



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 200MtCO₂-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.

THE ENERGY TRANSITION FRAMEWORK

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.

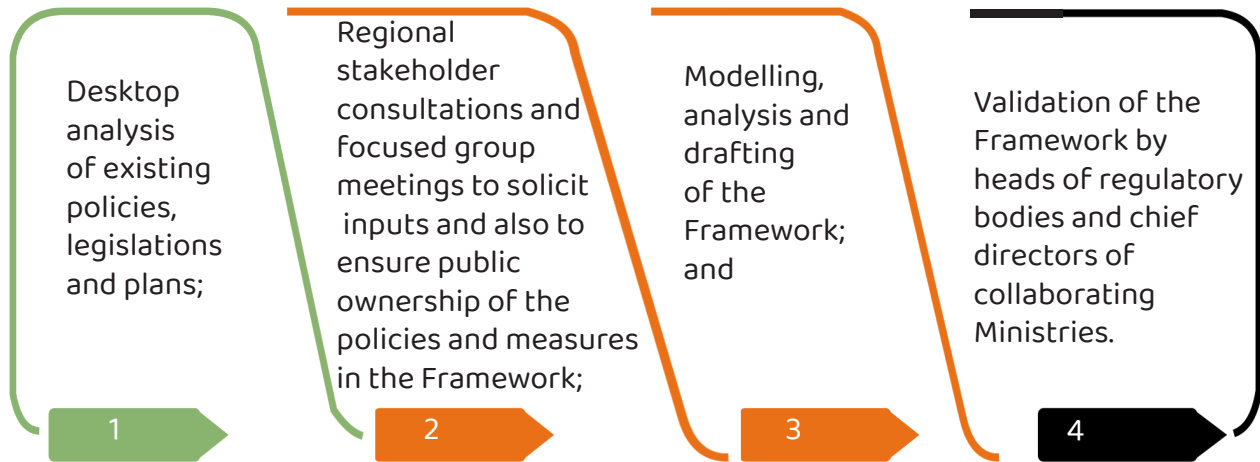
The Ministry of Energy in collaboration with other sector Ministries – Transport, Environment, Science and Innovation, Finance, Lands and Forestry, Water and Sanitation; has produced this Framework to provide a roadmap on Ghana's transition pathways to ensure sustainable development.

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 Framework, the following steps were taken:



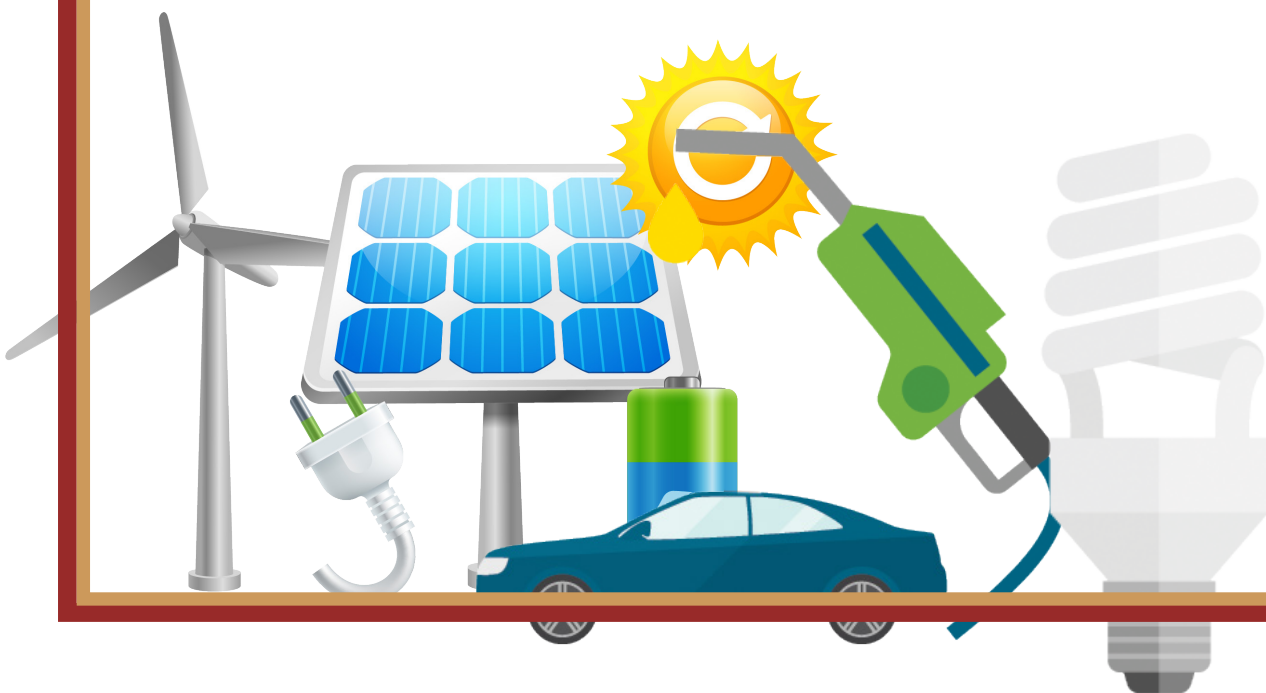
Ghana already has energy sector policies and measures in place which have the effect of reducing GHG emissions. While these policies were not formulated with net zero targets in mind, they provide an adequate baseline for Ghana's Energy Transition and contextualises ongoing emissions reduction efforts. 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. The Energy Transition Model (ETM) explores matured energy technologies for the use and transformation of fuels for the provision of energy. 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.

