market mechanisms (CDM, PoA, NAMA or projects developed under a future market mechanism arising from discussions on Article 6 of the Paris Agreement).

The energy sector is fundamental to Angola's economic and social development, making it possible to improve the quality and standard of living of the population. Renewable energy is on the rise and is expected to continue to grow with the help of private investment and government policies and guidelines. Renewables, such as hydro, solar and wind, are perhaps the best-known low-carbon technologies and are likely to be central to a decarbonised energy system. One of the challenges of decarbonising the energy sector is to reduce greenhouse gas (GHG) emissions sufficiently while ensuring energy reliability, security and affordability.

Decarbonisation is likely to depend on increased electrification of other sectors. The power sector may therefore need to increase capacity or improve efficiency as it decarbonises. This will happen while the sector is also changing in other ways, including the development of increasingly complex supply and demand networks, new requirements for bi-directional energy flows, new business models for energy production and network infrastructure development, and the increasing digitalisation of energy technology.

3.3. TRANSPORT SUBSECTOR

Although Angola is still in the process of introducing low-carbon transport, public and private projects are already underway to spread this type of transport throughout the country.

The Luanda Light Railway Network (RFLL) and the Metro Surface public transport project are underway, as is the Metro de Surface public transport project. In addition, at the end of 2019, the private taxi company T'Leva invested in the import of 1,000 100% electric cars for its fleet, contributing to the spread of this type of vehicle in Angola.

Luanda's light rail network is expected to cover 70% of the capital's total population and includes the possibility of building public transport corridors and multimodal systems consisting of light rail transit (LRT) and public road transport (BRT). - Light Railway Transit) and public road transport (BRT - Bus Rapid Transit). Part of this network will run on electricity, improving the environment and the quality of life of the population. The project is scheduled for completion in 2050.

A country's economic and social development is inextricably linked to the growth of its national transport networks. The growth forecasts for the country in the coming years, both in terms of population growth and economic growth, have an impact on emissions in the transport sector, resulting in an increase in global temperature and climate change.

3.4. SUBSECTOR OF THE OIL AND GAS INDUSTRY

This subsector is responsible for fugitive GHG emissions, which according to the inventory amount to xxx. As will be seen below, Angola is already on a mitigation path.

The PND 2023-2027 indicates that there has been a downward trend in crude oil production in recent years, coupled with operational problems that have forced unplanned production shutdowns. The PND indicates that factors such as the sharp natural decline in the main deepwater and ultra-deepwater producing fields, in the order of 8-15%; the loss of field efficiency, with an increase in unplanned shutdowns as production and processing facilities age; the financial situation, which has led to delays in the execution of new field projects, with the postponement of first oil, as well as the cancellation of drilling contracts intended for new development work; and planned operational shutdowns, which could exceed the entry into production of new fields and new approved work, are all contributing to the decline.

As far as the gas industry is concerned, the country has the Angola LNG plant. With a life expectancy of at least 30 years, the plant is supplied with gas from a variety of sources. Initially, the main source was gas associated with oil production from offshore blocks. In this way, the plant will make a significant contribution to eliminating gas flaring, allowing offshore oil reserves to be exploited in a more environmentally sustainable way.

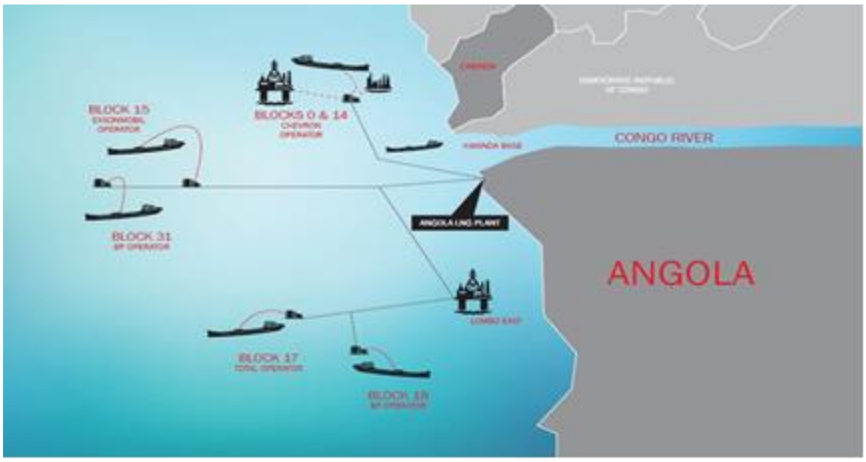
3.4.1. New gas consortium

An extensive pipeline network of more than 500 kilometres supplies the Soyo processing and liquefaction plant with gas from the offshore oil fields. The pipeline network initially transported feedstock from Blocks 15, 17 and 18. The subsea pipeline was then built to connect the Angola LNG plant to Blocks 0 and 14, located north of the Congo River. Blocks 31 and 32 have also been connected and, in due course, Angola LNG intends to connect the non-associated gas fields in Blocks 1 and 2.

In addition to the emissions from the process itself, this industry includes:

- Transportation by large carriers to large regasification terminals in distant countries;
- Transportation by small LNG carriers to small/medium sized marine terminals;
- Or even transport in small iso-containers or tanks by land, sea or rail to small storage and regasification units close to the consumer.

Figure 12: Angola LNG configuration



Proven reserves of more than 270,000 million cubic metres of natural gas have now been discovered, which will also be processed by Angola LNG. There have also been further discoveries of natural gas "on-shore" in Cabinda, making it possible to convert the turbines of local power stations to natural gas. Recently, significant new gas discoveries have been announced in blocks south of Luanda. Depending on the volume and cost of extraction, this could use the existing subsea pipeline infrastructure and expand the terminal at Soyo, or allow the construction of a new liquefaction plant south of Luanda, or even be used for internal consumption associated with large industrial, petrochemical or manufacturing projects. It is therefore to be hoped that this industry will grow in Angola.

3.5. AGRICULTURE AND FORESTRY SECTOR

According to the country's latest greenhouse gas inventory, the agriculture, forestry and other land use sector is responsible for 178,173,775 of the emissions in 2020.

The country has favourable conditions for agriculture and forestry, with great potential for production throughout the country. The sector is currently very important in the country, not only in terms of GDP (5% in 2020), but also in terms of the number of people it employs (34%).

Angolan agriculture is strongly based on family farming. Of the total cultivated area at national level (5,671,261 hectares, or 16.2% of the estimated total national arable area), family farms (EAF) accounted for 92%, with the remainder being commercial farms. Production remained at virtually the same level as the previous year. FAS were responsible for the agricultural production of more than 17,500,000 tonnes of agricultural products, corresponding to 81% of cereals, 92% of roots and tubers, 89% of pulses and oilseeds, 66% of fruit trees and 78% of vegetables produced nationally.

Agricultural mechanisation is still limited, but is increasing as a result of government and private sector investment. In terms of land preparation, family farming contributed 5,195,533 ha of cultivated land, which represents about 92% of the total cultivated area in the country. Of the total area cultivated, 3,740,784 ha (72%) were cultivated manually, 1,298,883 ha (25%) were cultivated using animal traction and some 155,866 ha (3%) were cultivated mechanically, also under co-financed projects. The Agrarian Development Institute (IDA) registers a total of 2,846,912 farming families throughout the country; however, only 33% of all farming families in the country receive any kind of technical assistance and only 4% benefit from technology packages.

According to the "Guidelines for Defining a Strategy for Exiting the Crisis Derived from the Fall in the Price of Oil on the International Market", agriculture will be a key sector for reducing oil dependency and diversifying the economy. One of the government's objectives is to make the country self-sufficient in basic foodstuffs, while the other is to increase exports and reduce imports.

Livestock accounts for between 30 and 50% of agricultural GDP. In the 2018-2019 marketing year, total meat production exceeded 137,000 tonnes. This figure represents a decrease in total production of almost 20% compared to the previous year. Livestock production statistics do not distinguish between family and corporate production, or between intensive and extensive production. National meat production is dominated by goat/sheep, which accounted for 59% of total production in the 2018/2019 season. However, this year it decreased by 30% compared to the previous season. This is followed by poultry (21% of the total), beef (17% of the total) and pork (4%). Production of these species was higher than in the previous marketing year. The northern region of the country was responsible for more than 50% of the total meat produced during the 2018/2019 campaign, followed by the centre, which produced almost thirty percent (29.2%), and the south, which contributed 20.6%. Egg production exceeded one billion units in the 2018/2019 season, 72% of which came from the northern region. There was a 2% decrease in production compared to the previous season. Milk production amounted to almost three million litres in 2018/2019. The central region contributed 54 % of the total, while the north contributed 29 % and the south 16 %. There was also a 16% decrease in production compared to the previous year.

The PND also proposes an increase in livestock production, setting targets of a 53% increase in meat production, a 164% increase in annual egg production and a 201% increase in annual milk production by 2022 compared to 2017 figures. At the same time, it aims to reduce the prevalence of major animal diseases from 15 in 2017 to 5% in 2022, and animal mortality from 12% in 2017 to 2%.

The promotion of sustainable practices in agriculture, the promotion of the water-energy nexus and food production using new technologies, and the efficient use of water and land are important to avoid GHG emissions and enable development from an economic, environmental and energy perspective. Given that the agricultural sector in Angola is supported by projects financed by international partners, such as the World Bank's Commercial Agriculture Development Project, which has a sub-component on capacity building in good practices, or the IFAD's Strengthening the Resilience of Small Producers Project, it is important to consider the role of the private sector in supporting the agricultural sector.

Forests, in turn, are of great socio-economic importance due to the use of wood as fuel, raw material for construction and furniture, and for food and medicinal purposes. The forest is therefore a valuable resource for the country, not only because of its importance to the Angolan economy, but also because it provides numerous socio-economic and environmental benefits, such as its fundamental role as a carbon sink and regulator of the balance of ecosystems. Forests have a good capacity to recover from natural climatic variations, so the loss of vegetation cover can exacerbate the effects of climate change on ecosystems.

The 1st National Forest Inventory (IFN) started in 2009 with technical assistance from the Food and Agriculture Organisation of the United Nations (FAO). According to the preliminary results of the first phase (2000-2015), the national forest area is 69,383,687 hectares, about 55.6% of the national territory. The provinces with the largest forest cover are Moxico, with 17,451,000 hectares, and Cuando Cubango, with 15,526,000 hectares. The main activities carried out by households living near forests are family farming (55%), collection of non-timber forest products (18%), hunting (9%) and cattle raising (8%). The least common activities are handicrafts, trade, various services and continental fishing. According to the IFN, the annual deforestation rate during the period was 0.8%.

According to the IDF, there are approximately 57,450,000 m3 of timber reserves that can be exploited in the entire productive natural and planted forest. The plan indicates that, according to the principles of sustainable management, approximately 1,210,000 m3 of roundwood can be harvested each year, 360,000 m3 in the natural forest and 850,000 m3 in the planted forest.

National roundwood production totalled more than 52,500 m3, of which 60% was produced in Cabinda and 25% in Uíge (Uíge was licensed to produce twice as much). The Campaign's report states that there has been a downward trend in timber production over the last three years, partly as a result of the measures taken to improve management, which have involved some stoppages throughout the country, and also because of the change in approach to harvesting in natural forests. The aim is to reduce production in natural forests and increase timber production in planted forests.

It is important to note that intensive tree plantations have a much lower level of biodiversity than natural forests and are therefore more limited as carbon sinks. In fact, in a natural forest, the roots, stems and leaves of trees, as well as other plants, microorganisms and soils, absorb carbon. "In several cases, the amount of carbon dioxide sequestered in soils, where biological symbioses take place at the interfaces of soil, water, roots and microorganisms, is higher than the CO2 sequestered in trees alone". In addition, intensive, short-rotation plantations (10, 15 years) mean that the wood can be used in an industrial process and generate greenhouse gases. It also mobilises the soil and breaks symbiotic biological bonds, often irreversibly, which can turn the soil into a GHG emitter. If agrochemicals are used in logging, the sink potential of these forests is further reduced. It is important to establish methods for quantifying GHG emissions.

According to the "Guidelines for Defining a Strategy for Exiting the Crisis Derived from the Fall in Oil Prices on the International Market", agriculture will be a key sector for reducing dependence on oil and diversifying the economy. The country has favourable conditions for agricultural and forestry practices, with great potential for production throughout the territory. The sector is currently of significant importance in the country, not only in terms of GDP (9.9% in 2015), but also in terms of the number of people it employs.

One of the government's objectives for the agricultural sector is to increase exports and reduce imports in order to make the country self-sufficient in staple foods. In response to this strategy, the agricultural sector is expected to grow significantly in the coming years, so it is important to support this growth by promoting sustainable agricultural practices that will allow the sector to grow in a sustainable way, from an economic, environmental and energy point of view.

The ability of terrestrial ecosystems to sequester carbon is crucial, while also playing an important role in reducing the rise in average global temperatures. Forest ecosystems can capture and sequester large amounts of CO2 through the accumulation of aerial and below-ground biomass and the deposition of organic matter accumulated in the soil.

Forests are of great socio-economic importance due to the use of wood for fuel, building materials and other activities, as well as resources for food and medicinal purposes. The forest is therefore a valuable resource for the country, not only because of its importance to the Angolan economy, providing numerous socio-economic and environmental benefits, but also because of its fundamental role as a carbon sink and regulator of the balance of ecosystems. It must therefore be exploited in a sustainable manner.

Forests have a good capacity to recover from natural climatic variations, but the loss of vegetation cover can exacerbate the effects of climate change on ecosystems. In this sense, it is essential for the government to establish mitigation measures for the forestry sector that contribute to its preservation as a source of wealth for the country.

3.6. INDUSTRY

The industrial sector contributed 2,253,016 tonnes to GHG emissions. Angola's main industries are oil and gas production (discussed in the energy sector), diamond and other mineral extraction, and manufacturing.

There is a strong political will to develop manufacturing significantly in the short term. Indeed, the government has promoted the diversification of the economy. The PND recommends increasing domestic production of soap, sugar, maize and wheat flour, pasta, pasteurised milk, processed meat, steel bars and tubes to meet national needs, as well as increasing exports of domestic beer, juices and soft drinks, and cement.

There is an opportunity for the country to increase resource efficiency and clean production. One of the measures that can help reduce greenhouse gas emissions is to replace diesel generators with natural gas cogeneration systems that can produce electricity and heat. CHP systems will ensure a reliable supply of electricity, avoiding blackouts and the instability of Angola's power grids. In this way, possible damage to the various pieces of equipment will be avoided, as well as the advantage of using an endogenous and abundant fuel produced in the country. In addition, cogeneration systems allow the heat generated by the combustion of natural gas to be used in the industrial process itself, thereby increasing the efficiency of energy use.

Given the government's goal of diversifying the economy in the coming years, both as a response to the oil crisis and to promote economic diversification, the development of other industries in the country is imperative. The manufacturing sector, for example, is expected to develop strongly in the short term. In this sense, the government recognises that the growth of economic activity must be supported by energy consumption in a conscious and efficient manner.

Direct GHG emissions in the industrial sector result from various processes, including on-site combustion of fossil fuels for heating, non-energy use of fossil fuels, and chemical processes used in cement production, for example. In addition, industry generates indirect emissions from the centrally generated electricity it consumes. In order to promote a more energy and environmentally sustainable national industry, the government intends to encourage the replacement of diesel generators with natural gas combined heat and power systems.

From the point of view of energy security, the production of electricity for own use through cogeneration systems guarantees a reliable supply of electricity, avoiding blackouts and the instability of Angola's electricity grids. It also avoids any damage to the equipment and has the advantage of using an endogenous and abundant fuel produced in the country. In addition, cogeneration systems allow the heat generated by the combustion of natural gas to be used in the industrial process itself, increasing the efficiency of energy use. From an environmental point of view, replacing diesel with natural gas in industry is a measure that will help reduce greenhouse gas emissions.

3.7. WASTE SECTOR

According to Angola's greenhouse gas inventory, the waste sector accounted for only 1% of emissions in 2005.

Industrial development, population growth and high urban growth rates will lead to an increase in waste production in Angola. The Strategic Plan for Urban Waste Management (PESGRU), approved in 2012, is the basis for defining a strategy to solve the problem of urban waste management and identifies four main lines of action: expanding and optimising the collection rate of urban waste; gradually implementing the model for the treatment, recovery and disposal of urban waste at national level; collecting and disposing of existing liabilities; and introducing selective collection and structuring specific flows.

The intervention of the National Development Plan aims to strengthen waste collection and sorting, promote environmental awareness and education, and environmental monitoring, while the National Environmental Quality Plan aims to develop a programme to combat waste liabilities with the provincial governments.

The PND's programme to consolidate the electricity sector includes the construction of solid urban waste-to-energy plants in Luanda and Benguela. The use of methane produced in landfills to generate electricity is an example of how waste management can have a double benefit: on the one hand, the collection of waste in urban areas contributes to improving the health and hygiene of the population; on the other hand, the use of biogas produced in landfills contributes to the reduction of greenhouse gas emissions and to the security of energy supply, making it possible to decentralise electricity production close to where it is consumed.

Waste is one of the most complex problems in modern societies, due to its growth and economic development, and consequently generates difficulties inherent in its management. It therefore mobilises great political and social importance.

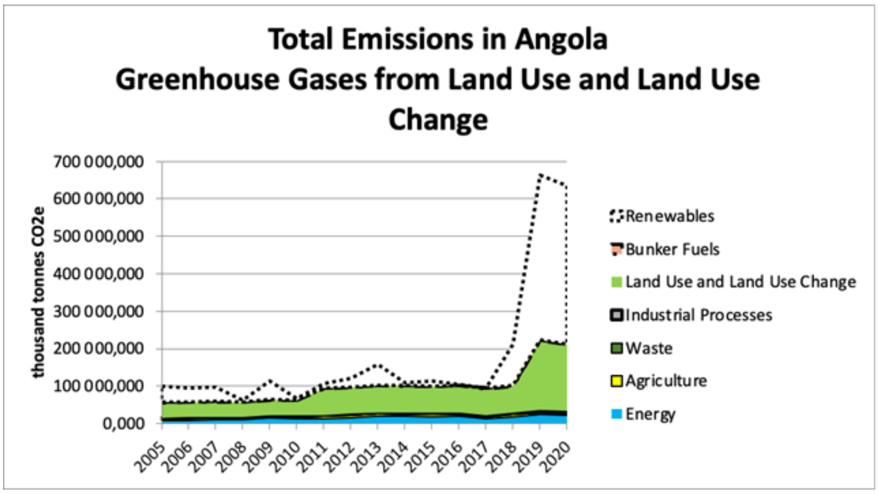
When waste is not properly disposed of in landfill sites, but in dumps or uncontrolled landfills, it becomes a problem for public health and contributes to the pollution of surface and groundwater, making it unfit for consumption.

Waste is one of the most complex problems facing modern societies due to their growth and economic development, and the difficulties inherent in its management. It is therefore of great political and social importance.

When waste is not properly disposed of in landfills, but in dumps or uncontrolled landfills, it becomes a public health problem and contributes to the pollution of surface and groundwater, making it unfit for consumption.

The use of methane from landfills to generate electricity is an example of good waste management, with a double benefit. If the collection of waste in urban areas helps to improve the health and hygiene of the population, the use of landfill biogas helps to reduce greenhouse gas emissions and secure energy supplies. In this way, electricity production can be decentralised to the areas of consumption.

Chart 28: Greenhouse gas emissions for the reference period of the reference period of the greenhouse gas inventory



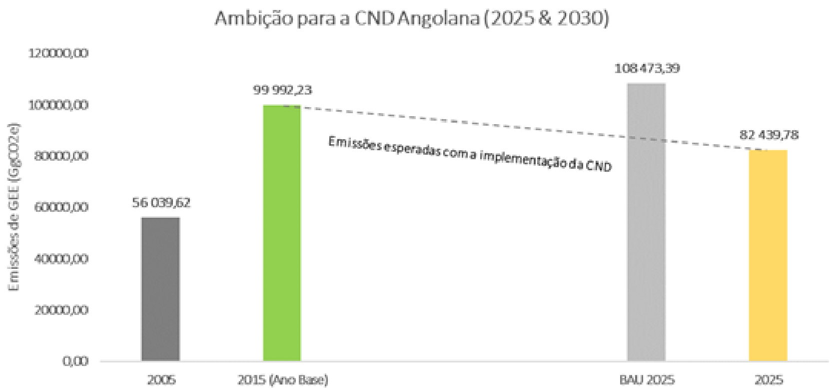
3.8. BUSINESS-AS-USUAL (BAU) SCENARIO

BAU refers to a scenario that assumes no mitigation policies or measures are implemented beyond those already in place and/or legislated or planned, i.e. the level of emissions that would occur in the absence of further policy effort.

