



# GHANA'S NATIONAL ENERGY TRANSITION FRAMEWORK (2022 - 2070)



# FOREWORD BY THE PRESIDENT

Ghana is committed to fulfilling her pledge to implement measures that will address climate change and its negative impacts on our socio-economic gains. Therefore, responding to climate change issues is top of the national development agenda. Ghana is, thus, implementing her Nationally Determined Contributions (NDCs) and the agreements of the Conference of Parties (CoP) 26 to contribute her quota to achieving the objectives of the Paris Agreement.

Ghana recognizes that the energy and transportation sectors are key areas in reducing emissions. Consequently, steps must be taken to transition these sectors towards a net-zero emissions future. To attain this, Ghana must transition to the production and utilization of clean energy and the implementation of measures to mitigate any emissions that occur in the process. This will ensure that Ghana contributes her quota to the reduction of global GHG emissions, and, more importantly, achieve decarbonization, energy access and security, and energy efficiency.



As a result, we have developed this National Energy Transition Framework, which is aimed at decarbonizing the energy sector. This is a long-term net-zero framework (2022-2070), expected to complement existing efforts with new measures, such as increased renewable energy penetration, conversion of thermal plants to natural gas and the integration of nuclear power into the energy mix.

This framework will ensure that Ghana's transition will be achieved in a just and equitable manner. In doing so, Ghana is not oblivious to the need to balance her commitment to net zero, and the urgent need to transform her economy through the exploitation of the natural resources with which she has been endowed. Ghana has discoveries of critical (green) minerals, including lithium and graphite in significant quantities. We recognize that the exploitation of these resources for the transition comes with opportunities, and we are determined to extract these resources, and make efficient use of them through value addition to establish Ghana as a hub for electric

vehicles and the production of battery technologies.

Ghana will establish the National Energy Transition Implementation Committee, and set up the National Energy Transition Coordinating Office to drive the implementation of this framework, with participation by the key institutions including the Ministry of Energy, Ministry of Transport, and Ministry of Environment, Science, Technology and Innovation.

It is my hope that the National Energy Transition Framework will serve as a blueprint for transitioning Ghana into a climate-resilient low-carbon energy country, that will accelerate her development efforts, and enhance the well-being of her people without sacrificing the quality of her environment and resources.

# PREFACE BY HON. MINISTER FOR ENERGY

Ghana, as a signatory to the Paris Agreement on Climate Change, is committed to implementing its Nationally Determined Contribution (NDCs) to contribute efforts towards combating climate change and its effects. Calls at the Conference of Parties (COP) 26 and the continuous rise in emissions globally means that the need for actions towards the reduction in emissions is as necessary today as ever. The energy sector is one of the high emitting sectors and therefore key if Ghana is to achieve its net-zero ambitions.

For this purpose, this National Energy Transition Framework has been prepared to provide the vision and guidance in this transition process. In preparing this framework, we considered all existing policies and the programs that are being implemented towards achieving our NDCs. We also consulted Ghanaians across the length and breadth of the country to ensure that the peculiar energy needs and issues at various parts of the country are captured and addressed in the framework. There were other engagements with key stakeholder of various sectors of the economy including organized and non-organized labour as well as consultation with key development partners and the international community.



The framework seeks to guarantee the best fuel supply security through the provision of a diversified energy mix and cost-efficient electricity generation to accelerate socio-economic development. Ghana aims to achieve universal access by 2024. The Energy Transition Framework envisages to meet future electricity demand of 380,000GWh with an installed capacity of 83GW. Ghana's diversified energy mix shall include 21GW of renewable energy which provides the opportunity to commercialize the renewable energy carbon credit. This energy mix is expected to provide affordable electricity at a generation cost below 4.5cents/kwh.

This clean energy mix is estimated to mitigate 200MtCO<sub>2</sub>-eq of Green House Gas emissions which will minimize energy-related indoor air pollution and its related illnesses. It is estimated that 48,218 premature deaths will be avoided as a result of the improvement in air quality. Achieving clean energy production and utilization status will enable Ghana to gain access to the future green trade market.

The framework significantly impacts women and children who are the main gatherers of firewood for cooking. It is estimated that 30.05 million hours will be gained by women and children due to the upscaled adoption of clean cooking fuels and technologies. The implementation of the framework will provide over 1.4 million new job opportunities due to the introduction of new technologies such as Carbon Capture Utilization and Storage, Nuclear Power, Hydrogen, EV charging stations, Clean Cooking Stoves, etc.

The Ministry of Energy will continue to play a key role as the lead implementation institution of this framework and collaborate with the National Energy Transition Implementation Committee in ensuring that the objectives of this framework are achieved.

# Table of Content

LIST OF TABLES	VIII
LIST OF FIGURES	IX
LIST OF ACRONYMS	XII
GLOSSARY	XV
EXECUTIVE SUMMARY	1

## **CHAPTER 1:** 11

BACKGROUND .....	12
------------------	----

OBJECTIVES OF THE PLAN .....	14
------------------------------	----

PROCESS OF DRAWING UP THE PLAN .....	15
--------------------------------------	----

Desktop Analysis .....	15
------------------------	----

Regional Stakeholder Consultations and Focused Interest Groups Meeting .....	16
--	----

Modelling, Analysis and drafting of the Transition Plan .....	18
---	----

Validation by Collaborating Ministries and Regulatory Bodies .....	18
--	----

## **CHAPTER 2:** 19

DEMAND AND SUPPLY OF ENERGY .....	20
-----------------------------------	----

Drivers of Energy Demand .....	20
--------------------------------	----

ELECTRICITY SECTOR.....	21
-------------------------	----

Demand for Electricity .....	21
------------------------------	----

Supply of Electricity.....	23
----------------------------	----

The State of Electricity Infrastructure.....	25
--	----

UPSTREAM PETROLEUM SECTOR.....	28
--------------------------------	----

Demand and Supply of Crude Oil .....	28
Demand and Supply of Natural Gas .....	29
The State of Oil and Gas Infrastructure .....	30
<b>DOWNSTREAM PETROLEUM SECTOR</b> .....	31
Demand for petroleum products .....	31
Supply of petroleum products .....	33
The State of Downstream Petroleum Infrastructure .....	35
<b>CHAPTER 3:</b> .....	38
MAIN SOURCES OF EMISSIONS .....	39
GHANA'S GREENHOUSE GAS EMISSION INVENTORY .....	40
Distribution of GHG Emissions .....	42
Contributors of Emissions in the Energy Sector .....	43
National Overall Emission Reduction Targets .....	45
Emission Reduction Targets in the Energy Sector .....	45
EFFECTS OF EMISSIONS .....	47
<b>CHAPTER 4:</b> .....	48
PETROLEUM SECTOR .....	50
TRANSPORT SECTOR .....	52
CRITICAL MINIERALS .....	52
Bauxite and Manganese .....	53
Lithium .....	53
Other Green Minerals .....	53
<b>CHAPTER 5:</b> .....	54
FORECASTING OF POLICY DIRECTION .....	55
SCOPE OF MODELLING .....	55
KEY FORECASTING ASSUMPTIONS .....	56
ENERGY DEMAND FORECAST .....	57

ELECTRICITY PRODUCTION FORECAST WITH ASSOCIATED EMISSION .....	58
NATIONAL ENERGY TRANSITION PLAN.....	59
Capacity.....	59
Generation .....	60
ELECTRICITY SECTOR EMISSIONS.....	61
ENERGY SECTOR CO2-EQ EMISSION BY SUB-SECTOR.....	62
RECOMMENDED TRANSITION TARGETS.....	63

## **CHAPTER 6:** 66

The implementation of the energy transition framework will impact on the economic, social and the environmental indicators of the nation.

ECONOMIC IMPACTS .....	67
Revenues and Contribution to GDP .....	67
Petroleum Assets .....	67
Funding Fossil Fuel Investments .....	68
Funding for Renewable Energy and Clean Energy Resources .....	69
Energy Access and Security .....	69
Productive Use of Energy .....	70
Jobs .....	71
Agriculture and Food Security .....	72
SOCIAL IMPACTS .....	73
Gender .....	73
Health .....	74
ENVIRONMENTAL IMPACTS.....	75

## **CHAPTER 7:** 77

COST AND INVESTMENT REQUIREMENTS OF THE TRANSITION.....	78
Energy Cost.....	78
Transport cost.....	78
Industrial and Service Cost.....	79
Residential Cost .....	79
Total Cost .....	79

FINANCING STRATEGIES .....	81
FINANCING PLAN APPROACH .....	83
<b>CHAPTER 8:</b>	84
APPENDIX I: GHANA ELECTRICITY ACCESS MAP AS OF DECEMBER 2021	94
APPENDIX II: REMP IMPLEMENTATION SCHEDULE 2019 TO 2030	96
REMP IMPLEMENTATION PLAN - RE TARGETS UP TO 2030 .....	96
APPENDIX III: NATIONAL ENERGY TRANSITION COMMITTEE MEMBERS	98
APPENDIX IV: NATIONAL ENERGY TRANSITION DRAFTING COMMITTEE MEMBERS	100

## LIST OF TABLES

Table 21: Installed Electricity Generation Capacity - 2021.....	21
Table 22: Refinery Production (Metric Tonnes).....	26
Table 23: Ghana National Gas Company Production (Metric Tonnes).....	27
Table 24: Petroleum Products Storage Capacity (cubic meters).....	28
Table 25: Types and Regional Distribution of Petroleum Retail Outlets.....	28
Table 31: Ghana's total GHG emissions from 1990 -2019 by Sector.....	31
Table 32: Sector Emissions Contributions.....	33
Table 33: Contributors of Emissions Reductions in the Energy Sector by 2030.....	35
Table 51: Main Macroeconomic and Demographic Assumptions.....	42
Table 71: Investment needs for power supply in the transition.....	64



## LIST OF FIGURES

Figure 21: Electricity Consumption by Sectors	21
Figure 22: Peak Load (2020 - 2021)	22
Figure 23: Projected Electricity Requirement (2022 - 2040)	23
Figure 24: Electricity Generation (GWh)	24
Figure 25: Historical Ghana Net Exports	25
Figure 26: Total Energy Consumed by Fuels (Ktoe)	31
Figure 27: Total Energy Supplied	32
Figure 28: Petroleum Imports (Metric Tonnes)	34
Figure 31: Total Emissions Trends by Sectors	40
Figure 32: Emissions trends in Ghana	41
Figure 33: CO2e Emissions by Sectors	41
Figure 34: Total Emissions Trends by Drivers in the Energy Sector.	43
Figure 35: Energy Sector Emissions by Category/Drivers	44
Figure 36: Emission Reduction by Sectors	45
Figure 51: Energy Demand BaU vs T1	59
Figure 52: Energy Demand BaU vs T2	59
Figure 53: Energy Demand BaU vs T3	59
Figure 54: Energy Demand BaU vs T4	59

Figure 55: Electricity Demand - BaU vs T1	60
Figure 56: Electricity Gen Emission - BaU vs T1	60
Figure 57: Energy Demand - BaU vs T2	61
Figure 58: Electricity Gen Emission - BaU vs T2	61
Figure 59: Energy Demand - BaU vs T3	61
Figure 510: Electricity Gen Emission - BaU vs T3	61
Figure 511: Energy Demand - BaU vs T4	61
Figure 512: Electricity Gen Emission - BaU vs T4	61
Figure 513: Generation Capacity - BaU vs T1	63
Figure 514: Generation Capacity - BaU vs T2	63
Figure 515: Generation Capacity - BaU vs T3	63
Figure 516: Generation Capacity - BaU vs T4	63
Figure 517: Generation by Technology under BaU	64
Figure 518: Generation by Technology under T1	64
Figure 519: Generation by Technology under T2	64
Figure 520: Generation by Technology under T3	64
Figure 521: Generation by Technology under T4	64
Figure 522: Generation by Fuel under BaU	65
Figure 523: Generation by Fuel under T1	65
Figure 524: Generation by Fuel under T2	65

Figure 525: Generation by Fuel under T3	65
Figure 526: Generation by Fuel under T4	66
Figure 527: Energy Sector Emission – BaU vs T1	66
Figure 528: Energy Sector Emission – BaU vs T2	66
Figure 529: Energy Sector Emission – BaU vs T3	67
Figure 530: Energy Sector Emission – BaU vs T4	67
Figure 531: Energy Emission by Sub-sector – BaU	68
Figure 532: Energy Emission by Sub-sector – T1	68
Figure 533: Energy Emission by Sub-sector – T2	68
Figure 534: Energy Emission by Sub-sector – T3	68
Figure 535: Energy Emission by Sub-sector – T4	69
Figure 536: GHG Emissions from Energy Demand under T1 scenario for all sectors	69
Figure 536: GHG Emissions from Energy Demand under T1 scenario for all sectors	69

## LIST OF ACRONYMS

AFOLU	: Agriculture, Forestry and Other Land Use
ARDA	: African Refiners and Distributors Association
ATK	: Aviation Turbine Kerosene
BIDEC	: Bulk Import Distribution and Export Company
BPA	: Bui Power Authority
CCUS	: Carbon Capture Utilisation and Storage
C&I	: Construction and Installation
MtCO <sub>2</sub> e	: Metric Tonnes of Carbon Dioxide Equivalent
DVLA	: Driver and Vehicle Licensing Authority
ECG	: Electricity Company of Ghana
EPC	: Enclave Power Company
EV	: Electric Vehicle
FPSO	: Floating Production Storage and Offloading
GDP	: Gross Domestic Product
GHG	: Greenhouse Gas
GIADEC	: Ghana Integrated Aluminium Development Corporation
GMP	: Gas Master Plan
GNGC	: Ghana National Gas Company

<b>GWh</b>	: Gigawatt-Hour
<b>HFO</b>	: Heavy Fuel Oil
<b>IPPU</b>	: Industrial Processes and Product Use
<b>IPSMP</b>	: Integrated Power System Master Plan
<b>Km</b>	: Kilometre
<b>Ktoe</b>	: Kilotonne of Oil Equivalent
<b>kV</b>	: Kilovolts
<b>kW</b>	: Kilowatts
<b>LNG</b>	: Liquefied Natural Gas
<b>LPG</b>	: Liquefied Petroleum Gas
<b>LULUCF</b>	: Land Use, Land-Use Change and Forestry
<b>MARPOL</b>	: International Convention for the Prevention of Pollution from Ships
<b>MGO</b>	: Marine Gas Oil
<b>Mt</b>	: Metric Tonnes
<b>MW</b>	: Megawatt
<b>NDC</b>	: Nationally Determined Contributions
<b>NEDCo</b>	: Northern Electricity Distribution Company
<b>NPP</b>	: Nuclear Power Plant
<b>OECD</b>	: Organisation for Economic Co-operation and Development
<b>OPEC</b>	: Organization of the Petroleum Exporting Countries

O&M	: Operations and Maintenance
ORF	: Onshore Receiving Facility
PV	: Photovoltaic
RE	: Renewable Energy
REMP	: Renewable Energy Master Plan
RFO	: Residual Fuel Oil
SGN	: Sankofa Gye Nyame
SLT	: Special Load Tariff
SME	: Small and Medium Enterprises
TEN	: Tweneboa, Enyenra, Ntomme
TMPT	: Tema Multiproduct Terminal
TOR	: Tema Oil Refinery
WAGP	: West African Gas Pipeline
WAPCo	: West African Gas Pipeline Company

## GLOSSARY

**Best-in-class:** Superior product within a category of hardware or software

**Biofuel:** Liquid fuel produced from biomass materials.

**Biomass:** Organic matter used as a fuel heat and power.

**Carbon Capture, Utilization and Storage (CCUS):** The process of capturing carbon dioxide emissions, using it to produce materials (utilization) or permanently storing them thousands of feet below the earth's surface (storage).

**Carbon Neutrality:** A balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks.

**Climate Change:** Long-term shifts in temperatures and weather patterns

**Cross-cutting policies:** Policies that are identified as important and that interlace most or all other areas i.e., Decarbonisation, Energy Efficiency, Energy Security and Access.

**Energy Efficiency:** Using less amount of energy to perform the same task or produce the same results.

**Energy Transition:** A pathway toward transformation of the global energy sector from fossil-based to zero-carbon within the century.

**Decarbonization:** The reduction of carbon footprint, primarily greenhouse gas emissions in order to reduce its impact on the climate

**Gas Flaring:** Combustion of natural gas produced during oil production or industrial activity.

**Greenhouse Gas:** Gases that trap heat in the atmosphere.

**Net Zero emissions:** Achieving a balance between the greenhouse gases put into the atmosphere and those taken out.

**Non-Motorized Transport:** Modes of transport that do not rely on engines or motors.

**Renewable Energy:** energy from sources that are naturally replenished on a human time scale when used.

**Stranded Asset:** It relates to the loss of value of an asset due to changes in policy, regulation, consumer behaviour and preferences and technology.

**Woodlot:** Parcel of a woodland or forest for sustainable production of woodfuel and other forest products.



# EXECUTIVE SUMMARY

The average global temperature has seen a gradual increase since the industrial revolution. This rise is due to anthropogenic greenhouse gas (GHG) emissions. As a result, the United Nations' Sustainable Development Goal 13 and the 2015 Paris Agreement on Climate Change were adopted to combat climate change and its effects. Despite modest efforts made since the Paris Agreement, global emission levels are still rising and fall far short of the Agreement's ambitions. This necessitates the acceleration of efforts to achieve net zero GHG emissions.

Ghana must commit to transition to net-zero GHG emissions for the following reasons: potential threat to energy security; reduced funding for fossil-related projects; potential stranded assets; job losses; potential royalties and revenue loss in the oil and gas sector; and access to the global green market.

This document lays out a framework for decarbonizing the energy sector and reaching net-zero emissions by 2070 while ensuring socioeconomic growth and the use of Ghana's natural resources.

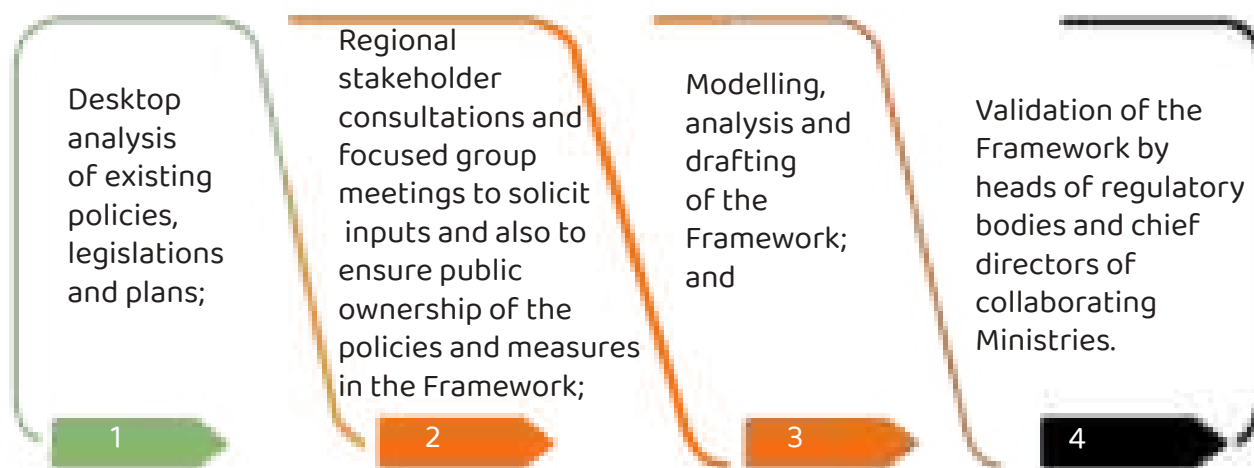
The Ministry of Energy in collaboration with other sector Ministries – Transport, Environment, Science and Innovation, Finance, Lands and Forestry, Water and Sanitation; has produced this Framework to provide a roadmap on Ghana's transition pathways to ensure sustainable development.

The specific objectives of the Framework are to:

- ⚡ Identify viable pathways for the country to transition towards carbon-neutrality within a secure and efficient energy sector;
- ⚡ Harness the opportunity for a fair and equitable energy transition as the country relies on carbon-intensive industries for economic growth;
- ⚡ Evaluate the impacts of energy transition on the economy (infrastructure, government revenue, jobs and social development);
- ⚡ Develop medium to long-term targets and policies for achieving a carbon-neutral economy; and
- ⚡ Estimate the cost of implementing the framework and identify financing options for the realization of the stated objectives.



In developing the National Energy Transition Plan, the following steps were taken:



Ghana already has energy sector policies and measures in place which have the effect of reducing GHG emissions. While these policies were not formulated with net zero targets in mind, they provide an adequate baseline for Ghana's Energy Transition and contextualises ongoing emissions reduction efforts.

These policies and measures include:

- Ghana Integrated Power Sector Master Plan;
- Renewable Energy Master Plan;
- Gas Master Plan;
- Ghana's Updated Nationally Determined Contribution under the Paris Agreement (2020 – 2030);
- Ghana Trade Policy
- National Infrastructure Plan by the National Development Planning Commission (NDPC);
- Policy on Zero Gas Flaring;

- National LPG Promotion Policy;
- 2020 National Transport Policy;
- The Energy Transition and Critical Minerals in Ghana: Diversification Opportunities and Governance Challenges; and
- Energy Efficiency Regulations.

Modelling was employed in forecasting the net-zero target using historical and current data, national policies, and plans as baseline information.

Key assumptions for the modelling are as follows:

- GDP is projected to grow at an annual rate of 5% from USD 79.08 billion in 2021 to USD 863.69 billion by 2070.
- The population is projected to increase from 30.8 million in 2021 to 72.2 million by 2070 at an annual rate of 2%.
- The urban-rural share is expected to grow from 56% in 2021 to 85% by 2070 at an annual rate of 1%.

The modelling considered the use of:

- nuclear for power generation;
- Carbon Capture, Utilization and Storage (CCUS) technology;
- compressed natural gas, electric and hydrogen fuel cell vehicles;
- sustainable aviation fuel;
- efficient energy transformation processes; and
- efficient end-use appliances.

The modelling forecasted following:

- **Energy Demand Forecast:** Ghana's total energy demand is expected to rise over time due to population and economic growth. The total energy demand is expected to increase from 8,195 Ktoe to 41,725 Ktoe in 2070.
- **Electricity Production Forecast with Associated Emission:** Electricity production will rise continuously over time increasing from 18,592 GWh in 2020 to 344,272 GWh in 2070. The related emissions are projected to increase from 7.5 MtCO<sub>2</sub>-eq in 2020 and peak in the mid-2050s and then decrease to zero(0) MtCO<sub>2</sub>-eq by 2070. The attainment of net zero is attributed to the introduction of cleaner technologies.
- **Electricity Generation Capacity Requirement:** The installed electricity generation capacity increased from 5,392 MW in 2020 to 84,308 MW in 2070. Natural gas-fuelled power plants will play a significant role in the generation mix but to achieve net-zero emission for the electricity generation sector, nuclear power and CCUS technologies shall be required. In terms of cost minimization and fuel security, nuclear power will become predominant from the mid-2050s.
- **Generation of electricity by fuel types:** The use of natural gas is expected to decline in the mid-2050s due to the optimal scaling up of nuclear power in the generation mix. Renewable energy in the form of solar and wind would contribute 20% of installed generation capacity by 2070.
- **Energy Sector Emissions:** Total emissions will increase from 28 MtCO<sub>2</sub>-eq in 2020 and peak by the mid-2050s and decline thereafter. By 2070, emissions are expected to reduce to 14.5 MtCO<sub>2</sub>-eq contributing to economy-wide net-zero emission. This is due to switching to cleaner fuels for energy services, such as the adoption of electricity and hydrogen.

This energy transition framework guarantees the best fuel supply security, the most diversified energy mix and cost-efficient electricity generation for accelerated economic development.

The Energy Transition targets over the next five decades are presented below.

### **Net-Zero Targets -2030**

- New sales of household electrical appliances are best in class.
- More than 95% of households are electrified.
- Introduction of CNG-fuelled ICEs and trains.
- More than 60% of cooling appliances and systems are best in class.
- 10% of electricity generation capacity is renewable energy.
- Introduce a 10% ethanol blend in major petroleum products.