HIGHLIGHTS OF GHANA'S ENERGY TRANSITION FRAMEWORK

- ⚡ It is a long-term framework (**2022 – 2070**);
- ⚡ Guarantees the best fuel supply security due to a diversified fuel mix including natural gas and nuclear energy;
- ⚡ Estimated **200MtCO₂-eq** emission avoided (Energy Transition emission - **14.5MtCO₂-eq**);
- ⚡ Access to and commercialization of the green trade market (**21GW** of installed capacity);
- ⚡ Achieves universal access to electricity – **99.8%** by **2030**;
- ⚡ Lower long-term cost of electricity generation - below **4.5cents/kWh**;
- ⚡ Meets future electricity demand of **380,000 GWh** (**83GW** install capacity) due to fuel switch;
- ⚡ Minimises energy-related indoor air pollution and its related illnesses - **48,218** premature deaths avoided due to improvement in air quality and health;
- ⚡ **30.05 million** productive hours gained due to the upscaled adoption of clean cooking fuels. This would have a significant impact on women and children who are the main gatherers of firewood;
- ⚡ New job opportunities to be created is estimated at **1,404,702** due to the introduction of new technologies such as CCUS, Nuclear, Hydrogen, EV charging stations, etc.;
- ⚡ Achieves just and equitable transition both in universal access to electricity and the exploitation of our natural resources to support economic development; and
- ⚡ Requires estimated financing to the tune of **US\$562 billion**.





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%.**

Key assumptions for the modelling are as follows:

