ENERGY OUTLOOK

FOR GHANA

Demand and Supply Outlook

2024

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DECEMBER 2023

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EXECUTIVE SUMMARY

The Energy Commission in fulfilment of its mandate under the Energy Commission Act (Act 541, 1997) Section 2(2)c presents supply and demand forecasts for electricity, petroleum and woodfuel for the year 2024.

Electricity Sub-sector

As of December 26, 2023, Ghana's system peak load stood at 3,618 MW, representing a 4.3% increase from the 2022 recorded peak demand. In 2024, system peak load is estimated to be 3,788 MW, reflecting a 4.7% increase from 2023. Factors to influence the peak demand in 2024 include economic growth and increased loads, notably, commissioning of ongoing rural electrification initiatives within ECG and NEDCo distribution zones, aligned with Ghana's goal of achieving universal electrification by the end of 2024. In November 2023, total electricity consumption reached 21,440 GWh, with a projected year-end figure of 23,617 GWh. In 2024, projected electricity consumption is 24,997 GWh, representing a 5.8% increase.

Hydro, thermal, and renewables constitute Ghana's electricity generation mix. Installed generation capacity excluding embedded capacity as of November 2023 was 5,194 MW with a total dependable capacity of 4,756 MW. The installed capacity increases to 5,492.1 MW (with a dependable capacity of 5,012 MW) if embedded capacity at the sub-transmission (distribution grid) level is added.

In 2024, installed capacity of 5,194 MW with a dependable capacity of 4,756 MW will be available to the grid and utilized to meet the projected system peak demand of 3,788 MW giving a reserve margin of 25%. However, factoring in planned scheduled maintenance for generation units and fuel supply situation, available capacity could be 4,400 MW of the total dependable capacity.

Hydropower and thermal plants are projected to generate 8,734 GWh (34.9%) and 16,091 GWh (64.4%) of total electricity supply in 2024. The remaining supply of 172 GWh, representing 0.7%, is expected to be met by other renewables, including solar PV and biogas operating at the sub-transmission level.

No power import is anticipated in 2024. However, inadvertent energy exchanges on tie-lines could result from transient flows. Emergency imports may be necessitated as a result of short-term capacity shortages caused by faults or fuel supply contingencies.

In 2024, natural gas will remain the predominant fuel for thermal power facilities. The projected total natural gas consumption for electricity generation in 2024 is approximately 137.5 TBtu (121,650 MMscf). In 2024, an estimated 341,190 barrels of HFO will be required by the AKSA to fuel some of its units. The total fuel expenditure for the year is estimated at US$1,147.23 million, with US$1,116.50 million, about 97% expected to be used for the procurement of natural gas, while the remaining will be for the procurement of HFO to fuel some units of the AKSA plant.

GRIDCo's analysis of the transmission network reveals that lowest losses are registered on the NITS in the Balanced Generation scenario, which includes the relocation of the 250 MW Ameri Power Plant from Takoradi to Kumasi to create another generation enclave aside the East and West enclaves. This scenario is expected to reduce transmission system losses significantly, improve voltages and aid export.

Also, GRIDCo is executing a number of projects aimed at improving reliability, transfer capacity, reducing losses and improving voltages. Key among them are:

- 161 kV, Achimota - Accra line reconstruction
- 161kV Achimota – Mallam line reconstruction

Petroleum Sub-sector

As of July 2023, the total volume of crude oil produced from the three commercial fields - Jubilee, TEN, and Sankofa was 26.42 million barrels, a decrease from the 30.40 million barrels produced over the same period in 2022. In 2024, Ghana anticipates a further decline in total crude oil production to 44.94 million barrels, attributed to reductions in output from the Jubilee, TEN, and Sankofa fields. The average daily production is forecasted to be 123,129 barrels, with the Jubilee field contributing the highest at 82,391 barrels per day. Brent crude oil prices for 2024 are projected at US$82.58 per barrel.

Natural gas production from the three domestic fields is estimated to reach 300,680 MMscf in 2024, with an average daily production of 824 MMscf. Gas exports to the Atuabo Gas Processing Plant (AGPP) and ENI Offshore Receiving Facility (ORF) are projected to be 36,600 MMscf and 86,010 MMscf, respectively in 2024. Power plants are expected to consume 121,650 MMscf, while non-power industries will utilise 13,759 MMscf. Meanwhile 26,550 MMscf is expected to be imported from Nigeria to supplement domestic supply.

Total petroleum product consumption in 2024 is estimated at 4,797.3 kilotonnes, with gasoil, gasoline, and LPG accounting for significant shares. Gasoil consumption is projected at 2,109.5 kilotonnes, gasoline at 1,781.4 kilotonnes, and LPG at 329.05 kilotonnes. Other products, including ATK, kerosene, Premix, RFO, and MGO, are also expected to see varying levels of consumption.

Woodfuel Sub-sector

In 2023, wood extraction for direct use as firewood was estimated at 1,720 Ktoe, while extraction for charcoal production was 2,327 Ktoe. Other biomass production, mainly crop residue, was estimated at 23 Ktoe. In 2024, firewood extraction is projected to increase by 1.2% to 1,740 Ktoe, while charcoal production is expected to rise by 1.9% to 2,370 Ktoe. Other biomass production will remain at 23 Ktoe.

The residential sector was the largest biomass consumer in 2023, with households using 2,572 Ktoe, while the industrial and services sectors consumed 324 Ktoe and 105 Ktoe, respectively. Biomass consumption has been on the rise over the past decade, but this trend could be reversed with increased LPG penetration, especially in rural areas. In 2024, household biomass consumption is expected to reach 2,618 Ktoe, with the services and industrial sectors consuming 112 Ktoe and 351 Ktoe, respectively.

In 2023, the national average price per kilogramme of charcoal was GH¢2.84 which is lower than the average price of LPG per kilogramme (GH¢12.6). Considering the efficiencies of LPG stoves and charcoal stoves, the cost of utilising charcoal in the traditional charcoal stove is 7% to 28% cheaper than using LPG. When improved cookstove such as Gyapa is used instead of LPG, the saving is almost half of the cost of using LPG.

PREFACE

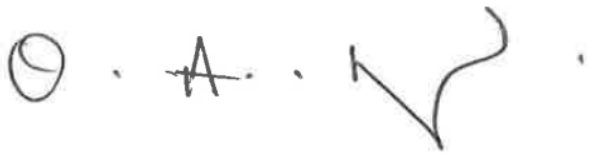
ENERGY COMMISSION is mandated to prepare, review and update periodically indicative national plans to ensure that reasonable demands for energy are met in a sustainable manner. The Commission is also mandated to secure and maintain a comprehensive database for national decision-making for the efficient development and utilisation of energy resources available to the nation. The Commission's jurisdiction includes promoting and ensuring uniform rules of practice for the production, transmission, wholesale supply, distribution and sale of electricity and natural gas.

In fulfilment of its mandates, the Commission has been preparing energy demand and supply outlook annually to provide guidelines to energy sector operators and potential investors as well as the wider business community wishing to operate in the country. The 2024 Annual Energy Outlook is to give government, industry and business, indications of the levels/quantities of electricity, liquid and gaseous fuels that would be required to be provided by the energy producers for this year.

The Energy Outlook for Ghana outlines projections for energy demand and supply for the year 2024. It provides an overview of the actual performance of the energy sector, specifically the electricity and petroleum industry performance as well as the woodfuel subsector of the preceding year (2023) comparing actuals to projections. It continues to forecast 2024 energy demand and supply.

In this report, 'Demand' is used when referring to gross fuel or energy required by a demand sector, e.g., residential, commercial, or industry. 'Supply Requirement' is supply or generation/production plus transmission/transport losses.

Your comments and suggestions are most welcome.



Ing. Oscar Amonoo-Neizer
Executive Secretary

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATION

AGPP	Atuabo Gas Processing Plant
ATK	Aviation Turbo Kerosene
BGS	Bui Generation Station
BPA	Bui Power Authority
BSPs	Bulk Supply Points
CEB	Communauté Electrique du Bénin
CIE	Compagnie Ivoirienne d'Électricité
COVID-19	Novel Coronavirus Disease
ECG	Electricity Company of Ghana
EIA	US Energy Information Administration
EMOP	Electricity Market Oversight Panel
ESD	Emergency Shutdown
FPSO	Floating Production Storage and Offloading
GDP	Gross Domestic Product
GNGC	Ghana National Gas Company
GNPC	Ghana National Petroleum Corporation
GRIDCo	Ghana Grid Company
GWh	Gigawatt hour
HFO	Heavy Fuel Oil
IPPs	Independent Power Producers
kg	Kilogram
km	Kilometer
Ktoe	Thousand Tonnes of Oil Equivalent
KTPP	Kpone Thermal Power Plant
kV	Kilovolt
kW	Kilowatt
LCO	Light Crude Oil
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MAF	Million Acre Feet
MGO	Marine Gas Oil
MMBtu	Million British Thermal unit
MMscf	Million Standard Cubic Feet
MVA	Megavolt Amperes
MVAr	Megavolt Ampere of Reaction Power
MW	Megawatt
MWp	Megawatts-peak