The projections were calculated using the Greenhouse Gas Abatement Cost Model (GACMO) developed by the UNEP-DTU partnership. The BAU scenario was constructed based on the 2015 National GHG Inventory in accordance with IPCC guidelines.

Mitigation measures were selected and prioritised based on stakeholder consultations, which formed the basis for the calculation of the mitigation scenario calculated using the GACMO model.

Chart 29: Angola's NDC ambition



In its NDC, Angola aims to achieve an unconditional 15% emission reduction by 2025. In addition, under a conditional mitigation scenario, the country is expected to achieve a further 10% below BAU emissions by 2025.

To achieve this, various measures have been identified, analysed and selected for unconditional (Table) and conditional contributions (chart 32).

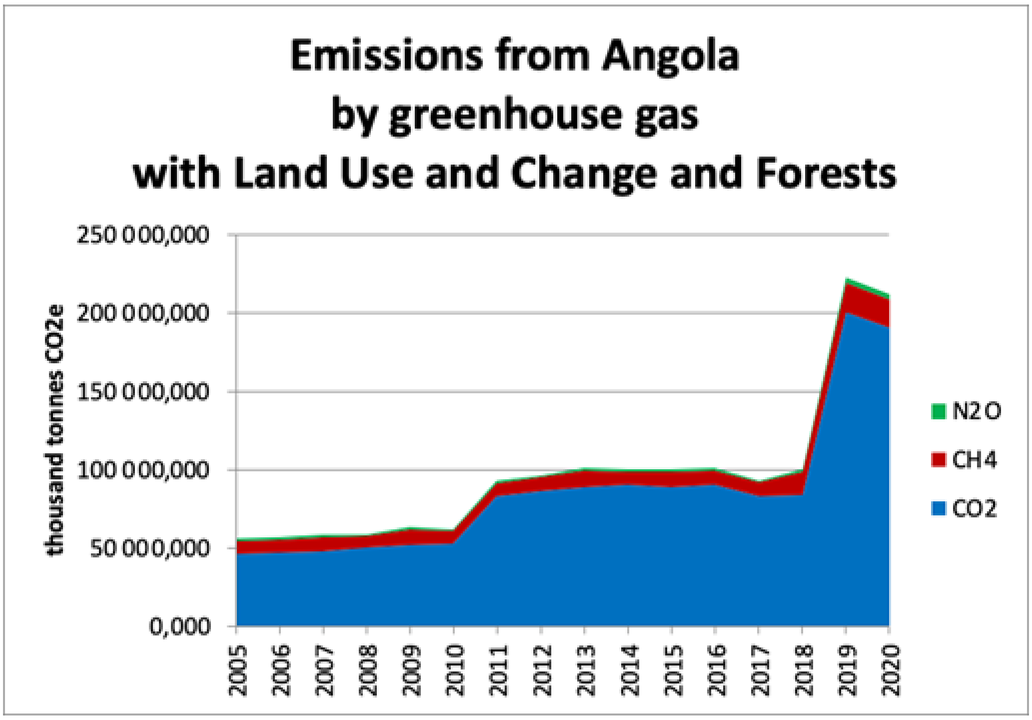
In addition, Annex 8.2 presents measures to achieve Angola's 2030 target. The unconditional target is to reduce emissions by 21% by 2030, which corresponds to an estimated reduction of 23.3 million tCO2e in that year. In addition, under a conditional mitigation scenario, it is hoped that the country will be able to reduce emissions by a further 15% below BAU by 2030, equivalent to an estimated mitigation level of 39.7 million tCO2e in that year.

Table 92: GHG emissions by sector from 2005 to 2020

Sector without LULUCF	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy	8638,891	9230,566	10036,754	10718,181	14454,777	12881,310	13433,315	15917,137	20255,030	19088,695	18115,620	19424,871	11983,559	18820,386	24247,176	**21904**,662
Agriculture	5322,952	5474,780	5647,282	5552,982	6038,672	6013,010	5987,196	6057,751	6107,864	6307,743	6608,453	6242,049	5857,070	5849,020	5475,776	5215,734
Waste	1685,496	1761,174	1816,491	1889,989	1993,139	2094,430	2168,886	2267,018	2392,688	2966,758	3151,339	3357,458	3554,708	3776,480	3810,213	3980,701
Industrial Processes	360,940	366,312	376,475	453,752	441,529	578,663	507,415	1818,068	1857,274	1638,805	1819,919	1550,973	1349,917	1693,582	2214,911	2253,016
Land Use and Land Use Change	40062,605	39907,397	40153,357	40065,406	40233,866	40189,886	70552,361	70392,155	70417,382	70432,479	70360,442	70430,964	70406,684	70409,590	186281,911	2253,016
Total Angola	56070,883	56740,229	58030,358	58680,311	63161,982	61757,300	92649,173	96452,129	101030,238	100434,481	100055,773	101006,315	93151,938	100549,058	186281,537	178173,775
Bunker Fuels	424,431	658,432	982,231	0,000	755,692	928,265	1224,346	1405,946	523,107	732,419	660,835	740,932	700,245	914,575	862,824	801,640
Renewables	43532,841	37541,762	37732,022	4399,755	48723,020	4506,947	13932,477	23897,040	56742,111	6769,011	13179,420	1863,364	1738,548	109482,687	440620,869	423183,117

Source: Author’s calculations, 2024

Chart 30: Distribution of Angola's emissions in 2020 by sector



The largest share of GHG emissions in Angola, around 49%, comes from the energy sector, particularly fugitive emissions associated with hydrocarbon production, Figure 3. As the third largest economy in sub-Saharan Africa, characterised by its dependence on revenues from the oil industry (responsible for more than 90% of national exports, more than 70% of tax revenues and around 23% of national GDP in 2015), it is normal that a large proportion of its GHG emissions are associated with the energy sector.

Emissions from the agricultural sector are the second largest source of emissions in the country, accounting for 36% of total emissions in 2005. The agricultural sector is important to the country, not only because of the number of people it employs (around 70% of the population), but also because of its contribution to national GDP, estimated at 9.9% in 201530.

However, it is recognised that the evolution of emissions will be different in the coming years, due to the national objectives of diversifying the economy, on the one hand, and the consequent reduction of dependence on the oil sector, on the other, in particular for the reasons set out in the recent government memorandum approved at the beginning of 201650. These factors will lead to an increase in GHG emissions from other sectors, which means that mitigation measures will have to be designed to take account of these development prospects.

As Angola is particularly vulnerable to climate change (ranked 50th on the Climate Risk Index in 2015) and is in the process of diversifying its economy, it needs to prepare for future challenges related to climate change. To do this, it is important to implement policies that accompany economic growth in a sustainable way, while trying to avoid the mistakes made by other countries in the past that have led to the current climate emergency.

3.9. STRATEGIC DOCUMENTS RELEVANT TO THE MITIGATION PILLAR

As part of the international commitments to combat climate change, Angola is committed to integrating the mitigation pillar into its sectorial policies, thus contributing to global efforts to reduce GHG emissions. Within the scope of mitigation, the following strategic documents stand out:

1. Long-term development strategy for Angola (Angola 2025) (2007);
2. National Energy Security Policy and Strategy (2011);
3. National Development Plan for 2023-2027 (PND) (2023);
4. Strategic Plan for Urban Waste Management in Angola (PESGRU) (2012);
5. Strategic Plan for New Environmental Technologies (2013);
6. Action Plan for the Energy and Water Sectors 2023-2027 (2023);
7. Atlas and National Strategy for New Renewable Energies (2015);
8. Angola Energies 2050 - long-term vision for the electricity sector (2023).

The set of priority mitigation actions and projects is designed to meet Angola's self-imposed targets of unconditionally reducing its GHG emissions by 35% by 2030 compared to the baseline scenario (2005 base year), and a further 15% by 2030 with the help of international funding.

The mitigation actions presented are divided into sectors (energy, agriculture, forestry and other land use, industry and waste) and classified according to their relevant contribution to the 17 Sustainable Development Goals. In addition to the sectorial breakdown, the mitigation actions presented in the ENAC are grouped into 11 initiatives, as shown in the table below.

Table 93: Mitigation initiatives

Sectors	Mitigation initiatives	Planned	In progress
Energy	Low-carbon electricity generation	x	x
	Access to low-carbon energy in rural areas		x
	Electricity sector regulations	x	
	Low-carbon transport (air, sea, rail, road)	x	
	Energy efficiency		x
	Low-carbon street lighting	x	
	Reducing fugitive emissions from oil and natural gas exploration and production		x
	Energy Transition - Green Carbon		
Agriculture, forestry and other land uses	Promoting low-carbon agriculture Soil correction Use of natural fertilisers	x	
	Management of forests and other land uses Reducing deforestation Planting new forest polygons for various purposes	x	
Industry	Energy efficiency in industry Technology transfer	x	
Waste	Waste management Reducing waste production Improving collection and final disposal	x	X

For each mitigation initiative, the objectives, targets to be achieved, mitigation measures, justification for implementing these measures and identified training needs were also identified. The importance of capacity building at school and university level is recognised: students are important agents for disseminating good practices and approaches to their families and communities.

3.9.1. Mitigation initiatives for the energy sector

The main mitigation measures for this sector are grouped into seven initiatives: (1) low-carbon power generation; (2) access to low-carbon energy in rural areas; (3) electricity sector regulation; (4) low-carbon transport; (5) energy efficiency; (6) low-carbon public lighting; (7) reduction of fugitive emissions from oil and gas exploration and production, tables below.

Table 94: Low-carbon electricity generation

<table>
<tr><th>Sector: Energy</th><th colspan="3">Low-carbon electricity generation</th></tr>
<tr><th>Objectives</th><th>Targets</th><th>Responsible</th><th>Alignment with SDGs</th></tr>
<tr><td>Increased penetration of renewable energies
Increase in electricity access charges for all Angolans
Reducing GHG emissions</td><td>Achieve 70 % of installed renewable power by 2050</td><td>Ministerial department and the Energy and Water portfolio</td><td>SDG 7 - Renewable and Affordable Energy
SDG 13 - Climate Change
SDG 11 - Sustainable cities and communities</td></tr>
<tr><th colspan="4">Justification</th></tr>
<tr><td colspan="4">Angola recently published two strategy documents for the energy sector, the "Atlas and National Strategy for New Renewable Energies" (MINEA 2015) and "Angola Energy 2025" (MINEA 2016). The government's objectives for the energy sector are to implement the mitigation measures listed in these two strategies, based on the country's high renewable potential, identified in the "Atlas and National Strategy for New Renewable Energies": solar energy has a potential of 17.3 GW; electricity production from hydroelectric power stations has a potential of 18 GW; electricity production from biomass and MSW has a potential of 3.7 GW; wind energy production has a potential of 3.9 GW. Alongside the development of large-scale energy projects, it is important to promote the electrification of Angola, which currently covers only 30 % of the territory.
This Atlas establishes targets for the promotion and exploitation of renewable energy sources in Angola and predicts that by 2025 there will be a large increase in energy demand of around 7.2 GW.
The increase in the economy's energy needs must be met not only by renewables, but also by the production of energy by thermal power stations, which offer greater flexibility and production availability.
Angola has natural gas reserves, which are being exploited at the Angola LNG terminal. The natural gas produced here makes it possible to install more power. Natural gas will accompany the installation of renewable energy projects on the fossil side because, as well as being an endogenous source, it is less polluting.
The extension of the country's electrification, which is strategic for promoting the development of human capital and the well-being of Angolans, will enable wealth creation and job creation, and is an important vector for the country's industrial and human development. The electricity grid is in a phase of major development, with plans to integrate the five main existing regional grids (North, Centre, East, South and Cabinda) and to strengthen the stability of the electricity supply to the main consumer centres, both residential and industrial. Angola does not currently have a system for calculating the emission factor (EF) of its electricity grid, which is why it is important to develop it, not only to allow a more accurate and up-to-date calculation of emissions from burning fossil fuels in the electricity sector, but also to serve as a tool for all participants in projects and programmes aimed at reducing emissions within the framework of the UNFCCC market mechanisms (CDM, POA, NAMA or projects developed within the framework of a future market mechanism resulting from discussions on Article 6 of the Paris Agreement).</td></tr>
<tr><th colspan="4">Mitigation measures</th></tr>
<tr><td colspan="4">Continue the process of installing renewable energy plants
Evaluate the possibility of implementing geothermal energy projects
Encouraging the replacement of the most polluting fuels with natural gas in thermal power stations for electricity generation
Continue to promote the interconnection of Angola's electricity systems and the electrification of rural areas
Increasing the use of energy efficiency in households;</td></tr>
<tr><th colspan="4">Capacity building and institutional actions</th></tr>
<tr><td colspan="4">Create a renewable energy research centre at a national university that promotes interaction with other universities, centres, institutes and international associations for training in renewable energy
Create the National Institute for Rural Electrification
Launch communication campaigns on renewable energies to raise public awareness of the importance of their implementation
Develop a tool to regularly calculate the FE of the electricity grid</td></tr>
</table>

Table 95: Access to low-carbon energy in rural areas

Sector: Energy	**Access to low-carbon energy in rural areas**		
Objectives	**Targets**	**Responsible**	**Alignment with SDGs**
Increased electricity access charges for all Angolans Reducing GHG emissions	Guarantee access to electricity for 60 % of the population.	Ministerial department and the Energy and Water portfolio Ministerial Department and the Department of Agriculture and Forestry Ministerial Department and the Department of Geology and Mining	SDG 7 - Renewable and Affordable Energy SDG 13 - Climate Change SDG 11 - Sustainable cities and communities
Justification			
Promoting the economic development and well-being of Angolans means making electricity available to everyone. The country's electricity distribution infrastructure does not cover the whole country, which is why it is extremely important to implement isolated electricity production projects based on renewable energies. Currently, the electricity penetration rate in rural Angola is very low. It is 6%, according to the "See4All" initiative, which makes it essential to extend electrification in the country, in line with the target set to promote the country's industrial and human development. According to the Atlas and National Strategy for New Renewable Energies (2015), the potential for implementing this type of project is high throughout Angolan territory, and should therefore be exploited to provide Angolans with better welfare conditions.			
Mitigation measures			
Implementing small-scale isolated projects based on solar, wind and hydroelectric power, which provide electricity to rural areas Extend the "Solar Villages" project so that by 2025 there will be at least 500 villages benefiting from this programme Distribute at least 500,000 solar lanterns in rural areas Implement biodigester projects in villages without access to electricity, especially in areas with the highest livestock activity			
Training and institutional actions			
Launch communication campaigns on renewable energies to raise public awareness of the importance of their implementation			

Table 96: Electricity sector regulations

Sector: Energy	Electricity sector regulations		
Objective	**Targets**	**Responsible**	**Alignment with SDGs**
Create regulations that encourage increased investment in renewable energies and energy efficiency	Creation of "green" tax incentives	Ministerial department and the Energy and Water portfolio Ministerial Department and the Economy Department Ministerial Department and the Finance Department	SDG 7 - Renewable and Affordable Energy SDG 13 - Climate Change

Justification

Stimulating investment in certain technologies often has to be pushed to attract investment. The creation of *feed-in* tariffs or the streamlining *of power purchase agreements* (PPAs) have been widely used to stimulate private investment in renewable energy projects that contribute to climate change mitigation. Tax measures linked to renewable energies are also a way of incentivising investment, as are clear and diligent project licensing procedures.

Feed-in tariffs are characterised by remunerating the production of electricity from renewable energies based on the generation cost of each technology, meaning that the sales tariff for the energy produced is higher than the existing tariff. With this type of compensation, electricity producers are able to guarantee a fixed price for the sale of their electricity, usually determined by the government, which is higher than the existing tariff for conventional energy production. With the maturing of technologies, *feed-in* tariffs should gradually decrease over time in order to keep up with technological developments.

PPAs are energy supply contracts that define the commercial terms for buying and selling energy between the producer and the buyer. Drawing up a PPA can be subject to lengthy bureaucratic processes, which end up delaying investor interest, which is why it is important to create mechanisms that guarantee the speed of the process, in order to avoid investor disinterest due to the delay in the process.

In addition, the creation of energy efficiency legislation is also a powerful tool to help mitigate GHG emissions. The creation of legislation that establishes certain *standards* for the products used by Angolans in their daily lives will thus contribute to more conscious energy consumption. At the same time, an effort should be made to make the population aware of the need to use the most efficient appliances: choosing and using equipment properly will save the environment and the Angolan family budget.

Mitigation measures

Approve specific laws for renewable energies that encourage their implementation
Creating *feed-in* tariffs to promote private investment in renewable energies
Create legal instruments to facilitate contracts (PPA)
Create legislation that guarantees the sale of electrical appliances in Angola in accordance with the latest energy efficiency labelling *standards*.

Training and institutional actions

Organising information sessions for investors on renewable energy regulations in the country
Promote energy efficiency awareness campaigns among families

Table 97: Low-carbon transport

Sector: Energy	Low-carbon transport		
Objective	**Targets**	**Responsible**	**Alignment with SDGs**
Promoting sustainable growth in the transport system	Expanding the transport network Reducing emissions from the transport sector	Ministerial Department and the Transport Department	SDG 11 - Sustainable cities and communities
Justification			

The economic and social development of a country cannot be dissociated from the growth of the national transport network. On the contrary, it must keep pace with its evolution. The country's growth forecasts over the next few years have implications for emissions from the transport sector, both from the perspective of population growth and its economy.

Road transport

Public passenger transport is underdeveloped in Angola, with mainly individual transport being used to the detriment of public transport. The so-called "candongueiros", old informal public transport vans, are widely used in the country. At rush hour, traffic is very heavy in urban areas, and GHG emissions are particularly aggravated. In general, a large part of the country's car fleet is made up of old vehicles with old and inefficient engines. To reverse the situation, the growth of the population and urban centres must be accompanied by the development of public passenger transport, which offers a quality public service that is less polluting and more comfortable for the population. The creation of exclusive public transport routes within the main cities is a measure that will reduce GHG emissions and facilitate the population's mobility, allowing people to use these infrastructures on a daily basis in the short/medium term, to the detriment of individual transport. In addition, measures to promote road freight and passenger transport must be accompanied by the creation of legislation to limit GHG emissions.

Rail transport

The development of logistics platforms on the main axes of economic development to promote the flow of industrial products is included in the 52nd crisis exit strategy document. The creation of logistics platforms from scratch to accompany the development of the economy is an opportunity to organise the transport sector and the rehabilitation and construction of new railway lines cannot be dissociated from the development of these platforms. In this way, it can accompany the development of Angolan industry, contributing not only to getting raw materials to the industries, but also to getting the end products to them, based on a less polluting means of transport. In terms of passenger transport, investment in railways is an important measure that helps to increase the movement of people and goods in and out of the country in a sustainable way, reducing GHG emissions. As well as comfort, this equipment promotes quality of service and a cleaner environment.

Air transport

In October 2016, the United Nations International Civil Aviation Organisation (ICAO) approved the implementation of a system for offsetting CO_2 emissions in international air transport, CORSIA, the "Carbon Offsetting and Reduction Scheme for International Aviation". This system will be implemented in phases until 2026, followed by a mandatory participation phase for all airlines, although there are exceptions for less developed countries, small island states, landlocked developing countries and states with very low levels of international aviation. It is therefore to be expected that the aviation sector will be subject to stricter rules on GHG emissions in the medium to long term under this programme. For this reason, national airlines must establish programmes to monitor and reduce their GHG emissions.