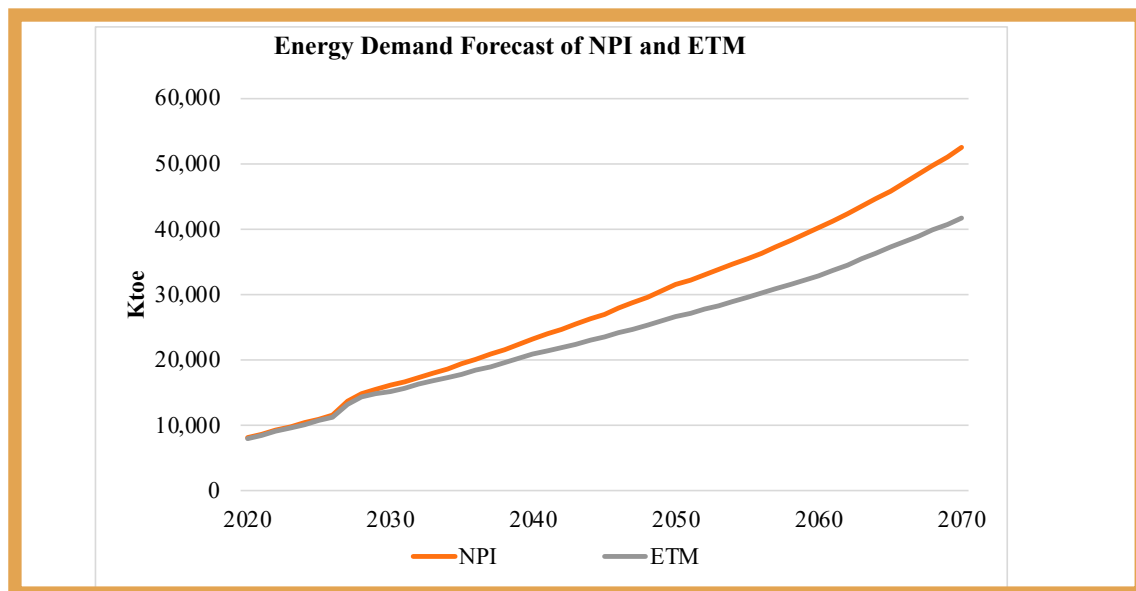


The Energy Transition Model (ETM) considered the use of:

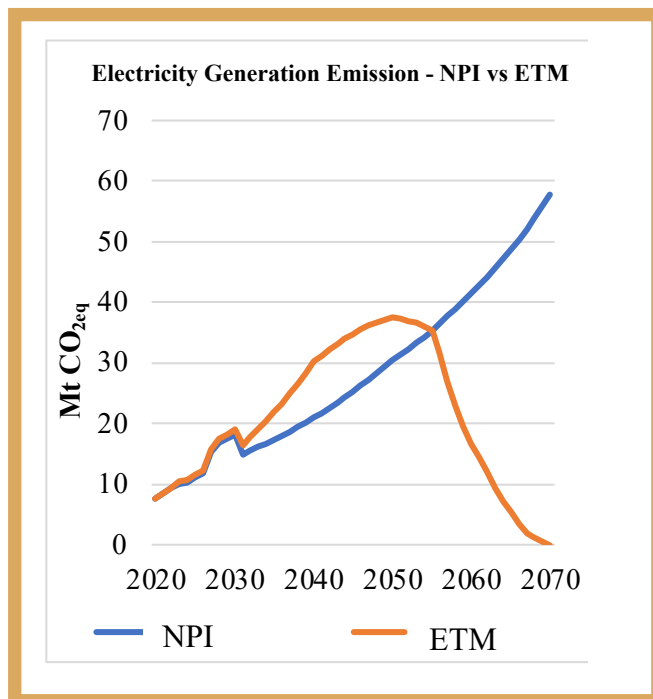
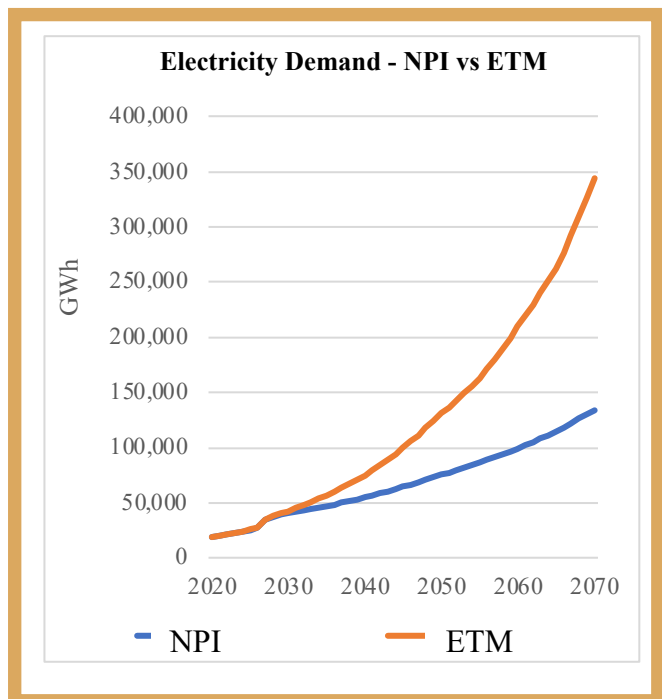
- ⚡ nuclear for power generation;
- ⚡ Carbon Capture, Utilization and Storage (CCUS) technology;
- ⚡ compressed natural gas, electric and hydrogen fuel cell vehicles;
- ⚡ sustainable aviation fuel;
- ⚡ efficient energy transformation processes; and
- ⚡ efficient end-use appliances.