NEDCo	Northern Electricity Distribution Company
NG	Natural Gas
N-Gas	Nigeria Gas
NITS	National Interconnected Transmission System
NMS	Network Manager System
NPA	National Petroleum Authority
OCTP	Offshore Cape Three Point
OMCs	Oil Market Companies
ORF	Offshore Receiving Facility
PC	Petroleum Commission
PIAC	Public Interest and Accountability Committee
PPTC	Power Planning Technical Committee
PURC	Public Utilities Regulatory Commission
PV	Photovoltaics
RFO	Residual Fuel Oil
SAPP	Sunon-Asogli Power Plant
SCADA	Supervisory Control and Data Acquisition
TAPCO	Takoradi Power Company
Tbtu	Trillion British Thermal Unit
TDS	Takoradi Distribution Station
TEN	Tweneboa, Enyenra, Ntomme
TICO	Takoradi International Company
TOR	Tema Oil Refinery
TT1PP	Tema Thermal Power Plant 1
TT2PP	Tema Thermal Power Plant 2
TTIP	Tema-Takoradi Interconnection Pipeline
TUF	Transformer Utilization Factor
US WTI	US West Texas Intermediate
VALCO	Volta Aluminium Company
VRA	Volta River Authority
WAGP	West Africa Gas Pipeline
WAGPCo	West Africa Gas Pipeline Company
WAPCO	West Africa Pipeline Company
WAPP	West African Power Pool

Chapter 1: Introduction

1.1 Introduction

Energy demand and supply in Ghana is influenced by a range of factors such as weather, economic growth, inflation and energy efficiency. In particular, residential electricity use is sensitive to weather conditions. A trend analysis of historical consumption shows that during the colder periods (June to September), households tend to use less electricity, and during the warmer (January to May), households tend to use more.

In addition to weather conditions, economic growth increases energy demand in the commercial and industrial sectors. The country's overall real GDP is projected to grow by some 2.8% (non-oil real GDP to grow by 2.1%[1]) in 2024, which will drive an increase in energy demand. Additionally, the government's efforts to expand access to electricity will impact both the demand and supply sides of energy.

However, the government's efforts to promote energy efficiency and the ongoing activities of the utilities (ECG & NEDCo) to reduce losses (especially commercial losses) are likely to offset some of the increases in energy demand. The 2024 Annual Energy Outlook, therefore, seeks to determine the country's ability to meet its energy demand sustainably.

[1] Highlights of the 2024 Budget and Economic Policy: https://mofep.gov.gh/sites/default/files/budget statements/2023-Budget-Highlights.pdf

Chapter Two: Electricity Outlook 2024

2.1 Electricity Demand Outlook

2.1.1 Projected Peak Demand for 2024

As of December 27, 2023, Ghana's system peak load, observed on December 11, 2023, stands at 3,618 MW. This peak load signifies a 4.3% increase compared to the recorded peak demand of 3,469 MW during the same period in 2022.

In 2024, the country's system peak load is estimated at 3,788 MW, representing a 4.7% increase from the December 11, 2023 peak demand. The peak for 2024 is anticipated to take place in December 2024 (see Figure 1). This estimate is accompanied by a 95% confidence interval, with a lower bound of 3,587 MW and an upper bound of 3,989 MW.

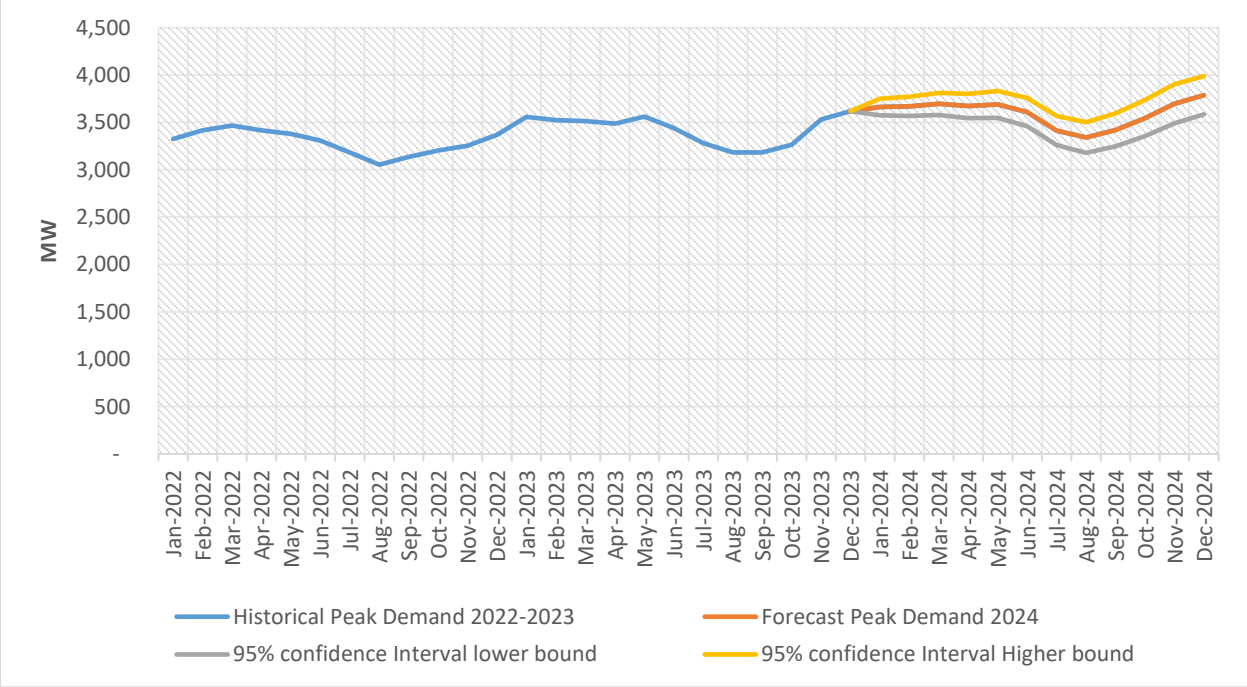


Figure 1: Monthly projected peak demand for 2024 with 95% confidence interval

Anticipated factors influencing the peak demand in 2024 include the expansion of the ECG and NEDCo networks leading to increased loads, commissioning of ongoing rural electrification

initiatives within ECG and NEDCo distribution zones, aligned with Ghana's goal of achieving universal electrification by the end of 2024.

In 2024, it is anticipated that ECG and NEDCo will contribute 65.3% and 8.1% to the system peak, while Export and the Mines are expected to contribute 9.1% and 6.9% respectively. VALCO, operating on two pot-lines, is projected to contribute 3.6%, and other direct customers are expected to contribute 1.3%. Transmission loss, along with network usage, is estimated to contribute 4.6% to the system peak (see Figure 2).

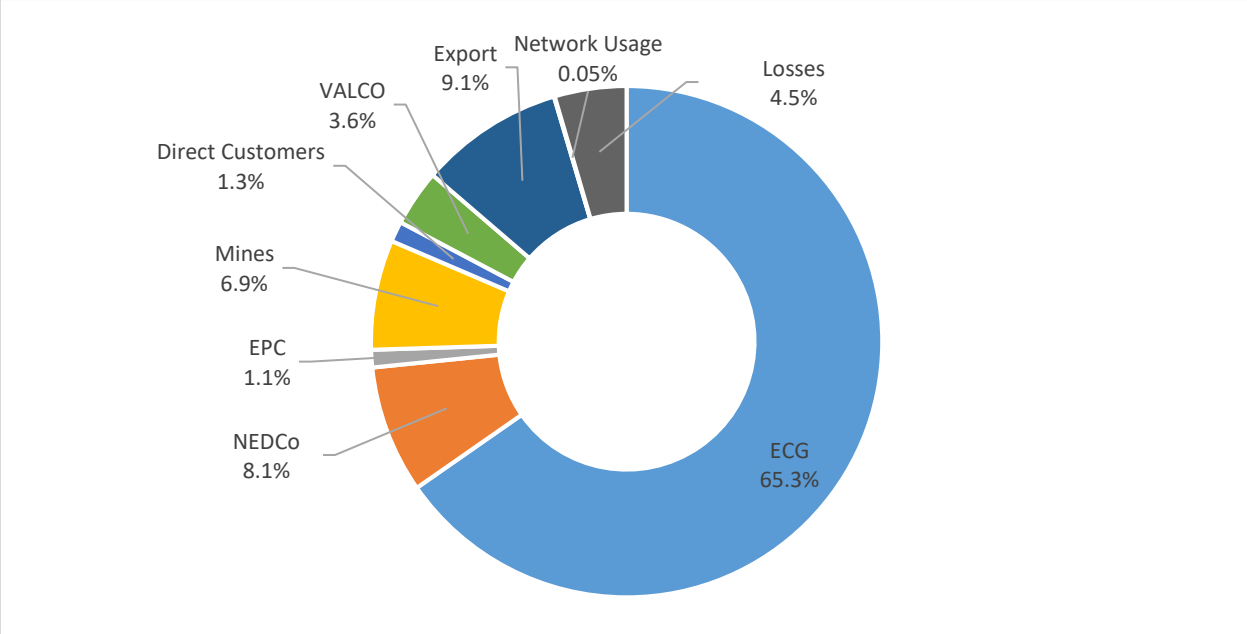


Figure 2: Share of projected peak demand by customer class in 2024

2.1.2 Projected Electricity Consumption for 2024

As of November 2023, the total electricity consumption has reached 21,440 GWh, reflecting a 4.3% growth compared to the corresponding period in 2022. The projected total electricity consumption for the entire year of 2023 is expected to be 23,617 GWh, representing a 5.1% increase over the 2022 consumption of 22,478 GWh.