Maritime transport

In 2011, the International Maritime Organisation (IMO) adopted technical and operational energy efficiency measures that contribute to reducing GHG emissions. In addition, in October 2016, the IMO approved the Roadmap for reducing GHG emissions from ships, which was adopted in 2018. Maritime transport in Angola ranges from small boats to large ships controlled by different companies. It is currently difficult to estimate the emissions associated with maritime transport in Angola, which is why it is considered important to improve the control of fuel consumption in maritime transport and to encourage energy efficiency and the reduction of GHG emissions in the sector, in accordance with IMO guidelines.
Mitigation measures
Road transport Continue to promote the use of public transport: implement an efficient, fast and isolated BRT (*bus rapid transit*) type mass transport system in provinces other than Luanda; continue to extend the taxi network throughout the country; implement intermodal transport Progressively converting the fossil fuels used in public passenger transport fleets to natural gas. Create legislation to limit the import of vehicles with high levels of gas emissions per kilometre Create legislation that obliges the incorporation of a percentage of biofuel in the fuel used for road transport; Promoting ethanol production in the country based on sugar cane Review existing regulations on pollution limits and the periodicity of road vehicle inspections in order to control GHG emissions **Rail transport** Continuing the rehabilitation of railway lines to extend the supply of public transport and freight transport in the country Replacing *diesel* locomotives with electric locomotives, a measure that also presupposes the gradual electrification of the railway. **Air transport** Improve the monitoring of fuel consumption and estimate GHG emissions, based on ICAO guidelines Prepare a programme for offsetting GHG emissions in national airlines, with a view to joining CORSIA **Maritime transport** Promote the implementation of fuel consumption monitoring rules, based on IMO guidelines Promote the adoption of technical and operational measures that lead to greater energy efficiency and a reduction in GHG emissions, based on IMO guidelines
Training and institutional actions
Road transport Carry out awareness-raising campaigns on the need to maintain own vehicles properly Carry out municipal campaigns to promote the use of public passenger transport Promote capacity-building actions in urban planning and transport, in order to find the best ways to implement mitigation measures in the transport sector. Promoting training activities for companies in the logistics sector to optimise transported cargo and define the most efficient distribution routes **Rail transport** Carry out municipal campaigns to promote the use of public passenger transport **Air transport** Promote training for monitoring fuel consumption and estimating GHG emissions, based on ICAO guidelines **Maritime transport** Promote training in monitoring fuel consumption and adopting energy efficiency measures, based on IMO guidelines

Table 98: Energy efficiency in buildings

Sector: Energy	Energy efficiency in buildings		
Objective	**Targets**	**Responsible**	**Alignment with SDGs**
Promoting energy efficiency	Creation of legislation on the inclusion of measures for the rational use of energy in new buildings, implementation of energy efficiency measures in all state buildings	Ministerial Department and the Urban Planning and Housing Department Ministerial department and the Energy and Water portfolio	SDG 4 - Quality Education SDG 11 - Sustainable Cities and Communities
Justification			
Sustainable urban development is one of the priorities in the light of the SDGs and the New Urban Agenda, which emerged from the 3rd United Nations Conference on Housing and Sustainable Urban Development (Habitat III), held in Quito, Ecuador. The event discussed the challenges of cities for the future, which must be increasingly inclusive, sustainable, safe and low-carbon. Angola is going through a phase of population growth, with the consequent development of its metropolitan areas, which is why its planning must be based on this Agenda. The government recognises the challenges arising from the growth of urban areas and is therefore committed to pursuing the objectives discussed in Quito. Accordingly, it is committed to encouraging the adoption of energy efficiency measures in new buildings, as well as promoting energy efficiency improvements in existing buildings, while contributing to the reduction of GHG emissions. Another very important aspect of this issue is organising information sessions for families and communities on sustainable urban development issues. It is therefore imperative that people assimilate the principles of energy efficiency by various means, including awareness campaigns. Angola has a significant deficit between electricity demand and production, which implies an extremely urgent process of educating communities to avoid wasting electricity. The government's approach will be at local level, counting on the support of municipalities and, above all, schools, as pupils are seen as an important vehicle for these messages to their communities.			
Mitigation measures			
Continuing to promote efficient lighting, in particular through the continuation of the light bulb exchange programme Create legislation to include energy efficiency practices and renewable energy sources in new buildings Implementing energy efficiency measures in public sector buildings Implementing energy efficiency measures in schools			
Training and institutional actions			
Continue awareness-raising campaigns among families and communities to make them aware of the need to use energy rationally on a daily basis. Continue to implement the "Life, Energy and Me" programme, the aim of which is to instil in citizens daily behaviours that lead to more conscious energy consumption habits.			

Table 99: Low-carbon street lighting

Sector: Energy	Low-carbon street lighting		
Objective	**Targets**	**Responsible**	**Alignment with SDGs**
Using energy more efficiently	Progressive replacement of conventional light bulbs with LED lights	Ministerial Department and the Urban Planning and Housing Department	SDG 11 - Sustainable Cities and Communities
Justification			
The increase in population in urban areas implies the sustained growth of cities, not only in terms of the buildings themselves, but also in terms of public lighting, sewage systems, water supply, roads and transport infrastructures. The progressive replacement of conventional luminaires with LED luminaires contributes to increased energy efficiency, allows for savings in energy consumption, efficient use of resources and a reduction in GHG emissions. In addition, and from an economic perspective, LED technology is clearly more interesting today due to its superior energy efficiency, allowing for a reduction in electricity bills. It should also be noted that the lack of public lighting in urban areas ends up fuelling crime, the cancer of large metropolises. This is why there is an urgent need to implement public lighting, in conjunction with other measures, to guarantee the energy security of the country and its populations and to reduce GHG emissions.			
Mitigation measures			
Gradually replace all street lighting with LEDs Gradually replace inefficient light bulbs with efficient ones and install control devices (light sensors and motion sensors) in the state's central and local administration public services. Promoting public lighting, using solar lamps in rural and isolated areas not connected to the electricity grid Carry out campaigns to supply efficient light bulbs and control devices (light sensors and motion sensors) to households Create legislation to limit the use of inefficient light bulbs			
Training and institutional actions			
Carry out awareness campaigns to encourage more efficient behaviour in state buildings Evaluate the institutional arrangements to determine which bodies should be responsible for managing public lighting			

Table 100: Reduction of fugitive emissions from exploration and production of oil and natural gas

Sector: Energy	Reducing fugitive emissions from oil and natural gas exploration and production		
Objective	**Targets**	**Responsible**	**Alignment with SDGs**
Reducing fugitive emissions in oil and natural gas production	Reduction of fugitive emissions resulting from the exploration and production of oil and natural gas	Ministerial Department and the Petroleum Department	SDG 9 - Industry, Innovation and Infrastructure SDG 12 - Sustainable production and consumption
Justification			
GHG emissions in the energy sector, particularly fugitive emissions associated with hydrocarbon production, accounted for 49 % of Angola's GHG emissions, according to the 1st NPP. As the largest oil producer in Africa since 2015, it is natural that a large part of Angola's GHG emissions are associated with this sector. The country must therefore endeavour to reduce emissions related to this sector.			

Some of the natural gas that is released from the wells along with the oil is burnt off in *flares*, which is a waste of energy and a source of CO_2 . However, this natural gas can be reused to increase production from oil wells by re-injecting it or even utilised for energy production. Angola recently joined the World Bank's "Zero Routine Flaring by 2030" initiative9 , which aims to put an end to *flaring* in normal operations (*routine* flaring), reducing gas flaring and thus contributing to the reduction of GHG emissions. At the same time, and as in any industrial process, increasing energy efficiency in the oil exploration and production chain must also be the target of efforts on the part of the producing country.
Mitigation measures
Implementing energy efficiency measures in industrial hydrocarbon extraction and production processes Reducing the *flaring* process, with a view to ending the routine burning of natural gas in the long term, in line with the World Bank initiative
Capacity building and institutional actions
Promote the participation of industry experts in international working groups to assess the possibility of applying the principles of capturing, transporting and storing CO_2 in depleted hydrocarbon reservoirs or using it in other industrial processes in order to reduce fugitive GHG emissions. Encouraging the participation of oil industry technicians in international working groups studying alternatives to *flaring* and seeking the use of this gas in other applications, and in working groups exploring ways of optimising oil-related industrial processes in order to increase their energy efficiency.

3.9.2. Mitigation initiatives for the agriculture, forestry and other land use sectors

Table 101: Low-carbon agriculture

Sectors: Agriculture, forestry and other land uses Soil		**Low-carbon agriculture**	
Objectives	**Targets**	**Responsible**	**Alignment with SDGs**
Increasing the use of sustainable agricultural production systems	Doping up agricultural communities with implemented renewable solutions	Ministerial Department and the Department of Agriculture and Forestry	SDG 3 - Quality Health SDG 4 - Quality Education SDG 5 - Gender equality SDG 12 - Sustainable Consumption and Production
Justification			
According to the "Guidelines for Defining a Strategy for Exiting the Crisis Derived from the Fall in the Price of Oil on the International Market", agriculture will be a key sector for reducing oil dependency and diversifying the economy. The country has favourable conditions for agriculture and forestry, with production potential all over the country. The sector is currently important for the country, not only in terms of GDP, 9.9% in 201510 , but also in terms of the amount of labour it employs. One of the government's objectives for the agricultural sector is to increase exports and reduce imports, with a view to making the country self-sufficient in basic food products. In response to this strategy, the agricultural sector is expected to grow in the coming years, which is why it is important to promote this growth, based on the promotion of sustainable agricultural practices. Only in this way will the sector grow in a sustainable way from an economic, environmental and energy point of view.			
Mitigation measures			
Promote sustainable, low-carbon agricultural practices that help combat desertification and unsustainable use of agricultural land and contribute to improving Angola's food security and domestic supply. Regulating the use of fertilisers			

9 World Bank (2017). Zero Routine Flaring by 2030. Available on the internet: <http://www.worldbank.org/en/programs/zero-routine-flaring-by-2030#4> [Consulted 10 April 2017].

10 INE (2017). Press Release No. 02 - Provisional National Accounts 2014 and Preliminary 2015.

Develop a programme to prevent and monitor burning, a practice widely used in the preparation of agricultural land. Adopt measures to sensitise and raise awareness among the population in order to achieve this objective. Promote the modernisation of traditional agriculture, based on sustainability, applying agricultural practices that ensure a reduction in GHG emissions and at the same time increase producers' income. Facilitating the purchase of agricultural equipment that uses renewable energies or less polluting fuels, through special financing programmes for this purpose Quantifying the potential of biofuels to replace fossil fuels and their impact from an environmental point of view
Training and institutional actions
Train small and large producers in the advantages of applying low-carbon agricultural practices and how these can help increase their productivity. Develop pilot projects for school gardens, where students can apply the principles of sustainable agriculture in practice and pass them on to the communities where they live.

Table 102: Management of forests and other land uses

Sectors: Agriculture, forestry and other land uses		**Management of forests and other land uses**	
Objective	**Targets**	**Responsible**	**Alignment with SDGs**
Managing the country's forests based on the principles of sustainability	Reduce deforestation by 2035	Department of Agriculture and Forestry	SDG 15 - Protect terrestrial life SDG 7 - Renewable and Affordable Energy SDG 12 - Sustainable Consumption and Production
Justification			
As part of the National Forest Inventory (IFN), work began in 2009 on the first inventory carried out in Angola, with national coverage, with technical support from the Food and Agriculture Organisation of the United Nations (FAO). The preliminary results of the first phase (2000 - 2015) estimated the national forest area at 69,383,687 hectares, around 55.6 % of the national territory. The IFN is a fundamental tool that makes it possible to better understand and manage the country's forest resources, while also allowing for transparent accounting of removals from the forest area and thus monitoring the rate of deforestation and promoting measures to combat it. According to the IFN, the annual deforestation rate during the period in question was 0.8 %. Forests are of great socio-economic importance due to the use of wood as fuel, building materials and the utilisation of other resources for food and medicinal purposes. Forests are therefore a valuable resource for the country, not only because of their economic importance, providing countless socio-economic and environmental benefits, but also because of their fundamental role as a carbon sink and regulator of the balance of ecosystems. It must therefore be exploited in a sustainable way. Forests have a good capacity to recover from natural climate variations. However, the loss of vegetation cover can have overwhelming consequences, because it exacerbates the impacts of climate change on ecosystems. In this sense, it is essential for the government to establish mitigation measures for the forestry sector that help preserve this source of the country's wealth.			
Mitigation measures			
Ensuring sustainable forest management Promote the reforestation of degraded areas Implement a tool, based on a geoFigureic information system, to inventory and monitor the forest and changes in land use.			
Training and institutional actions			
Providing adequate specialisation for provincial technicians involved in afforestation and reforestation issues Promote training sessions for rural producers on the recovery of degraded pastures			

Promote awareness-raising sessions among people living in forest areas about the problem of deforestation and the role they should play in preventing it.

3.9.3. Mitigation initiatives for the industrial sector

According to the country's GHG inventory, the industrial sector accounted for only 1% of Angola's emissions in 2005. The main mitigation measures for this sector fall under Initiative 10, which aims to implement measures that contribute to energy efficiency in industry.

Table 103: Energy efficiency in industry

<table>
<tr><th colspan="2">Sectors: Industry</th><th colspan="2">Energy efficiency in industry</th></tr>
<tr><th>Objective</th><th>Targets</th><th>Responsible</th><th>Alignment with SDGs</th></tr>
<tr><td>Using energy more efficiently in industry</td><td>Use of natural gas in all industrial facilities by 2035, to the detriment of other fossil fuels</td><td>Ministerial department and the Energy and Water portfolio
Ministerial Department and the Industry Department</td><td>SDG 7 - Affordable Renewable Energy
SDG 9 - Industry, Innovation and Infrastructure</td></tr>
<tr><th colspan="4">Justification</th></tr>
<tr><td colspan="4">Considering the objective of diversifying the economy, which the Angolan government intends to promote in the coming years, both to respond to the oil crisis and to promote economic diversification, in the context of its LDC programme, the manufacturing industry is expected to develop considerably in the short term. In this sense, the government recognises that the growth of economic activity must be sustained by energy consumption, in a conscious and efficient manner.
With the aim of promoting a national industry that is sustainable from an energy and environmental point of view, the government intends to encourage the replacement of diesel generators with natural gas cogeneration systems, with the capacity to produce energy and heat, which responds to two problems: security of energy supply and preservation of the environment.
From the point of view of energy supply security, the production of electricity for self-consumption using cogeneration systems will guarantee a reliable electricity supply, avoiding power cuts and the instability of Angola's electricity grids, as well as any damage that these may cause to machinery, in addition to the advantage of using an endogenous and abundant fuel that is produced in the country. In addition, cogeneration systems allow the heat generated by the combustion of natural gas to be used in the industrial process itself, increasing the efficiency of energy use. From an environmental point of view, replacing the use of diesel with natural gas in industry is a measure that contributes to reducing GHG emissions.</td></tr>
<tr><th colspan="4">Mitigation measures</th></tr>
<tr><td colspan="4">Implement more efficient measures and processes in Angolan industry in order to reduce specific fuel consumption in industrial production
Promoting the application of solar and solar photovoltaic technologies for the production of electricity and heat in industry
Promote the replacement of diesel generators with natural gas turbines
Promoting cogeneration in industry</td></tr>
<tr><th colspan="4">Training and institutional actions</th></tr>
<tr><td colspan="4">Carry out awareness-raising campaigns on the advantages of implementing energy efficiency measures in industrial facilities</td></tr>
</table>

Source: Author’s calculations.

3.9.4. Mitigation initiatives for the waste sector

According to the country's greenhouse gas inventory, the waste sector accounted for only 1% of emissions in 2005.

Table 104: Municipal waste management

<table>
<tr><th colspan="2">Sector: Waste</th><th colspan="2">Urban waste management</th></tr>
<tr><th>Objective</th><th>Targets</th><th>Responsible</th><th>Alignment with SDGs</th></tr>
<tr><td>Managing and recovering waste</td><td>Increase waste collection rates by 100 % in peri-urban areas by 2020 and by 80 % in rural areas by 2022.
Meet the minimum recycling rate of 10 % of all recyclable materials by 2022.
By 2022, at least 90 % of healthcare facilities will have efficiently treated hospital waste</td><td>Ministerial Department and the Environment Department
Ministerial Department and the Health Department</td><td>SDG 6 - Drinking Water and Sanitation
SDG 7 - Renewable and Affordable Energy
SDG 11 - Sustainable Cities and Communities
SDG 12 - Sustainable Consumption and Production</td></tr>
<tr><th colspan="4">Justification</th></tr>
<tr><td colspan="4">Industrial development, population growth and the high growth rates of cities will lead to an increase in waste production in Angola. The Strategic Plan for Urban Waste Management (PESGRU), approved in 2012, is the basis for defining a strategy for resolving the problem of urban waste management and establishes four main lines of action: extending and optimising the collection rate for urban waste; the phased implementation, at national level, of the model for the treatment, recovery and disposal of urban waste; the collection and disposal of existing liabilities; and the launch of selective collection and structuring of specific flows.
The development of the waste sector makes it possible not only to minimise environmental and public health impacts, improving the population's well-being, but also to create jobs and valuable by-products, making it a sector with high economic potential when managed well. In addition, waste management makes an effective contribution to mitigating GHG emissions. The use of methane generated in landfill sites to produce electricity is an example of how waste management can have a double benefit: on the one hand, waste collection in urban areas contributes to improving the health and hygiene conditions of the population, and on the other, the use of biogas generated in landfill sites contributes to reducing GHG emissions and securing energy supplies, making it possible to decentralise electricity production close to consumption areas.</td></tr>
<tr><th colspan="4">Mitigation measures</th></tr>
<tr><td colspan="4">Construction of landfills, using the biogas generated to produce electricity
Continue to establish selective waste collection programmes, covering all municipalities.
Closing down rubbish dumps in use, replacing them with landfills, burning biogas and treating leachate.</td></tr>
<tr><th colspan="4">Training and institutional actions</th></tr>
<tr><td colspan="4">Carry out municipal campaigns to raise awareness of waste issues, in partnership with organisations in the sector, encouraging recycling and reuse.
Running waste recycling and composting programmes in schools to encourage pupils to share the knowledge they have acquired with their communities.</td></tr>
</table>

3.9.5. A survey of the need for Legislation to fulfil the mitigation measures

In order to implement the proposed mitigation measures, it is necessary to carry out a comprehensive survey of existing and missing legislation. This survey should be carried out in the short term, within the framework of the Interministerial Commission on Climate Change and Biodiversity, with a view to creating the legal framework necessary for the rapid achievement of the mitigation targets.

Table 105: Selected hydroelectric projects (Angola 2025) (3)

Dam	Location	Date of construction	Reservoir capacity (hm^3)	Installed capacity (MW)	State (In)
Bioscope	Benguela	1956	2,2	15,2	Exploitation
Caculo Cabaça	Kwanza-Sul	2018	463	2171	Construction
Cambambe	Kwanza-Norte	1963	20	180	Exploitation
Capanda	Malanje	2005	4795	520	Exploitation
Chicapa	Lunda-Sul	2008	1	16	Rehabilitation
Chiumbe-Dala	Lunda-Sul			12	Construction
When	Huambo			1	Exploitation
Cunje I	Cuito	1971	87,1	1,62[11]	Exploitation
Gove	Huambo	1974	2574	60	Exploitation
Laúca	Malange		5482	2067	Exploitation
Lomaum	Benguela	1964	0,7	35	Exploitation
Luachimo	Lunda-Norte	1953		8,4[12]	Exploitation
Luquixe	Uíge			2,1	Rehabilitation
Mabubas	Bengo	1954	61,7	18	Exploitation
Matala	Huíla	1954	78	40,8	Exploitation
Ruacana	Cunene	1975	18	341	Exploitation
Tundavala	Huíla	1975	2,05		Exploitation

In order to extend the rural electrification network, a tender was launched for the preparation of basic projects and specifications for the rural and local electrification of some localities in 12 provinces:

[11] It will have an installed capacity of 10 MW
[12] It will have an installed capacity of 32 MW

Table 106: Basic projects and tender specifications for rural and local electrification in some localities in Angola (3)

Province	NO. Sub-stations		Network AT [km]		PTs			MV network [km]		LV network [km]	IP network [km]	Domestic Connections
	QT	Voltage ratio	220 kV	60kV	Q/UN	POWER (KVA)	TOTAL (KVA)	30kV	15kV			
Kwanza-Sul	3	60/30		136	64	250	16.000	24		599	599	59.477
					48	400	19.200					
					22	630	13.860					
Zaire	1	220/60/30		305	306	250	76.457	148		223	110	35.304
	4	60/30										
Bengo	3	60/30		130	237	250	59.244	185		99,9	99,9	8.427
Kwanza-Norte					14	250	3.500	40		9	13	680
Namibe	1	60/30			14	250	3.500	137		46	20,64	782
Huíla	1	220/60/30		86	62	100	6.200	301	10	327	150	8.898
	3	60/30			65	250	16.250					
Benguela	1	220/60	1,47	274.29	127	100	12.700	140		576	280	45.818
	9	60/30			72	250	18.000					
					5	400	2.000					
					6	630	3.780					
Huambo	1	220/60/30		187	316	250	79.098	66		170	170	73.429
	4	60/30										
Total	**31**		**1,47**	**844**	**1.358**		**294.589**	**1.041**	**10**	**2.041**	**1.083**	**232.815**

The implementation of this vast programme will make it possible to connect around 230,000 families (1,400,000 people) to the electricity distribution and supply system, through the construction of 31 substations of different voltage levels, the installation of 1,358 transformer stations of different power ranges, the construction of around 1,000 km of 30 kV lines and 10 km of 15 kV lines, 2,000 km of low-voltage networks and 1,000 km of public lighting networks. The electrification rate is 5%.