#### **Net-Zero Targets -2040**

- Upscaling of nuclear power in the electricity generation mix.
- CCUS for electricity generation, Oil & Gas and Industries.
- Introduction of sustainable aviation fuel (Biofuel for aviation kerosene).
- Phasing out off-road fossil-fuelled ICEs.
- Phased out fossil liquid fuel for electricity generation.

#### **Net-Zero Targets -2050**

- More than 50% of water heating systems are solar heaters.
- More than 50% of metro urban households use electric stoves.
- More than 90% of household electrical appliances are best in class.
- More than 70% of road vehicles are electricity and hydrogen fuelled.

#### **Net-Zero Targets -2070**

- More than 70% of rural households use LPG for cooking.
- More than 98% of all appliances and cooling systems are best in class.

- All road and rail mobilities are electricity and hydrogen fuelled.
- Net-zero emission in electricity generation in the mid-60s.
- 20% of electricity generation capacity is Renewable energy.

The implementation of the energy transition framework will impact on the economic, social and the environmental indicators of the nation. Projected net cashflows for the oil and gas sectors are estimated at US\$35 billion and US\$1.3 billion respectively. Electricity sales is expected to increase during the transition with sales revenue rising to about US\$140 billion in 2070 representing 16% of the country's GDP.

The impact of the global transition on fossil fuel assets generally is expected to negatively affect the industry through stranding. In the petroleum sector, assets at risk include fossil fuel reserves and capital goods used for the extraction, processing and transportation of fuel. The downstream sector is expected to experience notable changes. New CNG stations and electric vehicle charging points will be built to meet the demand for new transport fuels.

Accessing funding for oil and gas projects could be challenging and expensive as the risk of stranding is built into the cost. Renewable and clean technology investments are expected to increase in the future, and thus financial institutions are strategizing to adequately finance such investments. Although current investments in renewable energy and clean technologies are not at the level required for the transition, it is expected that more funding will be made available in the future.

The country achieves universal access to electricity and high access to modern cooking fuels in energy transition which raises the energy access profile of the country. This provides adequate electricity for all sectors of the economy and increases industrial and socioeconomic development.

Improved access to clean cooking fuels could translate to the use of clean fuels for productive activities. It is worth noting that, with universal electrification, more than 95% of households would have access to electricity for other productive uses such as running cold stores, hairdressing saloons, dressmaking and local eateries, among others. The transition takes into account improvement in access to solar irrigation which would guarantee all-year round farming and have positive impact on agriculture.

The energy transition will entail a shift in energy generation technologies, fuel-use, end-use equipment and devices among others, with its attendant implications on jobs. The transition in the electricity sector is projected to yield a total of 1,367,894 jobs translating to 4,344,210.07 job-years. It is estimated that 52% of the jobs created will be in the construction and installation sectors. It is projected that, a total of 911,929 indirect and induced jobs or approximately 2.9 million job-years, 455,965 direct jobs or approximately 1.45 million job-years will be created.

Over the period, 24,539 indirect and induced jobs translating to 1.4 million job-years and 12,269 direct jobs translating to 681,223 job-years will be created in the fuel supply sector. A total of 36,808 jobs which is approximately 2.05 million job-years will be created. Towards the year 2070, as the economy becomes electricity driven, jobs in the fuel supply chain will reduce significantly. In summary, total jobs to be created will be 1,404,702 jobs leading to 6.4 million job-years.

The energy transition will require land of approximately 120,459 acres which is about 0.17% of Ghana's estimated agricultural land area in Ghana. Therefore, the transition does not have substantial implications for agriculture and food security.

The energy transition will impact on women and children in various ways. Averagely about 1.6 hours is spent daily gathering fuel wood, a burden that mostly falls on women and girl. Time spent on foraging for wood restrains participation in education. An improvement in access to energy both for cooking and for lighting will help address this. The transition framework targets over 70% rural access to LPG by 2070. This will lead to a total avoided time loss of 30.05 million hours. This would have a significant impact on women.

Without the transition, 234 years in every 1000 lives would have been lost. Minimising energy-related indoor air pollution could avoid 48,218 premature deaths. Reduction in energy-related emissions from transportation, cooking, building and industry will have

a direct impact on improving human health. The reduction in fine particulate matter will prolong the lives of people in communities, especially those who use high GHG emitting sources as cooking fuels.

About US\$76 billion is estimated for transmission and distribution infrastructure cost due to the increase in electricity requirement. The cost of additional gas infrastructure, including distribution and transmission networks, sums up to US\$14.5 billion. An additional US\$15.1 billion is required for the cost of Carbon Capture Use and Storage (CCUS) for Natural Gas generation plants and storage facilities. The cost of replacing or switching fuel in the transportation sector is US\$12.2 billion. The main means for road transport in the transition are electric vehicles, CNG ICEs and hydrogen vehicles. By 2040, a considerable number of gasoline and diesel filling stations will be repurposed to serve vehicles that use CNG, electricity and hydrogen. For an estimated 2 million CNG cars by 2060 a total of US\$570 million would be required for additional investment in infrastructure. Electric vehicle charging points will require a total investment of US\$7 billion. The major expected changes in the industrial sector include, replacing biomass boilers with gas and electric boilers and the enhancement of electric motors for efficiency. The total cost estimate for industry is US\$7.4 billion.

In the service sector, the transition focuses on space cooling and refrigeration since they account for more than 85% of the sector's energy consumption. Therefore, the cost of replacing less efficient ACs and refrigerators with more efficient ones is estimated at US\$14.5 billion. The main residential appliances considered include cooking, lighting, refrigeration, space cooling, water heating, cloth washing and dish washing which is estimated to cost US\$148 billion. This brings the total estimated cost of the transition to US\$562 billion.

Ghana will initiate discussions with relevant stakeholders in the global financial sector to source for funding for the transition. These will include Domestic Banks, Specialised Debt and Hedge Funds, Development Banks, Investment Banks, Pension Funds, and Multilateral Development Banks.

Some of the financing strategies that would be pursued are:

- Mobilise private and public finance to catalyse and create traction for renewable energy investments.
- Establish Public Private Partnerships to co-finance the construction, development



and deployment of transition infrastructure including Solar PV, Wind, Hydro, Mini grids, Nuclear, CNG plants, etc.

- Stimulate access to domestic financing for Small and Medium Enterprises to increase investments for both supply and demand requirements of transition, especially in the end-use technologies sector.

Following a series of national and regional stakeholder and focused group engagements, as well as expert input and a modelling process, relevant policy options were developed. The policy options are classified into four categories: Decarbonisation, Energy Efficiency, Energy Security and Access, and Cross-Cutting. The policy options recommended for consideration include:

## DECARBONIZATION

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- GHG emitting industries shall be required to establish tree plantations to offset emissions.
- Encourage fossil fuel companies to invest in renewable energy projects.
- Natural Gas shall be a transition fuel for electricity production, industrial heating and transport.
- Promote and encourage the use of Electric Vehicles.
- Introduce Carbon Capture, Utilisation and Storage (CCUS) technology in applicable thermal power plants and industries.
- Promote the use of Hydrogen Fuel.
- Increase the share of renewables in the energy generation mix.
- Introduce and increase the share of nuclear in the energy generation mix.

## ENERGY ACCESS AND SECURITY

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- Expedite Oil and Gas Exploration and Production to fund the development of Clean Energy Technologies.

- Expand Gas Infrastructure to ensure reliable and adequate supply of gas for Power and Non-Power Uses.
- Promote and encourage the use of LPG to reduce dependency on wood fuel.
- Strengthen and expand power transmission and distribution systems to accommodate intermittent Renewable Energy technologies.
- Exploit lithium and other critical mineral resources to develop the clean energy industry.
- Promote sustainable woodlot as biomass fuel.

## ENERGY EFFICIENCY

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- Intensify the promotion of energy efficiency programmes.
- Ensure the use of the most efficient lamps suitable for various lighting needs.
- Encourage and promote the use of best-in-class energy appliances.
- Encourage the use of clean cookstoves.
- Encourage the construction of energy-efficient buildings.
- Promote energy efficiency in Small and Medium Scale enterprises.

## CROSS-CUTTING

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- Decentralize the energy transition implementation process.
- Establish an energy transition fund.
- Incorporate energy transition into the curricula of academic institutions.
- Encourage regional cooperation among African countries for the development of clean energy initiatives.
- Mainstream gender in the implementation of the energy transition framework.
- Promote alternative livelihood programmes for persons affected by the energy transition.
- Promote local content and local participation in the implementation of Energy Transition programmes.



# CHAPTER 1: INTRODUCTION

## BACKGROUND

The average global temperature has seen a gradual increase since the industrial revolution. This rise is due to the release of large amounts of greenhouse gases (GHG) into the atmosphere as a result of anthropogenic (human activities) emissions. The burning of fossil fuels for electricity generation, heating, transport, and industrial processing mainly accounts for the release of carbon dioxide into the atmosphere<sup>1</sup>. Since 1970, CO<sub>2</sub> emissions have increased by about 90%, with emissions from fossil fuel combustion and industrial processes contributing about 78% of the total greenhouse gas emissions<sup>2</sup>. According to the International Energy Agency (2021), GHG emissions were dominated by the burning of coal (42%), followed by oil (34%) and natural gas (22%)<sup>3</sup>.



The United Nation's Sustainable Development Goal 13 therefore called for an urgent action to combat climate change and its impacts following which the 2015 Paris Agreement on Climate Change was adopted. Major emitting countries that cannot reduce their emissions to acceptable levels agreed to support developing countries to adopt the use of cleaner energy options in exchange for carbon credits. Africa accounted for only 3.8% of global

<sup>1</sup> <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>, IPCC (2014). *Climate Change 2014: Mitigation of Climate Change*.

<sup>2</sup> <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>, IPCC (2014). *Climate Change 2014: Mitigation of Climate Change*.

<sup>3</sup> <https://www.iea.org/articles/greenhouse-gas-emissions-from-energy-data-explorer>, Article 10 Nov 2021

greenhouse gas emissions in 2020<sup>4</sup> which calls for more low carbon investments on the Continent.

Despite the modest efforts made since the Paris Agreement, global emission levels are still increasing and falling far short of the ambitions of the Agreement. The UN Climate Change Conference in Glasgow (COP26) affirmed the need to accelerate actions to reduce CO<sub>2</sub> emissions to reach a net-zero level.

World trade is also shifting towards green markets (commodities that are manufactured using clean energy resources). International funding of national programmes and projects is increasingly aligned toward green economies. Therefore, Ghana and the rest of Africa need to take advantage of its green energy resource potential (hydro, uranium, biomass, geothermal, wind, tidal waves and solar) and abundant natural resources (diamond, gold, platinum, copper, cobalt, iron ore, phosphate, bauxite, copper, silicon and titanium) to strategically position itself for the green trade.

Even though Ghana's current total CO<sub>2</sub> emissions are negligible compared to the middle-income and industrialized countries, the energy sector is the leading source of the emissions. Ghana therefore needs to commit to the international community's call to transitioning the energy sector towards net-zero CO<sub>2</sub> emissions in the future due to the following reasons: potential threat to energy security; reduced funding for fossil-related projects; potential stranded assets; job losses; potential royalties and revenue loss in the oil and gas sector and access to the global green market.

This document provides the path to decarbonize the energy sector toward net-zero emission by 2070 while ensuring socio-economic growth and the utilization of Ghana's natural resources.

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4 <https://www.cdp.net/en/research/global-reports/africa-report>

## OBJECTIVES OF THE FRAMEWORK

The National Transition Plan reflects the nation's development vision expressed in Article 36 (1) of the 1992 Constitution, which enjoins the government to manage the national economy efficiently to maximise the welfare of the citizenry. The global transition from fossil fuels to cleaner sources of energy presents opportunities and threats towards the realization of this vision, as it promises to change the economic and social dynamics of the country with medium to long-term consequences for the welfare of the citizens.

The Ministry of Energy in collaboration with other sector Ministries – Transport, Environment, Science and Innovation, Finance, Lands and Forestry, Water and Sanitation; has therefore produced this Plan to provide a roadmap on Ghana's transition pathways to ensure sustainable development that maximizes the welfare of the citizens.

The specific objectives of the Plan are to:

- Identify viable pathways for the country to transition towards carbon-neutrality within a secure and efficient energy sector;
- Harness the opportunity for a fair and equitable energy transition as the country relies on carbon-intensive industries for economic growth;
- Evaluate the impacts of energy transition on the economy (infrastructure, government revenue, jobs and social development);
- Develop medium to long-term targets and policies for achieving a carbon-neutral economy;
- Estimate the cost of implementing the plan and identify financing options for the realization of the stated objectives;

## PROCESS OF DRAWING UP THE FRAMEWORK

The Government established an Inter-Ministerial Committee to develop the National Energy Transition Plan in consultation with the citizens of Ghana and other relevant stakeholders.

In developing the National Energy Transition Plan, the following steps were taken. The first step involved desktop analysis of existing policies, legislations and plans. The second step involved regional stakeholder consultations and focused group meetings to solicit inputs to ensure public ownership of the policies and measures in the Plan whilst the third step covered the modelling, analysis and drafting of the transition plan. The final step was validation of the Plan by heads of regulatory bodies and Chief Directors of collaborating Ministries after which the Plan was submitted to Cabinet for approval.

### DESKTOP ANALYSIS

There exists significant amount of literature on the energy policy of the country. These cover energy sector plans, policies and legislations. The plans include but are not limited to the following:

- Ghana Integrated Power Sector Master Plan.
- Renewable Energy Master Plan.
- Gas Master Plan.
- Ghana's Updated Nationally Determined Contribution under the Paris Agreement (2020 – 2030).
- Ghana Trade Policy.
- National Infrastructure Plan by the National Development Planning Commission (NDPC).
- Policy on zero gas flaring.
- National LPG Promotion Policy.
- 2020 National Transport Policy.

- Energy Efficiency Regulations.
- Ghana Climate Change and Adaptation Plan.

The analysis of these policies and plans identified important gaps as well as opportunities for the development of the energy transition plan.

## REGIONAL STAKEHOLDER CONSULTATIONS AND FOCUSED INTEREST GROUPS MEETING

The National Energy Transition Committee held regional consultation forums in all the 16 Regions of Ghana and solicited the views of the Ghanaian citizenry. These include:

- Civil Society Organizations
- Academic Institutions
- Traditional and Chieftaincy institutions
- Local Government Agencies
- other organized groups such as Students, Women and Youth groups

These consultations involved presentations and sensitisation which provided relevant information to participants. This was followed by panel discussions with panellists drawn from various interest organizations. Representation by women and People with Disability were particularly encouraged to ensure inclusiveness in the process. Participants also had opportunity to ask questions and provided inputs on most of the issues including policy and the operationalization of the Energy Transition Plan.

Discussions were also held between members of the Transition Committee and focused groups with direct interest in the transition efforts. These include:



## STATE INSTITUTIONS

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- Parliament
- Judicial Service
- Council of State

## INDUSTRY NETWORKS

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- Chamber of Bulk Import Distribution and Export Companies,
- Association of Oil Marketing Companies
- Ghana Upstream Chamber
- Chamber of Independent Power Producers
- Association of Ghana Industries
- Ghana Association of Bankers etc.

## CONSUMER AND LABOUR UNIONS

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- Trades Union Congress
- Ghana Private Road Transport Union (GPRTU)
- Chamber of Petroleum Consumers
- Market Women groups etc.


Also relevant in these consultations were Academic and Research Institutions such as the Universities and Research Centers specialized in energy sector policies and operations.

## MODELLING, ANALYSIS AND DRAFTING OF THE TRANSITION PLAN

A modelling tool was employed in the forecasting and analysis using historical and current data, national policies and plans as baseline information to model the net-zero target. This modelling was done using various scenarios to best fit the socioeconomic structure of the country. Two main scenarios were considered; the Business-as-Usual (BaU) and the Transition Scenarios. The BaU scenario takes into consideration the current national trends, existing policies and programmes being implemented. The Transition scenario takes into consideration measures that will reduce emissions to net-zero. These include fuel and appliance switches, and other emission mitigation measures. In addition, other sensitivity scenarios were developed to assess the uncertainty of other parameters on the main scenario. The various sectors of the economy as well as inputs from the stakeholder consultations were considered in the analysis. The information obtained from the analysis led to drafting of this document to guide the energy sector towards net-zero emission.


## VALIDATION BY COLLABORATING MINISTRIES AND REGULATORY BODIES

The Committee also organized consultation fora where the Draft National Energy Transition Plan was presented for further discussions to validate the measures and targets formulated.



# CHAPTER 2:

## CURRENT SITUATION OF THE ENERGY SECTOR



# DEMAND AND SUPPLY OF ENERGY

## DRIVERS OF ENERGY DEMAND

The main drivers of energy demand include demographic and economic factors, as well as government policies and programmes. Demographic factors such as population growth, changes in the share of the urban and rural population and changes in urban and rural household sizes drives energy use such as lighting, cooking and space cooling especially in the residential sector. Ghana's population has increased from 24.7 million in 2010 to 30.8 million in 2021 with the corresponding total energy use of 5,537 ktoe in 2010 to 9,345 ktoe in 2021. Though the growth rate has declined (from 2.5% between 2000-2010 to 2.1% between 2010-2021), the country's population is expected to reach 50 million by the year 2050 which will lead to an increase in energy demand.

Growth in GDP, changes in personal disposable income, and changes in the structure of the economy (i.e. shares of industry, services and agriculture in total GDP) also influence the level of energy demand in the country. The country's GDP in 2010 was USD 32.2 billion increasing to 79.1 billion in 2021. The structure of the economy has also changed from an agricultural sector led to a service sector led economy which accounted for the largest share of 48.9% of total GDP formation in 2021 as compared to 42.6% in 2010. Disposable income correlates positively with ownership and usage of energy-use devices such as vehicles and electrical appliances that drive energy demand.

Government policies such as the National Electrification Scheme, Accelerated Industrialization and Agricultural Programmes, and the promotion of Productive Uses of Energy also contribute to the energy demand growth. The share of the population with access to electricity increased from 64.4% in 2010 to 87% in 2021. However, the promotion of energy efficiency programmes also reduced wastage in energy utilisation and contributed to a reduction in the overall growth in energy demand. This is reflected in the energy intensity of the economy which reduced from 73.8 toe/million US\$ in 2010 to 71.8 toe/million US\$ in 2021.

5 2010 population and house census report (GSS, 2014)

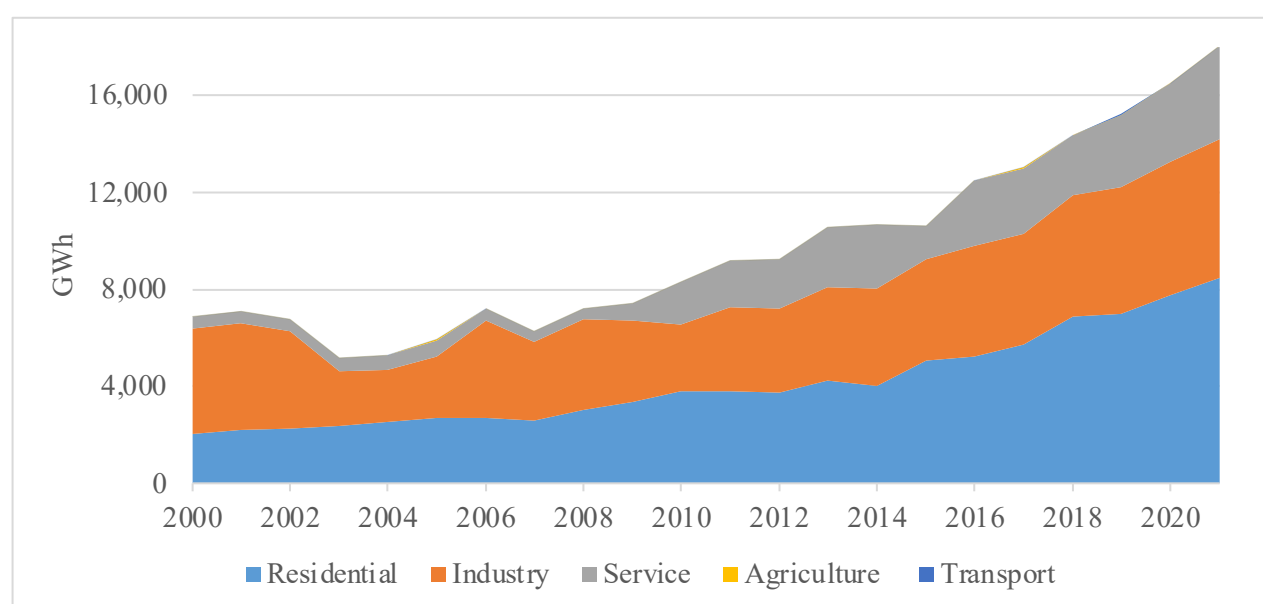
6 Ghana Statistical Service: Rebased 2013-2021 Annual Gross Domestic Product, April 2022 edition

7 Energy intensity measured in terms of total energy supply and GDP, PPP (constant 2017 international \$)

## ELECTRICITY SECTOR

### DEMAND FOR ELECTRICITY

Total electricity consumption by all sectors of the economy more than tripled between 2000 and 2021. From 6,889 GWh in 2000, total consumption increased at an average of 2.8% every year reaching 8,317 GWh in 2010. Total electricity consumption increased at an annual average growth rate of 9.3% between 2016 and 2021 reaching 18,067 GWh.<sup>8</sup> Residential electricity consumption increased by over 300% from 2000 to 2021, at an annual average growth rate of 7.3% from 2,026 GWh in 2000 to 8,484 GWh in 2021. (Figure 2-1)

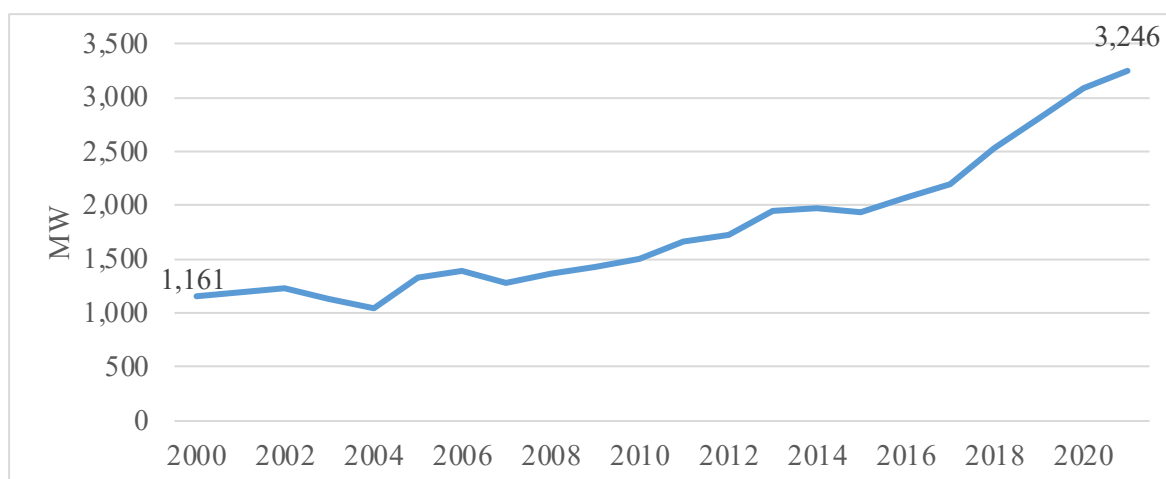


*Figure 21: Electricity Consumption by Sectors*

The industrial sector recorded an average annual growth rate of -1.3% between 2000 and 2010, increased to 2.5% between 2010 and 2015 and further increased to 5.5% between 2015 and 2021. The negative growth rate is attributed to reduced production by Volta Aluminum Company (VALCO) and other industries due to inadequate generation capacity.

Peak load for electricity (including export) increased annually by about 5.3% on average from 2000 to 2021. In 2000, the peak load was 1,161 MW reaching 1,506 MW in 2010 and

further increased to 3,246 MW by 2021. It however recorded negative growth rates in 2003, 2004, 2007 and 2015 (Figure x2) as a result of a load curtailment programme due to the inability of the existing supply to meet demand<sup>9</sup>.