The modelling forecasted the following:

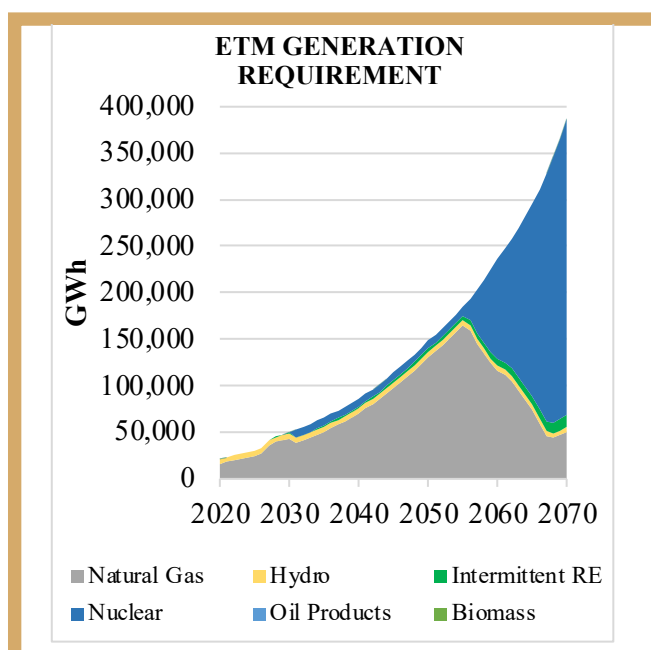
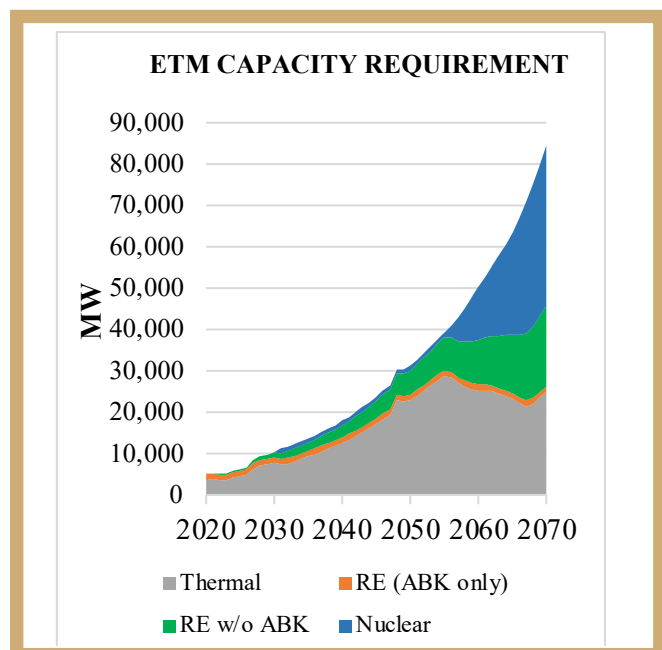
- ⚡ **Energy Demand Forecast:** Ghana's total energy demand is expected to rise over time due to population and economic growth. The total energy demand is expected to increase from 8,195 Ktoe to 41,725 Ktoe in 2070.