Table 107: Electrification capacity in each region

Region	Provinces	Enterprise	River Basin	Installed Groups (MW)	Installed capacity (MW)
South	Huíla	Matala	Cunene	3x13,6	40,8
East	Lunda-North	Luachimo	Congo	4x2,1	8,4
Centre	Benguela	AH Biopio	Catumbela	4x3,6	14,4
	Benguela	AH Lomaum	Catumbela	2x10 + 2x15	50
	Huambo	AH Gove	Cunene	3x20	60
North	Malanje	AH Capanda	Kwanza	4x130	520
	Malanje	Laúca	Kwanza	6x334	
	Kwanza-Norte	AH Cambambe	Kwanza	4x65	180
	Bengo	AH Mabubas	Dande	4x6,4	25,6
	Uíge	AH Luquixe		2x0,45	0,9

3.9.5. New energy sources

Angola, a country rich in renewable resources, aims to achieve 500 MW of electricity from various renewable energy sources, including solar, wind, bioenergy and mini-hydro. Priority will be given to solar energy.

Among Angola's provinces, Luanda, Kwanza Norte and Kwanza Sul have the most viable projects due to their greater capacity to absorb intermittent energy from the grid.

367 potential projects have been identified and studied, representing a total of approximately 17.3 GW of potential solar photovoltaic power generation. Of these, 3,455 MW (122 projects) are suitable for grid connection.

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367 potential projects have been identified and assessed, totalling some 17.3 GW of potential solar photovoltaic power generation. Of these, 3,455 MW (122 projects) are suitable for grid connection.

Autonomous photovoltaic systems have been implemented as part of the Aldeia Solar programme, which aims to electrify social infrastructures through the installation of autonomous (isolated) photovoltaic systems, namely Schools, medical centres, police stations, administrative buildings and social centres, including solar street lighting.

In response to the need to improve the collection of metrological data in Angola, the Wind and Solar Mapping Project installed metrological stations throughout the country. This led to the identification of 10 priority solar projects, representing a total of 100 MW for the market and the construction of solar parks in the provinces of Benguela, Cunene, Huíla and Namibe in a first phase.

3.9.6. Wind energy

According to the statistics of the Angolan Wind and Solar Mapping Project, the country has a gross capacity of more than 140 GW, with the greatest potential in the province of Namibe, followed by the provinces of Huíla, Cuanza-Sul, Malanje and Moxico.

The wind resource, located in the southwest of the country and on the Atlantic escarpment, along a north-south axis, identified in recently completed studies, Angola has a wind potential of 3.9 GW. (Of this total potential, 13 projects have conditions for connection to the grid.

This potential results from the integration of various variables and constraints, namely: areas with average wind speeds of more than 6.0 m/s, areas outside nature reserves or protected areas, and areas with favourable technical conditions in terms of terrain and accessibility.

Technically exploitable potential will be identified after studies have been carried out for the construction of wind farms, which have not yet been realised. No wind potential has been identified in the provinces of Luanda, Cabinda and Zaire.

The wind mapping identified ten priority projects totalling 552 MW between the provinces of Benguela, Bié, Kwanza-Norte, Kwanza-Sul, Huambo, Huíla and Malange, which generally have average wind speeds of over 6.5 m/s, equivalent to a capacity factor of around 33%. Projects with these characteristics could compete with other generation sources, both renewable and conventional, in terms of generation cost and could be a competitive alternative for power generation.

3.9.7. Biomass

In Angola, four types of waste have been identified for bioenergy production: forestry waste, agri-food industry waste, agricultural and livestock waste, and municipal waste.

Forestry has the greatest potential, estimated at 3.3GW out of the 3.7GW identified. Angola has a potential of 3.7 GW of electricity generation from biomass energy and municipal solid waste (MSW), spread over 42 projects. Of this, 3.3 GW is related to forestry. 42 sites have been identified as favourable areas for the implementation of biomass projects. These sites have been identified on the basis of the Biomass Potential Atlas and are located close to motorways, towns and the electricity grid.

Despite having a maximum total resource potential of 3.7GW, only one project was considered and studied for each of these sites, with the output being matched to the resource and technology.

A total of 1.5 GW of capacity was analysed, distributed across the different technologies:

Forest biomass: 32 projects with a capacity of 1130 MW

Sugarcane: 8 projects with a capacity of 250 MW

Municipal solid waste: 2 projects with a capacity of 120 MW

In terms of geographical distribution, the province of Benguela has high potential due to the 180 MW Alto Catumbela project planned as part of the hydrothermal project. The provinces of Malanje (where Biocom is located), Lunda Norte, Moxico, Huíla, Huambo and Luanda (RSU) also have high potential.

3.9.8. Mini-hydro (Up to 10 MW)

Angola's mini-hydro potential is around 18 GW, 86% of which is located in the Kwanza, Queve, Catumbela and Cunene basins. These mini-hydro plants are among the most economical technological alternatives studied to date.

Hydropower (up to 10 MW): The hydropower potential is estimated at 18 GW. Numerous rivers have been identified in the country with flows and falls suitable for smaller projects (up to 10 MW);

Mini-hydro is the most economical alternative for electricity generation among the renewable technologies studied. However, these projects have a fairly wide range of costs, with levelized energy costs ranging from around US$20/MWh to over US$1,000/MWh.

Of the 100 sites identified for the construction of mini-hydropower plants (with a total installed capacity of around 600 MW), around 35 sites (close to 400 MW) allow the implementation of projects with very competitive levelized energy costs and with greater ease of financing and energy management, both for grid connection and for rural electrification. In the latter case, it may be necessary to consider thermal support for energy production during the months of low flow.

3.9.9. Hybrid power stations

There are currently 35 MW of hybrid power plants in Angola, of which 14 MW are solar and 21 MW are diesel. These plants consist of 3 MW diesel + 2 MW solar and are located in Cabinda (5 MW), Bocoio - Benguela (5 MW), Longonjo - Huambo (5 MW) and Londiumbale - Huambo (5 MW), Tombwa - Namibe (5 MW), Xangongo - Cunene (5 MW) and Sanza Pombo - Uíge (5 MW). (3) (6)

Figure 13: Hybrid power stations

Natural gas - In addition to oil, Angola has significant natural gas reserves, which are currently being developed through the Angola LNG (Liquefied Natural Gas) project. Total proven reserves amount to more than 270,000 million tonnes.

An infrastructure of hundreds of kilometres of subsea pipelines collects the gas from the various oil production units and transports it to the Soyo terminal, where it is processed and liquefied for export. The configuration of the Angola LNG terminal represents about 3.5 Mm3 /day (about 1.3 Bm3 /year) in gaseous state for local use. This gas for local consumption is distributed at a constant flow rate. However, the available storage in the pipeline between the terminal and the power station - the so-called "block line" - and any other type of gas storage that can be built, will allow consumption to be concentrated at certain times of the day.

The Angola LNG (Liquefied Natural Gas) terminal is designed to liquefy and export around 6 Bm3 of natural gas - around 5 times the volume of gas available in the gaseous state. The liquefaction process is carried out by reducing the temperature of the gas to -162o C, which reduces the volume by about six hundred times. Current technology allows:

- Transportation on large carriers to large regasification terminals in distant countries;
- Or transport in small LNG tankers to small/medium sized marine terminals;
- Or even in small iso-containers or tanks, transported by land, sea or rail to small storage and regasification units close to the consumer.

For Angola's energy sector, LNG can be used to feed both a medium-sized LNG terminal associated with new large power plants and small storage and regasification units associated with smaller turbines. Recent discoveries of onshore natural gas in Cabinda make it possible to convert turbines at local power stations to natural gas. Significant new natural gas discoveries have recently been announced in blocks south of Luanda. Depending on the size and cost of its extraction, this gas may be able to use the existing subsea pipeline infrastructure and improve or extend the life of the terminal at Soyo, or it may allow for a new liquefaction plant south of Luanda, or it may simply be used for domestic consumption in conjunction with major projects in the petrochemical or manufacturing industries.

The Angola LNG project will also produce LPG (Liquefied Petroleum Gas), a by-product of oil exploration, which could replace coal and firewood in urban and semi-urban areas.

The Soyo plant is designed to process 1.1 million cubic metres of natural gas per day and has the capacity to produce 5.2 million tonnes of LNG per year, as well as natural gas, propane, butane and condensate.

The plant represents an important step in the efficient use of Angola's natural resources and has a workforce that is now experienced in all aspects of LNG production, from plant construction, commissioning and testing to logistics.

The plant's infrastructure includes storage tanks for LNG, propane, butane and condensate, and a 315 metre LNG loading jetty capable of receiving vessels.

For reasons of reliability, the production process is based on a "two trains in one" concept, which allows the plant to operate continuously even when the compressor is switched off, resulting in high plant availability.

With a life expectancy of at least 30 years, Angola LNG will be supplied with gas from a variety of sources. The primary source was initially offshore associated gas from the oil operations in blocks 15, 17 and 18. This was followed by the connection of blocks 0 and 14 and blocks 31 and 32. Angola LNG will also develop and produce non-associated gas from dedicated discoveries in the areas of Blocks 1 and 2 as required.

The use of associated gas as the main source of supply differentiates Angola LNG from other gas projects, which tend to use non-associated gas. As a result, the plant will make a significant contribution to the elimination of gas flaring in Angola, enabling the development of offshore oil reserves in an environmentally sustainable manner.

An extensive pipeline network of over 500 kilometres supplies the Soyo processing and liquefaction plant with gas from the offshore oil fields.

The pipeline network initially transported feedstock from Blocks 15, 17 and 18. The subsea pipeline was then built to connect the Angola LNG plant to Blocks 0 and 14, located north of the Congo River. Blocks 31 and 32 have also been connected and, in due course, Angola LNG intends to connect the non-associated gas fields in Blocks 1 and 2.

The gas pipeline network is owned by Sonangol E.P. and operated by Sociedade de Operações e Manutenção de Gasodutos (SOMG) - Gas Pipeline Operations and Maintenance Company, a company established to transport the gas from the blocks to the onshore plant.

Once onshore, the gas from the various blocks passes through a metering station before entering the general feed stream for purification and processing.

Figure 14: Natural gas thermal power station

Angola LNG has built one of the world's most advanced LNG processing facilities. The first stage of the liquefaction process removes impurities such as water, oil and gases such as carbon dioxide and hydrogen sulphide. The purification process also removes any traces of mercury in the natural gas. Natural gas liquids such as propane and butane are also extracted at this stage. The cleaned gas is then cooled in stages in heat exchangers until it is liquefied at around minus 160°C to form a clear, colourless, non-toxic liquid - liquefied natural gas, or LNG. The LNG is then stored in airtight tanks until it is ready for loading and shipping.

LPG & Condensate - Liquefied petroleum gas (LPG) - propane or butane gas - is a combustible mixture of hydrocarbon gases used as a fuel in heating appliances and vehicles. LPG is removed from natural gas when it is converted to LNG and can be an alternative to electricity and oil for heating in rural areas where there is no access to piped natural gas.

LPG can be used as an energy source for combined heat and power (CHP) technologies. CHP, or cogeneration, is the process of producing and using combined heat and power from a single fuel source. This technology has enabled LPG to be used not only as a fuel for heating and cooking, but also to generate electricity. LPG can also be used as a fuel for vehicles, often referred to as Autogas or autopropane.

Condensate is the heaviest fraction of the natural gas mixture, which can be used as gasoline or as a feedstock for cracking, and can be extracted from natural gas during the purification process to be marketed and shipped to customers.

Natural gas - Today, **natural gas** is one of the most important sources of energy for many everyday needs and activities. It is a vital part of the world's energy supply. Despite its importance, there are many misconceptions about natural gas. In its pure form, it is colourless, shapeless and odourless. Unlike other fossil fuels, natural gas burns cleanly and emits relatively low levels of potentially harmful by-products into the air. Natural gas consists mainly of methane, but can also contain ethanol, propane, butane and pentane. Angola LNG will supply natural gas to the Angolan market, helping to meet local industrial and energy needs.

The commissioning of the Soyo natural gas terminal will give the electricity system access to a cheaper, lower-emissions fuel: natural gas. By 2017, the country's installed thermal generation was expected to increase by 750 MW as a result of the Soyo combined cycle power plant, and gas is expected to account for almost 50% of installed thermal generation.

Figure 15: Gas-fired power station

Rational use of energy and energy efficiency - the sector plans to implement measures to raise awareness of the rational and efficient use of energy in Angola, including the awareness programme.

Efficiency is a fundamental aspect of energy, both in the way the sector operates and in the way, energy is ultimately used. Programmes to promote efficiency in the sector should be launched at two levels:

At the level of company operations, cost reduction programmes will be launched with the aim of identifying the main cost items and measures to reduce them.

At the energy efficiency level, ENDE should promote an energy efficiency programme focusing on lighting, where there is significant potential for gains.

3.9.10. Green hydrogen

As part of the energy transition process, the country will be able to produce and export green hydrogen in the form of ammonia by 2025, following the country's progress in the field of renewable, sustainable energy accessible to all, the production of green hydrogen as a way to contribute to carbon neutrality, security of supply of clean energy and a climate transition that can be implemented in a socially just way. The country will be able to create more jobs with the creation of a new hydrogen industry and use the human capital and knowledge of the oil industry to qualify this new sector, in addition to the advances in renewable energies.

The initiative is a joint initiative of the German Renewable Energy Federation, the German Solar Industry Association, the German Energy Agency and Eclareon, supported by the German government.

3.9.11. Interministerial commission for energy security

The Inter-ministerial Commission for National Energy Security was set up by Resolution 8/09 of 30 January 2009 with the aim of coordinating all the work involved in drawing up the energy strategy and policy and the energy security programme, defining the institutional structure responsible for coordinating, monitoring and controlling the implementation of these instruments and guiding the drawing up of the energy balance and energy matrix.

Coordinated by the Minister of Economy and Planning, the Commission is composed of the following bodies MIREMPET, MINEA, MINFIN, MINAGRIF and MINPESMAR, MINAMB and MIND, MESCTI, the Secretary of State for Water, the Director of the General Office of Special Works (GOE), the Economic Advisers to the President of the Republic, the Chairman of the Board of Directors of SONANGOL, the Chairman of the Board of Directors of the National Electricity Transmission Network (RNT) and the Director General of the Office for the Exploitation of the Middle Kwanza (GAMEK). It is therefore possible to integrate climate change adaptation and mitigation in the energy sector at the highest level.

This creates the institutional conditions for integrating climate change into the various sectors at national level. In terms of ministerial structures, some of the most important in the field of climate change are listed below.

Given the current context of the country and the changes that have taken place, it is important to update the Commission to take better advantage of funding for new renewable energy systems, as well as the reporting process and structural organisation.

3.9.12. Carbon Market

The country is accelerating the process of capacity building and institutional coordination to take advantage of existing carbon market initiatives that contribute to reducing greenhouse gas emissions in order to accelerate the national contribution to emission reductions, as well as join REED+ initiatives to reduce emissions from deforestation and address the needs of local communities.

GOVERNO DE ANGOLA

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CHAPTER 4 – ANGOLA'S NATIONAL MONITORING, REPORT AND VERIFICATION SYSTEM

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With Support From:

UN environment programme

gef

CHAPTER 4 – ANGOLA'S NATIONAL MONITORING, REPORT AND VERIFICATION SYSTEM

Article 12 of the United Nations Framework Convention on Climate Change requires all Parties to report to the Conference of the Parties (COP) information relevant to the implementation of the Convention, including on greenhouse gas emissions and removals. This enables the Convention to have reliable, transparent and comprehensive information. Information on greenhouse gas emissions, actions and support to raise awareness of current emissions levels and the extent of existing efforts and progress made, both nationally and internationally.

The arrangements that culminated in the national reports have evolved over the history of the Convention and the Kyoto Protocol into a comprehensive MRV framework. Significant measures have been adopted under the Convention to improve the transparency of actions and support. These measures were adopted as part of the Bali Action Plan at COP 13 and have been further developed in decisions taken at subsequent COPs.

The Parties to the United Nations Framework Convention on Climate Change are required to provide information to the Conference of the Parties (COP), through the Secretariat, on the actions taken or to be taken to implement the Convention through national communications and biennial reports. This is considered a fundamental task for the implementation of the Convention, as it allows the Parties to be informed about national actions, which serve as a basis for assessing the level of implementation of the Convention by COP member countries.

The reporting provisions of the Convention were strengthened by the Bali Action Plan, adopted at COP 13 in 2007. The Bali Action Plan introduced the principle of measurement, reporting and verification (MRV) for both developed and developing countries, with the aim of maximising action to mitigate climate change emissions at national and international levels. This principle has been further developed through several subsequent COP decisions, resulting in a comprehensive MRV framework under the Convention.

For developing countries, the existing MRV framework includes the submission of National Communications every four years and Biennial Update Reports (BURs). In addition, Parties are required to engage in the international consultation and analysis (ICA) process, establish a domestic MRV system for domestically supported Nationally Appropriate Mitigation Actions (NAMAs), and undertake MRV under REDD+ agreements, with the aim of receiving contributions based on concrete results.

The Convention requires all Parties to submit to the COP, through national communications, information on their emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, as well as on measures taken to implement the Convention. This second obligation includes reporting on national or, where appropriate, regional programmes containing measures to mitigate climate change and to facilitate appropriate adaptation to climate change, as well as any other information that the Party deems relevant for achieving the objective of the Convention.

The evolution of international negotiations on climate change has defined a number of reporting obligations over time. In addition, Angola's graduation from LDC status, scheduled for 2021, would have an impact on reporting to the UNFCCC.

Prior to the Cancun Accords, developing countries were required to prepare their National Communications under Articles 4 and 12 of the Convention on a voluntary basis, but at COP 16 in 2010, more demanding reporting targets were set for developing countries, namely the obligation to prepare National Communications every four years and BURs every two years, which means that the national emissions inventory has to be prepared every two years.

In 2015, the Paris Agreement introduced a new set of challenges for the accounting and reporting of GHG emissions and mitigation and adaptation actions undertaken by countries, requiring transparency, rigour, comparability and consistency in accounting.

In addition to NCs and BURs, Parties are now required to prepare and update their Nationally Determined Contributions (NDCs) every 5 years. These developments in international climate policy mean that, from 2021, Angola will be required by the UNFCCC to produce: a) the National Communication every 4 years; b) the Biennial Update Report every 2 years; c) the NDCs every 5 years.

4.1. DEVELOPMENT OF THE MRV SYSTEM FOR ANGOLA

Measuring, for developing countries covers both efforts to tackle climate change and the effects of these efforts, including the level of greenhouse gas (GHG) emissions by sources and removals by sinks, emission reductions and other benefits. This measurement is done at the national level. Prior to COP 16 and 17, the measurement of GHG emissions by sources and removals by sinks was mainly contained in national GHG inventories, which are part of national communications. Based on the decisions taken at COPs 16 and 17, measurement methodologies are not defined in the Convention; therefore, Parties rely on methodologies developed externally, including by the Intergovernmental Panel on Climate Change (IPCC) and other organisations. Whenever possible, the COP identifies and endorses the methodologies to be used by Parties.

Reporting for developing countries takes the form of National Communications (NCs), Biennial Update Reports (BURs) and Nationally Determined Contributions (NDCs). Parties are required to report on their climate change actions in their National Communications, which include information on GHG inventories, adaptation, mitigation actions and their effects, constraints and gaps, support needed and received, and other information deemed relevant to achieving the Convention's objectives. National Communications are to be submitted every four years and are to be prepared in accordance with guidelines approved by the Conference of the Parties. BURs should be submitted every two years and should provide an update of the information presented in the national communications, in particular on national greenhouse gas inventories, mitigation actions, limitations and gaps, including support needed and received. NDCs derive from the commitments of the Paris Agreement and must be submitted every 5 years.

Verification is addressed at the international level through the International Consultancy Analysis (ICA) on BURs, which is a process to increase the transparency of mitigation actions and their impacts, as well as the support required and received. National communications are not subject to ICA. At the national level, verification is carried out through national MRV mechanisms established by non-Annex I Parties, the general guidelines for which were adopted at COP 19 in 2013. Provisions for verification at the national level that are part of the national MRV framework must be reported in the BURs. Specific provisions have been adopted for the verification of REDD+ activities.