*Figure 22: Peak Load (2020 - 2021)*

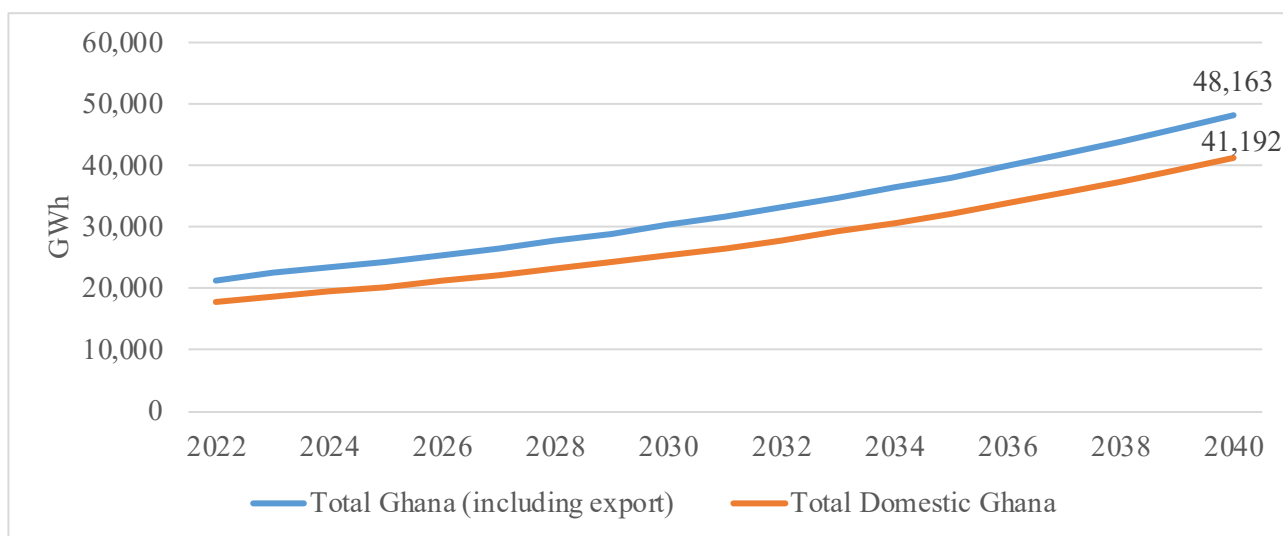
The customer base of the distribution utilities<sup>10</sup> has been increasing by an average of about 8.8% every year. In 2000, there were 932,598 customers made up of 758,558 (81.3%) residential, 173,245 (18.6%) non-residential and 795 (0.1%) Special Load Tariff (SLT) customers. By the end of 2021, it increased to 5,426,242 customers consisting of 85.7%, residential, 14.3% non-residential and 0.04% SLT customers. Increasing population, urbanization and industrialization are expected to result in the growth of the customer base of the utilities.

Electricity demand for the country is projected to reach 41,192 GWh by 2040<sup>11</sup> and 48,163 GWh factoring in export. It could rise even faster depending on how quickly the country moves to decarbonize its energy economy. A more rapid decarbonization pathway would imply increased electricity use beyond the projected. This increase will largely occur in transportation where there will be an increase in the adoption and use of electric vehicles as well as in industry.

<sup>9</sup> 2022 National Energy Statistics, Energy Commission, April 2022

<sup>10</sup> Electricity Company of Ghana (ECG), Northern Electricity Distribution Company (NEDCo) and Enclave Power Company (EPC)

<sup>11</sup> Integrated Power Sector Master Plan – 2019 published in 2020

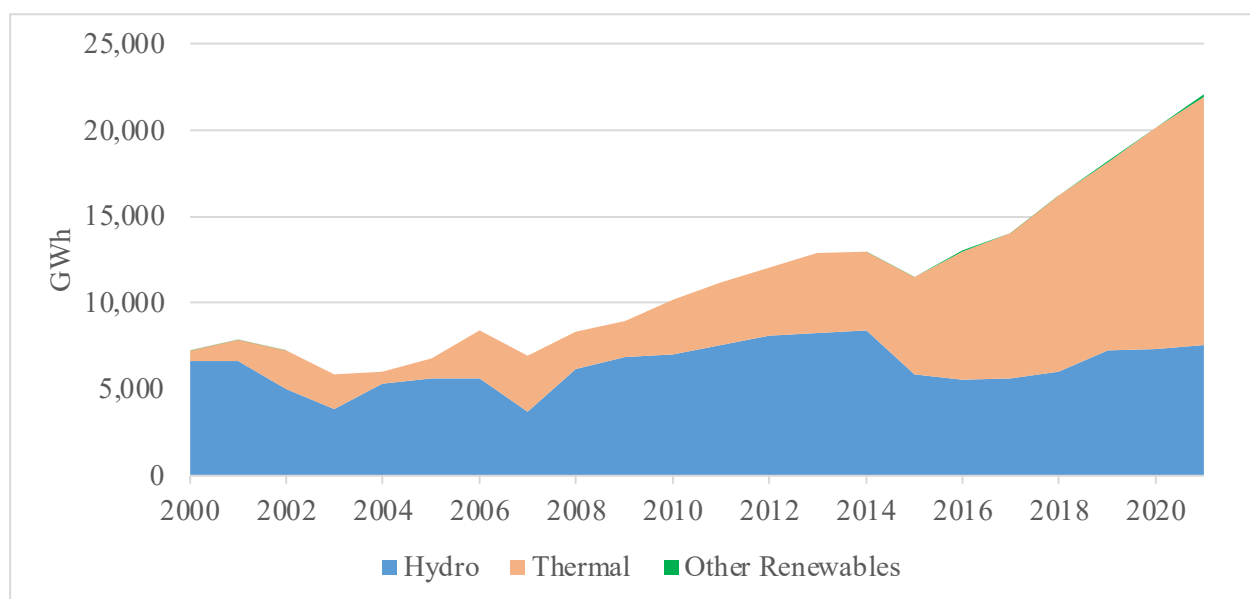


*Figure 23: Projected Electricity Requirement (2022 - 2040)*

## SUPPLY OF ELECTRICITY

The electricity generation mix in Ghana has predominantly been from hydro and thermal sources. In 2000, total electricity generated was 7,224 GWh of which hydro was the highest, 6,610 GWh, representing 92% and the remaining 614 GWh being thermal. Total electricity generated increased to 10,166 GWh in 2010 representing a growth of 40.7%. The share of hydro in 2010 reduced to 68.8% whilst that of thermal increased to 31.2%. Ghana started producing grid electricity from renewable sources when the 2.5 MW Navrongo solar plants were connected to the grid in 2013. In that year, 12,871 GWh of electricity was generated with a marginal 3 GWh coming from these solar plants. The penetration of renewable has been increasing steadily due to efforts to diversify the energy mix.

In 2016, for the first time, electricity generated from thermal sources surpassed hydro accounting for 7,435 GWh and representing 57.1% of total electricity generated. Hydro and solar contributed 42.7% and 0.2% respectively. In 2021, 65.3%, 34.1% and 0.6% of a total of 22,051 GWh of electricity generated was from thermal, hydro, and other renewable sources respectively.



*Figure 24: Electricity Generation (GWh)*

Ghana has power supply arrangements with its neighbouring countries. In 2000, a total of 864 GWh of electricity was imported, increased to 1,146 GWh in 2002 and declined to 81 GWh in 2011. In 2016, electricity imports increased to 745 GWh and dropped to 44 GWh in 2021. The decline was largely due to an increase in the electricity generation capacity of the country, where domestic production was adequate to meet demand.

Electricity export, on the other hand, increased from 392 GWh in 2000 to 1,036 GWh in 2010. It further increased to 1,801 GWh in 2020 before reducing marginally to 1,734 GWh in 2021<sup>13</sup>. Generally, Ghana has been a net exporter of electricity as shown in figure 2-5.



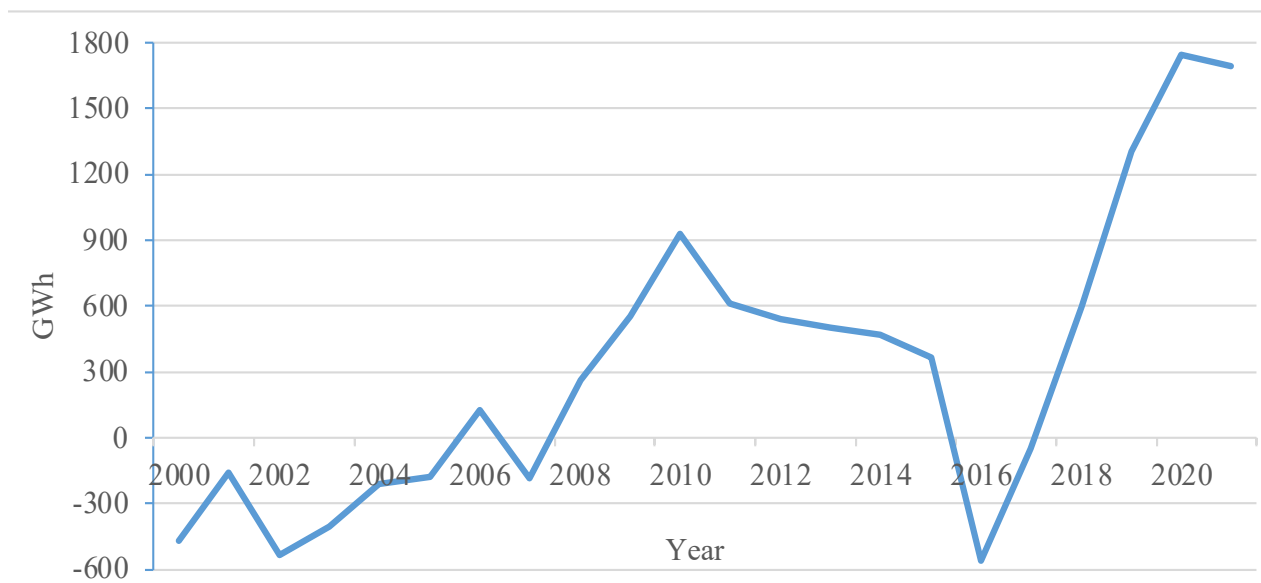


Figure 25: Historical Ghana Net Exports

## THE STATE OF ELECTRICITY INFRASTRUCTURE

Ghana's 5,492.8MW installed electricity generation capacity as of 2021 is made up of 68.4% thermal, 28.8% hydro and 2.8% renewables<sup>14</sup>. There are 3 large hydro-plants and 1 mini-hydro plant (Akosombo, 1020 MW; Bui, 400 MW; Kpong, 160 MW; Tsatsadu, 45 kW), 7 other renewable and 15 thermal plants. Variability in the hydrology has, over the years, posed a challenge to electricity generation from these hydro plants. Preparatory work for the commencement of the construction of a multipurpose solar-hydro hybrid power plant in Pwalugu in the Upper East region is currently ongoing. This facility will be made up of 50MW Solar PV and 60MW hydro and is expected to come online in 2026. This will add to the renewable energy portfolio of the country.

Sunnon Asogli plants with a combined capacity of 560MW is the largest thermal plant in the country. This is followed by the 470 MW Karpowership plant which has been relocated from Tema to Takoradi to run on indigenous natural gas. The next is AKSA and Cenpower with capacities of 370MW and 360 MW respectively. Other thermal plants with a capacity ranging between 44MW and 340MW add up to the remaining thermal plants in the country. These thermal plants run on light crude oil, natural gas or heavy fuel oil in their operations. The use of liquid fuels for power generation in Ghana has diminished significantly following

the discovery and use of natural gas for power generation. AKSA is the only thermal power plant that continues to run on HFO for power generation.

Six (6) grid connected solar power plants with a total capacity of 117MW, distributed solar photovoltaics with combined capacity of 30.9 MW and a biogas facility with a capacity of 0.1 MW make up the grid connected renewable energy infrastructure in the country. The 2.5 MW Navrongo utility-scale solar plant is the first grid connected solar facility in the country commissioned in 2013. This was followed by the BXC solar plant with a capacity of 20 MW and the Meinerger solar facility which also has a capacity of 20MW. The largest solar plant in Ghana, the 50 MW solar power plant operated by Bui Power Authority (BPA) was connected to the grid in 2021. This plant is being expanded to 250MW. BPA has installed the first 1MW floating solar PV in the country. There are also five public mini-grids in some island communities on the Volta Lake. These facilities with a total capacity of 250kW provide electricity supply to about 3,500 people in five remote island communities (Kudorkope, Atigagorme, Wayokorpe, Aglakope and Pediatorkope) on the lake.

Even though progress has been made in increasing the share of renewables in the country's energy mix, some challenges persist. These include high initial investment cost, land acquisition, and the intermittent nature of renewables.

Source	Installed Capacity (MW)	Share (%)
Hydro	1,584.1	28.8
Thermal	3,753.0	68.3
Other renewables	155.8	2.8
Total	5,492.8	100

*Table 21: Installed Electricity Generation Capacity - 2021*

Ghana has a transmission infrastructure with a total length of approximately 6,303.9 km. The transmission voltage levels span 69 kV (212.8 km), 161 kV (5,065.9 km), 225 kV (92.2 km) and 330 kV (933 km). The national grid is interconnected with its neighbours to enable power exchange between Ghana and countries within the West African region. There are a number of other cross-border connections at 33kV for some mines and border communities in our neighbouring countries.

Increasing electricity generation would require an increase in the transmission network to be able to evacuate power to load centers. There are a number of ongoing transmission upgrading and expansion projects which are expected to reduce transmission losses.

Adequate distribution infrastructure ensures electricity delivery reliability and reduces technical losses. Currently, there are three electricity distribution companies namely ECG, NEDCo, and EPC. ECG and NEDCo are responsible for electricity distribution activities in the southern and northern sectors of the country respectively whilst EPC distributes electricity to the Free-Zone industrial enclave in Tema. Electricity is distributed through 46,670 km of sub transmission and 124,300 km of distribution networks across the country. ECG and NEDCo own 70% and 27% respectively of these networks. There are also over 38,100 11kV and 33kV transformers in the distribution system. One of the major challenges facing electricity distribution is the high level of system losses (technical and commercial). This is mainly due to the obsolete nature of distribution equipment, electricity theft, low collection rate and non-payment of bills by customers.

There is the need for sustainable technology and infrastructure to deliver cleaner energy as the world shifts towards a cleaner energy future. Technologies for renewable electricity generation, storage and power grids are important to decarbonize existing supply and meet growing electricity demand from rapid electrification of the transport sector and industry.

## UPSTREAM PETROLEUM SECTOR

### DEMAND AND SUPPLY OF CRUDE OIL



Petroleum Upstream covers the exploration, development and production of oil and gas. Crude oil supply in Ghana commenced with production from the Saltpond field in 1978 but was not commercially significant until the discovery of crude oil in the Jubilee field. Currently, the supply of crude oil is from three producing fields, namely, Jubilee, TEN and SGN. Crude oil export increased substantially in 2011 from 24.7 million barrels to 55.4 million barrels by 2021<sup>15</sup>.

On the other hand, total crude oil imports increased from 8.9 million barrels in 2000 to 13.8 million barrels in 2008 but dropped to 6.8 million barrels in 2009 due to importation of finished petroleum products by Bulk Import Distribution and Export Companies (BIDECs) as well as TOR's financial and technical challenges. Following the commencement of indigenous gas production from Jubilee, Tweneboa-Enyenra-Ntomme (TEN) and Sankofa-Gye-Nyame (SGN) fields, crude oil imports for electricity generation began to decline and in 2021 no crude oil was imported for this purpose due to fuel substitution by converting thermal power plants to also use natural gas as fuel.

15 2022 National Energy Statistics, Energy Commission, April 2022

The Organisation of Petroleum Exporting Countries (OPEC) has forecasted that global crude oil demand will rise by 17.6 mb/d to 108.2 mb/d between 2020 and 2045. The Organisation of Economic Co-operation and Development (OECD) countries also projected that, their oil demand will peak at around 46.6 mb/d in 2023, before it starts a long-term decline towards 34 mb/d by 2045 due to the transition to cleaner fuels. However, the decline in demand by OECD countries will be neutralised by increased oil demand from non-OECD countries due to an expanding middle class, high population growth rates and stronger economic growth potential. The transportation sector, aviation, petrochemical industry, and residential areas among others, will be the key demand sectors in these countries. Oil demand from non-OECD countries is expected to increase from 48.6 mb/d to 74.1 mb/d in 2045.

Ghana has the potential to increase the supply of crude oil as global demand is projected to increase in the future. However, there is growing uncertainty about upstream investment as financing for fossil fuel projects has been declining due to the global energy transition. This means that, risk capital which remains a major viable option for upstream investment, may lead to changes in government policy to attract investment in the upstream sector.

## DEMAND AND SUPPLY OF NATURAL GAS

Prior to 2014, natural gas was imported from Nigeria through the West African Gas Pipeline (WAGP). Commercial natural gas production commenced in 2014 in the Jubilee field. Natural gas is currently being produced from the three producing fields. Imports of natural gas have been declining over the years as a result of an increment in production from domestic sources.

In 2021, a total of 107.8TBtu (101,315.79 mmscf) of Associated Gas (AG) and Non-Associated Gas (NAG) was produced from Ghana's fields against 18.71TBtu (17,584.59 mmscf) which was imported in the same year<sup>16</sup>.

Gas is projected to be the strongest-growing fossil fuel and will increase by 0.9% from 2020 to 2035, peaking in 2037. However, demand for gas will decline by 0.4% from 2035 to 2050 as reliance on gas for power generation will reduce due to the generation of more clean energy<sup>17</sup>. Demand for LNG is expected to grow by 3.4 percent per annum till 2035 as domestic supply in key gas markets will not keep up with demand growth. From 2035 to 2050 demand for LNG will grow by 0.5%.

<sup>16</sup> Energy Commission's Energy Statistics, 2022

<sup>17</sup> Global gas outlook to 2050 by Mckinsey and Company

The demand sectors for gas in Ghana are from the power and non-power sectors. However, demand is likely to increase when the Petroleum Hub is established. The steel and bauxite industries, fertilizer, and ethanol production as well as the transportation sector are potential gas demand areas in the country. Meeting future gas demands will require that gas production from Ghana's fields is increased and additional sources exploited. The establishment of LNG terminals will also contribute to meeting gas demands in the future.

## THE STATE OF OIL AND GAS INFRASTRUCTURE

There are over twenty-five (25) discoveries across Ghana's sedimentary basins, of which four are being considered for appraisal.

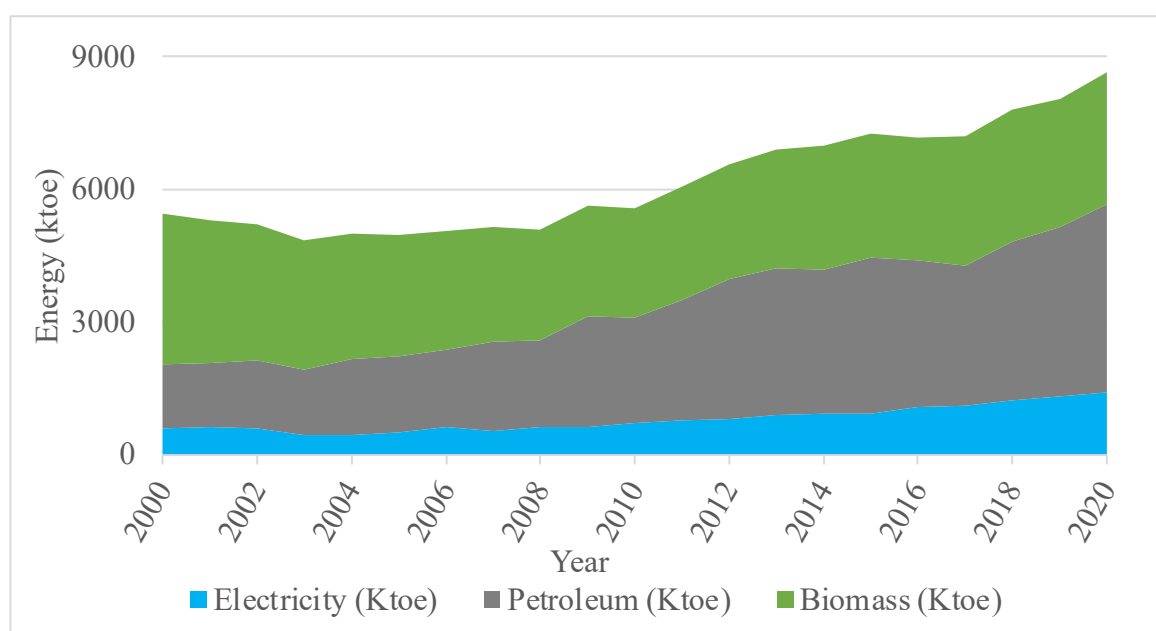
Ghana has four sedimentary basins which are the Western, Central, Eastern and the Voltaian Basins. The Western Basin is the most explored and hosts the three producing fields. The Saltpond field, which is being considered for decommissioning, lies in the Central Basin. This notwithstanding, the Central, Eastern and Voltaian basins are under-explored.

There are three Floating Production Storage and Offloading (FPSO) vessels and their associated subsea infrastructure and an Onshore Receiving Facility (ORF) for receiving and processing natural gas in the country. A welding and fabrication facility has been established to support subsea installations. The continuous investment in petroleum infrastructure provides strategic national assets for the exploration and exploitation of Ghana's oil and gas resources.

## DOWNSTREAM PETROLEUM SECTOR

### DEMAND FOR PETROLEUM PRODUCTS

In Ghana, petroleum (Oil and gas) demand increased from 2,394Ktoe in 2010 to 4,255Ktoe in 2020. Petroleum was the highest share of total energy consumption (averagely 47% per annum) between 2010 and 2020. In this share, the transportation sector constitutes the highest, followed by manufacturing/industries, agriculture, and domestic households. Petroleum consumption grows at an average annual rate of 5.5%. Ghana's national consumption reached 4.63 million metric tonnes (MMT) by the end of 2021, which was 9% higher than the national consumption of 4.20 MMT in 2020. This is illustrated in Figure 2-6.



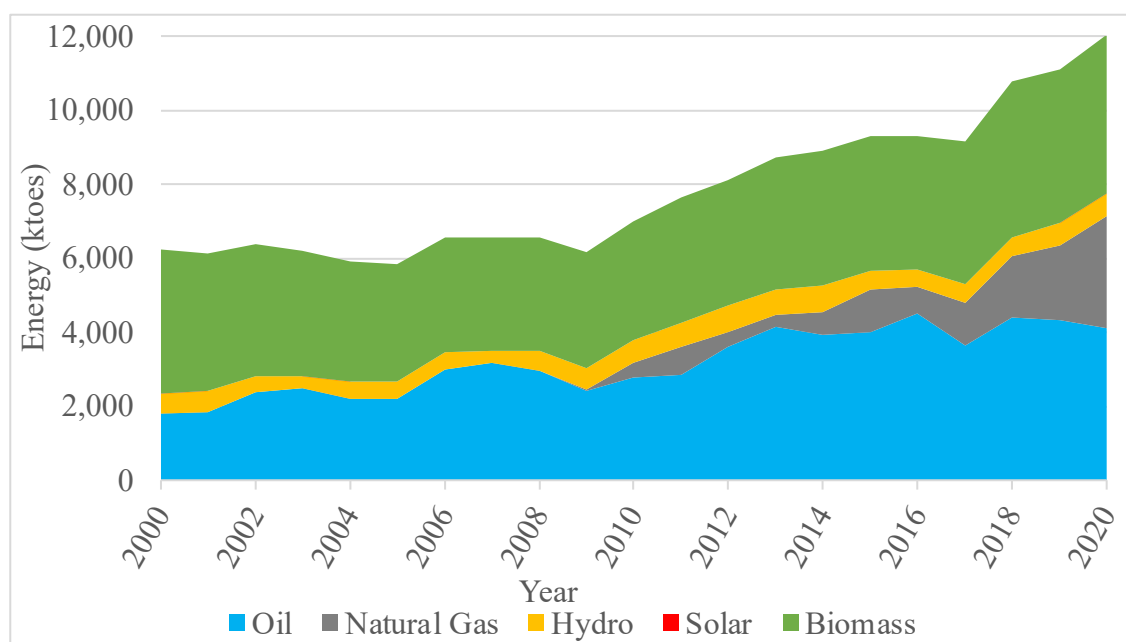
*Figure 26: Total Energy Consumed by Fuels (Ktoe)*

Road use fuels, mainly petrol, diesel, and Liquefied Petroleum Gas (LPG) are the most common transportation fuels. Others include marine and inland river transportation fuels such as Marine Gasoil (MGO), Premix fuel and aviation fuel. The most used industrial fuels are Residual Fuel Oil, LPG and diesel. It is anticipated that petroleum will remain the dominant energy source in the short to medium term.