In 2024, the projected electricity consumption is 24,997 GWh, representing a 5.8% increase from the expected consumption in 2023. This estimated electricity consumption for 2024 falls within

a 95% confidence interval, with a lower bound of 22,739 GWh and an upper bound of 27,271 GWh (see Figure 3).

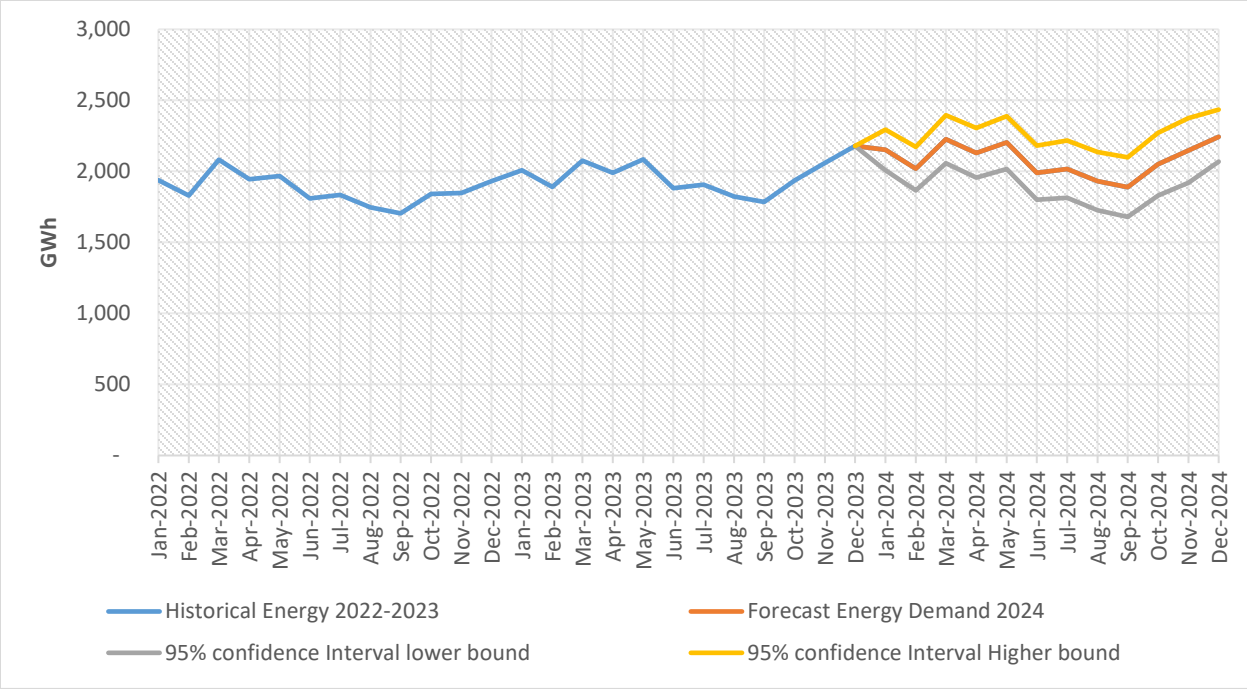
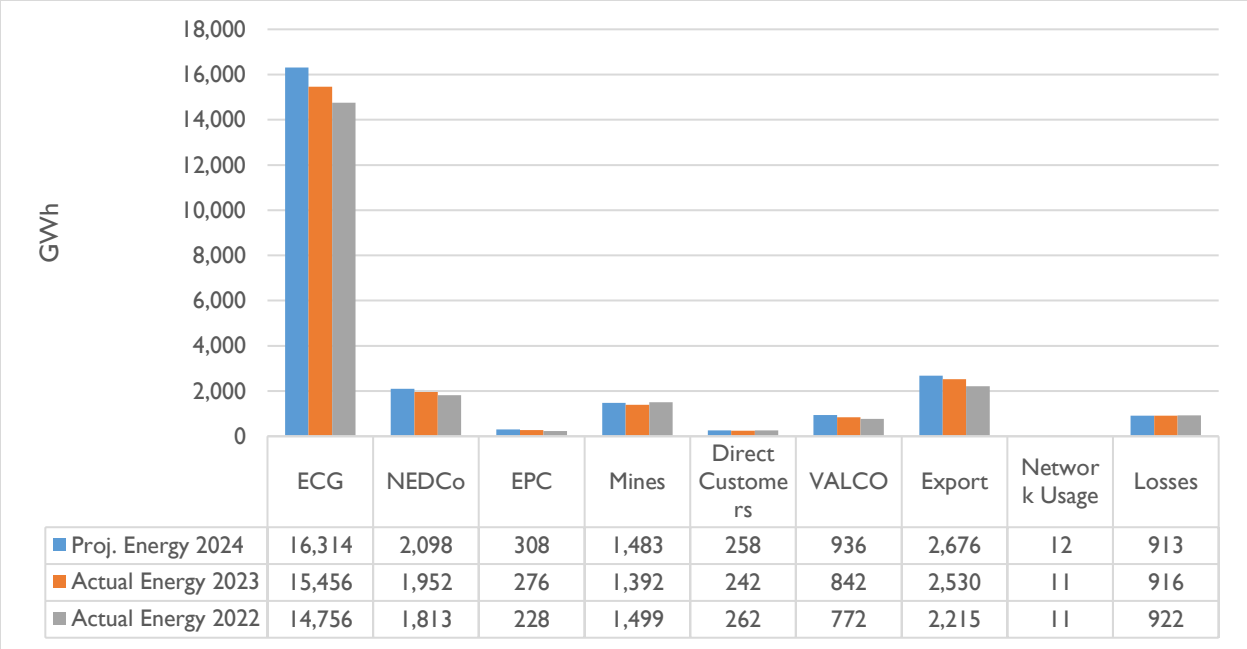


Figure 3: Projected monthly energy for 2024 with 95% confidence interval

As of November 2023, the amount of electricity ECG and NEDCo consumed is 14,039 GWh and 1,771 GW respectively. These figures are higher than the 13,449 GWh and 1,664 GWh consumed in the same period in 2022. By the end of the year, ECG and NEDCo consumption are expected to reach 15,456 GWh and 1,952 GWh, representing 4.8% and 7.7% increase from the previous year. Anticipated consumption for other customers by year-end 2023 compared with 2022 are shown in Figure 4.

In 2024, ECG consumption is estimated to reach 16,314 GWh, representing a 5.5% increase from 2023 consumption. Forecasts for 2024 are shown in Figure 4.



	ECG	NEDCo	EPC	Mines	Direct Customers	VALCO	Export	Network Usage	Losses
Proj. Energy 2024	16,314	2,098	308	1,483	258	936	2,676	12	913
Actual Energy 2023	15,456	1,952	276	1,392	242	842	2,530	11	916
Actual Energy 2022	14,756	1,813	228	1,499	262	772	2,215	11	922

Figure 4: 2024 Projected electricity consumption by customer classes, Network Usage and Losses

ECG's share of electricity consumption will be 65.3% of the total projected electricity consumption for 2024. Export (to Togo/Benin, Côte d'Ivoire and SONABEL) is expected to constitute 10.7% of total consumption. NEDCo and Mines are projected to consume 8.4% and 5.9% of total electricity consumption, respectively (see Figure 5).

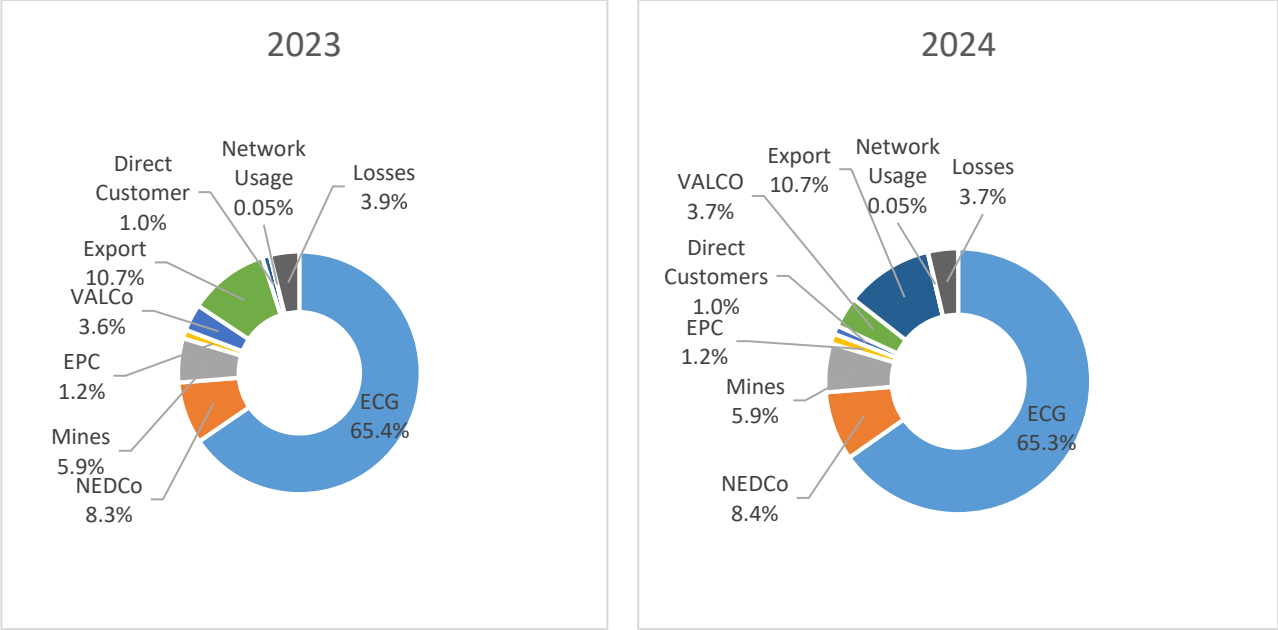


Figure 5: Share of projected electricity consumption by the various customer classes, and Losses