Angola's participation - Since 1992, Angola has participated in the global process aimed at reducing greenhouse gas emissions and creating the capacity to adapt to climate change, given the historical accumulation of emissions in the atmosphere in that year, recognised as the beginning of the industrial era. Angola's commitment began in 1992 with its participation in the Rio Summit and was reinforced in 2000 with its accession to the United Nations Framework Convention on Climate Change, an instrument that coordinates global action in this direction. In 1997, Angola acceded to the Kyoto Protocol and in 2015 to the Paris Agreement, which is currently being ratified.

Throughout the years of participation and implementation of the United Nations Framework Convention on Climate Change, a number of milestones have been reached, which underpin the position of the current processes and the commitment to future ones:

- In 2005, the National Strategy for the Implementation of the Convention and the Protocol was developed, which was in force for a period of 5 years;
- In 2011, the National Action Programme for Adaptation to Climate Change (PANA) was developed, identifying a series of priorities and projects that are now being implemented with the support of the Global Environment Facility;
- Preparation of the 1st National Communication in 2012, which will include the 1st National Adaptation Programme;
- In 2015, the national contributions were prepared to support Angola's accession to the Paris Agreement;
- Registration of the project under the Clean Development Mechanism;
- Active participation and chairmanship in various working groups within the Convention implementation process, namely: the Clean Development Mechanism (CDM) Executive Committee, the Least Developed Countries (LDC) Negotiating Platform, the Expert Group on Communication Support (CGE), the Expert Group on Least Developed Countries (LEG) Support, the Adaptation Committee, among others.

In addition, the following documents are in progress and some have already been finalised and are due to be submitted to the Convention in 2020:

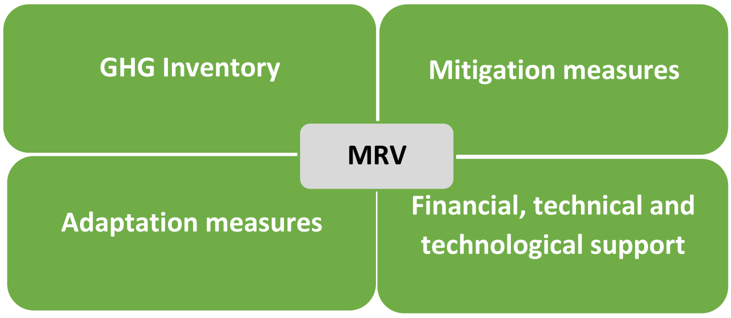
- Updated NDCs to better frame key development issues and the national context;
- The Biennial Update Report;
- The Second National Communication;
- The National Adaptation Action Plan (PANA);

- A number of projects are underway to help build national adaptation capacity and integrate climate change into sectoral plans and programmes.

The process of implementing the United Nations Framework Convention on Climate Change has gained international prominence due to the obstacles that climate change poses to development. As a result, there has been some acceleration in its implementation, which has led to new challenges and demands being placed on countries.

Thus, in response to the control needs of its domestic policies and the new challenges of the Paris Agreement, Angola proposes an MRV system composed of 4 sub-systems: GHG inventory, mitigation actions, adaptation actions and financial, technical and technological support, Figure 19.

Figure 16: Components to be developed from the Angolan MRV System



The operationalisation of the national MRV system should not only make it possible to systematically compile a national inventory of Angola's GHG emissions, which is essential for improving the reporting process to the UNFCCC, but should also serve as a tool for the implementation of this strategy, ensuring effective monitoring of the implementation of the country's climate change policy. In addition, the implementation of an MRV platform represents a valuable database for the country, especially for the development of future policies in different areas, such as the environment, land use planning and institutional policy.

Using the system's database, it will be easy and possible to assess the most polluting sectors of the economy and design policies to incentivise reductions in GHG emissions, evaluate adaptation measures and facilitate the monitoring of support received (financial, technical and technological).

The transparency with which the national MRV system is designed could provide opportunities for the implementation of Angola's climate change policy to mobilise more international funding for the country and thus respond effectively to the challenges posed by climate change.

4.1.1. The proposal for the national MRV system should include

Plan for methodologies and basic data - to be used for monitoring greenhouse gas emissions, mitigation and adaptation measures, and financial, technical and technological support. It should therefore seek to frame existing methodologies and adapt them to the Convention model in order to respond to the national institutional context.

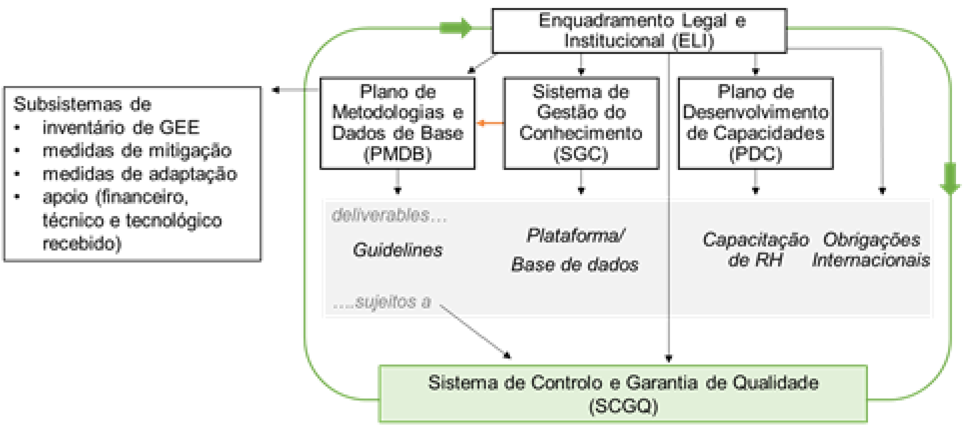
Knowledge Management System - this should bring together all the information collected by the various sub-systems and allow data to be consulted and entered in a simple and systematic way.

Capacity development plan - this should assess national, provincial and local capacities and define a framework for building and overcoming them to enable the country to respond to the challenges of climate change at all levels and in all sectors and to comply with the Convention.

Quality control and assurance system - Quality control and assurance are fundamental to the effectiveness and credibility of the system. For the GHG inventory in particular, the definition and implementation of a quality control and assurance system is considered good practice as required by the UNFCCC.

Legal and institutional framework - Legal instruments need to be defined to formalise the implementation of the MRV system, as well as the responsibilities and deadlines that make up the annual cycles of Angola's MRV system. Figure 21 shows a schematic of the proposed MRV system:

Figure 17: Proposed subsystems of the National MRV System to be developed



4.2. LEGISLATION AND REGULATIONS

The operationalisation of the MRV system requires a clear political, legislative and regulatory framework. This articulation is fundamental to coordinating Angola's response to climate change, as it legitimises the objectives and encourages action at both public and private levels.

Some of the mitigation, adaptation and financing needs identified require a legal framework for their implementation. In the case of Angola, the legal and regulatory needs already identified are summarised below:

- Drafting a decree law to regulate climate change in Angola. The decree must define the country's position on climate change, clarify the powers, duties and responsibilities of the ministry in charge of the portfolio and of the National Commission on Climate

Change and Biodiversity, legally establish the MRV system and the involvement of provincial governments, and specify long-term emission reduction targets;
- Establish specific regulations for the national MRV system, including deadlines and responsibilities for reporting by the various actors involved in the process;
- Establish working groups within ministries to identify the need for adjustments or new legislation. The work of these groups will result in communications to the CNACB on the needs identified, so that it can expedite the next steps;
- Regulation on the reduction of greenhouse gas emissions, following the developments resulting from the new market mechanism provided for in Article 6 of the Paris Agreement;
- Creation of a National Climate Change Finance Mechanism to support implementation and international financial flows.

From a capacity building perspective, a number of needs have already been identified and are being addressed on a case-by-case basis, particularly those that currently require a more comprehensive framework. In fact, these are important needs for the MRV system, as they will help to meet current and future requirements and facilitate climate finance. They are:

- Need for training in GHG inventory methodologies and the development of national methodologies;
- Need for capacity building in relevant methodologies, models and software related to mitigation, vulnerability and adaptation analysis;
- Need for systematic interpretation of meteorological data and climate modelling;
- Preparation and management of mitigation and adaptation projects;
- Informing and/or reporting on a range of climate change activities taking place in the country;
- Scientific research related to the national context and concerns;
- Funding, technology and research;
- Inadequate knowledge of vulnerability to climate change and its spatial distribution, due to a lack of knowledge of which region of the country it could occur in, which population groups will be most affected, and what economic impact it will have on the national economy;
- Limited dissemination and publicity of the National Adaptation Action Plan and the First National Communication, the National Contributions to the Paris Agreement, the Climate Change Strategy and other relevant documents related to the implementation of the Convention;
- The provision of resources for the work of presenting and disseminating the results;
- Limited number of qualified staff for the vast national territory;
- Limited national and local studies on climate change issues;
- Little interest on the part of institutions to integrate climate change into their sectoral plans and programmes.

The MRV proposal responds to an institutional framework that has enabled the country to respond to the challenges of the Convention and climate change:

- Ministry of Environment;

- Ministry of Culture;
- Ministry of Tourism;
- Ministry of Energy and Water;
- Ministry of Agriculture and Forestry;
- Ministry of Fisheries and Marine Resource;
- Ministry of Industry and Trade;
- Ministry of Planning and Investment;
- Ministry of Transport;
- Ministry of Mineral Resources, Oil and Gas;
- Ministry of Telecommunications, Information Technology and Social Communications;
- Ministry of Higher Education, Science, Technology and Innovation;
- Ministry of Health;
- Ministry of Finance.

To be most effective, the ministries, supported by the Inter-Ministerial Commission on Climate Change and Biodiversity, should have both a ministerial and a technical base to facilitate implementation.

The establishment of the MRV system is the mechanism for involving all the above actors and others to be invited. To this end, complementary legislation, such as joint ministerial decrees, will be completed as necessary to obtain all the information needed for the system to function.

Expected results

Matrices to facilitate the annual collection of information in the following areas:

- Proposal for a national energy balance;
- Matrix for the collection of information in the energy sector;
- Information collection matrix for the agriculture and forestry sector;
- Information collection matrix for the industry sector;
- Information collection matrix for the waste sector;
- Matrix for the collection of information on mitigation actions;
- Matrix for the introduction and collection of information on adaptation measures;
- Matrix for entering and collecting information on external and internal funding throughout the climate change process;
- Proposal for an agreement between the environment sector and the other data holding sectors;
- Analysis of current data and information from the various sectors of the greenhouse gas inventory and specific proposals for improvement;
- Identification of the need for legislation and implementation of specific proposals;
- Proposal for a national emission plan.

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CHAPTER 5 – CONSTRAINTS, GAPS AND NEEDS IN TERMS OF FINANCIAL, TECHNICAL AND CAPACITY-BUILDING SUPPORT RECEIVED TO ENABLE THE PREPARATION AND SUBMISSION OF THE BIENNIAL UPDATE REPORT

NOVEMBER 2024

With Support From:

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The MINAMB's tasks, as set out in its Organic Statute (approved by Presidential Decree No. 278/22 of 7 December), include coordinating and ensuring the implementation of mitigation measures for the development of climate change strategies, plans and projects, and promoting projects and programmes to reduce and balance gas emissions, as well as sustainability to stabilise greenhouse gases.

The National Department for Climate Change and Sustainable Development is a Direct Executive Service listed in the Organic Statute of the Ministry of Environment (MINAMB). It is the body responsible for the implementation of the National Climate Change Programme and the integration of policies leading to sustainability in the field of greenhouse gas emission reduction and programmes and projects to offset greenhouse gas emissions. Its responsibilities include:

- Coordinate and ensure the implementation of climate change mitigation measures, to develop strategies, plans and projects to mitigate and adapt to climate change (CA), and to control and reduce greenhouse gas (GHG) emissions;
- Promote projects and programmes to reduce emissions, prevent drought and desertification, and ensure sustainability by stabilising greenhouse gases;
- Identifying and coordinating viable projects that are not eligible for the carbon market;
- Ensure Angola's participation in the global carbon market;
- Facilitate the integration of adaptation and mitigation programmes with a view to integrating drought phenomena, disasters and environmental conservation;
- Carry out activities related to the implementation of the United Nations Framework Convention on Climate Change (UNFCCC);
- Promote and coordinate strategies aimed at establishing the framework for Angolan intervention in the legislative, technical, prevention, mitigation and adaptation fields, in order to contribute to the stabilisation of greenhouse and other gas emissions.

The process of implementing the Convention has shown that strengthening and consolidating institutional capacity is fundamental to the whole process of implementing the Convention and responding to adverse climate change phenomena. This process is taking place at a rather slow pace compared to the country's own context, which is quite dynamic in many respects. In contrast to the implementation process, Angola is focusing its attention on economic, development and social integration issues, without neglecting the link between climate change and these factors, including survival.

There has been some solidity in the projects that have been implemented, although there is a lack of rigour in the selection and recruitment criteria. Most of the staff recruited for the projects are on precarious contracts, so much so that a new cycle begins when the projects come to an end. For their part, the responsible institutions often appoint people who are not very well equipped to deal with environmental issues, although the criteria should be different. The improvement of technical capacity is mentioned at the level of political and technical decision-making centres, civil society, the private sector and local communities as a result of their involvement in projects and various initiatives related to climate change. As one moves away from urban centres, capacity tends to decrease and problems become more entrenched.

From this perspective, it is important to emphasise the ongoing need to strengthen and update institutional capacity in the public sector, civil society and the private sector, so that changes in citizens' attitudes and behaviour are accompanied by a lasting increase in resilience and response to climate change and sustainable development.

The process of raising awareness of climate change issues is closely linked to access to information and knowledge. Fortunately, there is a certain level of environmental awareness in the country as a result of the interventions of various projects and programmes over time. However, the overall approach to certain issues such as climate change, land degradation, etc. is still weak.

There has been much discussion about the need to include climate change in school curricula at different levels of formal education.

There is an urgent need to continue awareness-raising projects, with a more active involvement of the media, especially radio and television (non-formal education), while street activities such as lectures, talks, campaigns and competitions (informal education) are the responsibility of NGOs. In this way, a high level of popular participation is ensured, with direct results in the ongoing need to create a well-informed population that is aware of its social role and duty. However, the level of achievement is still limited and much more concentrated in urban areas, whereas most of the needs are in peri-urban and rural areas.

The main gaps are limited capacity, non-existence, limited data or lack of an advanced and integrated database, technical and technological limitations.

There is not yet sufficient information on possible climate change in Angola and its impacts. Therefore, it is not appropriate to make specific recommendations on adaptation or mitigation strategies. The envisaged strategies aim to reduce current vulnerabilities and build the capacity to adapt in the future, mainly by gathering accurate information on climate change in the region, possible impacts and appropriate adaptation methods. Adaptation strategies should increase the capacity to manage risks and avoid large, fixed investments that depend on factors that have not yet been studied.

Creating the capacity to deal with current situations (e.g. soil erosion, flooding or even mitigation) will be useful in dealing with future situations. This capacity can be built at individual, community, local and central government levels. In all areas of knowledge, it will be necessary to better understand the systems that could be affected by climate change. Only by understanding the vulnerability of the systems can strategies to reduce this vulnerability be tested with the support of the people involved and a way out of the problem be found.

On the other hand, limited knowledge and capacity does not absolve the country of its responsibility to implement and report on climate change issues. Identifying existing and necessary capacities becomes a fundamental tool for designing a programme and strategy to overcome limitations and improve existing capacities, thus seeking the necessary support and facilitating the implementation and reporting process.

Institutional capacity at all levels is still very limited, although there have been attempts to improve it at the intermediate level, but the lack of an integrating mechanism means that academic institutions and research centres are less able to participate. At the provincial and local level, this capacity is weaker and innovative and integrative ways are needed to adapt the response to the scale of the problem, which is climate change. It is necessary to work in line with the municipal process in order to integrate considerations related to change at the political, institutional, private, civil society and general population levels.

5.1. DIFFICULTY IN OBTAINING INFORMATION

Research institutions should make a better contribution to the generation of basic knowledge that will help the relevant governmental bodies and others to define/delimit the areas that are susceptible to and have the greatest impact on the phenomenon of climate change. The production of sectoral data is a very important aspect in the process of inventorying greenhouse gases by sector, such as agriculture and land use change, energy, waste and industrial processes, mitigation and adaptation measures. It is therefore important that institutions are able to produce this data on an annual basis, so that the reporting process is based on information already produced, which would reduce the reporting time. It is also important to highlight the continued limited national capacity to map vulnerabilities across the country in order to inform the adaptation strategy for each sector of activity and, in particular, for each geographical area.

The main difficulty highlighted in the assessment and monitoring process, which seems to condition all the others, relates to the use of models and software; the extrapolation and development of climate models is fundamental, not only for information purposes, but also as a key factor in raising awareness and demonstrating future climate trends, and consequently in taking political decisions that will be reflected in national and sectoral plans for economic and social development.

Mitigation is also a field of knowledge where technical capacity is limited, and the measures announced in the UNFCCC implementation strategy emphasise that:

- Revitalisation of national forest planning and intensification of forest management plans, introduction of measures to reduce uncontrolled deforestation, establishment of community forests with multiple uses (energy, timber, firewood and charcoal, tannins, sap, fruit, mushrooms, etc.) to provide a real alternative to the current energy deficit;
- Promoting and modernising traditional agriculture by encouraging and facilitating investments in rural areas that promote the introduction of new techniques and technologies (agroforestry, organic farming, micro-harvesting, hydroponics, etc.) and other methods that combine agricultural production, soil conservation and the maintenance of soil fertility;
- Increasing investment in clean energy production (hydroelectric, solar, wind, biogas), which is less damaging to the environment, and adopting measures to promote energy efficiency;

- Encouraging the use of technologies that allow greater use of gas associated with oil production or other underground formations for possible future use or conversion to multiple uses;
- Assessing the impact of landfills in Angola and the possibility of using them to generate energy and also to complement the generation of carbon credits.

A new medium- and long-term strategic vision needs to be defined to frame the climate change challenges in development, so that capacity building and management mechanisms can be strengthened, taking into account current and future climate change challenges.

The implementation of the National Climate Change Strategy must be able to respond to Angola's new climate scenarios, economic and social growth, including the National Emissions Plan and the Low Carbon Strategy.

The implementation of the strategy must also respond to the challenges of adapting to climate change and seek to integrate climate change into sector plans and programmes by mapping, upgrading, strengthening and complementing actions. This should be done not only through projects, but also by integrating these considerations into sector programmes. The Ministry of Environment should establish a monitoring structure to facilitate the reporting process.

During the implementation of the first climate change strategy, Angolan legislation was analysed, with a focus on legislation related to climate change. In this context, the need to:

Legislative reform, leading to an obligation to carry out a strategic and social environmental assessment, as well as the "climate proofing" of strategies, programmes and plans in key sectors of the national economy (including spatial planning instruments) and public infrastructures (roads, railways, ports, hydroelectric power stations, dams and reservoirs, buildings, social housing developments). Institutional reform of the forestry, wildlife and protected areas sectors and, the energy sector (legislation on energy efficiency and the use of renewable energies, creating incentives for their implementation), was equally considered.

Further regulation of:

- Land use planning, in particular along the coastline, the establishment of agricultural and ecological reserves, the establishment of protected areas along rivers and estuaries, the definition and limitation of areas for aggregate extraction, etc;
- Air quality and emission control - including emission limit values and monitoring requirements;
- Water resources management - regulating water rights, economic valorisation and efficient management to reduce waste and promote protection;
- Waste - proper waste management and energy recovery;
- Agricultural Development Law, which creates incentives for the development of crops and agro-sylvo-pastoralism; and
- Geological and mining activities.

Establish financial mechanisms (tax incentives, subsidised interest rates, etc.) for investment in environmentally friendly technologies, energy efficiency in industrial development and food production, in order to prevent mass adoption of biofuel production.

In addition to legislation, monitoring and enforcement capacity needs to be strengthened. This is particularly important in areas such as forestry, fisheries, land-use planning, aggregate extraction, environmental performance of construction and related activities. On the mitigation side, there is a need to strengthen the capacity to monitor emissions and to monitor and enforce legislation in areas such as oil exploration and industry.

Strengthening the functioning of the Inter-ministerial Commission on Climate Change must ensure the process of mainstreaming climate change, the strengthening of individual and institutional capacities, and the implementation of all instruments to achieve the Convention's objectives, in the spirit of meeting the needs of present and future generations.