Growth in gasoil and gasoline demand has also been driven by the growth in the number of registered vehicles in the country. According to the Driver and Vehicle Licensing Authority (DVLA), the number of newly registered vehicles has risen from 94,998 in 2009 to 272,181 in 2021, representing a 187% increase.

Ghana has significantly reduced the Sulphur content in its transport and industrial fuels from 5,000ppm to 50ppm for imports and 1500ppm for domestic production. This is in line with the cleaner fuel targets set by the African Refiners and Distributors Association (ARDA) and the International Convention for The Prevention of Pollution from Ships<sup>19</sup>. Ghana's National LPG Promotion policy seeks to ensure that, at least, 50% of Ghanaians have access to LPG for domestic, commercial and industrial use by 2030. This provides a cleaner cooking fuel option in place of biomass.

Compared to the other hydrocarbon fuels, natural gas is a transition fuel in Ghana and has seen a significant increase in consumption from 5Ktoe in 2016 to 118Ktoe in 2020. This is illustrated in figure 2-7 below.



*Figure 27: Total Energy Supplied*

The consumption of kerosene has steadily decreased over the years. The trend of consumption of kerosene in the last 10 years (2010-2021) shows a peak in demand in 2017 at 223,039mt, which was followed by a consistent fall in demand year-on-year. Relative to

19 The **International Convention for the Prevention of Pollution from Ships (MARPOL)**



the peak demand in 2017, kerosene demand in 2021, overall, fell to 4,584.88mt, marking a 98% drop. The continuous fall in kerosene consumption between 2010 and 2021 is largely attributable to increased access to electricity and the introduction of solar / LED battery-operated lanterns as well as the implementation of the Fuel Marking Programme. The Programme addressed the problem of kerosene being used as an adulterant for gasoil. In line with the policy position by government to shift from the consumption of wood fuel to the use of LPG, it is expected that the consumption of kerosene will reduce further in the years to come. Increased urbanization is also expected to drive the switch from the use of kerosene to cleaner sources such as LPG.

Compressed Natural Gas (CNG) is being considered for use in large commercial vehicles. About 30% - 50% of the LPG consumed in the country is also sourced as a by-product of natural gas processing.

## SUPPLY OF PETROLEUM PRODUCTS

Petroleum products such as LPG, gasoline, gasoil, Kerosene, Aviation Turbine Kerosene (ATK), Residual Fuel Oil (RFO), Naphtha and Condensates are locally produced by Tema Oil Refinery (TOR), Akwaaba Refinery, Platon Oil and Gas and the Ghana National Gas Company (GNGC).

Total production from GNGC accounted for 66.3% of total refinery production in 2021. The total production for Akwaaba, Platon and Tema Oil Refinery accounted for 30.4%, 2.5% and 0.8% respectively. GNGC's output (LPG & Condensate only) in 2021 was 121,848 MT.

Ghana witnessed a reduction in refinery output from 166,350 mt in 2018 to 162,092 mt in 2019, mainly due to the frequent shutdown of the state-owned refinery. Subsequently, there was a significant drop in production across all the local refineries in 2020 to 134,227 mt largely due to the impact of COVID-19. Refinery output however rose to 183,696 mt in 2021. The surge in local refinery output was largely due to GNGC and Akwaaba's production. These are illustrated in the tables below.

Year	Company	Residual Fuel Oil (Industrial)	Heavy Fuel Oil (Power Plants)	Gas oil (Diesel)	Marine Gasoil (Local)	Naptha (Unified)	Kerosene	LPG - Butane	LPG - Propane (Power Plant)	Gasoline (Premium)	Premix	Marine Gasoil (Foreign)	Gasoil (Mines)	ATK	Gasoil (Rig)	Unified	All Products
2021	AKWAABA OIL REFINERY LIMITED	37,298	787	16,641	23	1,101	-	-	-	-	-	-	-	-	-	-	55,849
	PLATON GAS OIL LIMITED	401	-	4,105	-	-	-	-	-	-	-	-	-	-	-	-	4,507
	TEMA OIL REFINERY (TOR)	-	-	-	-	-	-	1,494	-	-	-	-	-	-	-	-	1,494
2020	AKWAABA OIL REFINERY LIMITED	9,444	-	7,617	-	978	-	-	-	-	-	46	-	-	-	-	18,085
	PLATON GAS OIL LIMITED	829	-	468	-	778	-	-	-	404	-	-	-	-	-	-	2,479
	TEMA OIL REFINERY (TOR)	-	-	-	-	-	-	-	-	-	-	-	-	187	-	-	187
2019	AKWAABA OIL REFINERY LIMITED	17,852	-	29,470	-	4,070	-	-	-	-	-	-	-	-	-	-	51,392
	PLATON GAS OIL LIMITED	7,198	-	2,230	-	928	-	-	-	-	-	-	-	-	-	-	10,356
	TEMA OIL REFINERY (TOR)	-	-	3,488	-	-	-	5,527	-	1,182	-	2,544	-	992	-	-	13,733
2018	AKWAABA OIL REFINERY LIMITED	14,516	-	24,116	-	122	-	-	-	-	-	-	-	-	-	-	38,755
	PLATON GAS OIL LIMITED	9,908	-	2,877	593	1,240	-	-	-	-	-	639	-	-	-	-	15,257
	TEMA OIL REFINERY (TOR)	-	-	2,489	-	-	-	6,539	-	993	-	-	-	306	-	-	10,327
2017	PLATON GAS OIL LIMITED	1,404	-	49	-	-	-	-	-	-	-	639	-	-	-	1,125	3,217
	TEMA OIL REFINERY (TOR)	-	-	842	-	-	-	22,765	-	802	-	-	-	37	-	-	24,445

Table 22: Refinery Production (Metric Tonnes)

Year	2015	2016	2017	2018	2019	2020	2021
LPG Production (mt)	89,539	80,500	113,517	84,198	68,001	83,793	93,155
Condensate Production (mt)	-	15,616	17,542	17,814	18,609	29,683	28,693

Table 23: Ghana National Gas Company Production (Metric Tonnes)

Refined petroleum product imports have increased steadily over the years from 3.44 million mt in 2017 to 4.58 million mt in 2021 marking a 33.1% increase as indicated in Figure 2-9.

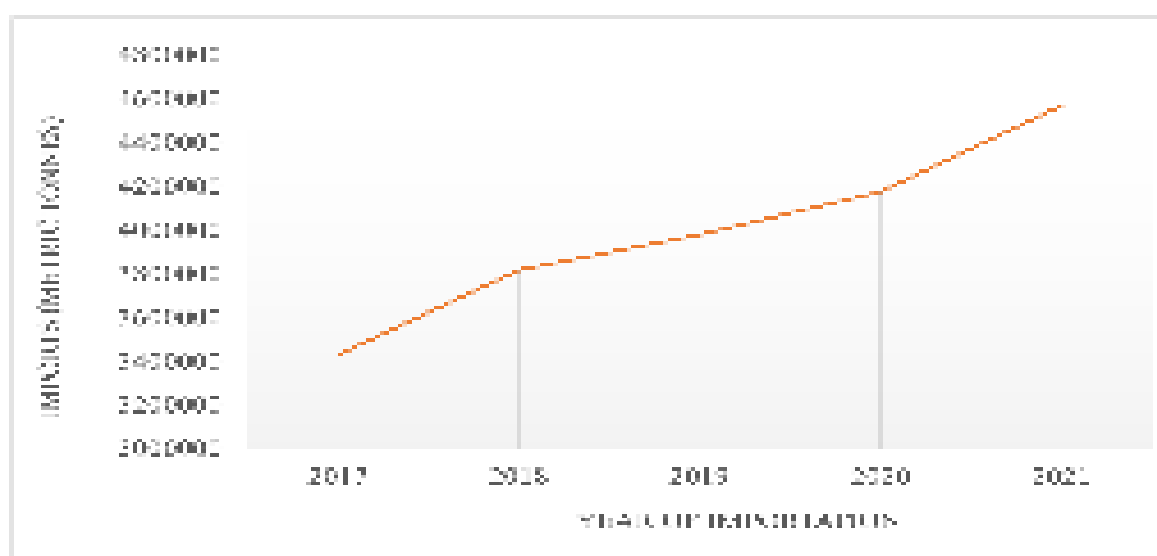


Figure 28: Petroleum Imports (Metric Tonnes)

## THE STATE OF DOWNSTREAM PETROLEUM INFRASTRUCTURE



Ghana's storage capacity (excluding fuel for power generation) for petroleum products currently stands at 2.35million m<sup>3</sup>. Out of this, 1.79 million m<sup>3</sup> (76%) is dedicated to refined products, while 555,168 m<sup>3</sup> is dedicated to crude oil storage. Storage capacity dedicated to gasoil use has remained the largest in the country. The 2022 storage capacity for gasoil regular, currently stands at 875,919 m<sup>3</sup>. Gasoil storage capacity represents 37% of total storage (refined and crude oil storage) and 49% of total refined products storage.

Overall, the Government-controlled infrastructure remains the largest storage provider of both crude oil and refined products storage, accounting for 64% (1.49million m<sup>3</sup>) of the national storage capacity. This dominance is predominantly driven by the crude oil capacity held at the Tema Oil Refinery, which provides 455,000 m<sup>3</sup> of crude oil capacity, accounting for 19% of the total storage and 82% of crude oil storage.

Tema Tank Farm Ltd. maintained its position as the largest private sector storage provider with a capacity of 120,000m<sup>3</sup>, representing 14% of the total private storage capacity, followed by the Tema Multiproduct Terminal (TMPT) which provided 13.9% of the private storage capacity.

These are illustrated in the Table 2 4.

Table 24: Petroleum Products Storage Capacity (cubic meters)

There were 4,695 petroleum retail outlets nationwide as of April, 2022, out of which 22.3% are in the Greater Accra region, 16.8% in the Ashanti Region and 11.1% in the Central Region. The full breakdown of the retail outlets nationwide is provided in Table 2-5.

Region / Type of Outlet	Service Stations	Filling Stations	Kero Outlets	LPG	Premix	Reseller Outlets	Grand Total
Ahafo	30	31	-	19	-	3	83
Ashanti	381	275	-	114	-	17	787
Bono	87	57	-	38	-	2	184
Bono East	66	45	3	26	-	3	143
Central	236	186	4	83	1	11	521
Eastern	170	156	19	73	1	7	426
Greater Accra	643	195	5	195	-	8	1,046
North East	11	28	-	1	-	5	45
Northern	98	69	2	14	-	8	191
Oti	19	24	4	6	-	12	65
Savannah	23	29	-	3	-	1	56
Upper East	73	90	-	17	-	8	188
Upper West	42	60	-	11	-	3	116
Volta	122	83	15	63	-	3	286
Western	174	141	-	53	1	3	372
Western North	39	84	3	19	-	41	186
<b>Grand Total</b>	<b>2,214</b>	<b>1,553</b>	<b>55</b>	<b>735</b>	<b>3</b>	<b>135</b>	<b>4,695</b>


Table 25: Types and Regional Distribution of Petroleum Retail Outlets<sup>20</sup>

<sup>20</sup> The length of the coloured data bars within the cells give an indication of the value of each cell with respect to the data in other cells: therefore the greater the cell value, the longer the length of

The Ghana National Gas Company (GNGC) and the West Africa Gas Pipeline Company Limited (WAPCo) manage their respective natural gas pipeline infrastructure within the country; both onshore and offshore. The infrastructure of GNGC is as below:

- The offshore gas export pipeline, which is a 12inch diameter 58km long subsea pipeline, transporting dense-phase Jubilee gas and TEN gas to the Gas Processing Plant (GPP) at Atuabo.
- Main onshore 20inch diameter 111 km gas pipeline which includes the Atuabo Initial Station (AIS), Esiama Distribution Station (EDS), and the Takoradi Distribution Station (TDS).
- 20inch diameter 75km lateral pipeline system from the EDS to Prestea Regulating and Metering Station (PRMS).
- 
- The 20inch diameter 8km onshore pipeline system, which starts at TDS with a terminal station at Sekondi referred to as the Sekondi Regulating and Metering Station (SRMS) and a 24inch diameter 10km offshore pipeline system to Karpowership at Sekondi Naval Base.
- Other key infrastructure of GNGC includes the 0.8km onshore distribution pipeline from the TDS to Twyford Ceramics Company at Aboadze and the 9km onshore pipeline to WangKang Ceramics Company at Eshiem all in the Western Region.

There are also a 20-inch diameter offshore pipeline from Takoradi to Tema owned and operated by WAPCo, and a 63km (26inch) submarine pipeline from SGN Field to the onshore receiving facility at Sanzule.



# CHAPTER 3:

## GREENHOUSE GAS EMISSIONS INVENTORY

## MAIN SOURCES OF EMISSIONS

This section presents the overall Greenhouse Gas (GHG) emissions situation in the energy sector in Ghana.

The energy sector emissions are associated with the production and processing of primary energy, its transformation into secondary energy, and the final energy for economic activities. Generally, the production of electricity, processed heat or steam, from the combustion of petroleum products and biomass often leads to anthropogenic greenhouse gas emissions. Oil and Gas production is considered as a source of emission through venting, flaring, and fugitive emissions.



## GHANA'S GREENHOUSE GAS EMISSION INVENTORY

The total national GHG emissions level including Land Use, Land-Use Change and Forestry (LULUCF) at the end of 2019 reached 59.8MtCO<sub>2</sub>e. LULUCF's contribution is significant and accounted for 14.5MtCO<sub>2</sub>e in 2019. Between 1990 and 2016, the Agriculture, Forestry and Other Land Use (AFOLU) sector was the major contributor to GHG emissions in Ghana, followed by the energy sector as shown in table 3.1. The emissions trend by sectors over the years (1990 to 2019) is shown in figure 3-1 below.

Commercial oil and gas production in 2010 and 2017 significantly increased the emissions in the energy sector due to increased gas flaring in these years.

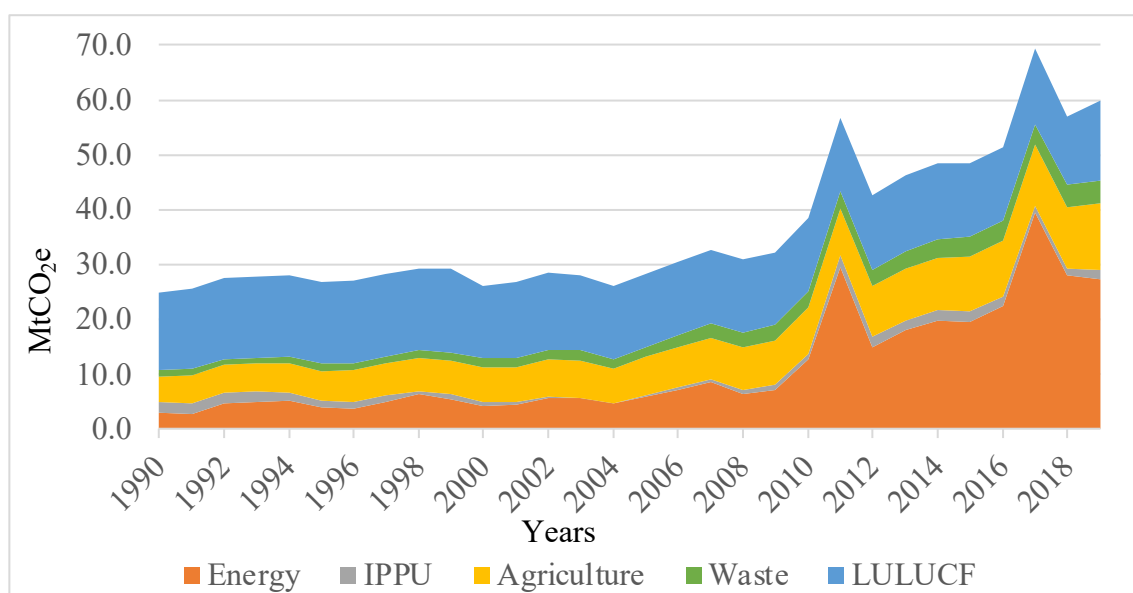


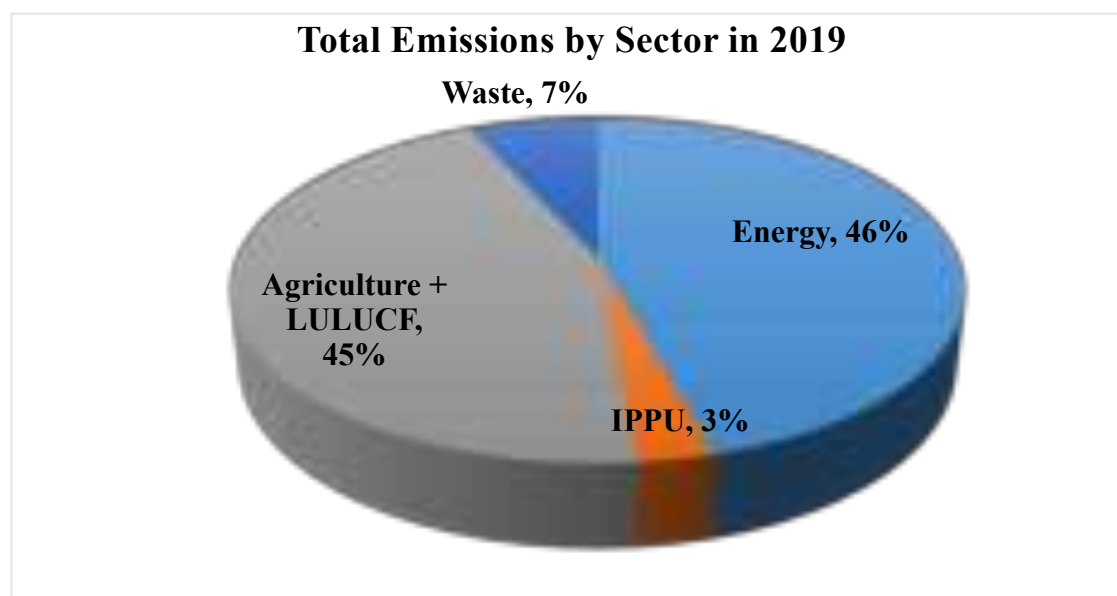
Figure 31: Total Emissions Trends by Sectors



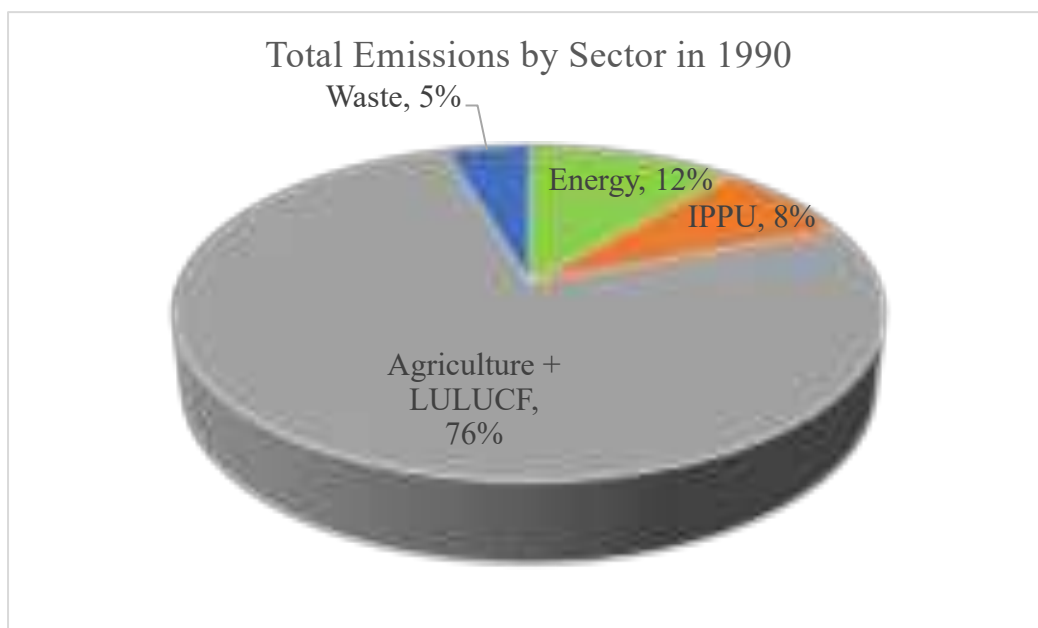
Sectors/ Categories	Total Emissions (MtCO <sub>2</sub> e)					Percentage change (%)	
	1990	2000	2012	2016	2019	2016-2019	1990-2019
National Emissions incl. LULUCF	25.0	26.2	42.6	51.4	59.8	16.3	139.6
National Emissions excl. LULUCF	10.7	12.8	29.1	38.0	45.3	19.1	325.0
Energy	2.9	4.1	14.9	22.4	27.3	22.1	853.1
Industrial processes and products use (IPPU)	2.0	0.9	2.0	1.7	1.7	3.1	-11.8
Agriculture, forestry, & other Land Uses	19.0	19.5	22.6	23.7	26.6	12	40.2
Waste	1.1	1.6	3.1	3.6	4.1	14	265.1

*Table 31: Ghana's total GHG emissions from 1990 -2019 by Sector<sup>21</sup>*

At the end of 2019, the emissions from the energy sector reached a total of 27.3MtCO<sub>2</sub>e, making it the leading source of GHG emission in Ghana. The energy sector in 2019 accounted for 45.7% of the total national emissions, followed by the agricultural sector (including LULCF) accounting for 44.6%. IPPU remains the least emitting sector accounting for 2.8%.



*Figure 32: Emissions trends in Ghana*



*Figure 33: CO<sub>2</sub>e Emissions by Sectors*

In the past three decades, the CO<sub>2</sub> emissions from the energy sector increased elevenfold from 2.5 Mt to 26.4 Mt at an 8.9% annual growth rate as shown in figure 2. The growth is primarily as a result of the increasing proportion of thermal electricity generation since 2010, gas flaring and fossil fuel use in the transport industry.

## DISTRIBUTION OF GHG EMISSIONS

In 2019, Carbon Dioxide (CO<sub>2</sub>) remained the largest greenhouse gas source in Ghana and constituted approximately 41.94MtCO<sub>2</sub> representing 70.1% of the total national emissions. This is followed by Nitrous Oxide, representing 13.7% of total national emission (8.54 MtCO<sub>2</sub>e), then methane 13.3% and the rest being fluorinated gases.

The energy sector level of 26.4Mt accounted for 96% of the total national CO<sub>2</sub> emissions without LULUCF. When the LULUCF carbon emissions are added, the energy sector makes up 63% of the total carbon emission (Table 3-2).

Table 3-2 provides data on the GHG contributions to the national emission levels in Ghana.

Sectors	Mt	Emissions (MtCO2e)				Share of Total	
	CO2	CH4	N2O	PFC	HFC	% With LULUCF	% Without LULUCF
Energy	26.4	0.58	0.35			45.7	60.9
Industrial processes and products use	0.62			0.52	0.59	2.9	3.9
Agriculture, forestry, & other Land Uses	14.9	4.16	7.55			44.5	26.1
Waste	0.02	3.46	0.65			6.9	9.2
National Emissions incl. LULUCF	41.94	8.2	8.56	0.52	0.59	100	
National Emissions excl. LULUCF	27.04	8.2	8.55	0.52	0.59		100

*Table 32: Sector Emissions Contributions*

## CONTRIBUTORS OF EMISSIONS IN THE ENERGY SECTOR

The contributors of emissions in the energy sector are energy industries, oil and gas production, manufacturing industries & construction, transport, and others. As shown in Figure 3, energy use for transportation has consistently been the major contributor to GHG emissions in the energy sector since 1990. In 2019, this accounted for 33.8% of the total energy emissions, followed by the oil and gas production 29.5% and energy industries 27.2%. Figure 4 presents the contributions by the drivers of emissions in the energy sector.