2.1.2.1 Transmission Loss in 2024

As of November 2023, transmission loss stood at 3.9% (835 GWh), a decrease from 4.1% (849 GWh) in the same period in 2022 and is anticipated to reach 3.9% (915 GWh) by year-end 2023. In 2024, transmission loss is forecast to reduce slightly to 913 GWh (representing 3.7% of the total electricity to be transmitted). The decline in losses (see Figure 6) is attributed to measures taken by GRIDCo, notably some major reinforcement in the NITS.

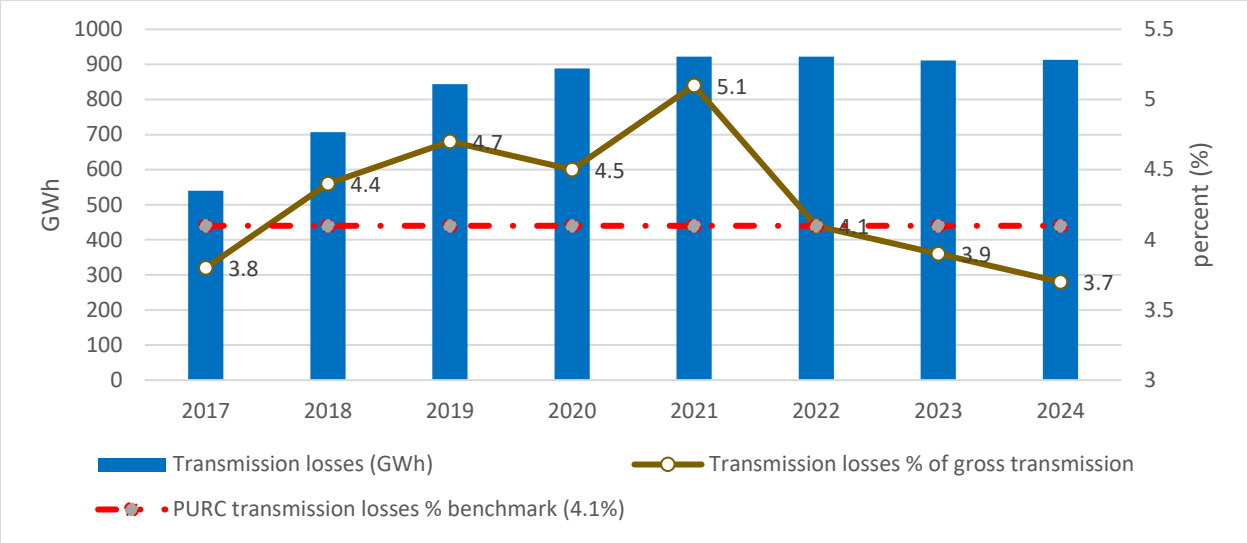
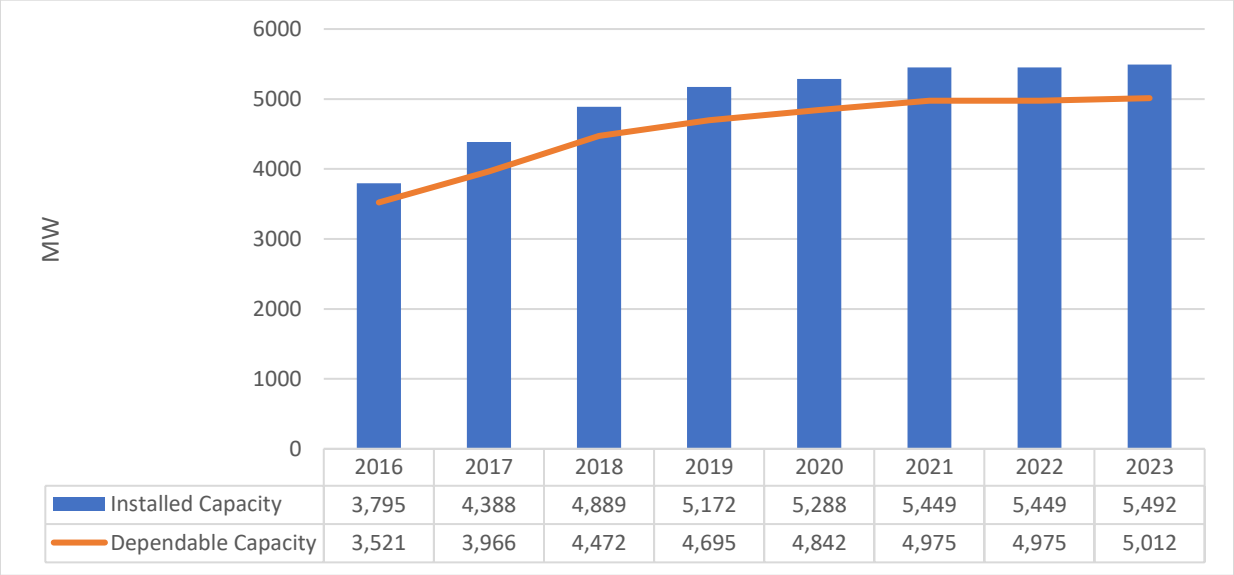


Figure 6: Trend in transmission losses

2.2 Electricity Supply Outlook

2.2.1 Generation Sources for 2024

Ghana's electricity generation sources are hydro, thermal (fired using natural gas, light crude oil, heavy fuel oil and diesel) and renewables (solar and biogas). Electricity generation capacity has increased over the last few years, as depicted in Figure 7.



	2016	2017	2018	2019	2020	2021	2022	2023
Installed Capacity	3,795	4,388	4,889	5,172	5,288	5,449	5,449	5,492
Dependable Capacity	3,521	3,966	4,472	4,695	4,842	4,975	4,975	5,012

Figure 7: Installed and dependable capacity in the recent past

Total installed electricity generation capacity increased from 3,795 MW in 2016 to 5,492.1 MW as of November 2023, representing an increase of 44.7%. Dependable capacity increased from 3,521 MW to 5,012 MW over the same period. Excluding embedded generation units, installed capacity as of the end of November 2023 was 5,194 MW, with a total dependable capacity of 4,756 MW. Table 7 shows the full complement of power plants in Ghana and shares of installed and dependable capacities by generating sources (hydro, thermal and other renewable).

Table 1: Installed generation capacity as of the end of November 2023

Power Plant	Fuel Type	Installed Capacity (Nameplate)	% Share	Dependable Capacity	% Share
Hydro Power Plants					
Akosombo	Hydro	1,020		900	
Bui	Hydro	404		330	
Kpong	Hydro	160		140	
	Sub-total	**1,584**	**28.8%, *30.5%**	**1,370**	**27.9% *28.8%**
Thermal Power Plants					
Takoradi Power Company (TAPCO)	Oil/NG	330		315	
Takoradi International Company (TICO)	Oil/NG	340		330	
Sunon–Asogli Power (SAPP)	NG	560		530	
Tema Thermal Plant1 (TT1P)	Oil/NG	110		100	
Tema Thermal Plant2 (TT2P)	Oil/NG	80		70	
CENIT Energy Ltd (CEL)	Oil/NG	110		100	
KTPP	Oil	220		200	
AMERI	NG	250		230	
Karpower	NG/HFO	470		450	
AKSA	HFO	370		330	
Cenpower	Oil/Diesel	360		340	
Amandi	Oil/NG	210		201	
Early Power	NG/LPG	200		190	
	Sub-total	**3,610**	**69.5%**	**3,386**	**71.2%**
Genser	NG/LPG	181		157.8	
Sub–total (incl. embedded gen.)		**3,791**	**69.0%**	**3,544**	**70.7%**
Renewables (excl. large hydro)					
VRA Solar (Navrongo)	Solar	2.5		2	
Meinergy Solar	Solar	20		16	

BXC Solar	Solar	20		16	
VRA Solar (Lawra)	Solar	6.5		4.5	
VRA Solar (Kaleo)	Solar	13		10	
Tsatsadu Hydro	Hydro	0.045		0.045	
Bui Solar	Solar	55		49.5	
Safisana Biogas	Biogas	0.1		0.1	
Sub–total		**117.145**	**2.1%**	**98.145**	**2.0%**
Total (incl embedded gen.)		**5,492.145**		**5,012**	
Total (excl embedded gen.)		**5,194**		**4,756**	

*Capacity share excluding embedded generation capacity

As of November 2023, hydro plants contributed 28.9% of the total installed capacity, with conventional thermal plants and renewable sources contributing 69.1% and 2.0% respectively. Thermal plants contributed about 71.2% of the dependable capacity used to meet the peak demand of the country in 2023. In 2024, no committed power plants (plants expected to come online during the year) are anticipated to be commissioned. Thus, only existing capacity as of November 2023 will be considered for electricity supply in 2024.