5.2. LIMITATIONS AND TECHNICAL CONSTRAINTS ON THE USE OF THE IPCC SOFTWARE

The GHG inventory is the most important component of the reporting process, but it is also the most time-consuming due to its complexity and limited capacity. Therefore, in order to set up the inventory team and give it the capacity to carry out the inventory, it is necessary to appoint permanent and dedicated people from the different sectors to make the process regular, permanent and sustainable.

An innovation in the reporting process that was emphasised in the preparation of the BUR was the creation of working groups for the main components. However, they didn't work as well as they could have, perhaps because of the intermittent process that the report went through, as well as the rotation of staff at the beginning, which made it difficult for the same people to follow up on issues.

5.3. TECHNICAL LIMITATIONS IN DEVELOPING THE MODELS

At the beginning of the collection of information for the development of the spreadsheets, in order to facilitate the collection of information for the later use of the LEAP MODEL, contacts were made for training, but once the conditions were in place to receive the foreign team, it was not possible to carry out the training because the agenda was unavailable, making it impossible to use the aforementioned model in this report.

The spreadsheets are prepared, with some information, but much more is needed. That's why it is hoped that the implementation of the Reporting and Verification Mechanism will help to structure them so that there is a real output of data that can be used by different processes.

5.4. DIFFICULTY IN OBTAINING LAND SAT IMAGES - INTERNET

Through partnerships and cooperation, it was possible to collect Land Sat imagery for the years 2010/2015 and 2020 with greater precision for the forest sector inventory and land use change. It was also possible to create the conditions at the IDF for the training to take place, by hiring a local consultancy team to speed up the work, although the training did not take place due to difficulties in accessing the information sent.

The constraints and opportunities have thus been identified, suggesting that members of the National Space Programme need to be trained in the use of satellite imagery. Like them, technicians from the Forestry Development Institute, the Ministry of Environment and independent consultants need other skills to establish a permanent mechanism for collecting information and producing reports.

5.5. LIMITING THE CAPACITY TO RESPOND TO CLIMATE CHANGE

The process of implementing the Convention has revealed a number of difficulties and constraints in its various approaches, which are gradually being overcome. Nevertheless, some persist and require special attention if they are to be overcome and thus accelerate Angola's commitments and their sustainability. These constraints are:

- Limited understanding and/or familiarity with climate change among the majority of the population at different levels;
- Limited availability of data due to the lack of specific data production processes in most institutions to respond to climate change issues;
- Limited inter-institutional technical cooperation, which limits the willingness of sectors to take action;
- Difficulties in preparing data for processing in the IPCC inventory software;
- Limited availability of qualified staff in the institutions for the process, with the few available being prioritised for the challenges of the respective institutions;
- Limited number of training and capacity building activities at national, provincial and community levels;
- Lack of community action to communicate key climate change messages in local languages and, as a result, difficulties for local communities to interpret the signals received to avoid a range of losses and opportunities associated with climate change.
- Limited knowledge of English and French among the staff involved in the process, making it difficult for them to master the subjects taught in the training sessions. Roughly speaking, the training is conducted in these languages;
- Limited knowledge of climate change and its impacts.

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CHAPTER 6 – ANY OTHER INFORMATION THAT MAY BE RELEVANT TO THE ACHIEVEMENT OF THE OBJECTIVE OF THE CONVENTION

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Observed temperature trends confirm that between 1970 and 2004 there was an increase in surface temperature of 0.2 - 1.0 º C in Angola, in coastal areas and in the north, and an increase of 1.0 - 2.0 º C in central Angola and in the east. There is a consensus among scientists that these trends will continue, and climate models indicate that over the next 100 years there will be an increase in surface temperature of 3.0 - 4.0 ºC in central and eastern Angola, and a slightly smaller increase in coastal and northern Angola. Temperature increases are projected by all general circulation models (GCMs). In general, the probability of extreme daily maximum temperatures will increase.

The observed trends in rainfall do not guarantee that there have been significant changes in rainfall in the past, due to the inter-annual variability of rainfall in the different seasons. There is no consensus on future precipitation trends. There are different projections of rainfall in different parts of the African continent, particularly in the area where our country and the DRC are located, where some models indicate an increase in rainfall while others indicate a decrease (Bates et al, 2008, Figure 2.10).

Deforestation increases the risk of soil erosion. Most of the country's rainfall comes in the form of showers: the city of Huambo can record between 50 mm and 80 mm of rain on the wettest day of the year. This type of rain, which falls on vegetation-free surfaces, tends to leave the surface in furrows and gullies.

The province of Huambo is home to the sources of Angola's main rivers (Kwanza, Cunene, Queve, Cubango). The potential for erosion is high due to the difference in altitude between the river beds and the higher areas where most of the forests, roads and human settlements are concentrated. Sediment from erosion is transported by these rivers, changing the sediment-erosion balance further down the river basin or along the coast where the rivers flow.

Angola's economy is currently heavily dependent on mineral resources, oil and gas, but it is recognised that the economy needs to be diversified in the future and water resources will be crucial to this. Angola is part of a belt from east to west Africa (including Zambia, Malawi and northern Mozambique) with abundant water resources. And the countries of the south will be looking to this area for hydropower and water in the future.

Namibe is mainly arid and is predicted to become even drier over the next 100 years. It is already dependent on energy and water from the river basins that receive most of their water from rainfall in Angola (such as the Cuvelai, Kuvango, Cunene and Zambezi). South Africa is suffering from energy and water shortages and, having developed energy and water resources in the Drakensberg Mountains over the past 30 years, is once again looking northwards. Much of Angola's energy comes from hydroelectric and solar production centres. Agriculture is an important part of economic diversification, both irrigated and rainfed. The demand for water for domestic use in Angola is also likely to increase.

6.1. INSTITUTIONAL FRAMEWORK

The Ministry of Environment is the lead government institution responsible to coordinate climate action at national level, through the National Directorate for Climate Action and Sustainable Development, ensuring multistakeholders action. This body is also responsible for overseeing Angola's participation in international climate change intergovernmental process as well as responsible for coordinating the elaboration of Angola's reports to the UNFCCC.

Below we present important institutions and policy instruments that play an active role in the field of climate change in terms of research, inventory, monitoring and evaluation, both in the field of adaptation and mitigation. Their involvement and strengthening can accelerate capacity building in response to the scale of the problem.

6.1.1. National Climate Change Strategy - Presidential Decree 2016/22

The National Climate Change Strategy (ENAC 2022-2035) arises from the need to articulate objectives, instruments and institutions in the pursuit of sustainable economic growth and development. To this end, there is an urgent need to incorporate in the decision-making processes not only the challenges posed by the adverse effects of climate change, particularly on the economy and the living conditions of the population, but also the latest global consensus and the commitments arising from the Republic of Angola's accession to the Paris Agreement, as well as the Sustainable Development Goals of Agenda 2030a. In response to the challenges of climate change, as well as the commitments made, the National Climate Change Strategy establishes the vision of Angolan national policy for 2035, taking into account the need to articulate Angolan policy in terms of mitigation and adaptation to the impacts of climate change.

The National Climate Change Strategy will give way to the development of the National Emissions Plan (NEP) and the National Climate Change Adaptation Plan (NCCAP).

6.1.2. National Commission on Climate Change and Biodiversity

The Commission is established by the National Strategy on Climate Change (CNACB), as the vehicle to facilitate and ensure a coordinated action between sectors for climate change by improving implementation and policy harmonisation, bringing together various government agencies, academics and civil society representatives.

6.1.3. Centre for Tropical Ecology and Climate Change

The Organic Statute of MINAMB (Presidential Decree No. 278/.), which oversees and supervises the Centre for Tropical Ecology and Climate Change (CETAC), refers to a separate statute for its organisation and operation.

It is a public corporation with legal personality and administrative, financial and patrimonial autonomy, established by Presidential Decree no. 184/12, of 17 August, to carry out applied research in the field of tropical ecology, from the perspective of the management of natural ecosystems, supporting the development and implementation of policies and programmes for the conservation of the environment, as well as using the possibilities offered by this type of research to improve the living conditions of people through the rational use of their water, soil and climatic resources.

CETAC has the task to develop applied research to ensure environmental quality and better management of water resources; Carry out studies on the environmental quality of aquatic ecosystems; Carry out research, extension and teaching activities in the fields of environmental sciences and tropical ecology and other related areas that serve the interests of communities and sustainable development, in interaction with higher education institutions; To carry out and provide information and analysis for Environmental Impact Assessments (EIA); to design and explain mathematical models that describe the growth of animal and plant populations; to inventory and analyse ecological systems; and to conduct, support or carry out studies on the ecology of populations, communities and ecosystems, the conservation of nature and natural resources, the structure and functioning of tropical ecosystems, the adaptation mechanisms of tropical species, the nature of primary production in tropical terrestrial and aquatic ecosystems, and the efficiency and productivity of tropical ecosystems.

6.1.4. Agro-ecological Centres

The Demonstration Centres for Good Environmental Management Practices are units for the practice of scientific research applied to the environment, which are equivalent to departments for all purposes and comprise two sections.

The Agro-ecological Centres are research institutions that aim to achieve food self-sufficiency for the population through innovative agro-ecological techniques, which is currently a field of research that involves the ecological management of natural resources through responsible and participatory collective social action, with the aim of achieving social and environmental sustainability in Angola.

The Demonstration Centres for Good Environmental Management Practices and the Agro-Ecological Centres are services under the INGA, which provides methodological supervision, and are governed by their own statutes and diplomas that define their organisation and operation. They were created by a joint executive decree of the Ministry of Environment and the Ministry of Territorial Administration.

The centres must contribute with concrete actions to the response to local environmental problems such as land degradation, desertification, climate change, etc.

6.1.5. National Civil Protection Commission

The hierarchy of civil protection in Angola is established by Law 28/03 of 7 November. The National Assembly defines the civil protection policy framework and supervises its implementation. The Government defines the main guidelines of the policy and provides the means for its implementation. The Executive is also responsible for declaring a disaster or public emergency, either on its own initiative or on the basis of a reasoned proposal from the Minister of the Interior or the provincial governments. In this case, the Executive must allocate funds and take exceptional measures to restore normal living conditions in the affected areas.

The Chief Executive is responsible for coordinating and directing the actions of the members of the Government in matters relating to civil protection; taking charge of operations in situations of national disaster or catastrophe; convening the Higher (or National) Council for Civil Protection and chairing its meetings. The National Civil Protection Council is the inter-ministerial body that hears and advises the Chief Executive on civil protection matters and must issue opinions on the organisation and operation of civil protection bodies, on legislation in the sector and on the approval of the National Emergency Plan.

The provincial governors participate in the Council meetings, which deal with matters of interest to their respective provinces. The National Civil Protection Commission (CNPC) is the specialised technical advisory and operational coordination body for civil protection bodies and structures. It is governed by Presidential Decree 101/11 of 10 November, is chaired by the Minister of the Interior and is made up of the representatives of the ministries that make up the Council, the General Commander of the National Police, a representative of the General Staff of the Angolan Armed Forces, the Commander of the Fire Service, the Director of the National Civil Protection Service, the Director of Civil Aviation, the Director of the Merchant Navy and Ports and the Director of the Meteorological Institute.

The CNPC is responsible for proposing: legislative measures and technical standards; mechanisms for institutional cooperation and technical and operational coordination between all the bodies and services involved; criteria and technical standards for organising the inventory of public and private resources and assets that can be mobilised at local, provincial and national levels in the event of a major accident, disaster or calamity; and for drawing up general and specific emergency plans at local, provincial and national levels and defining priorities in the field of civil protection.

The CNPC is also responsible for raising public awareness of self-protection and cooperation with civil protection bodies, as well as for actions to be carried out within the education system to disseminate theoretical and practical knowledge about the nature of risks and how each individual can help to limit the effects of a serious accident, disaster or calamity, and for programmes to train, update and improve the staff of the bodies and structures that make up the national civil protection system. In areas under the jurisdiction of the Maritime Authority, responsibility for civil protection lies with the services under that authority. Provincial Commissions of the National Civil Protection Service should be established in the provinces.

The Civil Protection Agents are the entities that carry out civil protection functions in the areas of warning, alerting, intervention, support and rescue in accordance with their own attributions. The agents are: the Fire Service; the Security and Public Order Forces; the Angolan Armed Forces; the National Department of Civil Aviation; the National Department of Merchant Shipping and Ports; the Maritime Inspectorate of the Ministries of Fisheries and the Environment; the Angolan Red Cross, in accordance with its statutes. The health services, social security institutions, institutions subsidised by the State for relief and social solidarity purposes, the authorities responsible for forests, parks and nature reserves, industry, energy and water resources, transport, communications, fisheries and the environment all have a special obligation to cooperate with the civil protection authorities.

Civil protection is therefore an essential partner in the field of climate change. The partnership is in the area of vulnerability and adaptation to climate change, which is operationalised in the CNPC, of which MINAMB is a member. It is recommended that the members of the CNPC, such as the representatives of the ministries responsible for civil protection, are also involved in the CNAB.

The main sectors in need of adaptation to climate change in Angola are Water resources, ecosystems, agriculture, forests, coastal zone, infrastructure and health. The main areas for mitigation are: energy, industry, forests and land degradation, agriculture and waste.

6.1.6. The Decree on environmental impact assessment and licensing

The EIA (Decree No. 117/04) sets out the rules, modalities and mandatory nature of studies that identify the foreseeable impacts and mitigation measures of certain types of projects. As the EIA is one of the requirements for the approval of CDM projects, the legal conditions for its implementation have been created.

Considering that the rational use of renewable natural resources is part of MINAMB's mission, the Strategic Plan for New Environmental Technologies (Presidential Decree 88/13 of 14 June) includes Programme ES 4: Environmental Technologies in the Energy and Water Sectors, which includes Initiative ES 4.1: Promotion of Renewable Energy in the Energy and Water Sectors.

DNTNA should consider renewable energy as one of its two lines of action. Renewable energy "appears to be a vector for changing the energy paradigm. This change is fundamental, not only from an environmental point of view, since the use of renewable energy sources for energy production contributes significantly to reducing the emission of harmful gases into the environment, but also from a strategic point of view, since it reduces energy dependence on the oil sector and makes it possible to reconfigure the national energy matrix by taking advantage of existing natural resources". With regard to the implementation of the plan, initiative ET 1.2: Training for new sustainable habits refers to "environmental technologies in the energy sector, such as the various types of renewable energy applicable in Angola and biofuels". MINAMB is expected to gather information on the potential for the use of renewable energy in the Angolan context, given the natural resources available and the climate of the national territory.

On the basis of this information, the country will be able to identify the environmental technologies that can be implemented in Angola in the field of renewable energy production, and to prepare the corresponding studies for each renewable energy source. Depending on the renewable energy source in question, each study must include the applicable environmental technologies and the potential of the renewable energy source in question for energy production in the country. In particular, these studies should focus on the transversal impact of the implementation of the respective technologies in the following sectors: urban planning and construction (due to the potential of using some of these technologies, such as solar panels, in buildings); agriculture and forestry (particularly in the field of bioenergy and micro-generation in isolated communities with precarious access to the electricity grid); and industry (due to the possibility of creating industries related to the production of these technologies, highlighting the resulting impact on national economic growth and job creation).

Finally, each study, and therefore each renewable energy source, should propose an immediate action plan to promote the effective implementation of environmental technologies in each of the areas studied. The renewable energy studies should be made available to government agencies, communities and businesses. In the context of awareness and training programmes, the work should be as broad as possible in order to ensure its dissemination and the application of the knowledge of environmental technologies applicable in this sector by the relevant actors.

6.1.7. Reporting and verification mechanism

The implementation of DP 8/22 MRV - Aims to institutionalise MRV in order to make reporting processes credible and accelerate the implementation of a range of mitigation and adaptation actions.

6.1.8. National Climate and Environmental Observatory

The Climate Observatory is an essential tool for monitoring climate issues to prevent destruction, death and climate refugees. Its implementation should help answer many other questions related to the consequences of climate change throughout the country.

6.1.9. Implementation of the National Adaptation Programme of Action (NAPA)

The National Adaptation Programme of Action (NAPA) has identified a number of priorities, including Promoting renewable and alternative energy to reduce deforestation; promoting sustainable land management to increase agricultural land; ensuring the basis for access to and monitoring of health services; studying the vulnerability of fisheries to changes in climate and currents; extending electricity to rural areas; reviewing sectoral legislation to promote proactive adaptation; establishing early warning systems for floods and storms; National institutional mechanisms for adaptation, integration and planning; control of soil erosion, through organic methods; diversification of plantations towards less climate-sensitive crops; assessment of technological needs, varieties adapted to local conditions; climate monitoring and data management system, study of the impact of changes in epidemiological parameters (animal) and water availability for livestock; increase in water availability at community level, through boreholes and wells.

Current projects:

- Responding to urgent coastal adaptation needs and capacity gaps in Angola;
- Integrating climate change into environmental management and sustainable land use;
- Integrating climate resilience into agro-pastoral systems;
- Promoting the development of climate resilience and strengthening adaptive capacity to withstand risks in the Cuvelai River Basin.

In addition to the projects that are being implemented, other projects are in the start-up phase that will help build capacity to respond to climate change and prepare the territory for other phenomena that are already being felt.

However, in order to adopt adaptation measures that can minimise the impact of climate change in an area of interest, it is essential to know the possible climate changes that may occur in that region, which makes it imperative to make regional and local projections of the future climate, so that the impact of the expected change can be assessed in each region or location, based on climate models.

6.1.10. Other actions that have been developed

The country has sought to achieve food security as a primary objective to meet people's needs. That's why society needs to be made aware of the urgent need to work harder and produce more, and with this in mind a series of major projects and other measures are underway to stimulate families and businesses. On the other hand, the issue of infrastructure is fundamental to the country's development, with a focus on energy, water, roads, ports, airports, railways, housing, health, telecommunications and other sectors.

The drought situation in the south of our country still requires special attention, although the bleak scenario of the past is changing as a result of the important investments being made in infrastructure. Some 250,000 people and 240,000 head of cattle are already benefiting from the water stored and distributed by the Cafu Canal, which is 165 kilometres long.

In addition, as part of the programme to combat the effects of drought in southern Angola, particularly in the province of Cunene, the Calucuve dam is under construction, with a storage capacity of 141 million cubic metres of water and a 111-kilometre-long adductor canal. At the same time, the Ndúe dam is under construction, with a storage capacity of 170 million cubic metres of water and a 75 km long adductor canal.

The fight against drought in the south of the country also involves other projects that are due to start soon: the rehabilitation and desilting of 43 dams in Namibe Province; the construction of the large Carujamba, Inamangando, Curoca II, Giraul, Bero and Bentiaba dams, all in Namibe; and the project to study and exploit the groundwater in the Chela aquifer in the city of Lubango

It should be noted that the work of the Ministry of Environment has essentially focused on identifying vulnerabilities and adopting adaptation measures or options. Meanwhile, the different sectors have to contribute with concrete measures at their own level. Meanwhile, the Ministry of Environment's projects have helped to build local capacity for adaptation and vulnerability reduction.

Among the various communication tools on vulnerabilities and adaptation options, the National Communications, the National Contributions to the Paris Agreement and the National Strategy for Climate Change stand out. The Ministry's work has not focused on quantifying displaced populations, as this task falls to other government institutions. However, it has regularly reported on the various activities.

The National Adaptation Action Programme aims to contribute to reducing the country's vulnerability to the effects of climate change and to creating the conditions for adaptation, in line with the urgent and priority sectoral actions identified. On the other hand, the development of the National Adaptation Plan should enable the long-term institutionalisation of adaptation issues in central and local government structures.

Climate change is mainly reflected in erratic intensity and frequency of rainfall, sudden changes in temperature and relative humidity, increased heat in some regions, increased cold in others, prolonged droughts, floods and inundations, increased or decreased frequency and intensity of winds, climate variability.

One of the most visible effects of climate change is its impact on water resources and, through them, on human well-being and the country's economic activities, such as agriculture, oil exploration, shipping and fishing.

According to a report by the United Nations Development Programme (UPDN), between 1960 and 2006, the area in which Angolan territory is located has experienced a temperature increase of about 1.5ºC, or 0.33ºC per decade in surface temperature. The increase was greater in the dry season (0.47ºC) than in the hot season (0.22ºC per decade). Therefore, there was an increase of 0.47ºC per decade in the dry season and only 0.22ºC per decade in the hot season. From 1960 to 2006, the annual precipitation decreased by about 2 mm per month (2.4%), mainly in the months of March, April and May, and by 5 mm per month (5.4%) per decade.