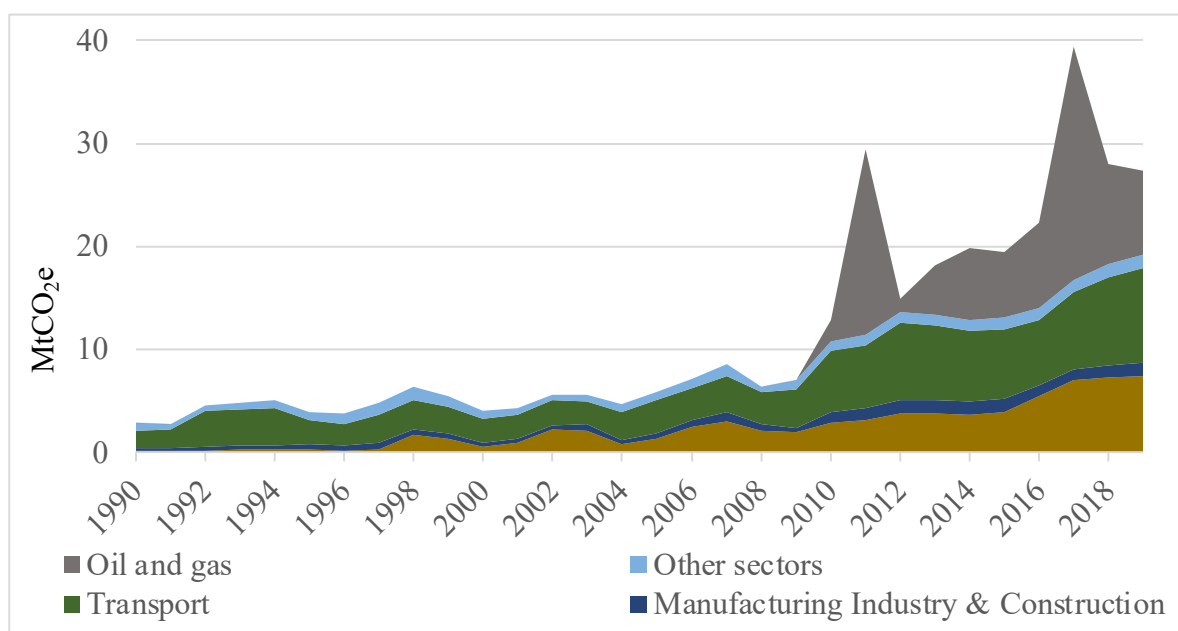


Figure 34: Total Emissions Trends by Drivers in the Energy Sector.

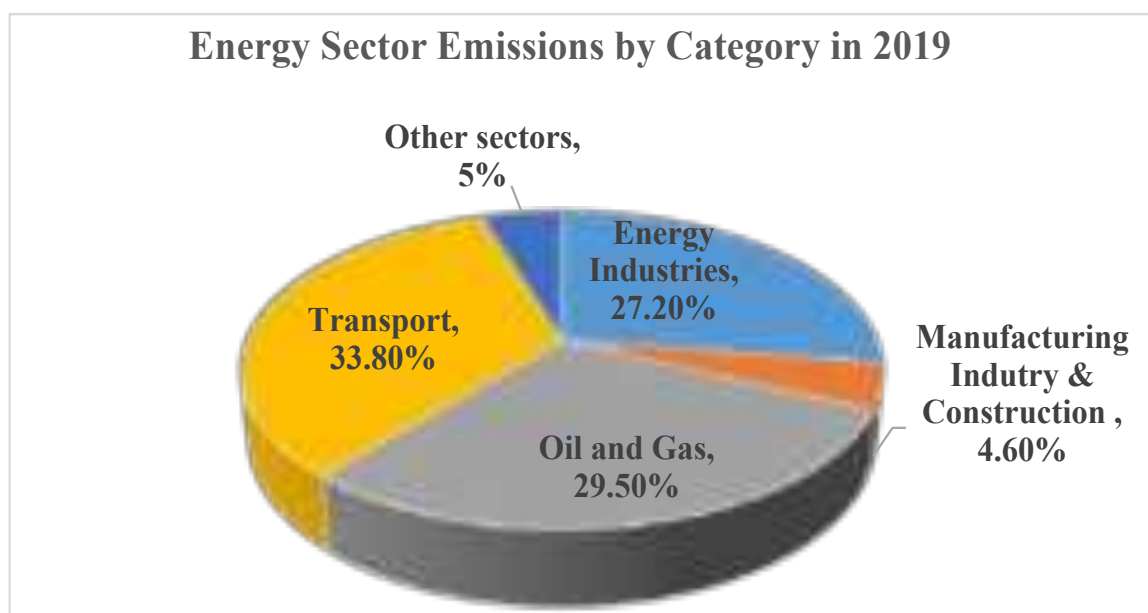
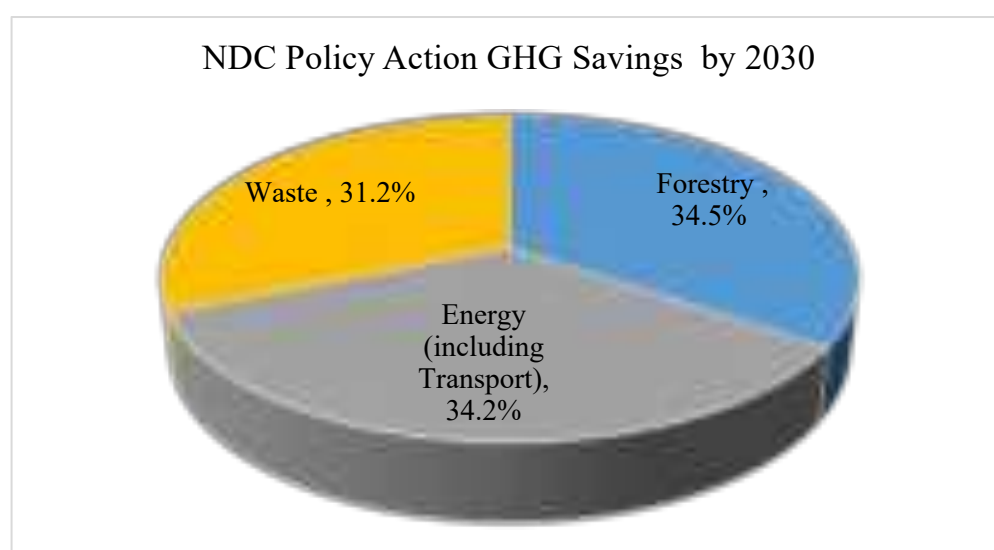


Figure 35: Energy Sector Emissions by Category/Drivers

## NATIONAL OVERALL EMISSION REDUCTION TARGETS

Under the updated Ghana National Determined Contribution (Gh-NDCs), a total of 47 climate actions are expected to be implemented to build climate resilience, generate absolute greenhouse gas emission reductions of 68.3MtCO<sub>2</sub>e, create over one million jobs and avoid 2,900 deaths due to improved air quality by 2030<sup>22</sup>. The implementation of the updated NDCs will span the period 2020 to 2030.

The energy sector including transport is projected to contribute 34.2% of the total national emission reduction target by 2030.



*Figure 36: Emission Reduction by Sectors*

## EMISSION REDUCTION TARGETS IN THE ENERGY SECTOR

The energy sector emissions reduction actions are mainly those outlined in the updated National Determined Contribution. A total of ten (10) mitigation actions have been identified to account for 34.2% emissions reduction (23.4MtCO<sub>2</sub>e) by 2030 with the details in table 3.

With a projected 1,000MW to 1,500MW nuclear power addition in 2030, annual emission savings of 7 to 8 million tons of CO<sub>2</sub> could be achieved. This coupled with waste-to-energy opportunities and low carbon transportation such as driving electric and natural gas/hydrogen fuelled mobility, the energy sector will account for over 50% of total emission

reduction by 2030.

Areas/ themes	PA Index	NDC Policy Actions (PA)	Climate Objective	GHG saving (kt/yr)
Transport	009	Expansion of inter-and-intra-city transportation modes	Mitigation	109.9
Energy	010	Promotion of energy efficiency in homes, industry, and commerce	Mitigation	1,899.3
Energy	011	Refrigeration and Air Conditioning (RAC)	Mitigation	3,874.2
Energy	012	Sustainable production in Industry	Mitigation	1,480.7
Energy	013	Low carbon electricity generation	Mitigation	4,439.4
Energy	014	Expand the adoption of market-based cleaner cooking solutions	Mitigation	8,438.3
Energy	015	Sustainable Charcoal Production	Mitigation	1,543.0
Energy	016	Promote clean rural households lighting	Mitigation	175.1
Energy	017	Scale up renewable energy penetration by 10% by 2030	Mitigation	1,338.4
Energy	018	Decarbonization of oil and gas production	Mitigation	74.6

*Table 33: Contributors of Emissions Reductions in the Energy Sector by 2030*

## EFFECTS OF EMISSIONS

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Greenhouse gases and other emissions have been the main cause of global warming resulting in extreme weather events such as rainstorms and floods, severe droughts, wildfires, and heat waves. These events negatively affect crop production, livestock, human health, energy and the environment.

In Ghana, the agricultural sector contributes significantly to poverty reduction as the majority of livelihoods depend on the sector. However, it is the most vulnerable sector to climate change due to its excessive dependence on adequate rainfall. Increasing temperatures result in a high rate of evapotranspiration in crops and vegetative covers. Climate change also affects the fish stock and their habitats, migratory patterns and mortality rates with its attendant consequences on households and individuals.

On the ecology and land use, climate change coupled with the destructive human environmental activities is aggressively aggravating desertification, particularly in northern Ghana. Most parts of the country will continue to be vulnerable to this effect.

As emissions levels increase, change in climatic conditions negatively affects the performance of the energy sector. Hydropower generation is affected making the resource a potential for regional conflict.

In the health and social sectors, higher temperatures and heat waves are becoming more frequent, and affecting thermal comfort leading to exhaustion and heat stroke. It is projected that as emission levels increase, high temperatures and reduced rainfalls will spark unprecedented epidemics and impoverish climate-vulnerable areas of the country.



# CHAPTER 4:

## CURRENT POLICY OBJECTIVES AND TARGETS



Ghana has introduced policies and measures to stimulate economic growth and directly or indirectly reduce greenhouse gas emissions. Some of the current policies and measures are presented in this section.

## ELECTRICITY SECTOR

### INTEGRATED POWER SECTOR MASTER PLAN (IPSMP)

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The IPSMP assesses current and future challenges and opportunities in the power sector and develops a resilient generation capacity expansion plan that adequately meets the electricity demand forecast at the least cost. The IPSMP highlights the following climate-resilient actions:

- Assess the sensitivity of renewable energy technologies to climate risks, particularly hydropower plants, to mitigate the risk of underperformance or disruption.
- Monitor trends and new climate projections, and implement adaptation measures over time to understand the changing climate risks and provide critical information on power system performance.

### RENEWABLE ENERGY MASTER PLAN (REMP)

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The goal of the REMP is to provide an investment-focused framework for the promotion and development of the country's renewable energy resources for sustainable economic development and reduce the adverse climate change effects. The REMP aims to achieve 10% renewable energy of installed capacity by 2030.

- The REMP also provides the option for renewable energy-based mini-grids and stand-alone-systems for the last mile electrification. The REMP also aims to achieve the following:
- Increase the proportion of renewable energy in the national energy mix;
- Reduce the dependence on biomass as the main fuel for thermal energy applications;
- Provide renewable energy-based decentralised electrification options in 1,000 off-grid communities;

- Promote local content and local participation in the renewable energy industry.

## ENERGY EFFICIENCY

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Efforts have been made by the government to promote energy efficiency and conservation in homes and industries. LI 1932 and LI 1815 which promote efficiency programmes for air-conditioning, lighting and refrigeration are being implemented. Interventions such as the introduction of energy performance standards, the prohibition of the importation of used appliances, labelling of electrical appliances and, special promotion packages are also being implemented.

The Building Code provides the regulatory framework for the construction of new buildings and retrofitting existing ones to be energy efficient.

## NATIONAL ELECTRIFICATION MASTER PLAN

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The National Electrification Master Plan provides the framework for the electrification of the country. The country is committed to achieving universal access to electricity by 2025.

## PETROLEUM SECTOR

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### POLICY ON ZERO GAS FLARING

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Concerted efforts are being made globally to curtail emissions from the oil and gas industry cognizant that it is one of the major contributors to greenhouse gas emissions. In line with the global efforts, Petroleum (Exploration and Production) Act 2016 (Act 919) provides for

no flaring of gas except for operational safety and under exceptional circumstances.

## GAS MASTER PLAN (GMP)

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The GMP considers power generation as one of the most economically attractive, low risk and urgent demand sectors for natural gas supplies. The GMP recommends that Ghana focuses on gas usage for power generation and non-power use, and outlines measures to meet the gas supply and demand balance.

Under the GMP, Compressed Natural Gas (CNG) is being considered for use in large commercial vehicles. A pilot project to be jointly implemented by the Ministry of Transport, Ministry of Energy and GNGC is expected to be implemented soon.

## NATIONAL LPG PROMOTION POLICY

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National LPG Promotion Policy aims to achieve LPG penetration of 50% by 2030. To support this plan, a new LPG for Development (LPG4D) programme has been developed. Under this programme, the implementation of the Cylinder Recirculation Model (CRM) is set to increase access to LPG for domestic and industrial use as well as for transportation.

## FUEL QUALITY POLICY

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Ghana has significantly reduced the sulphur content in its transport and industrial fuels from a maximum of 5000ppm to a maximum of 50ppm for imports and 1500ppm for domestic production, in line with MARPOL 2020 and original cleaner fuel targets set by the African Refiners and Distributors Association (ARDA).



## BIOFUEL

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The Renewable Energy Act, 2011 (Act 832) designates biofuel as a petroleum product and makes provision for its development and pricing under the National Petroleum Authority Act, 2005 (Act 691).

## BIOMASS

The Government is committed to distribute three million biomass cookstoves to reduce emissions and save up to 40% of fuelwood by 2030.

## TRANSPORT SECTOR

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The 2020 transport policy intends to reduce emission through the following: use of improved vehicle technologies, better traffic management and increased use of mass transit systems. The policy also aims at integrating land use and transport planning to reduce the incidence of congestion and air pollution in line with the Paris Agreement.

The Ministry of Transport in collaboration with the Energy Commission has rolled out the drive e-electric initiative aimed at promoting Electric Vehicles (EV). A programme to roll out electric buses, electric trains and other commercial vehicles is being developed. Additionally, the Energy Commission is developing regulations to guide the development of the EV value chains.

## CRITICAL MINERALS

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The key minerals and metals used in the production of the Lithium-Ion Batteries (LIB) are lithium and cobalt (Li-Co), manganese, nickel, aluminium, graphite, rare earth elements (REE), iron, copper, and phosphate. In view of their support of the “green transport revolution” which will lead to a transition to clean energy and therefore likely to be the ones on which demand would be focused in the future, these minerals are referred to as Green Minerals; also known as Critical Minerals or the minerals of the Future. The growing demand for electricity storage facilities for power generation, electric vehicles and electronics has driven and is expected to continue to enhance the demand for the green minerals, especially the Li-Co minerals.

Ghana has discovered some critical (green) minerals, including lithium and graphite. Critical minerals will replace hydrocarbons in the future and thereby become an important source

of government revenue, create jobs and business opportunities for Ghanaians. Government must therefore establish a transparent mechanism for allocation of concessions for the commercial exploitation of critical minerals and the management of revenue accruing from these minerals. The Ghana Geological Survey Authority (GGS) has confirmed that cobalt, nickel, graphite and rare earth elements (REE) have been discovered. Further exploration is required to establish feasibility for commercial exploitation of these metals.

Manganese (for the iron and steel industry) and bauxite (for aluminum) which are also green minerals are currently being exploited, but without value addition before export. It is therefore important to set up refineries to add-value to Ghana's critical minerals.

## BAUXITE AND MANGANESE


In line with the Ghana Integrated Aluminium Development Corporation (GIADEC) and Ghana Integrated Iron and Steel Development Corp (GIISDEC), Ghana is promoting the integrated development of bauxite, manganese and iron to realise their full potential for socioeconomic development.

## LITHIUM

Lithium activities in Ghana are largely at Stage 1 (exploration) of the supply chain with 30.1 million tonnes (Mt) at a grade of 1.26% Lithium Oxide ( $\text{Li}_2\text{O}$ ) identified. Ghana is covered with granite associated with pegmatite containing lithium from the south to the north, predominantly around Cape Coast, Kumasi, Sunyani, Bole and Wa. There are also many prospects that are being explored in the Southern granitic terrain which stretches from Senya Bereku through Winneba, Saltpond to Cape Coast.

## OTHER GREEN MINERALS

Base metals such as cobalt, nickel, copper, lead, zinc and chromium are found in the Buem Formation in the Oti Region. Graphite occurs around Kambale in the Upper West Region where intensive exploration is ongoing.



# CHAPTER 5:

## GHANA NET ZERO TRANSITION PATHWAYS AND TARGETS

## FORECASTING OF POLICY DIRECTION

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This forecasting aims to attain sustainable energy production and utilisation, bearing in mind the country's primary aim of achieving economic growth. For this reason, there are several intended outcomes from energy production and utilisation. Key forecasting objectives of the targeted scenario by 2070 include balancing energy security, affordability and decarbonisation.

## SCOPE OF MODELLING

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The modelling included all end-use energy demand sectors with their respective technologies being used for energy services. Different strategies and sensitivity scenarios on pathways towards net-zero emissions were explored.

## THE ENERGY TRANSITION MODEL (ETM)

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The transition model explores matured energy technologies for the use and transformation of fuels for the provision of energy. It also considers emerging technologies that are envisaged to replace existing technologies. The model includes the use of nuclear for power generation; coupling Carbon Capture, Utilization and Storage (CCUS) technology with specific emitting activities; use of compressed natural gas fuelled vehicles, Electric Vehicles, hydrogen fuel cell vehicles, sustainable aviation fuel, efficient energy transformation processes and efficient end-use appliances.

To compare the benefits and GHG emission savings of the Energy Transition Model, the No Policy Intervention (NPI) Scenario was developed based on the effect of current policies and programmes on energy demand and supply and its resultant emissions. It is the base scenario upon which the Energy Transition Model is built.

## KEY FORECASTING ASSUMPTIONS

The energy requirement is influenced by numerous factors, which are considered in estimating the demand and its associated emission. The main drivers are population, GDP, electrification rate and energy intensity.

TABLE 4.1 LIST SOME ASSUMPTIONS FOR THE MAIN DRIVERS.

Main assumptions		2021	2070	Avg. Annual Growth Rate
GDP(\$billion)		79.1	863.7	5%
Population(million)		30.8	72.2	2%
Urban share (%)		56.0	85.0	1%
Electricity access	National		99.8% (by 2030)	
	Rural Savannah*	57.3	99.8% (by 2030)	12%
	Rural Forest**	60.1	99.8% (by 2028)	14%
	Rural Coastal***	76.9	99.8% (by 2030)	4%
Transportation				

Table 51: Main Macroeconomic and Demographic Assumptions

Demographic factors such as population, changes in the shares of the urban and rural population, household sizes and transportation influence energy demand.

Economic factors such as per capita income, changes in the structure of the economy (i.e. shares of industry, services and agriculture in total GDP) influence the acquisition of energy-consuming appliances, average travel distance per person, type of vehicle and propulsion modes, fuel substitution, and energy intensity of the economy. GDP is therefore projected to grow at an annual rate of 5% from USD 79.08 billion in 2021 to USD 863.69 billion by 2070.

The population is projected to grow from 30.8 million in 2021 to 72.2 million by 2070 at an annual rate of 2%. The urban-rural share is expected to grow from 56% in 2021 to 85% by 2070 at an annual rate of 1%.



Government policies such as the National Electrification Scheme, accelerated industrialisation policies (e.g. One-District-One-Factory; integrated iron and steel industries; and integrated bauxite industries), accelerated agriculture (e.g. planting for food and jobs), and the promotion of productive uses of electricity would drive the electricity demand. GIADEC's development programme is to establish three new mines and expand the existing mine to produce a total of 5 million tonnes of bauxite per annum. In addition, the government's rural electrification drive is also expected to impact electricity demand. Ghana has a target to achieve 90% electricity access by 2024. A 99.8% household electricity is expected to be achieved by 2028.

Promotion of energy efficiency programmes such as labelling of energy appliances (air conditioners and freezers) and adopting LED bulbs would reduce waste in energy utilisation and the overall growth in final energy demand. The number of households using efficient bulbs is expected to increase from 6.3 million in 2021 to 18.6 million households by 2070.

## ENERGY DEMAND FORECAST

Under all the scenarios (Figures 5-1 to 5-4), Ghana's total energy demand is expected to rise over time. The total energy demand in the BaU scenario would increase from 8,195 Ktoe in 2020 to 52,557 Ktoe in 2070, with an annual rate of 3.7%. For the T1 scenario, total energy demand is expected to increase to 41,725 Ktoe in 2070, 20.6% less than the BaU scenario, with an average annual rate of 3.3%. The energy demand for the T2 and T3 scenarios are similar to the T1 scenario. The total energy demand in the T4 scenario (Figure 5-4) would increase to 48,413 Ktoe in 2070, 7.9% less than the BaU but 16% more than the T1 scenario, with an annual rate of 3.6%.

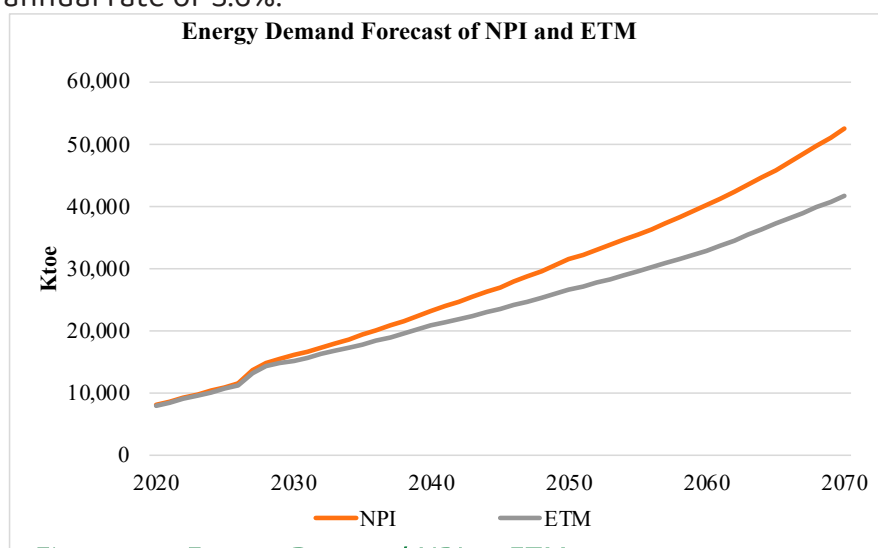


Figure 5 1: Energy Demand NPI vs ETM

## ELECTRICITY PRODUCTION FORECAST WITH ASSOCIATED EMISSION

One of the major fuel switches in the transition is the adoption of electricity as the main source of cooking, transport and thermal use. As a result, electricity production will be prominent during the transition efforts. As shown in Figures 4.5a to 4.8a, electricity production will rise continuously over time in all scenarios. The electricity requirement in the BaU Scenario increased from 18,592 GWh in 2020 to 134,432 GWh in 2070, with an annual rate of 4.0%. The production in the T1 scenario increased to 344,272 GWh in 2070, 156% more than the BaU scenario, with an average annual rate of 5.9%. Electricity requirements for the T2 and T3 Scenarios are similar to the T1 Scenario. On the other hand, the requirement for electricity under the T4 scenario is projected to increase to 244,209 GWh in 2070, which is 82% more than the BaU but 29% less than the other transition scenarios.