- 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 MtCO₂-eq in 2020 and peak in the mid-2050s and then decrease to zero (0) MtCO₂-eq by 2070. The attainment of net zero is attributed to the introduction of cleaner technologies.

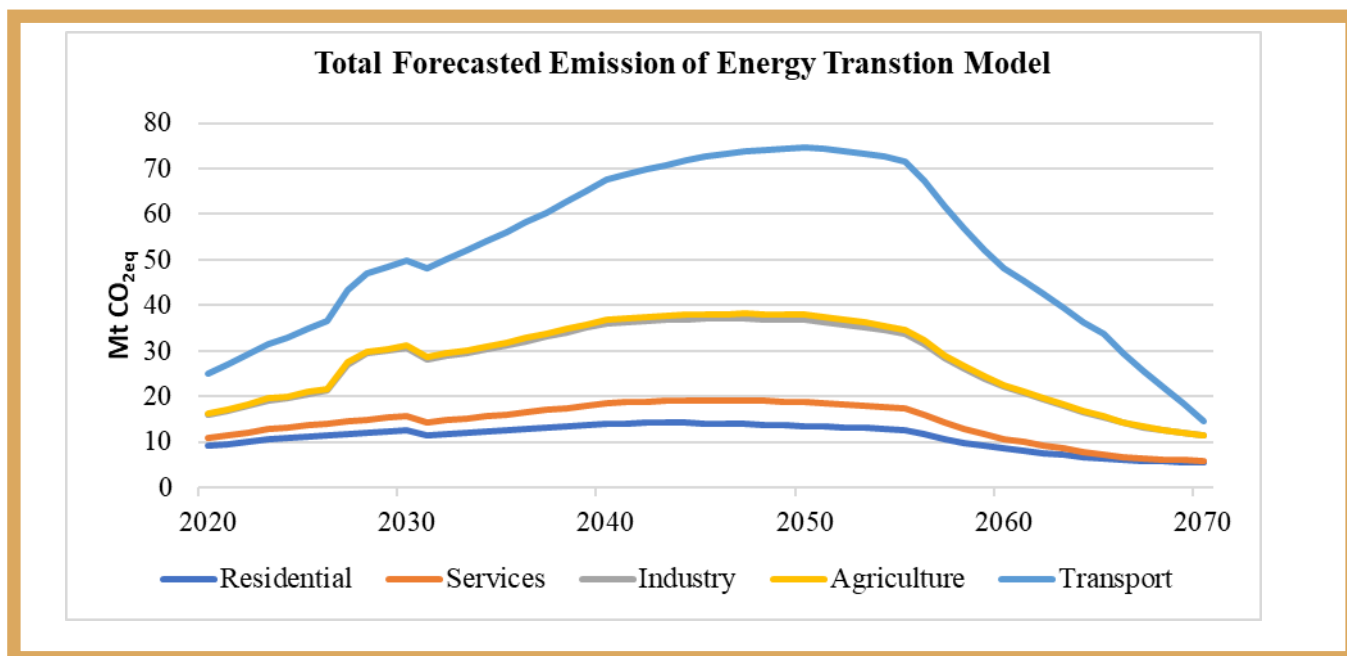


- Electricity Generation Capacity Requirement:** The electricity generation capacity requirement increased from 5,392 MW in 2020 to 84,308 MW in 2070. Natural gas-fuelled power plants will play a significant role in the generation mix but to achieve net-zero emission for the electricity generation sector, 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 MtCO₂-eq in 2020 and peak by the mid-2050s and decline thereafter. By 2070, emissions are expected to reduce to 14.5 MtCO₂-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

- ⚡ 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

- ⚡ 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

- ⚡ 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

- ⚡ 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.



Ministry of Energy
P. O. Box SD40
Stadium Post Office
Accra, Ghana

Tel+233 (0) 302 683961/4
Fax: 668262
DD Code (233-302)
Email: moen@energymin.gov.gh
www.energymin.gov.gh