2.2.2 Generation Sources Availability in 2024

2.2.2.1 Hydro Generation Sources

For 2024, all six units of Akosombo hydropower will be available for power generation. This gives an operating capacity of up to 900 MW with an average capacity of 150 MW for each of the six available units. Also, the Kpong hydropower plant (downstream of Akosombo) will have all four units available in 2024, with a total capacity of 140 MW. Bui hydropower plant is expected to operate one unit (110 MW) off-peak and a maximum of two units (220 MW) at peak in 2024. In critical situations, all three units (330 MW) will be dispatched to meet demand.

2.2.2.2 Thermal Generation Sources

Dependable capacity to be made available for thermal generation in 2024 amounts to 3,386 MW. Thermal facilities are primarily located in the South East and South West enclaves. Thermal plants in the South East constitute 54.3% of the total dependable capacity, while South West is 38.8%. A power enclave in the Ashanti is the most recent and it is expected to among others, improve

system reliability. The anticipated relocation of the 250 MW Ameri plant to the Ashanti enclave is projected to contribute the remaining 7%. Independent Power Producers (IPPs) are expected to play a significant role, providing the majority of the dependable capacity at 62.7%, with the remaining 37.3% supplied by the Volta River Authority (VRA).

2.2.2.3 Renewable Generation Sources

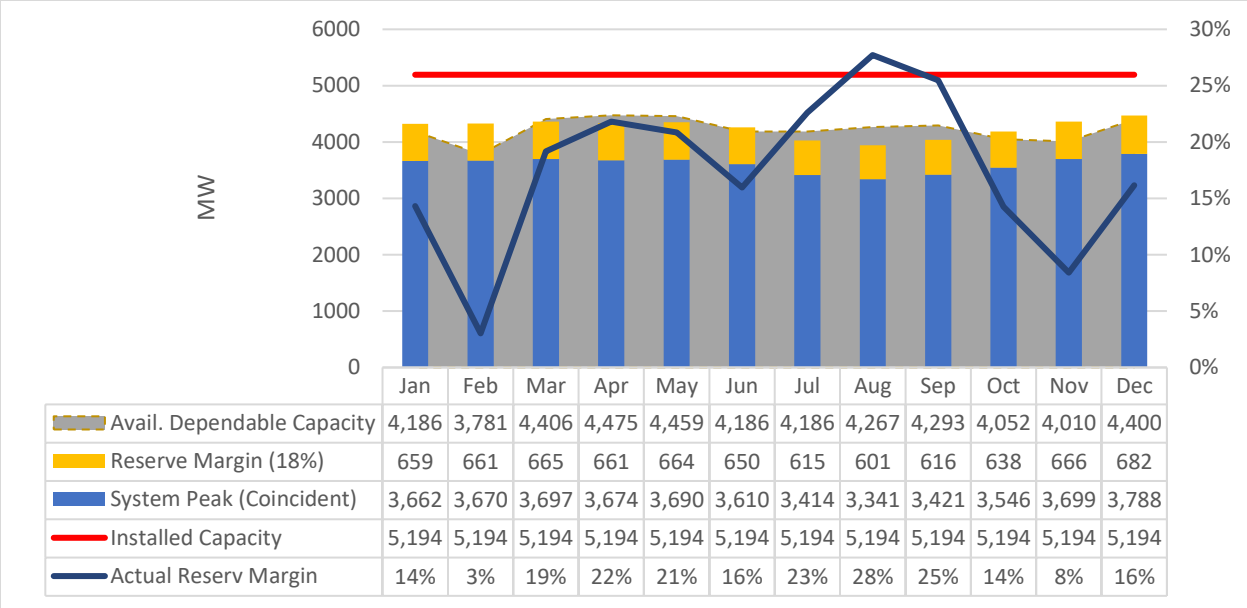
In the pursuit of a more sustainable and eco-friendly energy future, Ghana has committed to developing its renewable energy resources. The total renewable capacity going into 2024 is 117 MW. The Volta River Authority (VRA) contributes a total of 18.8% of the total utility-scale and grid-connected solar plants in the country. These include a 2.5 MWp solar plant in Navrongo, a 6.5 MWp facility in Lawra, and a 13 MWp installation in Kaleo. Bui Power Authority (BPA) adds substantial contributions through its 50 MWp Bui Solar PV farm and a 5 MWp floating solar facility to the renewable capacity. There are also private players including BXC and Meinergy contributing 20 MWp each to the renewable capacity.

2.2.2.4 Electricity Import

Power import in 2024 is not anticipated. However, inadvertent energy exchanges on tie-lines could result from transient flows. Emergency imports may be necessitated as a result of short-term capacity shortages caused by faults or fuel supply contingencies.

2.2.3 Generation Capacity and Projected Peak Demand

Projected monthly dependable capacities, taking planned units' maintenance and fuel supply situation into consideration, are shown in Figure 8. The monthly demand-supply balance for 2024 results in reserve margins between 3% and 28%. A reserve margin of 3% in February is due mainly to planned generation maintenance. Such a situation will require re-arrangement of non-critical outages.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avail. Dependable Capacity	4,186	3,781	4,406	4,475	4,459	4,186	4,186	4,267	4,293	4,052	4,010	4,400
Reserve Margin (18%)	659	661	665	661	664	650	615	601	616	638	666	682
System Peak (Coincident)	3,662	3,670	3,697	3,674	3,690	3,610	3,414	3,341	3,421	3,546	3,699	3,788
Installed Capacity	5,194	5,194	5,194	5,194	5,194	5,194	5,194	5,194	5,194	5,194	5,194	5,194
Actual Reserv Margin	14%	3%	19%	22%	21%	16%	23%	28%	25%	14%	8%	16%

Figure 8: Projected monthly available capacity versus system peak for 2024

2.2.4 Demand-Supply Balance for 2024

The criteria to be used to determine which power plants would be dispatched on a monthly basis during the year are as follows:

i. Power Purchase Agreement signed with IPPs
ii. Power plant nomination based on off-taker requirements
iii. Availability of fuel for power plants
iv. Must-run plants (e.g., solar)
v. System stability requirements
vi. PURC and EMOP energy allocation for the year

It should be noted that in instances where there is a supply surplus, some plants would not be dispatched. The aggregated electricity demand-supply balance for 2024 is presented in Table 4.

Table 2: 2024 Projected electricity demand/supply balance, GWh

Customer Class	**Demand/Supply**
Domestic	21,385.3
VALCO	935.8
Export (CEB+CIE+SONABEL)	2,675.7
Total Energy Requirement	**24,996.9**
Projected Generation	
Hydro	
Akosombo	6,135.4
Kpong	1,064.8
Bui	1,533.4
Sub-total	**8,733.6**
Thermal	
TAPCO	1,845.6
TICO	2,161.0
TT1PP	400.5
KTPP	494.5
TT2PP	80.3
AMERI Power Plant	-
SAPP	2,969.8
CENIT	467.3
Karpower Barge	2,076.3
AKSA	924.9
CEN Power	2,387.9
Amandi	1,523.3
Early Power	759.5
Sub-total	**16,091.0**
Renewable	
VRA Solar (Navrongo)	2.8
VRA Solar (Kaleo A)	19.4
VRA Solar (Lawra)	10.3
Bui Solar	79.6
BxC Solar	30.7
Safisana	0.4
Meinergy Solar	29.0
Sub-total	**172.3**
Grand Total	**24,996.9**

As of November 2023, hydro generation marked a noteworthy ascent, recording 8,296 GWh, representing a substantial 10.8% increase compared to the same period in 2022. This surge was primarily attributed to exceptionally high inflows into the Akosombo dam causing the water level to reach its maximum. Consequently, all six units of the Akosombo hydroelectric plant operated with a resultant 94.7% capacity utilization from 15 September-30 October when the dam underwent spillage. Projections suggest that by the end of 2023, hydro generation will be about 9,183 GWh.

In 2024, total hydro generation is estimated to be 8,734 GWh, signifying a 4.9% decrease from the full-year generation of 2023. The envisaged decline in hydro generation in 2024 is attributed to a reversal of astronomical high inflows into the Akosombo dam in 2023, prompting water spillage to preserve the structural integrity of the dam.