The production of electricity would result in a considerable amount of emission. In the BaU scenario, emissions from electricity production are projected to increase from 7.5 Mt CO<sub>2</sub>-eq in 2020 to 58.0 Mt CO<sub>2</sub>-eq in 2070, indicating no peaking and reduction in emission. In the T1 scenario, emissions are expected to peak in the mid-2050s then decrease to net-zero by 2070. The reduction in emissions in the 2030s is a result of the introduction of nuclear power for electricity generation. The attainment of net zero is attributed to the introduction of cleaner generation sources such as nuclear, RE and the use of CCUS with gas-fired power plants. Figures 5-5 to 5-12 show the electricity generation requirements per scenario and their corresponding emissions.

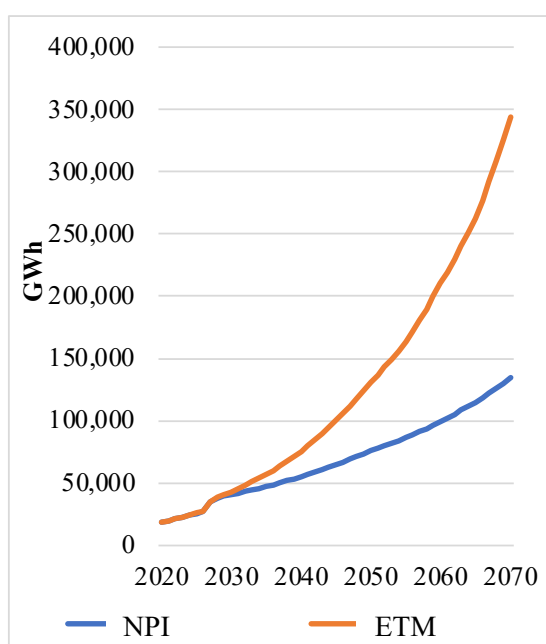


Figure 5 2: Electricity Demand - NPI vs ETM

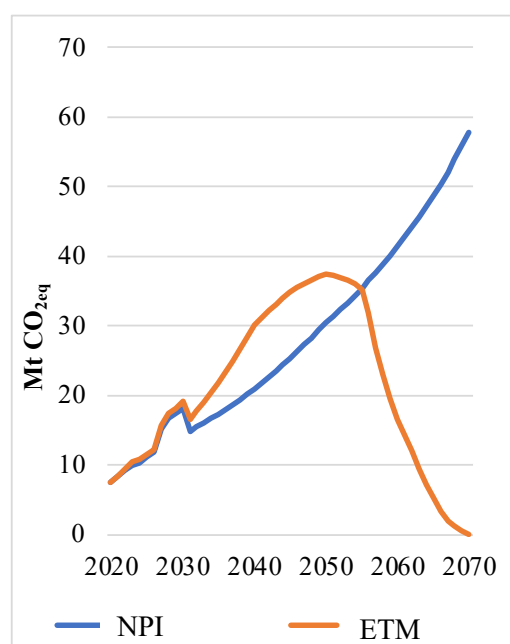
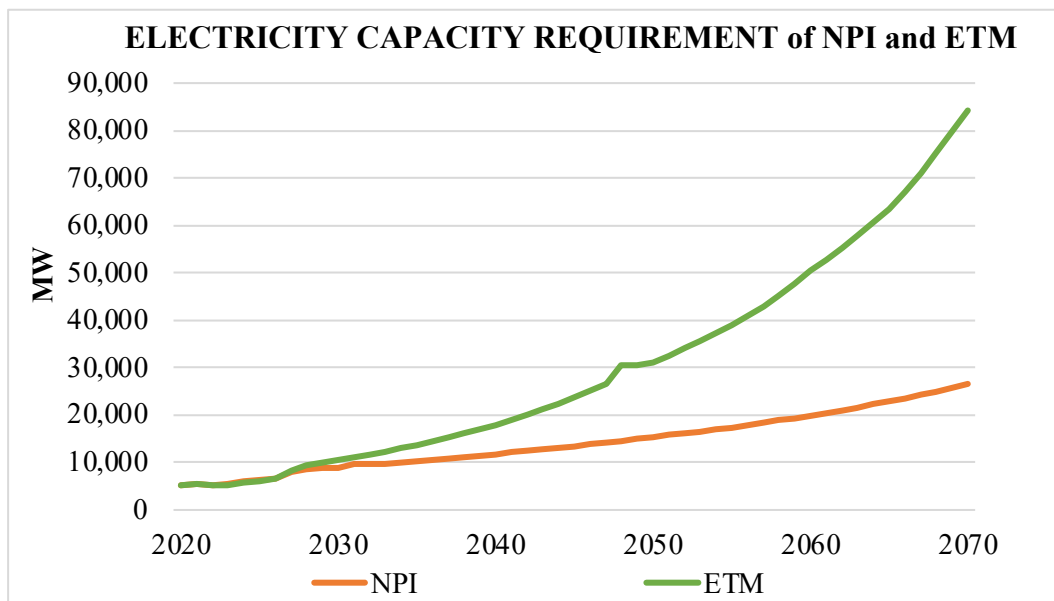


Figure 5 3: Electricity Generation Emission - NPI vs ETM

# ELECTRICITY CAPACITY REQUIREMENT

## CAPACITY

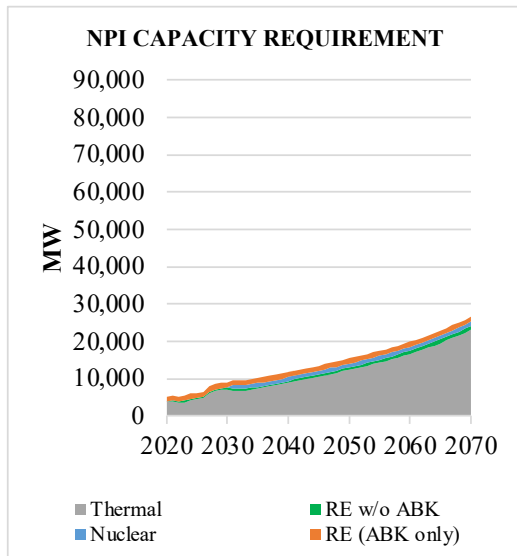
The electricity capacity requirement in the NPI will increase to 26,581 MW by 2070 at an estimated annual rate of 3.2%. The capacity in the ETM increased to 84,308 MW by 2070 at an estimated annual rate of 5.7%. Figure 5-4 provides the trends of the energy transition model and for the NPI.



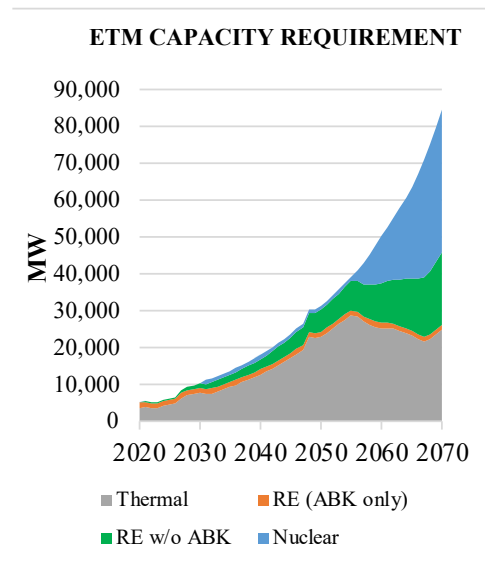
*Figure 5 4: Generation Capacity - NPI vs ETM*

## GENERATION

In all the scenarios, natural gas-fuelled power plants will play a significant role in the generation mix but to achieve net-zero emission for the electricity generation sector, nuclear power and CCUS technologies shall be required. In terms of cost minimization and fuel security, nuclear power will become predominant in the T1 scenario from the mid-2050



*Figure 5 5: Capacity requirement by Technology under NPI*



*Figure 5 6: Capacity requirement by Technology under ETM*

## GENERATION OF ELECTRICITY BY FUEL TYPES

In the NPI, natural gas will be a dominant fuel for electricity generation whereas in the ETM natural gas is expected to be displaced in the mid-2050s by nuclear power, as indicated in Figure 5-7 and Figure 5-8.

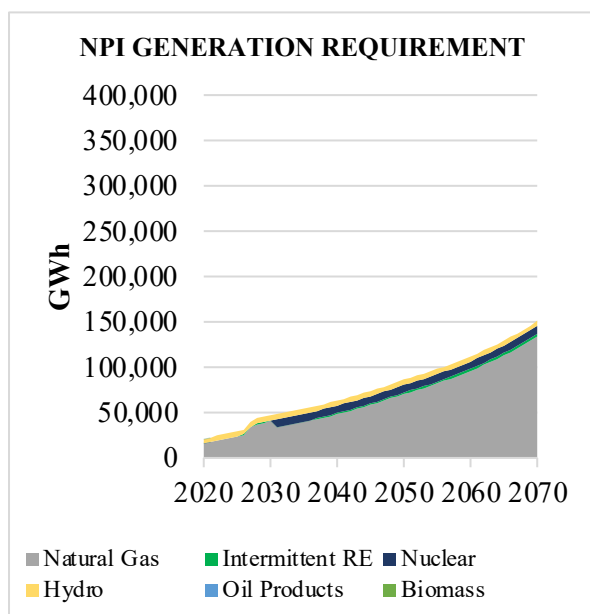


Figure 5 7: Generation by Fuel under NPI

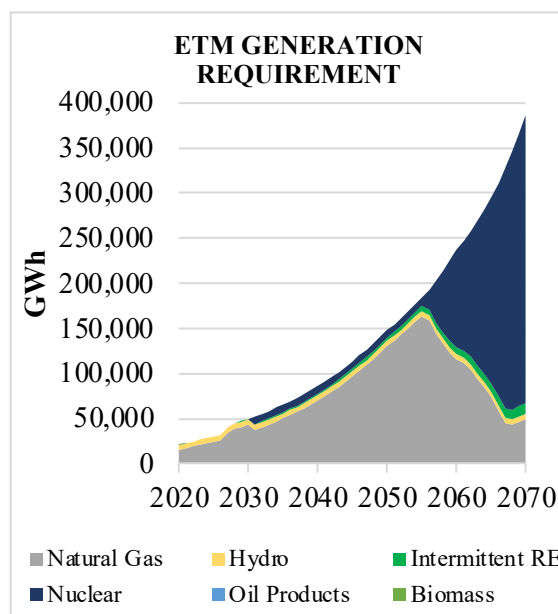
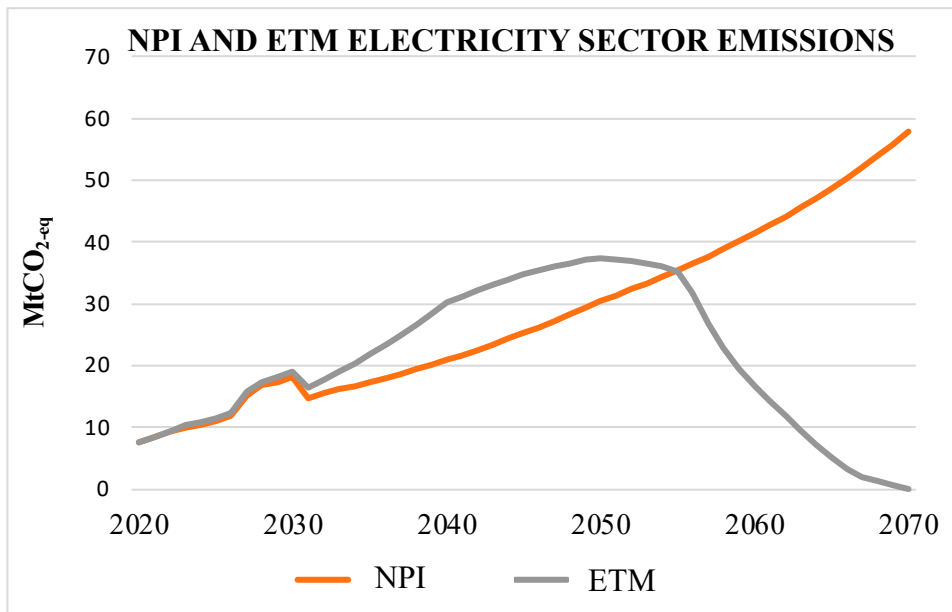


Figure 5 8: Generation by Fuel under ETM

## ELECTRICITY SECTOR EMISSIONS

The production of electricity would result in considerable amount of emissions. In the NPI, emissions from electricity production are projected to increase from 7.5 MtCO<sub>2</sub>-eq in 2020 to 59.0 MtCO<sub>2</sub>-eq in 2070, indicating no peaking and reduction in emission. In the ETM, emissions is expected to peak in the mid-2050s then decrease to net-zero by 2070. The reduction in emissions in the 2030s is a result of the introduction of nuclear power for electricity generation. The attainment of net zero is attributed to the introduction of cleaner generation sources such as nuclear, renewable energy and the use of CCUS with gas-fired power plants.



*Figure 5 9: Electricity Sector Emission – NPI vs ETM*

## ENERGY SECTOR CO<sub>2</sub>-EQ EMISSION BY SUB-SECTOR

In the NPI, total emissions would increase from 28.0 MtCO<sub>2</sub>-eq in 2020 to 198 MtCO<sub>2</sub>-eq in 2070, necessitating measures to reduce emissions. In the ETM, emissions will increase and peak by the mid-2050s and decline thereafter.

By 2070, emissions are expected to reduce to 14.5 MtCO<sub>2</sub>-eq contributing to economy-wide net-zero emission. This is due to switching to cleaner fuels for energy services, such as the adoption of electricity and hydrogen in the ETM.

In the NPI and ETM, the sector that produced the most carbon emission was the transport sector, followed by the industrial sector, as shown in Figure 5-10 to Figure 5-11.

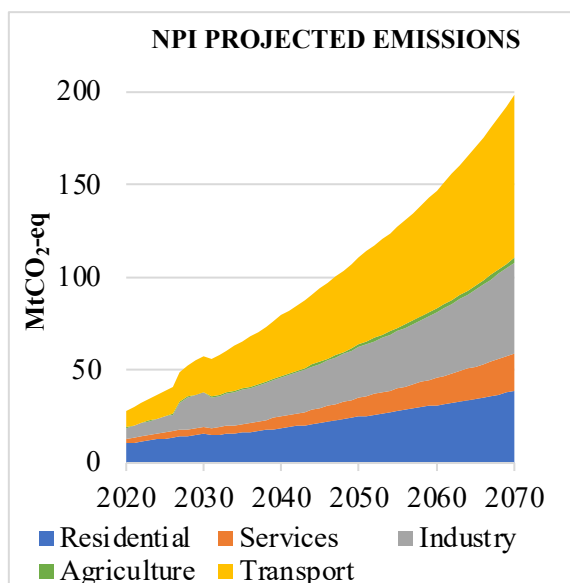


Figure 5 10: Energy Emission by Sub-sector – NPI

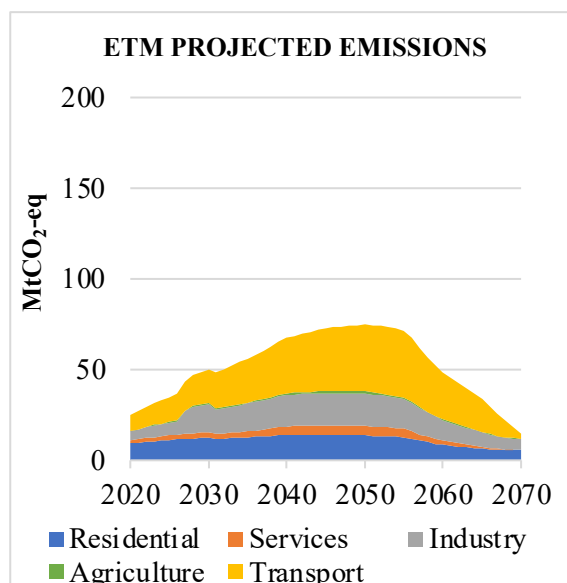


Figure 5 11: Energy Emission by Sub-sector – ETM

## RECOMMENDED TRANSITION TARGETS

ETM guarantees the optimal fuel supply security, the most diversified energy mix and cost-efficient electricity generation for accelerated economic development.

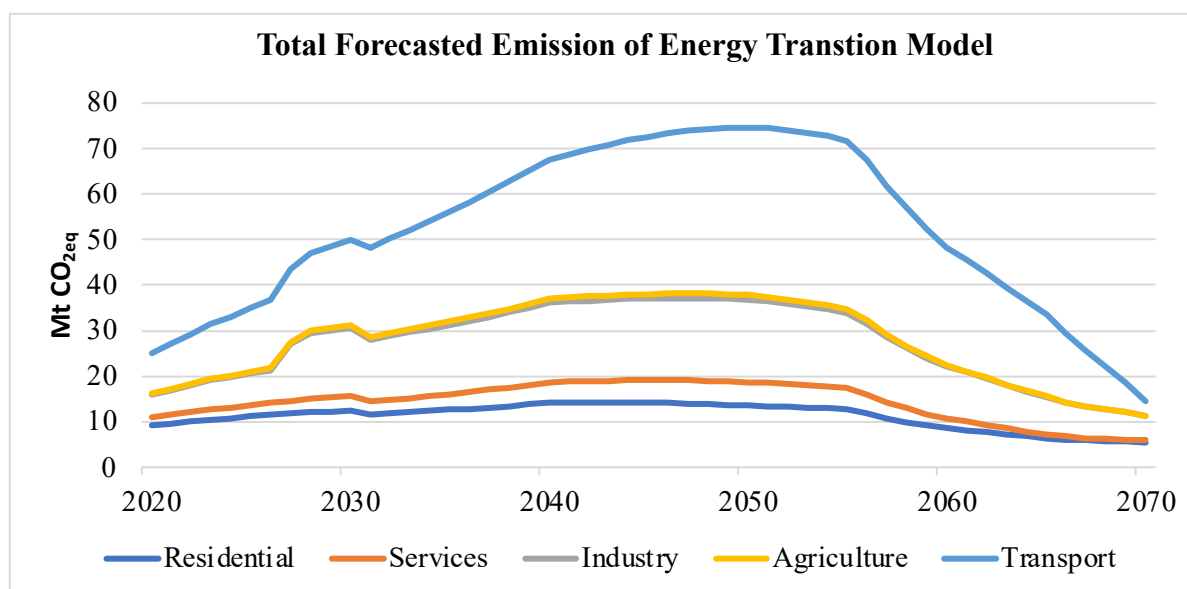


Figure 5 12: GHG Emissions from Energy Demand for ETM for all sectors

The Energy Transition targets over the next five decades are presented below.

### NET-ZERO TARGETS -2030

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- New sales of household electrical appliances are best in class.
- More than 95% of households are electrified.
- Introduction of CNG-fuelled ICEs and trains.
- More than 60% of cooling appliances and systems are best in class.
- 10% of electricity generation capacity is renewable energy.
- Introduce a 10% ethanol blend in major petroleum products.

### NET-ZERO TARGETS -2040

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- Upscaling of nuclear power in the electricity generation mix.
- CCUS for electricity generation, Oil & Gas and Industries.
- Introduction of sustainable aviation fuel (Biofuel for aviation kerosene).
- Phasing out off-road fossil-fuelled ICEs.
- Phased out fossil liquid fuel for electricity generation.

### NET-ZERO TARGETS -2050

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- More than 50% of water heating systems are solar heaters.
- More than 50% of metro urban households use electric stoves.
- More than 90% of household electrical appliances are best in class.
- More than 70% of road vehicles are electricity and hydrogen fuelled.



## NET-ZERO TARGETS -2070

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- More than 70% of rural households use LPG for cooking.
- More than 98% of all appliances and cooling systems are best in class.
- All road and rail mobilities are electricity and hydrogen fuelled.
- Net-zero emission in electricity generation in the mid-60s.
- 20% of electricity generation capacity is Renewable energy.



# CHAPTER 6:

## ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF ENERGY TRANSITION

The implementation of the energy transition framework will impact on the economic, social and the environmental indicators of the nation.

## ECONOMIC IMPACTS

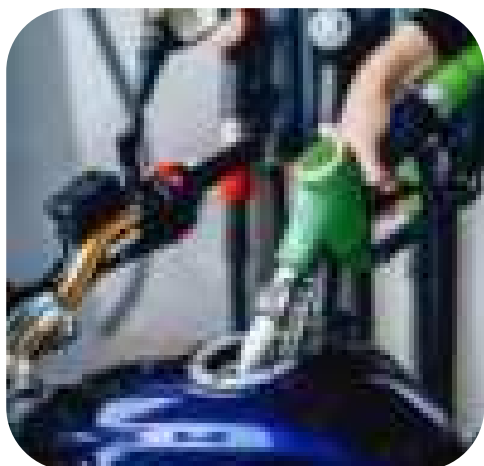
The impact of the energy transition is expected to influence the following areas of the economy; Revenue and contribution to GDP; Jobs; Financial and economic impact on petroleum assets; Funding for fossil fuel investments; Funding for renewable energy and clean technology resources; Energy access and energy security; Cost of energy; Agriculture and food security; among others.

### REVENUES AND CONTRIBUTION TO GDP

Projected net cashflows for the oil and gas sectors are estimated at US\$35 billion and US\$1.3 billion respectively. Revenue from the electricity sector is estimated as electricity sales revenue. Electricity sales is expected to increase during the transition with sales revenue rising to about US\$140 billion in 2070 representing 16% of the country's GDP.



### PETROLEUM ASSETS



The impact of the global transition on fossil fuel assets is generally expected to negatively affect the industry through stranding. In the petroleum sector, assets at risk include fossil fuel reserves and capital goods used for the extraction, processing and transportation of fuel.

Expected improvement in vehicle efficiency and changing transport mode across the globe, is reducing

demand for fossil fuel for transportation. Energy intensive industries are expected to reduce demand by using efficient technologies and increase the use of clean energy. The foregoing suggests that the upstream sector is exposed to low-demand risk leading to decreasing revenues and profits which will be driven by prices and carbon budget effects.

Given the current quantity of proven reserves and in consideration of 2045 as the terminal timeline for oil and gas production, the transition scenario does not envisage stranded reserves. The transition rather recovers revenues quicker and benefits the sector. However, if significant proven reserves are discovered, there may be stranded assets depending on the level of additional reserves and production. It is therefore expected that local petroleum refineries would be established with the capacity to supply local demand and export to neighbouring countries, before and after 2045. This will limit stranding. It will however require funding strategies to finance such investments since it will be difficult to attract foreign investment.

The downstream sector is expected to experience notable changes. New CNG stations and electric vehicle charging points will be built to meet the demand for new transport fuels (CNG and electricity). This change will bring new economic activities into the downstream sector as petrol and diesel fueling stations are repurposed into CNG and electric charging points. This will generate more investments in the sector and provide more jobs.

## FUNDING FOSSIL FUEL INVESTMENTS

More than 20 countries have pledged to halt new direct international public finance for unabated fossil fuels, including oil and gas by the end of 2022. This pledge among other signals limits funding to countries and entities that envision to continue or begin investments in fossil fuels.

Accessing funding for oil and gas projects could be challenging and expensive as the risk of stranding is built into the cost. Therefore, the policy to continue production of oil and gas to support economic development could face funding challenges. Hence, alternative sources to raise funds for the oil and gas sector must be explored. This includes risk-capital, which may require competitive fiscal terms in the oil and gas industry,



as well as, re-investing part of the revenue from current oil and gas exploits.

## FUNDING FOR RENEWABLE ENERGY AND CLEAN ENERGY RESOURCES



Renewable and clean technology investments are expected to increase in the future, thus financial institutions are strategizing to adequately finance such investments. Although current investments in Renewable Energy and clean technologies are not at the optimum level required for the transition, it is expected that more funding will be made available in the future as transition policy directions become clearer. Advanced economies are likely to make funding available for developing economies to

transition. Access to funding for Renewable Energy projects will be more accessible in the future. Creating traction by initially self-funding Renewable Energy and clean technologies could attract more funding quicker than expected. The government must also quicken the establishment of the Renewable Energy Authority and Renewable Energy Fund to promote the incentives provided in the Renewable Energy Act 2011 (Act 832) which includes renewable energy purchase obligation, as it guarantees security of the market to investors.