Daily temperature observations show significant increases in the trends of warmer days in all seasons, as well as in all nights, with the exception of December, January and February. The main trends in temperature increase according to the Global Climate Model are for 2060, with increases between 1.2 and 3.2ºC, and 2090, with increases between 1.7 and 5.1ºC. The period up to 2030 has not been estimated due to a lack of data. The annual projections also indicate a temperature increase for Angola of between 20-40% by 2060 and 25-65% by 2090.

The results since 2011 show that the need for adaptation is increasing. The human and technical capacity to respond to the problem must therefore be in place. To do this, everyone must take action to ensure that the survival of future generations is not jeopardised. It is important to continue to study the factors that contribute to the risk of flooding and to develop projects to reduce these risks.

In turn, it is necessary to continue to integrate climate change risks into infrastructure planning and investment, programme development and, where appropriate, urban planning. Success in this task will require the collection of information and resources and the strengthening of institutions.

The impacts of climate variability and change could seriously jeopardise current efforts to achieve economic growth, poverty reduction and sustainable development if appropriate adaptation measures are not taken.

Further south, for example, there is evidence of a reduction in rainfall and an increase in rainfall variability. The existence of structural constraints in the country reduces the local and national capacity to adapt and anticipate the likely impacts.

The variability of rainfall or its distribution in more intense rainfall implies a change in river basin parameters (sedimentation or probability of flooding). Increased soil erosion may affect sedimentation in river basins. Changes in hydrology also affect neighbouring countries, which are the final destinations of rivers originating in Angola.

The need for adaptation is now inextricably linked to the technical capacity to solve the problem and requires a concerted commitment so as not to jeopardise the survival of future generations.

The National Adaptation Programme of Action aims to reduce the country's vulnerability to the effects of climate change and to create the conditions for adaptation, in accordance with the urgent and priority sectoral actions identified.

The specific objectives are:

- To serve as a simplified and direct channel for communicating information on Angola's urgent and immediate adaptation needs;
- Strengthen the national capacity of Angolan experts in the field of vulnerability and adaptation to climate change, thereby ensuring an enabling environment for the implementation of the UNFCCC; and,
- Facilitate capacity building for the preparation and implementation of adaptation actions included in the First National Communication and identify urgent and immediate adaptation needs.

The programme is consistent with national development objectives and the principles set out in the National Strategy on Climate Change. It must therefore include activities that contribute to the achievement of sustainable development, namely training and professional capacity building, technology and knowledge transfer and attracting foreign investment:

Protect the climate system - for the benefit of present and future generations, in accordance with the country's responsibilities and capabilities;

Readiness - to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects, including the principle of cost-effectiveness of such measures. The measures to be taken must take into account the socio-economic context of the country and encompass all sectors of the country's economy whose activities have a direct or indirect impact on climate change;

Institutional cooperation - Efforts to combat climate change can be undertaken in cooperation between different government departments, the private sector and environmental civil society organisations. This cooperation should include the principle of international cooperation to achieve the goals set; and

Integration - Measures to combat climate change must be appropriate and integrated into the country's economic development programmes.

Future projections of rainfall, surface runoff and soil moisture are still very uncertain. There is insufficient information on the possible impacts of climate change in Angola, but it is not reasonable to assume that the climatic and hydrological conditions of the past will continue into the future. What is certain is that climate variability will increase and that the population is already experiencing water stress.

The current focus is on understanding the systems that could be affected by climate change in all risk areas, the vulnerability of these systems, and testing strategies to reduce vulnerability in local communities. There is little knowledge or availability of data to assess with the necessary precision the extent of impacts on water resources, natural systems, soils, forests or coastlines. Meanwhile, there is a glaring lack of data and technical capacity to monitor the climate system to provide timely weather forecasts and early warnings that allow for long-term projections of actions to remedy these deficiencies.

The main economic activity in southern Angola is rain fed agriculture, and the effects of climate change will have a greater impact on this sector. The reduction in rainfall is a fact that makes it opportune to respond to the effects of climate change in a coordinated way. In fact, this is what the government's programme is trying to do: respond with a variety of initiatives.

More important than preventing and responding to the effects of climate change is the drafting and subsequent implementation of the National Action Plan for Adaptation to Climate Change, an indispensable tool for combating its harmful effects.

The initial instruments are already in place, but it's now time to translate them into a concrete programme of activities that can respond to the challenges posed by climate change.

6.1.11. Disaster Risk Reduction (DRR)

Around the world, work is underway to raise awareness of environmental risks, reduce vulnerability to natural and industrial risks, and help countries integrate the environment into their risk reduction policies and activities.

Over the past decade, the role of ecosystems in disaster risk reduction (DRR) has received increasing global attention. Sustainable management of ecosystems for DRR is now recognised as a priority action in the **Sendai Framework for Disaster Risk Reduction**, of which UNEP is a signatory and active supporter. Drawing on its technical expertise and extensive experience in the field, the Task Force has helped decision-makers find new ways to support ecosystems for disaster risk reduction at local and national levels.

Through the implementation of projects under the National Climate Change Adaptation Programme and other initiatives, nature-based adaptation solutions have been sought. This can help reduce the high costs of adapting to climate change and speed up the process at the local level.

6.1.12. Loss and Damage

Loss and damage refer to the consequences of climate change that are unacceptable or require large financial resources to mitigate. In fact, it is a term used by the United Nations (UN) in climate negotiations to refer to consequences of climate change that are unacceptable or require large financial resources to mitigate. In general, these impacts affect the most vulnerable communities, making them a climate justice issue.

Environmental damage is a concept that refers to the resources used to cover accidents or unforeseen environmental problems, while harm is any change in the environment that leads to negative consequences, such as the improper disposal of plastic waste.

Collective efforts to reduce greenhouse gas emissions are not enough to mitigate the effects of climate change, so some loss and damage is inevitable. However, it is necessary for developed countries to provide financial support to help the most vulnerable communities cope with the consequences.

Since the adoption of the United Nations Framework Convention on Climate Change in 1990, vulnerable countries have been asking developed countries for financial resources to help them cope with loss and damage, but their requests have been rejected.

6.1.13. Environmental technologies

Climate change is the greatest environmental development challenge of the 21st century. A series of very intense climatic events over the last decade has already signalled that the planet's climate is undergoing significant change. Technologies, both for mitigation and adaptation, have an important role to play.

6.1.14. Mitigation technologies

Deforestation and burning are the main environmental pressures in rural areas. These activities are associated with travelling agriculture, poaching, domestic energy and some traditional land use practices. The transfer of technology, in terms of domestic energy and its mass use, substantially reduces the pressure on forests and other natural resources.

With the growth and development of infrastructure in the country, an increase in the number of vehicles in transport is expected, and it is therefore necessary to strengthen legislation and policies that promote the import of new-generation, less polluting and environmentally friendly vehicles and favour the use of public transport. Deforestation and slash-and-burn agriculture are the main environmental pressures in rural areas. These activities are associated with shifting cultivation, poaching, domestic energy and some traditional land use practices. The transfer of technology in the form of domestic energy and its mass use significantly reduces the pressure on forests and other natural resources.

With the growth and development of the country's infrastructure, the number of vehicles in the transport sector is expected to increase, and it is therefore necessary to strengthen legislation and policies that encourage the import of new generation, less polluting and environmentally friendly vehicles and promote the use of public transport.

Angola has important water resources, both surface and groundwater, but their distribution is not homogeneous, which means that climate change will affect the country differently. It is therefore important to transfer technology and build institutional capacity to ensure the economic valorisation, exploitation and sustainable use of the country's water resources.

Presidential Decree 256/11 of 29 September approved the National Energy Security Policy and Strategy. The decree aims to transform Angola's energy sector by strengthening its capacity and infrastructure, defining the main strategic guidelines for the sector (particularly in the power and oil and gas sub-sectors) and redefining the institutional model.

The main objective is to quadruple the current energy supply by making better use of endogenous resources and applying the most efficient technologies. The law also calls for an increase in production in this sub-sector, so that by 2025 supply will increase from the current 3% to around 10-15%.

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The stabilisation phase, scheduled for 2012, aims to create the short-term conditions for doubling the increase in the available capacity of the system. This increase is expected to be achieved with the implementation of the PESE (Executive Programme for the Electricity Sector, 2009), a document that defines the main investments. 46% are fully implemented and the remaining 54% are planned:

- The rehabilitation of at least 500 MW of generation capacity, to be achieved, for example, through the modernisation and rehabilitation of some hydropower plants (Cabambe and Gove) and the transmission and distribution network (in Luena, Ndalatando, Malanje, Menongue and Soyo);
- The construction of facilities to provide at least 700 MW of additional capacity, to be realised through the reinforcement of Luanda's thermal capacity, the completion of the Capanda-Luanda line and the installation of gas turbines in Cabinda, Namibe, Dundo, Xagongo and Ondjive, among others.
- The interconnection of the North-Central-South system and the connection of Uíje to the North system;
- The electrification of urban centres and the construction of small water reservoirs (e.g. Chiumbe-Dala in Moxico).

The short-term extension of electrification to rural areas through a series of specific projects, such as the development of the following sub-programmes:

- Small hydroelectric generation;
- Thermal generation systems;
- Implementation of photovoltaic systems.

With a long-term consolidation horizon, this law provides for the adoption of measures to initiate structuring investments in energy production, namely:

- Increasing the national generation park from the current 1 GW to 9 GW by 2025 (mainly from hydroelectric resources and natural gas);
- The promotion of renewable energies, with particular emphasis on hydro resources and, in some cases, wind and solar energy;
- Other endogenous resources that could play a complementary role.

Through the Clean Development Mechanism, it is possible to obtain funding for mitigation projects aimed at limiting greenhouse gas emissions. The country can gain access to cutting-edge technologies by attracting direct private, national or foreign investment, by making the granting of licences conditional on compliance with environmental legislation, and by offering incentives to companies that invest in this type of technology.

6.1.15. Adaptation technologies

In agriculture, it is important to adapt cultivation techniques that reduce soil erosion and salinization, and to introduce early, high-yielding seed varieties that are more tolerant to water stress.

In urbanisation and infrastructure construction, it will be important to adopt technologies adapted to local natural resources and to review and incorporate new parameters for their construction.

The industrial sector needs to invest in less polluting and more efficient technologies that will reduce operating costs and limit emissions. There are areas where it is crucial to adapt technologies to national realities. However, limited information/capacity building, insufficient and/or poorly managed human resources and other institutional constraints hinder the process. It is therefore important to strengthen the capacity of research institutions and to disseminate the results of their work to users and policy makers;

Technology transfer in Angola is needed in the energy, water, industry, infrastructure and transport, agriculture, forestry and land use, health and waste management sectors, among others.

The mission of the Strategic Plan for Environmental Technologies of the Ministry of Environment is to propose the formulation, implementation, execution and control of the Executive's environmental policy, with a view to protecting, preserving and maintaining the quality of the environment, pollution control, protected areas and the valorisation of the natural heritage, as well as the conservation and rational use of renewable natural resources.

The Ministry of Environment's vision for environmental technologies consists of

To develop programmes and initiatives to promote the dissemination of environmental technologies and their application in the public and private sectors;

Contribute to the sustainable development of the country in sectors of strategic importance such as urban planning and construction, agriculture, transport and geology and mining;

Dissemination and promotion of environmental technologies relevant to the priority sectors;

To promote and support the application of environmental technologies relevant to each sector in Angola and to ensure the sustainability of the sector concerned.

6.1.16. Capacity needs

The need for capacity building in institutions should be balanced across the different types of action. About one third of the institutions seem to be more focused on adaptation activities, another third on awareness-raising and/or education and the last third on research.

6.1.17. Mitigation and Adaptation

There is insufficient knowledge of vulnerability to climate change and its spatial distribution, because there is no concrete knowledge of which region of the country is most likely to be affected, which population groups are most likely to be affected, and what the economic impact will be on the national economy;

There is limited dissemination and disclosure of the National Adaptation Action Programme and other reporting tools.

There is a need to invest in training key actors and local populations to respond as quickly as possible to the many challenges.

6.1.18. Financing needs

The country has a relatively small number of funding lines for mitigation and adaptation. There is a need to maximise the opportunities offered by access to the various funding mechanisms included in the National Strategy and to strengthen bilateral cooperation so that development resources are no longer used for emergencies.

The establishment of a national fund to respond to the challenges of climate change is essential.

6.2. SUPPORT RECEIVED IN THE PROCESS OF DRAFTING THE BUR

In order to successfully complete the Biennial Update Report, GEF/UNEP, UNDP / CBIT-GSP / PATPA Lusophone Cluster on Transparency, with funding from the Belgium Government contributed to capacity building for the GHG inventory, the collection of land satellite imagery, the forestry inventory and the general review of actions to ensure the quality of the work done.

Due to the difficulty of using the IPCC software to carry out the GHG inventory, it was decided to use spreadsheets from Brazil that are less complex and have a smaller margin of error in the results.

The experts from the different national institutions were given the opportunity to be trained on the IPCC software and the spreadsheets from Brazil with a preference for using the spreadsheets so that for the next inventory all the data could be re-entered into the software and the calculations repeated.

The Lusophone Cluster was also responsible for providing guidance on how to carry out the work, as well as training on the transparency mechanism, reviewing the MRV and providing methodological guidance throughout the process. There is still a need for on-the-job training to familiarise national technicians with processes similar to those in other latitudes. To this end, the training line should be strengthened to meet this need.

This training and the partnership with the Lusophone Cluster have made it possible to improve the quality of staff and to clarify Angola's obligations as a country under the Paris Convention and the implementation of the Convention, as well as the National Strategy, although not yet in a coordinated manner.

6.3. THE MINISTRY OF ENVIRONMENT

The Ministry of Environment provided the facilities and some logistical support for the implementation of the project, including human resources for the various project activities and development. Institutional dynamics and changes were the main reason for the delay in the BUR1 sub-commission.

There is a need to reassess existing capacities with a view to developing a plan to create and update individual and institutional capacities to accelerate and maximise the process of implementing the Convention.

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CONCLUSIONS AND RECOMMENDATIONS

NOVEMBER 2024

With Support From:

UN environment programme

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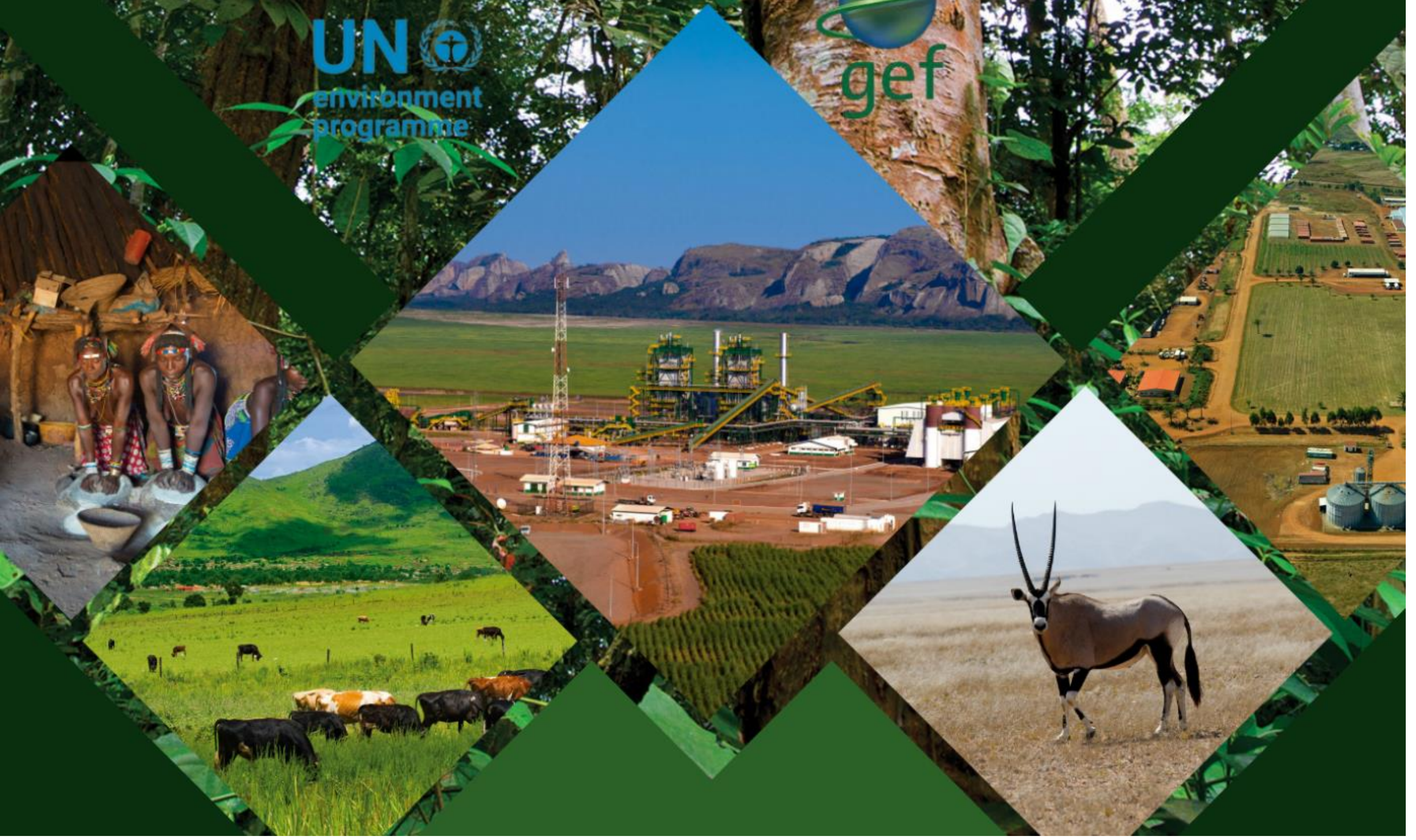

CONCLUSIONS AND RECOMMENDATIONS

The country is aware that natural resources such as oil, coal and natural gas are finite and for this reason invested in the energy transition process in order to stabilise the energy sector and ensure Angola's sustainable development.

The energy transition can be a solution that contributes to changing the current scenario, which aims to diversify the sources of energy production, with a focus on reducing emissions and achieving the national and international targets reported to the United Nations Framework Convention on Climate Change.

The process of assessing Angola's potential for energy production is a fundamental aspect of our journey towards sustainability and energy transition. In terms of renewable energy potential, the following stand out:

- Hydropower potential, which could generate up to 18 gigawatts;
- Wind potential, which could generate around 3.9 gigawatts;
- Solar potential, which could reach up to 17.3 gigawatts;
- Biomass potential, 3.7 gigawatts.

The energy mix is the most appropriate for the energy transition process, as it ensures the use of biofuels, solar and wind energy in different areas.

The country has natural resources that allows to diversify energy sources, reduce greenhouse gas emissions, promote socio-economic development and harmoniously develop the territory, creating a surplus for the sustainability of the region.

Continued commitment to reducing fugitive emissions in the oil and gas extractive sector, reducing deforestation, improving agricultural practices and restoring degraded ecosystems can help consolidate GHG neutrality in future national inventories.

Access to the carbon market has been hampered by limited technical capacity and a lack of financial resources. There is therefore an urgent need to attract investment across the board to facilitate mitigation proposals, given the government proactive attitude on mitigation, energy transition, grid expansion, rural electrification and renewable energy implementation. The same attention is also given to adaptation.

A number of challenges remain in the GHG inventory process, mainly related to the collection of data and information. These challenges are related to limited and weak data production capacity, data availability and analysis, as well as weak technical and institutional capacity to carry out GHG inventories efficiently and sustainably, in addition to the bureaucracy involved in providing data. These findings highlight the need to improve the legal and institutional framework to enable regular inventories.

Based on the constraints encountered during the preparation of the GHG inventory report, it is imperative to develop an institutional action plan to overcome all difficulties in order to facilitate the implementation of the MRV system to facilitate the preparation of subsequent inventories.

Likewise, it is imperative to propose a model and the corresponding directive that indulges the relevant institutions to carry out an annual energy balance in order to facilitate the data collection process for the energy sector.