A greater portion of electricity generation is from thermal sources. Between January and November 2023, the total electricity generated from thermal sources amounted to 12,999 GWh, an increase from the 12,947 GWh generated during the same period in 2022. Estimates indicate that by the end of 2023, the generation from thermal sources is expected to reach 15,341 GWh, marking an 8.4% increase from the year-end generation recorded in 2022. The forecast for year-end 2024 suggests a total generation of 16,091 GWh, reflecting a 4.9% increase over the anticipated generation in 2023 (see Figure 9).

Generation from renewable sources is expected to be 172 GWh in 2024, down from an anticipated 180 GWh by the end of 2023 (see Figure 9).

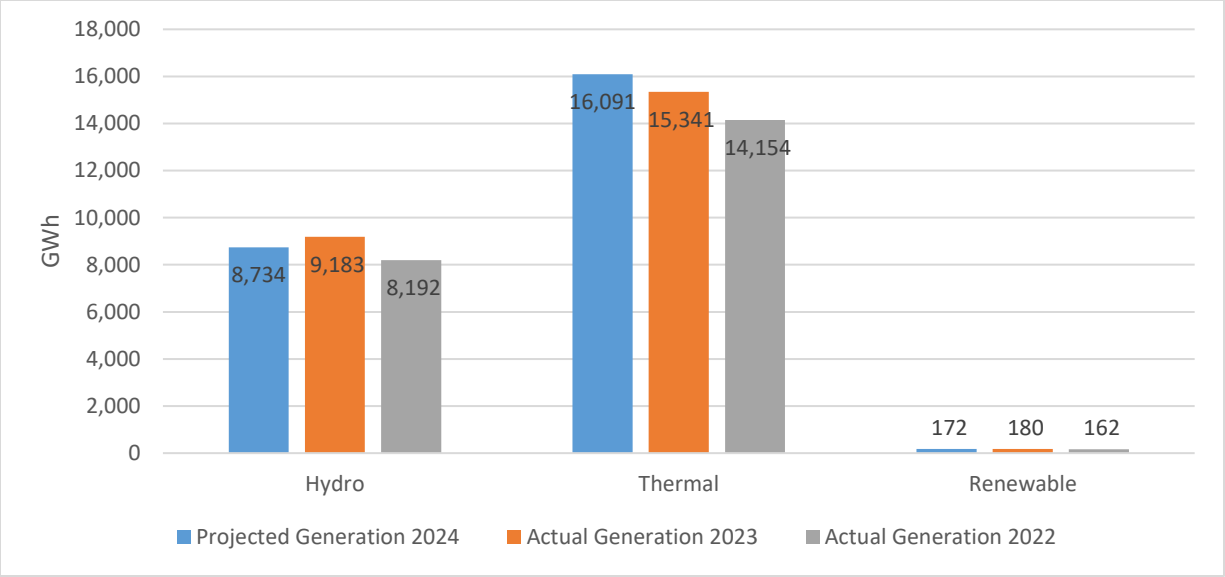


Figure 9: Projected electricity generation by generation source for 2024

Figure 10 shows the share of generation from various sources in 2024. Thermal generation and hydro generation would constitute 64.4% and 34.9% of total generation in 2024. Generation from renewable sources (solar PV and Biogas) would constitute 0.7%. This indicates the dominance of thermal generation in Ghana's overall generation mix and consequently the critical role that fuel availability to the thermal plants play in power supply reliability and supply security in the Ghana power system.

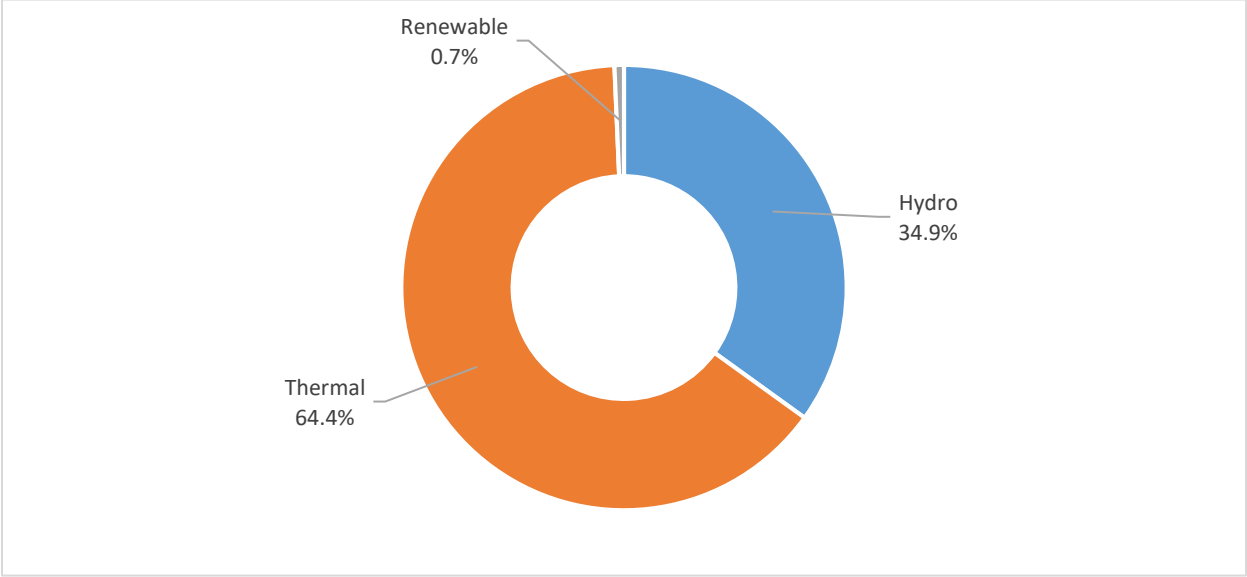


Figure 10: Share of electricity supply by generation source in 2024

2.3 Fuel Supply Outlook

2.3.1 Fuel Requirements

Natural gas will continue to be the dominant fuel for thermal electricity generation in 2024. It is expected to come from indigenous gas fields (Jubilee, TEN and ENI Sankofa) and import through WAGP. Based on the projected electricity supply from thermal sources, the total natural gas requirement for power generation for 2024 is projected to be 137.5 TBtu. The total fuel requirement for each thermal plant is shown in Figure 11.

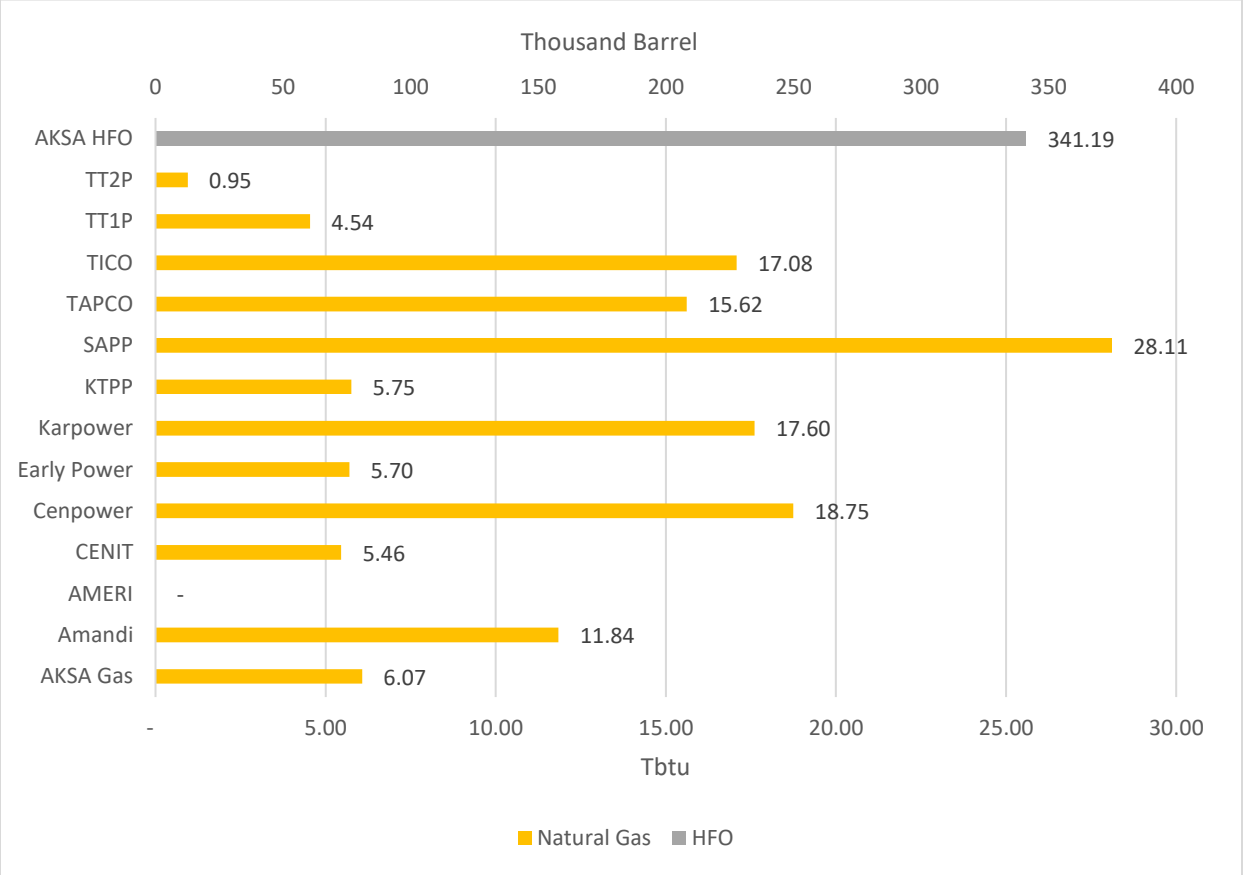
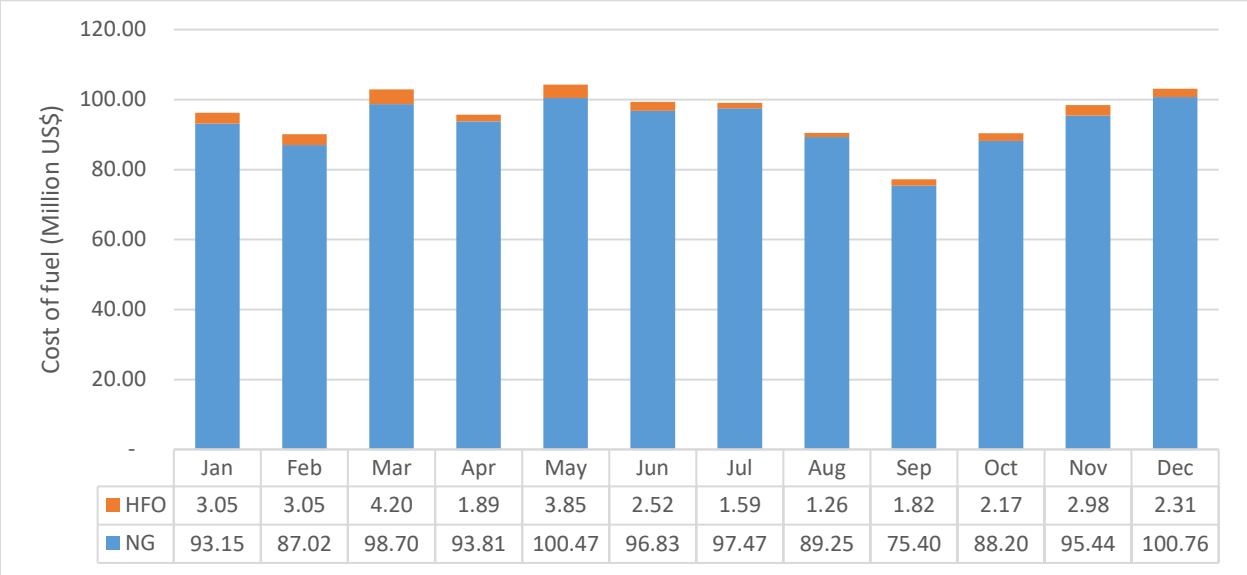