## ENERGY ACCESS AND SECURITY

The country achieves universal access to electricity and high access to modern cooking fuels in energy transition scenario which raises the energy access profile of the country. This provides adequate electricity for all sectors of the economy and increases industrial and socioeconomic development.

The primary electricity generation sources are principally gas thermal and nuclear power in the transition scenario. While gas could be available from



the country's oil fields for many more years, fuel for nuclear power, uranium, is expected to be imported. With nuclear power constituting the greater share of electricity generation

in the last three decades of the transition scenario, the country's energy security may be dependent on a sustainable supply of uranium.

## PRODUCTIVE USE OF ENERGY



Both GLSS 6 (2014) and 7 (2019) identifies that women constitute a high proportion of small and medium scale agro-processing entrepreneurs. In 2014, it was estimated that women constituted about 88% and 83% of such urban and rural entrepreneurs, respectively. In 2019, the proportions increased to about 90% for each of the categories in rural and urban areas. Typical agro-processing industries include the production of cassava flour, cassava chips, cooking oils, flour from other grains, gari, groundnut paste, home-brewed

drink, husked/polished rice, maize flour, processed fish, processed meat, shea butter, cassava dough, and corn dough. These constitute important livelihood ventures for the women. Typically, solid fuels are used in the production and these activities are energy intensive. Improved access to clean cooking fuels could translate to the use of clean fuels for productive activities. The cost of clean fuels will be a key consideration though, and reliance on solid fuels might persist in the transition.

It is worth noting that, with universal electrification, more than 95% of households would have access to electricity for other productive uses such as running cold stores, hairdressing saloons, dressmaking and local eateries, among others.

The Ministry of Food and Agriculture (2018) and the GLSS 7 report that owners and operators of farmlands constitute 44% of the total labour force engaged in agriculture. Out of this, 46.4% are women. The transition takes into account improvement in access to solar

irrigation which would have a positive impact on women farm owners. This will also provide the opportunity for dry season farming of vegetables as well as all year-round farming.

## JOBS

The energy transition will entail a shift in energy generation technologies, in fuel-use, end-use equipment and devices among others. This shift will have implications on jobs.



## POWER SECTOR

In the power sector, the transition plan foresees several new power plants to meet the power needs of the country. These comprise of gas-thermal power plants, hydropower plants, renewables plants and nuclear power plants. For each of the power plants, direct jobs in manufacturing, construction and installation, operation and maintenance, and decommissioning are considered.

In the Transition scenario, power generation rises from 18,592 GWh in 2020 to 344,272 GWh by 2070, enabled by a capacity increase from 5,392 MW to 64,791 MW. The transition in the electricity sector is projected to yield a total of 1,367,894 jobs translating to 4,344,210.07 job-years. It is estimated that 52% of the jobs created in the period will be in the Construction and Installation (C&I) sectors. Further analysis of the data indicates that this is due to rump-up of Nuclear Power Plant (NPP) installations in the run up to the year 2070. C&I and Operations and Maintenance (O&M) activities together will comprise over 90% of expected jobs in the period. Jobs from NPPs (C&I, O&M and manufacturing) constitute 77% of jobs to be realized in the power sector.

## FUEL SUPPLY

Key fuels in the final energy consumption in the transition Scenario are Biomass, LPG, Natural Gas, Uranium and Biofuel, CNG and Hydrogen.

A total of 36,808 jobs which is approximately 2.05 million job-years will be created in the

fuel supply sector. Towards the year 2070, as the economy becomes electricity driven, jobs in the fuel supply chain will reduce significantly.

In summary, total jobs to be created will be 1,404,702 jobs leading to 6.4 million job-years. Direct and Indirect jobs to be created amount to 936,468 and 468,234 respectively.

## AGRICULTURE AND FOOD SECURITY



The land for the development of power plants competes with other economic activities including tourism, and the building of other infrastructure, among others. It is therefore expected that the transition plan will have an impact on land use, though this should be moderate.

Particularly, the land for energy transition projects can be used for agricultural activities. Any additional land used because of the transition is assumed as land foregone by the agricultural sector.

The energy transition will require land of approximately 120,459 acres which is about 0.17% of Ghana's estimated agricultural land area in Ghana. Therefore, the transition does not have substantial implications for agriculture and food security.

*Table 7-3. Land requirement for power generation*

Technology	2022-2030 (MW)	Land required (Acre)	2031-2040 (MW)	Land required (Acre)	2041-2050 (MW)	Land required (Acre)	2051-2060 (MW)	Land required (Acre)	2061-2070 (MW)	Land required (Acre)	Total Land (Acre)
Thermal	3,743	1,872	5,027	2,513	10,228	5,114	2,371	1,185	-	-	10,684
Hydro	48	13	-	-	-	-	-	-	-	-	13
Solar	1,230	4,920	1,537	6,148	2,981	11,924	4,816	19,266	8,872	35,488	77,745
Nuclear	-	-	1,000	832	-	-	11,970	9,959	25,512	21,226	32,017
TOTAL											120,459

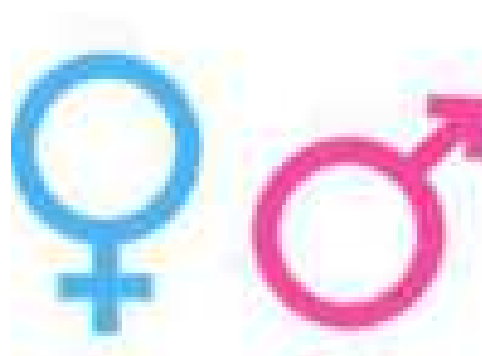


## SOCIAL IMPACTS

The social impact of the energy transition is expected in the following areas: Gender, Education and Health.

### GENDER

The energy transition will impact on women and children in various ways. The extensive use of biomass especially for cooking will disproportionately affect women and children who are the gatherers of these solid fuels. It is estimated that, in resource-depleted areas in Ghana, averagely about 1.6 hours is spent daily gathering fuel wood, a burden that mostly falls on women and girls<sup>23</sup>. Time spent on foraging for wood inhibits participation in education. An improvement in access to energy both for cooking and for lighting would lead to a total avoided time loss of 30.05 million hours for firewood collection.



Cooking fuels have direct implications for women's access to energy given their gender role in the management of domestic responsibilities. The Population and Housing Census (PHC) 2021 reports 51% and 14.8% urban and rural access to LPG respectively. Rural access recorded a growth rate of 58% at an average rate of change per year of 11.6% between 2014 and 2019. Between 2019 and 2021, a growth rate of 70% with an average rate of change of 35% is recorded. The transition plan targets over 70% rural access to LPG by 2070. This would have a significant impact on women.

The GLSS 7 (2019) reports 62.5% use of traditional biomass cookstoves which are linked to indoor air pollution with resultant illnesses such as pneumonia, acute lower respiratory disease, stroke, ischemic heart disease, lung cancer and chronic obstructive pulmonary disease. Improved access and use of electricity (urban) and LPG (rural) for cooking will reduce the use of biomass cookstoves as a primary technology for cooking, and therefore, considerably reduce the exposure to indoor air pollution.

The production of solid fuels, especially charcoal is an important source of livelihood for thousands of women involved in its production and trade, especially in the savannah, as well as the transitional ecological zones where these activities occupy the women during the long dry season. In the transition plan, biomass in the form of firewood and charcoal will continue to be part of the national primary energy mix. The transition plan takes into consideration the need to promote the establishment of sustainable woodlots for woodfuel production and use in improved cookstoves. The livelihoods of these women will be sustained.

## HEALTH



Without the transition, 234 years in every 1000 lives would have been lost. Minimising energy-related indoor air pollution could avoid 48,218 premature deaths. Reduction in energy-related emissions from transportation, cooking, building and industry will have a direct impact on improving human health. The reduction in fine particulate matter will prolong the lives of people in communities, especially those who use high GHG emitting sources as cooking fuels.

## ENVIRONMENTAL IMPACTS

The transition will obviate the challenges that are currently associated with increasing GHG emissions. The transition demonstrates a decreasing trend in the release of GHG emissions. Sectors such as residential, industry, road transportation and other transportation, which are high net emitters in the first half of the period in the transition plan will considerably decline in their emission rating, by tipping off from the year 2040 until 2070. Direct and indirect emissions from the transition scenario yielded very low GHG emission rates.

Energy supply will have emission consequences on the environment in the early years of the transition. This is because the majority of electric power generation plants and projects will continue to utilize fossil fuels as the main fuel source. The use of nuclear energy in the transition scenario offers the optimum opportunity to reduce GHG emissions from electricity supply processes. The net-zero emission in the transition will be due to the dominance of nuclear energy and carbon capture utilization and storage (CCUS) technologies.

During electricity generation, wind turbines do not produce emissions, but there are other debilitating impacts. One of the major environmental impacts of wind energy generation under the transition plan will be the potential deforestation for the construction of wind farms as well as the expropriation of smallholder arable land, and generation of turbine noise. Studies have revealed that some of the main socio-environmental challenges expected from the generation of wind energy include, the reduction in fauna and flora through the production of noise and the de-characterization of the natural landscape, for both on-shore and off-shore wind farms<sup>24</sup>. There could be instances of airborne faunal de-population from the flapping to death by wind rotors. Further environmental impact of wind energy is the disposal method after decommissioning<sup>25</sup>.

Solar energy farm installation requires adequate land sizes to be utilized. These will affect biodiversity and habitats. The manufacturing process of photovoltaic cell generate a variety of toxic materials, such as hazardous acid based on sulfur, hydrogen, chlorine, fluorine, nitrogen, and other organic compounds.

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<sup>24</sup> da Silva VP, Galvão MLdM. Onshore Wind Power Generation and Sustainability Challenges in Northeast Brazil: A Quick Scoping Review. *Wind*. 2022; 2(2):192-209. <https://doi.org/10.3390/wind2020011>

<sup>25</sup> Verma S, Paul AR, Haque N. Selected Environmental Impact Indicators Assessment of Wind Energy in India Using a Life Cycle Assessment. *Energies*. 2022; 15(11):3944. <https://doi.org/10.3390/en15113944>


Batteries for solar installation, power gadgets and electric vehicles will require sustainable management and disposal at the end of their lifetime, otherwise they become hazardous to the environment and human health.

The amount of heat released by the nuclear plant requires that water is pumped from nearby water points to cool the plant system and returned to the sources. The alteration in the temperature will have effects on the aquatic environment, depending on the specific measures undertaken in the design and operation adopted for the broader integrated water resource management scheme<sup>26</sup>. There are potential environmental contamination and long-time radioactive waste hazard<sup>27</sup>. Waste generation would create challenges of handling and storage with considerable health implications if not treated with the utmost care and due diligence that it deserves.

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<sup>26</sup> Jianguo Liu, et al., A tripartite evolutionary game analysis of Japan's nuclear wastewater discharge, *Ocean & Coastal Management*, Volume 214, 2021, 105896, ISSN 0964-5691, <https://doi.org/10.1016/j.ocecoaman.2021.105896>.

<sup>27</sup> Guidi, G, et al., LCA of strippable coatings and of steam vacuum technology used for nuclear plants decontamination. *Clean Techn Environ Policy* **12**, 283–289 (2010).



# CHAPTER 7:

## FINANCING THE ENERGY TRANSITION

## COST AND INVESTMENT REQUIREMENTS OF THE TRANSITION

The various cost for industry, residential, transport and required infrastructure have been evaluated with their corresponding forecast prices for fuels, infrastructure, and energy technologies for the 50years transition period.

### ENERGY COST

In terms of energy delivery infrastructure, there are cost estimates for additional infrastructure required to transport energy. About US\$76 billion is estimated for transmission and distribution infrastructure cost due to the increase in electricity requirements. Generation capacity is estimated at US\$266 billion. The cost of additional gas infrastructure, including distribution and transmission networks, sum up to USD14.5 billion. An additional USD14.6 billion is required for the cost of CCUS attached to some of the Natural Gas generation plants and storage facilities.

### TRANSPORT COST

The cost of replacing or switching fuel at the transportation sector is USD12.3 billion. The dominating road transport in the energy transition are electric vehicles, CNG ICEs and hydrogen vehicles. The enabling infrastructure includes electric charging points and stations, CNG bays, stations, and storage to cater for redundancies for fleet companies. The energy transition scenario estimates that by 2040, a considerable number of gasoline and diesel filling stations will be repurposed to serve vehicles that use CNG, electricity and hydrogen. The transition scenario does not support demand for CNG transport fuel by 2070. Hence repurposing of CNG stations would commence earlier than 2070 to increase the fuelling infrastructure for electric and hydrogen vehicles. For about 2 million CNG cars by 2060, US\$570 million would be required for additional investment in infrastructure. Electric vehicle charging points will require a total investment of US\$7 billion.

## INDUSTRIAL AND SERVICE COST

The major expected changes in the industrial sector include, replacing biomass boilers with gas and electric boilers and the enhancement of electric motors for improvement in efficiency. The total cost estimate for industry is US\$7.4 billion.

In the service sector, the transition focuses on space cooling and refrigeration since they account for more than 85% of the sector's energy consumption. Therefore, the cost of replacing less efficient ACs and refrigerators with more efficient ones is estimated at US\$14.5 billion.

## RESIDENTIAL COST

The main residential appliances considered include cooking, lighting, refrigeration, space cooling, water heating, cloth washing and dish washing. The total cost is estimated at US\$148.2 billion.

## TOTAL COST

The total cost of the transition is therefore estimated at US\$561.8 billion. A breakdown of the costs is presented in Table 7-1

Table 7-1: Investment needs for power supply in the transition

		Billion USD	% Share
Power Generation	Power Generation	266.1	47.4%
Residential	Appliances, modern fuels	148.2	26.4%
Services	Air conditioners	8.4	1.5%
	Refrigeration	6.1	1.1%
Industry	Electric motors	1.2	0.2%
	Gas and electric boilers	6.2	1.1%
Road Transport	Vehicle fleet renovations	12.3	2.2%
Infrastructures	Power Transmission and Distribution	76.0	13.5%
	CCUS	14.6	2.6%
	Electric charging stations	7.0	1.2%
	Gas Transmission	7.0	1.2%
	Gas Distribution	7.0	1.2%
	CNG stations	1.3	0.2%
	Storage	0.5	0.1%
Total Estimated Investments (2020-2070)		561.8	100.0%



## FINANCING STRATEGIES

The financial implications of the energy transition are enormous and must be planned and deployed with a strategy. An effective funding strategy is a fundamental requirement for a successful transition process. Generally, these strategies are guided by access, affordability, and terms of available financial options.

Ghana will initiate discussions with relevant stakeholders in the global financial architecture to deliberate on funding needs for energy transition. Ghana will engage with potential funders including Domestic Banks, Specialised Debt and Hedge Funds, Regional African Development Banks, European Banks, Investment Banks, Pension Funds, and Multi-Lateral Banks.

The following strategies would be pursued to raise funding for Ghana's energy transition:

- Mobilise private and public finance to catalyse and create traction for renewable energy investments.
- Establish Public Private Partnerships to co-finance the construction, development and deployment of transition infrastructure including Solar PV, Wind, Hydro, Mini grids, Nuclear, CNG plants etc.
- Stimulate access to domestic financing for Small and Medium Enterprises to increase investments for both supply and demand requirements of transition, especially in the end-use technologies sector.
- Encourage innovative financing in term of strategic procurement;
- Promote community energy ownership (encouraging municipalities and districts to contribute to own renewable energy installations);
- Support energy service companies to fund energy efficient technologies for industries.
- Explore the use of Municipal bonds for long-term and capital-intensive projects including rail development.


- Explore opportunities in the Green Bonds market.
- Establish a revolving funds strategy that could ensure continuous investments using the cost savings from already operating investments.
- Strategically accelerate the extraction of fossil fuels and other critical minerals, including bauxite, copper, lithium and others.
- Incentivise consumers to use low carbon technologies with flexible and affordable funding options from domestic banks and/or special funds.

## FINANCING PLAN APPROACH

The cost of the transition is about 550 billion dollars and is expected to be financed by different funding sources. Funding is expected to come from sources such as Government of Ghana (GoG), Multilateral Development Banks (MDBs), Development Partners (DPs) and Private Financiers and Beneficiaries (PF&B). As shown in Table 6, it is expected that majority share of the funding will be sourced from MDBs. It is also expected that Private Financiers and Beneficiaries will contribute a substantial amount to the total cost since the end-use technologies, including vehicles and cookstoves, will be largely financed by the private sector.

*Table 7-2: Financing of The Power Generation Plan*

	GoG	MDBs	DPs	PI&B	Total
Co-financing amount (billion US\$)	32.0	113.2	29.0	91.9	266.1
Share of co-financing	12%	43%	11%	35%	100%
Financing per decade in US\$(billion)					
Period up to 2030	2.9	2.6	0.7	2.1	8.3
Period 2030-2040	3.4	5.7	1.5	4.6	15.2
Period 2040-2050	3.5	6.4	1.6	5.2	16.7
Period 2050-2060	9.5	32.3	8.3	26.2	76.3
Period 2060-2070	12.7	66.2	16.9	53.7	149.5



# CHAPTER 8:

## POLICIES AND MEASURES TOWARD NET-ZERO ENERGY TRANSITION

After a series of national and regional stakeholders and focused groups engagements, and input from experts and modelling process, relevant policy options were churned out. Below are the policy options to guide the energy transition process towards net-zero emissions. The policy options are grouped under four areas namely, Decarbonisation, Energy Efficiency, Energy Security and Access, and Cross Cutting. The following policy options are therefore recommended for consideration.

## DECARBONISATION

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- **GHG-emitting industries shall be required to establish tree plantations to offset emissions.**

The development of industries is significant to the economic growth of the country. However, some industries are major contributors to the nation's carbon footprint. Such industries must undertake initiatives to offset their emissions. Government shall ensure that GHG emitting industries establish sustainable afforestation projects to mitigate their emissions.

- **Encourage fossil fuel companies to invest in renewable energy projects.**

To increase the contribution of renewable energy and also mitigate greenhouse gas emissions, fossil fuel companies must diversify their portfolios to include Renewable Energy Technologies. Government shall ensure that fossil fuel companies invest in renewable energy projects.

- **Natural Gas shall be a transition fuel for electricity production, industrial heating and transport.**

Globally, natural gas has been identified as a transition fuel since it is a cleaner fuel compared to other hydrocarbon fuels. Government shall continue to invest in the sustainable production of natural gas and the development and expansion of natural gas infrastructure for power generation, transportation and industrial use.

- **Legislate and develop rules for carbon finance and trade.**

The worldwide carbon pricing market has taken the centre stage for GHG-emitting countries which purchase carbon credits in other jurisdiction to meet their commitments to

GHG emission reduction. The Government of Ghana shall establish a legislation to regulate carbon finance and trade to enable the state and other carbon traders to harness the full benefits of GHG emission mitigation.

- **Aggressively promote afforestation as carbon sinks.**

The vegetation cover of a country is a significant contributor to its carbon mitigation interventions. Government shall aggressively pursue afforestation programmes to increase the nation's natural carbon sink.

- **Establish a regulatory framework to minimise GHG emissions from industries.**

Regulations are effective tools for enforcing emission targets such as cap-and-trade, carbon taxes and certified emission reductions. Government shall develop and establish a regulatory regime to reduce emissions from GHG emitting industries.

- **Promote and encourage non-motorized transportation.**

Non-motorised transportation such as walking, biking, skating and scooting are becoming an integral part of urban transportation, contributing significantly to emission reduction in towns and cities. Government shall develop the infrastructure to promote non-motorised transportation in urban areas.

- **Promote and encourage the use of electric vehicles.**

The use of electric vehicles for transportation has become one of the preferred options to decarbonise the transport sector. Government shall develop the infrastructure and provide incentives to promote the deployment of electric vehicles for mass transportation and private use.

- **Phase-out fossil-fuelled Internal Combustion Engine (ICE) vehicles.**

Phasing out the manufacture and sale of ICE vehicles will contribute to the decarbonization of the transport sector. This is in accordance with the global call for energy transition. Government shall implement measures in line with global trends to phase-out fossil-fuelled ICE vehicles.

- **Introduce Carbon Capture, Utilisation and Storage (CCUS) technology in applicable thermal power plants and industries.**

Technologies to capture, utilise and store carbon is evolving and offers the opportunity to reduce emissions from industries. Government shall introduce CCUS technologies in industries and power generation plants to significantly reduce carbon emissions.

- **Increase the share of renewables in the energy generation mix.**

Ghana has committed to promoting and developing renewable energy to reduce emissions and diversify the generation mix. Government shall continue to develop and increase the share of renewable energy in the energy generation mix.

- **Introduce and increase the share of nuclear in the energy generation mix.**

Nuclear Energy is clean and reliable, and its introduction will provide baseload power as well as help achieve net-zero electricity production, diversify the energy generation mix and ensure energy security. Government shall adopt and integrate nuclear energy into the energy generation mix.

- **Introduce and promote biofuel as an aviation and transition fuel.**

Biofuels have been considered as clean energy and can be blended with petroleum products for the transportation sector including aviation. Government shall promote biofuel production and utilisation as a blend in the transport sector.

- **Reduce the use of bulk road vehicles for transportation of goods.**

The reduction in the use of bulk road vehicles for the transportation of goods will contribute to a reduction in emissions. Government shall promote and expand the marine, rail and pipeline infrastructure for freight transport.

- **Promote the use of hydrogen fuel.**

Hydrogen is clean and renewable, and its development as a transition fuel is evolving and promising in the decarbonisation of the transport and power sectors. Government shall invest in the production and utilisation of hydrogen fuels to diversify the fuel mix.

## ENERGY ACCESS AND SECURITY

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- **Encourage innovation in renewable technologies.**

Innovation is essential to the promotion of renewable energy technologies. Government will encourage home-grown innovations to achieve a substantial increase in the share of renewable energy through research and development.

- **Expedite Oil and Gas Exploration and Production to Fund development of Clean Energy Technologies.**

Funding is a pre-requisite for the development and promotion of clean energy technologies, hence the need to expedite oil and gas exploration and production to increase revenue. Government shall create the necessary environment to incentivize exploration and production companies to invest in Ghana's hydrocarbon sector.

- **Expand Gas Infrastructure to ensure a reliable and adequate supply of gas for Power and Non-Power Uses.**

Natural gas-based power generation can play an important role in supporting clean energy development while providing a stable baseload. Government shall make efforts to expand the gas infrastructure to increase the natural gas supply for power and non-power uses.

- **Facilitate the creation of industries for local manufacture of clean energy components.**

The creation of local industries for the manufacture of clean energy components such as solar panels and batteries will enhance the country's industrialization drive and also promote energy security. Government shall facilitate the establishment of local industries through investments, access to technology and attractive business incentive schemes.



- **Promote and encourage the use of LPG to reduce dependency on wood fuel.**

Most households and industries in Ghana are heavily reliant on traditional biomass as the main source of fuel for cooking and heating. Government shall promote the use of LPG and the provision of incentives will reduce the dependency on wood fuel whilst ensuring cleaner energy is used.

- **Prioritise green energy to attract more investment.**

A favourable and non-discriminatory investment climate is a pre-condition for investment in green energy projects. Government shall prioritise and set clear targets for Renewable Energy capacity additions in the generation plans and encourage competitive procurement to attract investments.

- **Resource the National Oil Company to exploit national hydrocarbon resources.**

The National Oil Company will be supported to accelerate the development of Ghana's oil and gas resources. This is to prevent the occurrence of stranded assets in the petroleum upstream sector.

- **Accelerate the implementation of the Petroleum Hub.**

Ensuring that there is adequate capacity for refining crude oil and production of petrochemicals would be crucial to ensure Ghana is self-sufficient in the supply of petroleum products and petrochemicals during the transition period. Ghana's petroleum hub project will be accelerated to provide the needed infrastructure for the utilization of the country's oil and gas resources.

- **Strengthen and expand power transmission and distribution systems to accommodate intermittent Renewable Energy technologies.**

To increase the contribution of intermittent Renewable Energy resources such as solar and wind, there is a need to strengthen and expand the transmission and distribution systems. Government shall invest in upgrading and expanding the power infrastructure to accommodate variable Renewable Energy Technologies,

- **Exploit lithium and other critical mineral resources to develop the clean energy industry.**

Lithium is crucial for the transition to clean energy as it serves as a raw material in the production of batteries for energy storage in various applications including vehicles and grid stabilisation. Government shall support the exploration and exploitation of lithium and other critical mineral resources for the development of the clean energy industry and the value-added supply chain.