The Environment Sector, as coordinator, must strengthen the dialogue with the institutions in order to achieve internal ownership of the GHG inventory process, in order to make the process sustainable by:

- Proposing a matrix for each institution to facilitate the process of collecting spontaneous and regular information so that this data is available for processing when the inventory is prepared;
- Propose a legal mechanism to hold sectors accountable for producing and providing data to facilitate the development of greenhouse gas inventories;
- Involve interested universities in the process of developing national emission factors to reduce the use of default factors;
- Evaluate the legal requirements for the regular implementation of GHG inventories and the MRV system and propose specific recommendations for subsequent inventories;
- Determine the reliability of apparently conflicting data for inclusion in future inventories, in order to obtain results that are consistent with the nature of the activities. The use of IPCC emission factors could also affect greenhouse gas emissions;
- Identify the organisation responsible for the general data collection and the process of carrying out the inventory, preferably linked to the national statistical institute;
- Operationalise a mechanism for carrying out the national energy balance in order to overcome some limitations in data collection;
- Establish a communication and response channel to ensure that the data provided meets the standards and quality required for the GHG inventory.

For the energy sector:

Establish an integrated model for data collection and standardisation for the preparation of the national greenhouse gas inventory. The body responsible for the national energy balance must produce the inventory annually.

Continuous improvement of subsequent inventories:

- The variation in stocks must be compatible with Angola's total leverage capacity, to ensure that the information on the maximum leverage available on land is consistent with the variation in stocks. To this end, it is essential to have data on the existence of leverage on vessels, as well as on exports and imports;
- Promote studies on the use of charcoal and firewood (renewable and non-renewable fractions) in order to fill the existing gap, as well as to estimate the difference between the need to use energy for cooking and the use of LPG;
- Carry out studies to define the non-renewable fraction to be included in the inventory and the renewable fraction, which should only be reported in the same way as international bunkers, for information purposes only, as they are not included in the United Nations Framework Convention on Climate Change (UNFCCC) guidelines;

- Establish a monitoring system for local emissions (venting and flaring), which is the essential part of the bottom-up method, for the inventory, as well as a programme to reduce their emissions, since they represented 8% of fugitive emissions in 2018 and more than 14% in 2015;

It is important to go into detail so that the inventory can be analysed by sector, according to the different energy-consuming sectors, such as road, rail, sea and air transport and electricity generation, among others.

The inventory must detail the consumption and production of ordoil and cut-back, as well as the addition of fuel and asphalt to oil. It is therefore necessary to clarify the two sources of energy consumption (energy and non-energy) and their distinction (whether they are used internally or exported).

For the industrial sector:

Much of the industrial park is obsolete. Since colonial times, Angolan industry has lacked the primary processing of products, such as basic metallurgy and basic chemicals, which use industrial processes that contribute to the emission of large quantities of greenhouse gases.

Angola is currently a growing country whose production from GHG-emitting industries is still in its infancy, but significant. Despite the need for the industry to grow and develop, it is essential that it complies with the international context and commitments.

Hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) serve as alternatives to ozone-depleting substances (ODS), albeit in limited quantities. Fortunately, they are being phased out under the Montreal Protocol. Current and expected uses of HFCs and PFCs include (IPCC / TEAP, 2005):

- Refrigeration and air conditioning;
- Fire extinguishers and explosion protection;
- Aerosols;
- Solvent cleaning; and
- Foam products such as upholstery and mattresses.

In addition, the use of HFCs and PFCs in some applications, particularly rigid foam, refrigeration and fire suppression, can lead to the development of long-lived material banks.

Sulphur hexafluoride (SF6) is used for electrical insulation and circuit breakers in equipment used in the transmission and distribution of electricity. Emissions occur at every stage of the equipment life cycle, including manufacture, installation, use, maintenance and disposal. Most of the SF6 found in electrical equipment is used in gas-insulated substations and cubicles and in gas circuit breakers, although some SF6 is used in gas-insulated high-voltage lines, external gas-insulated instrument transformers and other equipment.

Recommendations for the next inventory

That the estimates for HFC and PFC emissions be improved, although these emissions are more difficult to estimate due to lack of information.

That the estimates for SF emissions be improved, despite the difficulties mentioned above.

For the forestry sector:

In addition to environmental problems, the exploitation of forest resources faces other problems such as non-compliance, illegality and tax evasion by exploiters, companies, groups or individuals. When the offenders are caught or fined, the product is confiscated by the Forestry Development Institute, in accordance with Presidential Decree 274/17 of 10 November. This situation is repeated almost every year and is the cause of many seizures. In fact, production in Angola exceeds official figures due to informal exploitation that takes place without the knowledge of the authorities.

With regard to crop production and planted areas, not all data on planting and replanting are reported, especially in the private sector. Little is reported on areas planted, either in the agroforestry sector or elsewhere. There is therefore a need for better information exchange between the different actors to facilitate coordination and information sharing.

There are a number of agroforestry activities taking place in the country, including charcoal production, logging, mining and community landscape management. Although the task of reforestation of degraded areas, carried out by the state, is imperative, it is essential to share and identify information on each location, sector or institution in order to better adjust emissions calculations. Cabinda is the province with the most biomass, while at the other end of the spectrum, Namibe is the province with the least biomass.

Overall, the results show the dynamics of change, with the percentage of urban areas increasing by 3.3% between 2003 and 2018. Agricultural land increased by 5% over the same period. Forests experienced a net loss of 200 000 ha between 2003 and 2018. In contrast, the area of grassland increased by 200 000 hectares, while the area of flooded land decreased by 7% over the same period.

Managed forests, which move from a situation where forests were net sinks in 2005 to a situation where they are sources of emissions in 2015, account for 95% of the sources of emissions from land use change in 2015. The emissions found are about 50 times higher than those estimated in the first inventory in 2000.

Few details are available on the conversion factors associated with the image and mapping scales. There is a need for further comparative studies using vegetation classifications similar to those used in Angola, or local research with permanent measurement and restoration plots such as those used in the national forest inventories.

This information on carbon stocks and growth in plantations and native forests is the most important parameter for monitoring emissions. Therefore, it is not only important to know what is being planted or conserved, but also which plant or tree species are being conserved. Some plants are better suited to a particular location or planting site, just as the carbon stock in a tree can compensate for many shrubs or grasses. Such comparisons are assessed in monitoring analyses of land use change and require local research to identify the potential for uptake or emission in each type of land use change or alteration.

More detailed and accurate information could suggest new directions for forestry policies or incentives in the search for verification and reporting of CO2 emission reductions for specific management actions in landscapes. Agroforestry plantations, consortia of plantations on the same site, regeneration management are examples of practices with a forestry component in economic activities that are considered to be carbon reducing. These and other initiatives can be better identified on maps and observed with field measurements to contribute to calculations of carbon reductions in the atmosphere and are also of economic interest.

On the other hand, mitigation actions that reduce the forestry component, which is considered to be a major contributor to high emissions, can be assessed for their ability to reduce the impact of mitigation. Monitoring activities can have economic benefits and may be underestimated in Angola's emissions calculations.

In order to improve the quality of the processes for compiling future inventories, we recommend:

- That the Forestry Development Institute request or require from the private sector the creation of polygons, combating desertification, reforestation, settlement and repopulation, and data corresponding to the tasks carried out.
- That the Forestry Development Institute make an accurate estimate of the production of firewood and charcoal, both for subsistence and for trade, in rural areas.
- That the State decides on the appropriate destination for sawn timber, as well as for all the most exploited timber and non-timber forest resources.
- The inspectorate should be strengthened, not only in terms of resources, but also in terms of technical and ethical training, as well as fair pay and career prospects for inspectors.
- Expanding the bibliographic review of IPCC conversion factors and Angola-specific bibliography, with the aim of reducing the margins of error by using standard factors.
- The collection of images of land use class change, in particular the Landsat satellite image series.
- That the transition matrices of the areas be redrawn by management unit, based on all the Landsat images and with the definition of Angola's specific forests cut out.
- That the revised data processing tables and transition area maps be revised.
- That an ongoing training programme be developed for local teams to adopt the methodological steps, taking into account the demands of deadlines and the amount of work involved in the new mediation, reporting and verification processes.
- When presenting the total value of fuelwood, take into account the existence of divisions of origin between native forests and planted forests, as well as between information on charcoal, sawnwood and logs.

In the field of agriculture

The sector still faces some challenges in the production of statistical data. In order to alleviate this situation, a project is underway to produce the agricultural statistics needed for greenhouse gas inventories.

To this end, we have been working to complete the data series for the years 2005 to 2010, in particular with regard to the number of herds in this period, as well as the use of limestone and urea.

Calculation of crop residues - For crop residues, the methodology analogous to Angola's main crops, fruit, vegetables, etc., was used, including was used, including: (I) the dry matter fraction factors for each crop, (II) the ratio between aerial residues and total products on a dry basis, (III) the nitrogen (N) fraction in the residues of the aerial part of these crops and (IV) the N fraction in the dry matter of the plant for the other temporary crops, according to the IPCC guidelines (equation 11.6 9 (with FracRenew = 1) and Table 11.2 Chapter 11 page 11.17).

Only synthetic fertilisers (used in EAF) have been inventoried by IDAR. Complete the nitrogen fertiliser series and check the units of the values used.

Re-evaluate data on rice cultivation to improve the stratification of cultivated areas and make progress in quantifying the associated N2 O emissions.

For the waste sector:

Establish a multisectoral technical group to develop a master plan for waste management (on the basis of this document, develop provincial and even municipal plans, taking into account the specificities of each locality) in order to:

- Promote research in all provinces to collect basic data that will facilitate future greenhouse gas inventories;
- Linking information with the industrial waste sector;
- Put in place efforts to obtain data from industry on the amount of waste incinerated in order to properly estimate emissions;
- Mapping of waste management practices be used to derive activity data and estimate the amount of waste burned in the open;
- Use the mapping of all waste management practices in the country to derive data on solid waste activities involving landfilling, biological treatment, incineration and open burning. This should be complemented by data on waste used for composting and anaerobic digestion (biogas production). Data providers may have information on waste used for biomass production and waste incinerated. This should be dealt with in a short time.

GHG emissions from wastewater should be estimated following the guidelines of the 2006 IPCC Guidelines. Mapping of discharge systems can be taken from the 2006 IPCC guidelines.

For industrial wastewater, efforts should be made to obtain data from industries that treat this water on-site. If there is no on-site wastewater treatment in the country, an adjustment coefficient of 1.25 should be applied to the domestic water estimates.

Environmental education needs to take a broad and holistic view of the problem of climate change. From the point of view of interpretation, dissemination and verification, this vision must be constructed to respond to social, scientific and technological problems.

Climate change is a clear priority in Angola. However, it is appropriate to integrate climate change variables into development models at a time when the country is undergoing rapid development, particularly in terms of building infrastructure (roads, railways, airports), housing, industrial centres and agricultural development.

The preparation of the Biennial Update Report has allowed for some capacity building on climate change. However, limited resources and short-term capacity building activities needs to continue.

To make informed decisions, decision-makers need reliable and easily understandable information. It is therefore necessary to strengthen capacities for research and dissemination of information on climate and related systems. This requires the full involvement of academic and research institutions. It is also necessary to deepen contacts between research institutions and to promote joint and multidisciplinary work in order to produce integrated surveys and models that will allow the development of more comprehensive scenarios that will provide scientific support for the formulation of public policies in the country.

A key aspect is to strengthen synergies between ministries, institutes, central and provincial structures. Inter-institutional coordination and cooperation is essential to share information, build capacity and implement the joint activities needed to meet the challenges of climate change.

In each institution, human, technical and methodological capacities need to be strengthened. This can start with the institutions that make up the Supervisory Committee set up to monitor the implementation of the National Strategy on Climate Change, the institutions that participate in the reporting process to the UNFCCC, and the units that make up the Multisectorial Commission on Climate Change and Biodiversity. In addition to the implementation of the National Strategy on Climate Change, it also ensures that the national contributions submitted to the Conference of the Parties are evaluated and that more or less resources are allocated to them.

Priority training programmes include:

- Strengthening the capacity of the institutions involved for effective implementation of the Convention, including reporting;
- Strengthening the capacity of the Meteorological Institute and the Agricultural Research Institute for climate modelling;
- The creation of a systematised documentary database of scientific support data on climate change at the Ministry of Environment or the National Institute of Statistics to enable cross-referencing with information from other institutions;

- Improving the means and techniques for disseminating information and building the capacity to evaluate it; and
- Negotiating and mobilising funding.

The sustainability of institutional capacity requires policies that promote the motivation and productivity of human resources. It is therefore necessary to harmonise human, material and financial resources in order to improve the conditions for the effective application of the knowledge acquired by the technicians of the different institutions.

There are various international financial and technical support mechanisms that can be channelled towards capacity building and used in such a way that several people can answer the same question to fill gaps in case of unavailability. The implementation of the Convention over the years has also highlighted the need for capacity building in terms of mobilising funds, preparing project proposals and monitoring their implementation.

There is a need to strengthen knowledge on the implementation of Article 6 and other greenhouse gas mitigation actions, as well as on other existing financial mechanisms. In the case of Angola, which has greater financial capacity, it is important to remember that this type of initiative is accompanied by international technical assistance, from which Angola can benefit in order to strengthen the country's capacities.

Efforts should be made to improve the climate change information system through specific capacity building measures and by providing it with the material, human and financial resources to perform at its best.

There are still some challenges in the GHG inventory process, mainly related to the collection of data and information. These challenges are mainly related to limited and weak data production capacity, data availability and analysis, as well as weak technical and institutional capacity to carry out GHG inventories efficiently and sustainably, and bureaucracy in data provision. These findings draw attention to the need to improve the legal and institutional framework to enable inventories to be carried out on a regular basis, as well as to the need to operationalise the technical component of the Commission on Climate Change and Biodiversity.

Based on the constraints encountered during the preparation of the GHG inventory report, it is imperative to develop an institutional action plan to overcome all difficulties and constraints in order to facilitate the implementation of the MRV process and the transparency mechanism for the preparation of subsequent inventories. We therefore recommend:

- Developing a model for the relevant institutions to prepare an annual energy balance sheet to facilitate the data collection process for the energy sector (proposal attached);
- Strengthen the dialogue between institutions in order to create internal ownership of the GHG inventory process and make it more sustainable;
- Proposing a matrix for each institution to facilitate the process of collecting spontaneous information, so that this data is available for the compilation of the inventory;

- Proposing a legal and formal mechanism to hold the sectors that hold the data and make it difficult to make it available accountable for facilitating the preparation of GHG inventories.

Recommendations to improve the quality of the processes for producing future inventories:

- That the Forestry Development Institute request or require the private sector engaged in agro-forestry practices to produce polygons, desertification control, reforestation, settlement and repopulation, as well as the data corresponding to the work carried out.
- That the Forestry Development Institute make an accurate estimate of the production of firewood and charcoal, both for rural subsistence and for commercial purposes.
- As in the case of sawn wood for subsistence, the other most exploited forest resources, both timber and non-timber, should be given an arduous task.
- The inspectorate should be strengthened, not only with resources, but with people, in acceptable numbers, with technical and ethical skills, and with fair pay that dignifies the inspector's career.
- That the literature review of IPCC conversion factors be expanded and the Angolan factors be specified, with the aim of reducing the margins of error when using the standard factors.
- The collection of images of land use changes, in particular the Landsat satellite image series.
- That the transition matrices of areas per management unit be reworked from the set of Landsat images and clipped to define Angola's specific forests.
- That the revised data processing tables and maps of transition areas be revised.
- That an ongoing training programme be developed to enable local teams to master the methodological steps, taking into account the demands of deadlines and the amount of work to be devoted to the new mediation, reporting and verification processes.
- The presentation of the total value of fuelwood should take into account that there are divisions of origin, such as native forests and planted forests. The same should apply to information on charcoal, sawnwood and roundwood.

In the agricultural sector

The sector poses some challenges for the production of statistical data. A project is underway to produce statistical data on agriculture, which could facilitate the production of data needed for greenhouse gas inventories in the sector.

This will require work to complete the data series for the years between 2005 and 2010, particularly in relation to the number of herds in this period and the use of limestone and urea.

Calculation of crop residues - Calculate crop residues using a methodology analogous to that used for Angola's main crops, fruit, vegetables, etc., including: (i) dry matter fraction factors for each crop, (ii) the ratio between aerial residues and total products on a dry basis (), (iii) the nitrogen (N) fraction in the residues of the aerial part of these crops, and (iv) the N fraction in the dry matter of the plant for the other temporary crops, according to IPCC guidelines (Equation 11. 6 9 (with FracRenew = 1) and Table 11.2 Chapter 11 page 11.17).

Only synthetic fertilisers (used in EAF) have been inventoried by IDAR. Complete the nitrogen fertiliser series and check the units of the values used.

Re-evaluate the activity data on rice cultivation in order to improve the stratification of cultivated areas and move towards quantifying the associated N2 O emissions.

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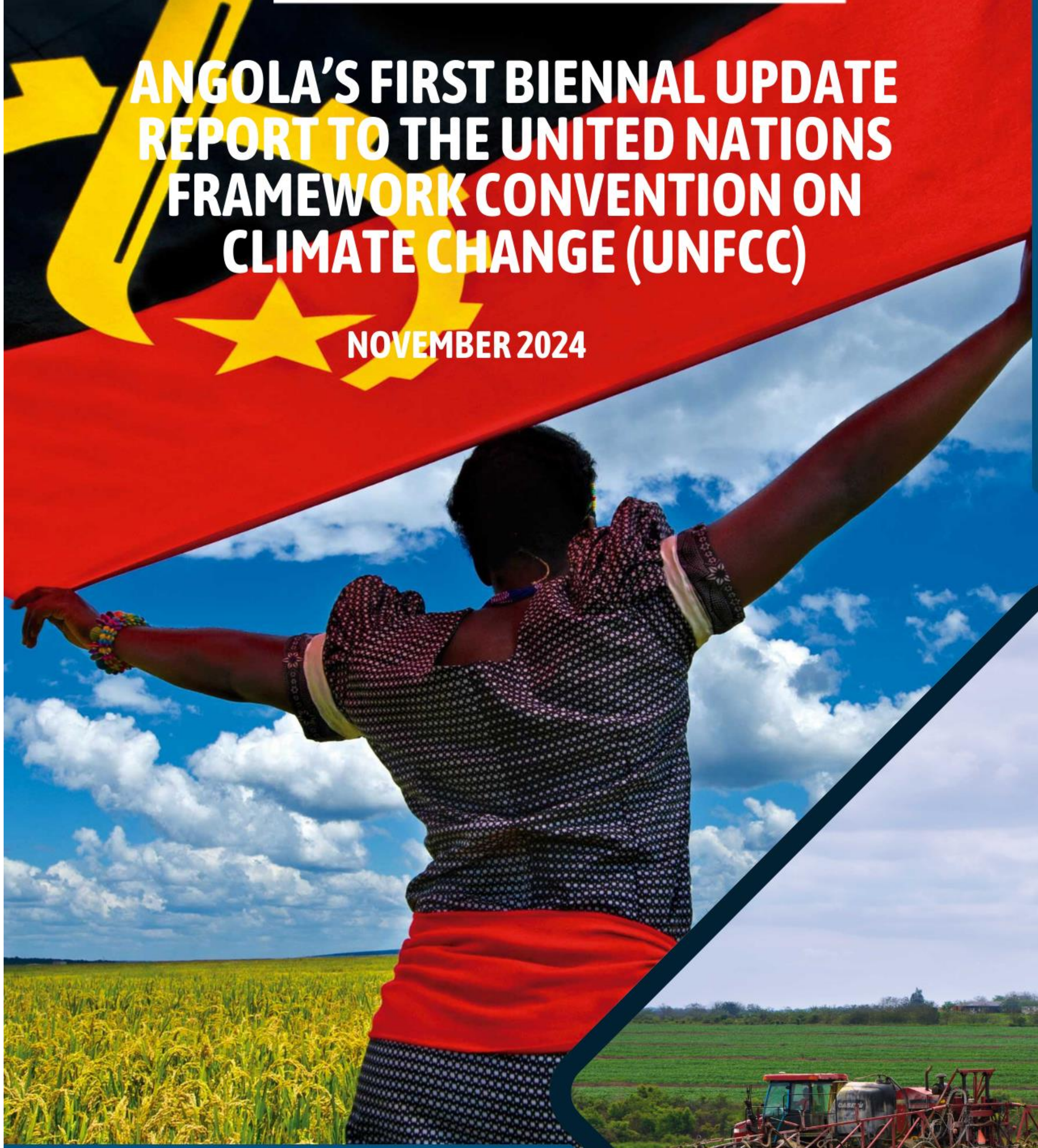

ANGOLA'S FIRST BIENNAL UPDATE REPORT TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCC)

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