Figure 11: Thermal plants' fuel requirements for 2024

The AKSA plant fuels some of its units using HFO and is expected to operate those as a standby in 2024. The plant will require a total of 341,190 barrels in the year. Light crude oil (LCO) and diesel would be required as backup fuels for some plants because of anticipated gas supply outages.

2.3.2 Fuel Price and Cost

It is expected that the Weighted Average Cost of Gas (WACOG) will remain at US$8.12/MMBtu. Thus, about US$1,116.50 million would be needed for gas procurement in 2024. This translates to a monthly average of US$93.04 million. HFO for the running of the AKSA plant would be procured at an expected delivery price of US$90/barrel and about $30.71 million will be required to procure HFO. Overall, an amount of US$1,147.23 million is required to purchase fuel for thermal power generation in 2024. Figure 12 presents the monthly total cost of natural gas and HFO.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HFO	3.05	3.05	4.20	1.89	3.85	2.52	1.59	1.26	1.82	2.17	2.98	2.31
NG	93.15	87.02	98.70	93.81	100.47	96.83	97.47	89.25	75.40	88.20	95.44	100.76

Figure 12: Expected monthly total cost of natural gas and HFO for thermal plants in 2024

2.4 Transmission Outlook

2.4.1 Overview of Transmission System

The National Interconnected Transmission System (NITS) is the backbone for transmitting electricity from various generating stations to load centres. Electricity transmission is done at three main voltage levels; 69 kV (3.0% of total transmission circuit length), 161 kV (73.2% of total transmission circuit length) and 330 kV (22.5% of total transmission circuit length). There is also

a 225 kV (1.3% of total transmission circuit length) that facilitates interconnection with Ghana's western neighbour Cote d'Ivoire and northern neighbour Burkina Faso. There is also an interconnection with Togo through two 161 kV lines and a 330 kV line. The 330 kV interconnection with Togo was constructed as part of activities towards the implementation of the West African Power Pool (WAPP). The NITS, as of the end of the year 2023 was made up of:

- Total transmission circuit length of 7,200.5 km;
- Total number of Bulk Supply Points (BSPs) of 65;
- Total number of load transformers at BSPs - 138;
- Total transformation capacity – 8,901.8 MVA;
- Total capacity of fixed capacitive compensation devices – 309.8 MVAr;
- Total capacity of reactors - 230 MVAr;
- One 40 MVAr Static Synchronous Compensator (STATCOM1) installed at the Tamale substation.

2.4.2 Transmission Line Feeder and Substation Availability in 2024

The criteria used for ensuring high transmission Line, Feeder and Substation availability are as follows:

- All existing transmission lines are expected to be in service in 2024 to ensure transmission of electricity from the generation stations to the Bulk Supply Points across the nation and to enable the execution of power exchanges with neighbouring countries.
- Maintenance work on transmission lines and substations is to be organised in order not to significantly affect power supply to customers except for single transformer substations and consumers served on radial lines.

Most transformers in operation on the NITS are designed with a capability of 100% continuous loading and Transformer Utilization Factor (TUF). Indications from GRIDCo therefore, suggest that there is adequate transformer capacity on the NITS for the supply of power under normal

operating conditions.

2.4.3 Transmission Losses in 2024

GRIDCo's analysis of the transmission network reveals that the lowest losses occur in the NITS under the Balanced Generation scenario. This means that in situations where there are gas interruptions which affect thermal generation and compel high volumes of generation from a particular enclave (West or East), losses increase significantly. The relocation of Ameri to Kumasi to create another generation enclave is expected to reduce losses on the NITS further.

GRIDCo is embarking on a number of projects which are expected to improve reliability, transfer capacity, voltages, and reduce losses on the NITS. These include:

- 161kV Kasoa Substation with 50MVAr SVC Plus,
- Upgrade of the 161kV Achimota-Mallam transmission corridor,
- Western Corridor Transmission system upgrades (GRIDCo is on the verge of securing funds with the assistance of the Ministries of Energy & Finance) to upgrade the old 161kV lines from the Takoradi Thermal plant through Prestea to New Obuasi along with substation upgrades and
- The Siemens projects for the development of the 330/161kV Dunkwa II substation, 3rd BSP in Kumasi and the replacement of the 161kV capacitor bank in Kumasi with a 50MVAr SVC Plus.

2.5 Electricity Supply Challenges in 2024

2.5.1 Fuel Supply Challenges

Hydro Risk

Even though there are high prospects for rainfall in 2024, it would still be prudent to continue the conservative dispatch of the hydro plants to ensure that the reservoirs are not drawn down below their minimum operating levels to guarantee sustainable operations in the coming years. The availability and reliability of the thermal units are also very key to maintaining the planned hydro draft rate.

Fossil Fuel Risk

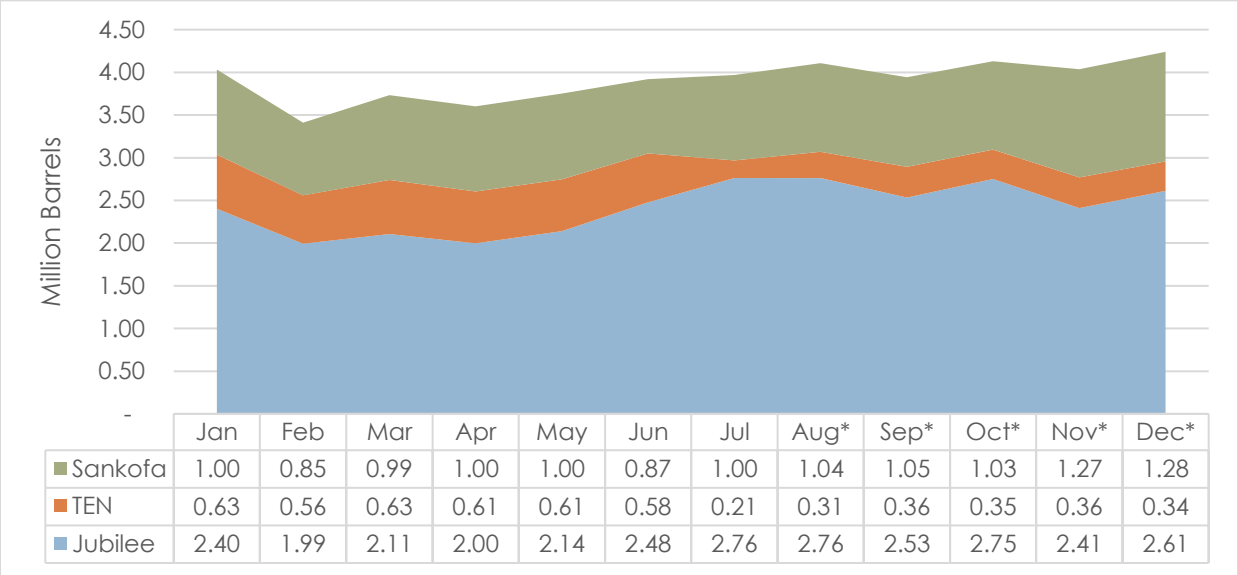
Although there is a relatively high installed generating capacity, gas supply sustainability remains one of the major risks to reliable electricity supply in the country. Any disruptions in fuel supply would render some thermal plants inoperable, which will negatively impact supply reliability. Thus, disruption in electricity generation can be averted by securing an alternative fuel supply to make up for any shortfall in gas supply within the period.