- **Promote sustainable woodlots as biomass fuel.**

Biomass in the form of firewood and charcoal will continue to contribute significantly to the national primary energy supply. Government shall promote the establishment of sustainable woodlots to meet the biomass fuel demand.

## ENERGY EFFICIENCY

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- **Intensify the promotion of energy efficiency programmes.**

Energy efficiency has been identified as one of the measures to reduce energy wastage and carbon emissions. Government will therefore intensify educational campaigns on the efficient use of energy to significantly reduce the overall energy intensity of the country.

- **Ensure the use of the most efficient lamps suitable for various lighting needs.**

Lighting is one of the high energy consuming appliances in buildings. The use of energy-efficient lamps will lead to an overall reduction in energy consumption. Government shall promote the production and use of best-in-class efficient lamps.

- **Encourage and promote the use of best-in-class energy appliances.**

Best-in-class energy appliances use less energy to produce the same level of service compared to inefficient ones. Government shall promote the adoption of best-in-class energy appliances to ensure a reduction in energy use.

- **Encourage the use of clean cookstoves.**

LPG and electric cookstoves are more efficient compared to woodfuel stoves. However, woodfuel is still a significant source of cooking fuel in Ghana and is expected to remain a major cooking fuel in some rural areas. Government shall promote the use of improved woodfuel stoves and provide interventions to transition to LPG and electric stoves.

- **Encourage the construction of energy-efficient buildings**

Energy efficient buildings reduce the overall energy requirements for thermal comfort and lighting. The local government in collaboration with relevant stakeholders shall be encouraged to promote the construction of energy-efficient buildings to lower the energy intensity.

- **Promote energy efficiency in Small and Medium Scale enterprises.**

Some Small and Medium Scale enterprises typically use obsolete technology in their production process resulting in wastage in energy use and loss in productivity and profitability. Promote the use of improved and efficient technologies in the production process of SMEs to reduce energy consumption and emissions and contribute to the profitability of these enterprises.

## **CROSS-CUTTING**

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- **Decentralise the energy transition implementation process.**

Decentralisation will be key in the implementation of the Plan ensuring that the transition does not only occur in urban centres but across the entire country. Local government and relevant stakeholders shall be encouraged to decentralize the implementation of the Plan.

- **Establish an Energy Transition Fund.**

It is imperative to explore sustainable financing options for the implementation of the Plan. An Energy Transition Fund will be created to ensure the availability of dedicated funds to support the implementation.

- **Incorporate energy transition into the curricula of academic institutions.**

There is the need to review the existing curricula to include energy transition-related subjects to ensure that the requisite skills and knowledge are obtained by Ghanaians to enrol in energy transition jobs. Academic institutions will be required to develop and adapt their curricula to ensure that Ghanaian students are prepared for the energy transition.

- **Create public awareness of the effects of continuous use of fossil-based energy and its impact on climate.**

The adoption of clean fuels will be only be successful if public awareness is created for the need to transition from fossil-based energy to clean energy sources. Concerted efforts will be made to create awareness and sensitize the general public about energy transition and the risks associated with the continuous reliance on fossil-fuel sources.

- **Encourage regional cooperation among African countries for the development of clean energy initiatives.**

It is vital for government to work with other countries in pursuance of emission reductions towards a net-zero Africa. Government will deepen cooperation with other African countries in this regard to reduce cost in developing and implementing clean energy projects and foster trade between countries.

- **Mainstream gender in the implementation of the energy transition plan.**

Currently, there is low participation of women in the energy sector value chain. Government shall encourage gender mainstreaming and gender balance in the implementation of the energy transition agenda.

- **Resource key technical educational institutions to undertake research and development in clean energy systems.**

Research and development are essential for the development and improvement of energy systems. Research and educational institutions in collaboration with relevant stakeholders shall be resourced to research and develop clean energy solutions.

- **Promote alternative livelihood programmes for persons affected by energy transition**

Implementation of Ghana's Energy Transition Plan may cause some people to lose their livelihoods. Therefore, Government shall promote alternative livelihood programmes to compensate affected persons.

- **Promote local content and local participation in the implementation of Energy Transition programmes.**

Local content and local participation are essential to ensure that there is technology retention, value addition and the creation of wealth among Ghanaians. To achieve this, Government shall support capacity-building programmes for Ghanaians to take up roles and provide services that will be required in the implementation of the transition plan.

- **Encourage private sector participation in energy transition programmes.**

The role of the private sector is key in the implementation of Ghana's energy transition agenda. The private sector must be engaged in the implementation of the plan to guide their investments in the energy transition. Government shall provide the enabling environment and encourage investment in the clean energy sector.

- **Promote low-carbon systems technologies to stimulate new business ventures.**

The implementation of the Energy Transition Plan will lead to the creation of new businesses and jobs that will stimulate economic growth. Given this, Government shall create the enabling environment for companies and businesses to adopt low-carbon technologies to improve their operations.

## APPENDIX I: GHANA ELECTRICITY ACCESS MAP AS OF DECEMBER 2021





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## APPENDIX III

### I. CONSULTATIONS

#### II. LEADERSHIP & ROLES IN PREPARATION OF THE FRAMEWORK

#### III. ACTIVITIES AND WORKPLAN FOR PREPARATION OF FRAMEWORK

#### IV. SUPPORT FOR PREPARATION OF THE FRAMEWORK

### APPENDIX I: CONSULTATIONS

#### 1. SCHEDULE

Consultations for the preparation of the National Energy Transition Plan started with the National Energy Transition Forum which was held on 22nd February 2022. This was followed by over forty (40) other consultations per the schedule below:

Date	Activity	Venue
<b>Round 1: Regional Engagements (14th)</b>		
22nd Feb	Stakeholder Forum for Southern Belt (Greater Accra)	Kempson Hotel, Accra
23rd Feb	Stakeholder Forum for Volta Belt (Volta, VU)	Yinka Jensen Hotel, Ho
23rd Feb	Stakeholder Forum for Western Belt (Western, Western North, Central)	Woods Hotel, Takoradi
1st Mar	Stakeholder Forum for Middle Belt (Ashanti, Brong Ahafo, Eastern, Brong Ahafo)	Golden Tide Hotel, Kumasi
2nd Mar	Stakeholder Forum for Northern Belt (Northern, Upper East, Upper West, Lower East)	Marlow Hotel, Tamale
<b>Round 2: National Engagements (24 Regional)</b>		
17th Mar	Stakeholder Forum for Brong Region	Elbert Hotel, Suape
17th Mar	Stakeholder Forum for Ashanti Region	Seven Hotel, Suape
17th Mar	Stakeholder Forum for Brong East Region	Al Plaza Hotel, Teshie
17th Mar	Stakeholder Forum for Eastern Region	Capital View Hotel, Koforidua
18th Apr	Stakeholder Forum for Upper West Region	Blue Hill Hotel, Wa
18th Apr	Stakeholder Forum for Ga West Region	Plaza Hotel, Dzorweng
18th Apr	Stakeholder Forum for Volta Region	Plaza Royal Hotel, Koforidua
18th Apr	Stakeholder Forum for North East Region	Prestige Inn, Nalerigu
18th Apr	Stakeholder Forum for Upper East Region	Accor Hotel, Bawumia
18th Apr	Stakeholder Forum for Western North Region	WOW, East West, Suape Hotel
18th Apr	Stakeholder Forum for CR Region	CRU, Upper West, Suape
<b>Round 3: Thematic Group Engagements</b>		
17th May	Manufacturing Sector (SME and Informal Sector Groups)	Alta Hotel, Accra
	Land & Agriculture Sector (Forestry Commission and related institutions)	Alta Hotel, Accra
	Energy SME's Engagements (SME, MSME, SME)	Alta Hotel, Accra
18th May	Labour Market / Trade Union (engaging)	Alta Hotel, Accra
	Education - SME, Tertiary, MSME, etc.	Alta Hotel, Accra
	Transport - SME, MSME, etc.	Alta Hotel, Accra
17th May	Communication and Information Sector (SME, MSME, SME, Media, etc.)	Alta Hotel, Accra
17th May	Health Sector (SME, MSME, and Health Sector Groups)	Alta Hotel, Accra
18th May	Association of Entrepreneurs	Marquis, Suape
17th May	National House of Chiefs	Marquis, Suape
17th May	NGOs and other Interest Groups	1st Pl. Ambassador Hotel, Suape
1st Jun	Indigenous Groups and Institutions	Yinka Ambassador Hotel
1st Jun	Key CSOs, NGOs etc.	Alta Hotel, Accra
18th Jun	Religious Community and Faith Leaders	Alta Hotel, Accra
18th Jun	Religious Institutions	Alta Hotel, Accra
18th Jun	Special Interest Groups (SME, Service Companies)	Alta Hotel, Accra

	<b>CHCUMBERTSOTO</b>	<b>Abuja Hotel, Abuja</b>
28 Jul	State IPPs/Channel, IPPs, Service Providers, Residents	Abuja Hotel, Abuja
	Channel Producers and Firewood Dealers, SHCDO	Abuja Hotel, Abuja
21st Jul	Hydro Power, GFA and Traders Association	Abuja Hotel, Abuja
12th Jul	State App. of Banks, State App. of Insurers, Other Pw. Industries	Abuja Hotel, Abuja
12th Jul	Parliament (C) - Water & Energy, Transport, C&I, Labor, Finance	Abuja Hotel, Abuja
14th Jul	Auditory - Northern Belt	Low-Cost Complex Bldg., Abuja
21st Jul	Auditory - Southern Belt	C&I Comp. Bldg., Kariakari
29th Jul	Council of State	ABJ, Abuja
14th Sep	State Sec. Assistants	HTO Abu Auditorium, Abuja
<b>Round 1: Stakeholder Engagement</b>		
27th July	Regulatory Institutions (CCRA, C&I, Insurers, Directors, Inspectors, etc.)	Intergraph Hotel, Abuja
8th August	Collaboratory Ministers (Chief Directors and Directors for PM&E)	Intergraph Hotel, Abuja

## APPENDIX B: LEADERSHIP & ROLES IN PREPARATION OF THE FRAMEWORK

### B.1 MINISTRIAL LEADERSHIP

Preparation of the National Energy Transition Framework was led by the Hon. Minister for Energy, Dr. Matthew Opoku Prempeh. He formed the National Energy Transition Committee and provided leadership in the preparation of this Framework. He participated in both regional and focused group discussions and provided direction to the Committee at various stages of preparation of the Framework.

The Hon. Minister and Deputy Ministers; Hon. Dr. Mohammed Amin Adam, Hon. William Oduroaku Adoo and Hon. Andrew Egyaga Mensah led various activities in the preparation of this framework. The Ministers participated and delivered keynote addresses in all regional and focused group engagements and held a session of Questions and Answers where they provided some insights into Government policy and the need for the National Energy Transition Framework.

The Hon. Minister for Transport, Hon. Kwaku Asaremah and Deputy Ministers; Hon. Frederick Otieng Adom and Hon. Hassan Torguul also played key parts as Collaboratory Ministers in the preparation of this Framework. They ensured that the Ministry of Transport as the key collaborative ministry was represented at each of the stakeholder events held across the country.

Below is a list of Ministers that played key roles in the preparation of this Framework:

#### Lead Ministers

1. Hon. Matthew Opoku Prempeh, Minister for Energy
2. Hon. Mohammed Amin Adam, Deputy Minister for Energy
3. Hon. William Oduroaku Adoo, Deputy Minister for Energy
4. Hon. Andrew Egyaga Mensah, Deputy Minister for Energy

#### Collaboratory Ministers

1. Hon. Kwaku Ofori Asaremah, Minister for Transport
2. Hon. Oti Kwaku Afreye, Minister for Environment, Science, Technology, and Innovation
3. Hon. Ken Ofori Atta, Minister for Finance
4. Hon. Frederick Otieng Adom, Deputy Minister for Transport
5. Hon. Hassan Torguul, Deputy Minister for Transport

## 3. ROLES IN PREPARATION OF THE FRAMEWORK

### 2.3 NATIONAL ENERGY TRANSITION COMMITTEE

The National Energy Transition Committee was inaugurated by the Hon. Minister for Energy on an 12th December 2021. The Committee was made up of key institutions across various sectors. Membership of the Committee is as follows:

#	Name	Designation & Institution	Role
1	Dr. Mohammed Amin Adam	Deputy Minister, Ministry of Energy	Chairman
2	M. Afolayan Oluoch	Director PPME, Ministry of Energy	Member
3	M. Toljamesi Azubuike	Director, Petroleum, Ministry of Energy	Member
4	M. Solomon Adeseye	Director, Power, Ministry of Energy	Member
5	Dr. Robert Sogbadefun	Deputy Director, Power (Nuclear), Ministry of Energy	Member
6	Ing. Seth Mutu	Deputy Director, Power (Renewable), Ministry of Energy	Member
7	M. Stanley Poku-Amankwah	Special Adviser to Minister, Ministry of Energy	Member/Secretary
8	M. Irene Ndetika	Director, PPME, Ministry of Transport	Member
9	M. Peter Dery	Director, Environment, Min. of Environment, Sci. Tech. In.	Member
10	M. Joseph Sanyang	Head, Energy & Petroleum Unit, Ministry of Finance	Member
11	Ing. Oluw. Amosun-Rheor	Executive Secretary, Energy Commission	Member
12	M. Saliu Ayo	Deputy Director, Energy Commission	Member
13	M. Joseph Odeje	Deputy CEO, Orons National Petroleum Corporation	Member
14	M. Stella Adams	Director, Policy Coordination, National Petroleum Authority	Member
15	M. Kwame Adu-Yebo	Senior Manager, Control, Orons Nat. Gas Company	Member
16	M. Waleed A. Tigolo	Manager, Gas Power Authority	Member
17	M. Sanyal Hual	CEO, Chamber of Bank Of Distribution	Member
18	Ms. Florence Adedoye Lawal	Administrative Officer, Ministry of Energy	Admin. Support

The Committee was tasked with Terms of Reference as follows:

1. assess the current situation in the energy sector and the effectiveness of existing policies and measures;
2. determine national objectives and targets for the transition;
3. propose policies and measures for achieving these targets;
4. assess the benefits, risks and cost of the global energy transition and prescribe risk mitigation measures; and
5. identify any cross-cutting issues that must be addressed.

The Committee created a Secretariat and formed teams for specific tasks.

## 2.1.1 SECRETARIAT

The Secretariat was formed by the Committee to provide support in terms of research and drafting the draft initial report from existing policy documents. Membership of the Secretariat is as follows:

#	Name	Designation	Role
1	Mr. Anthony Oadaka	Director, PP&E, Ministry of Energy	Chairman
2	Dr. Hubert Angbwa	Deputy Director, Power (Nuclear), Ministry of Energy	Member
3	Ing. Jack Mwa	Deputy Director, Power (Renewable), Ministry of Energy	Member
4	Mr. Stanley Poku Ametenuah	Special Aide to Minister, Ministry of Energy	Member
5	Mr. Gali, Akko	Deputy Director, Energy Commission	Member
6	Mr. Obed Enoh Baudre	Prog. Officer, Petroleum Downstream, Ministry of Energy	Member/Secretary
7	Mr. Albert Amegyei-Fortson	Engineer, Petroleum Upstream, Ministry of Energy	Member
8	Mr. Callistus Nene	Head for Petroleum Upstream, Ministry of Energy	Member
9	Mr. Marcus Morny	Head for Power G&T, Ministry of Energy	Member
10	Mr. Marcus Hoo	Head for Gas, Ministry of Energy	Member
11	Mr. Jeffrey Osei Mensah	PR & Deputy Minister, Ministry of Energy	Member
12	Mr. Francis Adu Eufor	Head for P&E, Ministry of Energy	Member
13	Mr. Mamadou Kourouh	Technical Advisor, Ministry of Energy	Member
14	Mr. Benjamin Akaho	Energy Economist, Energy Commission	Member
15	Dr. Daniel Tobi Sarafiah	Rg. Director, Climate Change /RA, Env. Protection Ag.	Member
16	Dr. Florence Opong	Manager, Commercial, Ghana National Gas Company	Member
17	Ms. Marcelline Eyiwa Napeye	Assistant Director 1, Ministry of Energy	Admin. Support

The Secretariat conducted initial desktop studies and review of existing plans and documents to prepare a draft Situational Analysis Report which formed the basis of the work of the Main Committee. The Secretariat continued to provide support for the Main Committee and also participated in stakeholder consultations as well as study trip events. As part of its duties, the Secretariat produced a report on the regional stakeholder consultations.

## 2.1.2 PLANNING AND ORGANIZING TEAM

The Planning and Organizing team was formed by the Main Committee to coordinate various engagements and events for the Main Committee. The team was responsible for planning and organizing the national, regional and focused group stakeholder events as well as some meetings of the Committee. Members of the team are below:

#	Name	Designation	Role
1	Mr. Anthony Oadaka	Director, PP&E, Ministry of Energy	Chairman
2	Mr. Stanley Poku Ametenuah	Special Aide to Minister, Ministry of Energy	Member
3	Mr. Obed Enoh Baudre	Prog. Officer, Petroleum Downstream, Ministry of Energy	Member/Secretary
4	Mr. Albert Amegyei-Fortson	Engineer, Petroleum Upstream, Ministry of Energy	Member
5	Ms. Marcelline Eyiwa Napeye	Assistant Director 1, Ministry of Energy	Member
6	Mr. Samuel Ofor	Head Protocol, Ministry of Energy	Member
7	Ms. Gidget Kwaku Aducci	Admin. Assistant, PP&E, Ministry of Energy	Member
8	Mr. Kwasi Obeng-Poku	PR&C, Ministry of Energy	Member
9	Mr. Kofi Kwaku Stephen	Protocol Officer, Ministry of Energy	Member
10	Mr. Georgei Salome Doku	Protocol Officer, Ministry of Energy	Member
11	Mr. Shadrach Osei	PR Officer, Ministry of Energy	Member
12	Mr. Anthony N. Nwagwu	Head PR, Ministry of Energy	Member
13	Mr. Kofi Akpan Akpan	Comm, Ministry of Energy	Member

### 2.1.3 REPORT DRAFTING/TECHNICAL TEAM

The Report Drafting/Technical Team was formed to model data gathered by the Committee and prepare a draft framework for the consideration of the Main Committee. The team came up with different modeling scenarios based on assumptions and data gathered from the Situational Analysis and consultations with stakeholders.

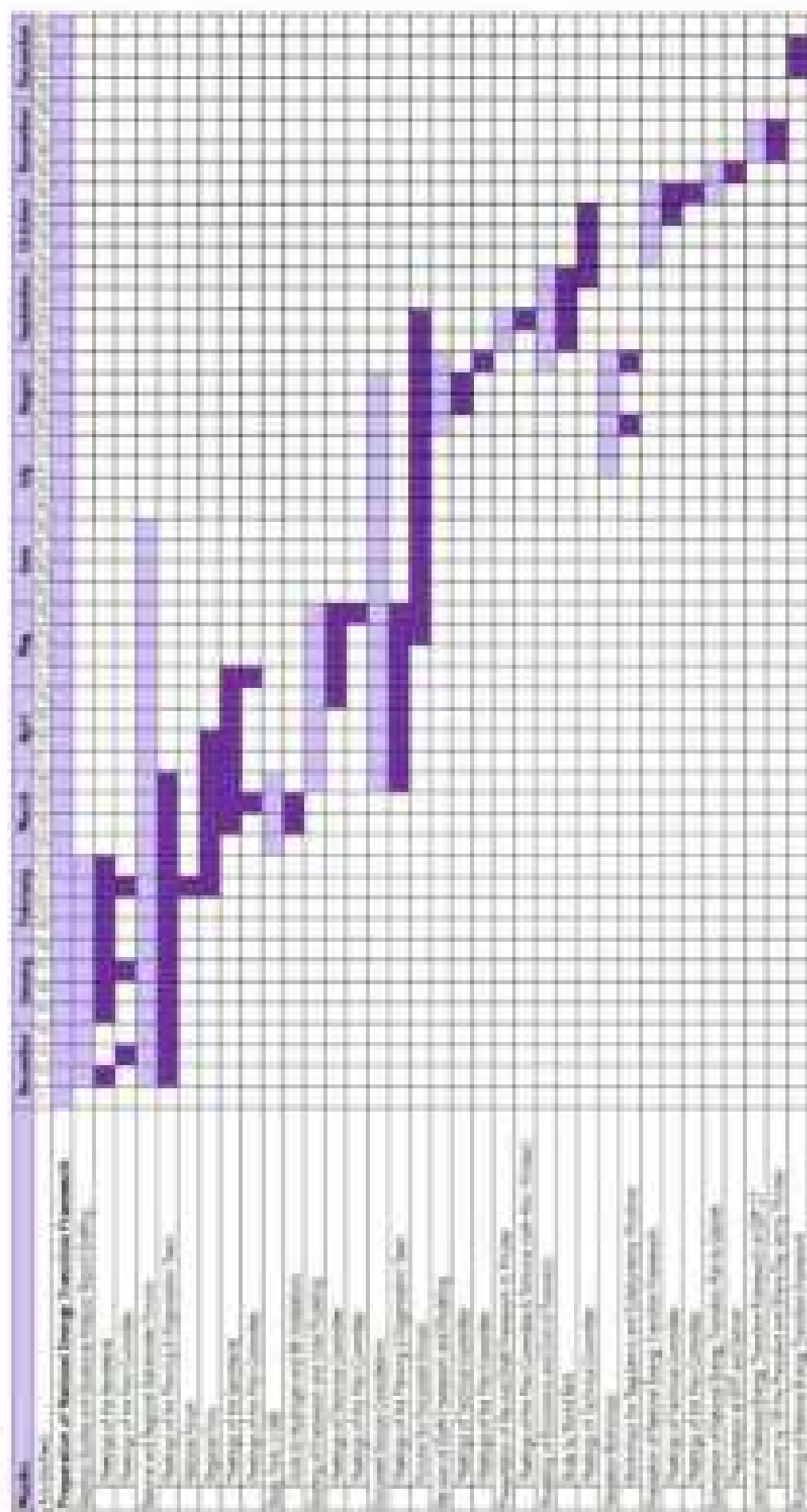
Members of the team were as follows:

#	Name	Designation & Institution	Role
1	Dr. Mohammed Amin Adam	Deputy Minister, Ministry of Energy	Chairman
2	Mr. Anthony Dauda	Director, ITME, Ministry of Energy	Member
3	Dr. Robert Engheda	Deputy Director, Power (Nuclear), Ministry of Energy	Member/ Secretary
4	Ing. Sali Maku	Deputy Director, Power (Renewables), Ministry of Energy	Member
5	Mr. Bradley Poku-Agyemang	Special Aide to Minister, Ministry of Energy	Member
6	Mr. Saliu Ades	Deputy Director, Energy Commission	Member
7	Ms. Stella Adams	Director, Policy Coordination, National Petroleum Auth.	Member
8	Mr. Winston A. Tugoba	Manager, Gas Power Authority	Member
9	Mr. Obed Fosu Brantah	Pring. Officer, Petroleum Downstream, Ministry of Energy	Member
10	Mr. Albert Agyekye-Forsah	Engineer, Petroleum Upstream, Ministry of Energy	Member
11	Mr. Godwin Nene	Head for Petroleum Upstream, Ministry of Energy	Member
12	Mr. Herman Mamey	Head for O&G, Ministry of Energy	Member
13	Mr. Maximilian Kwaheng	Technical Advisor, Ministry of Energy	Member
14	Mr. Simplice Akaho	Energy Economist, Energy Commission	Member
15	Dr. Hymenah Gyeng	Manager, Commercial, Ghana National Gas Company	Member

The Workplan for the Committee's activities towards the preparation of the Framework is shown below:

#### National Long Transition Committee

2006



The Chinese Government reported that the total amount of foreign direct investment in the copper industry in the following spending:

1. American and World Bank loan for construction

2. Loan from Japan Government

3. Electric fee Company of China

4. Full Power Company

5. Chinese National Government

6. National Petroleum Authority

7. American Government

8. World Bank



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