Chapter Three: Petroleum Outlook 2024

3.1 Outlook for Crude Oil

3.1.1 Crude Oil Production

Crude oil continues to be exploited from three fields – Jubilee, Tweneboa Enyenra Ntomme (TEN), and Sankofa Gye Nyame fields (hereafter referred to as Sankofa field). As of July 2023, the total volume of crude oil produced from the three commercial fields - Jubilee, TEN, and Sankofa was 26.42 million barrels, a decrease from the 30.40 million barrels produced over the same period in 2022. Poor reservoir performance and process upsets accounted for the production declines in February through April, whereas the addition of J64-P infill well on 22nd May 2023 accounted for production increases in May and June[2]. Figure 13 shows the monthly production of crude oil from the three fields up to July 2023. The projected production from August to December is also shown.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep*	Oct*	Nov*	Dec*
Sankofa	1.00	0.85	0.99	1.00	1.00	0.87	1.00	1.04	1.05	1.03	1.27	1.28
TEN	0.63	0.56	0.63	0.61	0.61	0.58	0.21	0.31	0.36	0.35	0.36	0.34
Jubilee	2.40	1.99	2.11	2.00	2.14	2.48	2.76	2.76	2.53	2.75	2.41	2.61

Figure 13: Monthly crude oil production up to July 2023, million barrels

Source: Petroleum Commission (PC)

[2] https://www.piacghana.org/ova_doc/piac-2023-semi-annual-report-1910/

As of July 2023, a total of 15.87 million barrels of crude oil was produced from the Jubilee field, down from 17.72 million barrels over the same period in 2022. The TEN field produced 3.83 million barrels of crude oil as of July 2023, lower than the 5.06 million barrels produced over the same period in 2022. The Sankofa field saw a decrease of 11.9%, with 6.72 million barrels of crude oil produced as of July 2023 as against 7.62 million barrels in the same period in 2022.

The average daily production from the three fields combined was lower in 2023 compared to 2022 over the same period. Average daily production per day reduced from 143,526 barrels in 2022 to 124,600 barrels in 2023, representing a decline of 13.2%. This also witnessed a reduction of 12.49% from the projected average daily production for 2023[3] (Figure 14).

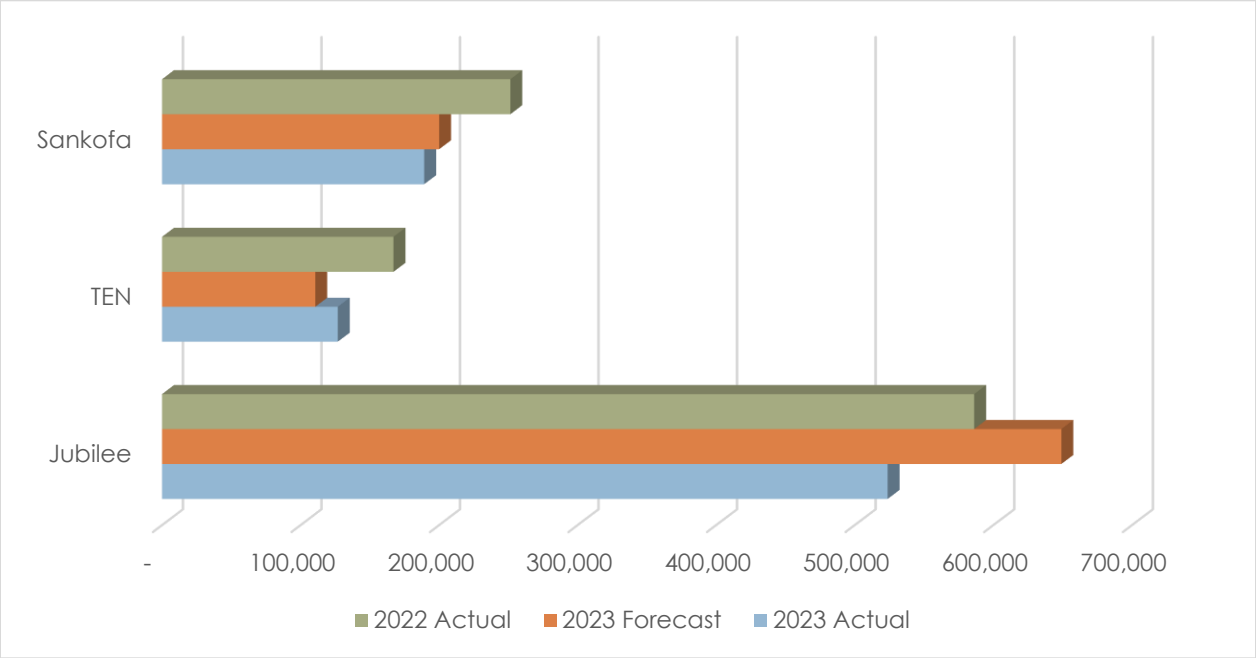
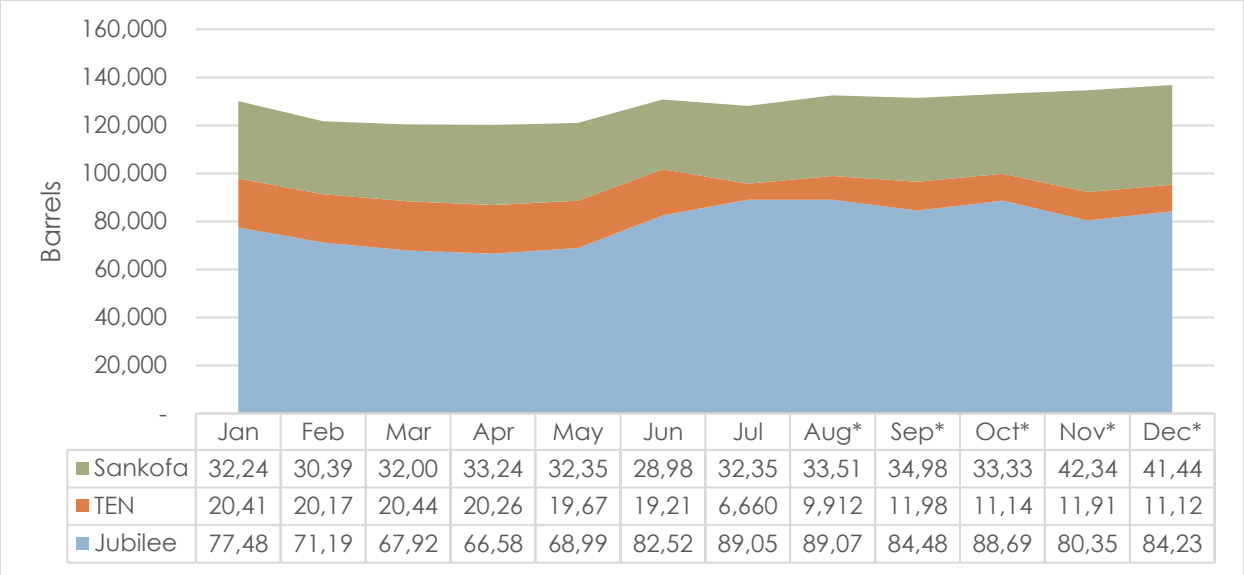


Figure 14: Actual and projected average daily production of crude oil (January-July)

[3] 2023 Energy (Supply and Demand) Outlook for Ghana: http://energycom.gov.gh/planning/data-center/energy-outlook-for-ghanalo



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep*	Oct*	Nov*	Dec*
Sankofa	32,24	30,39	32,00	33,24	32,35	28,98	32,35	33,51	34,98	33,33	42,34	41,44
TEN	20,41	20,17	20,44	20,26	19,67	19,21	6,660	9,912	11,98	11,14	11,91	11,12
Jubilee	77,48	71,19	67,92	66,58	68,99	82,52	89,05	89,07	84,48	88,69	80,35	84,23

Figure 15: Monthly average daily volumes of crude oil production in 2023

Source: PC, EC

The average daily production from the Jubilee field from January to July 2023 was 74,822 barrels compared to 83,736 barrels over the same period in 2022, representing a decrease of 10.6%. The average daily production from the TEN field reduced from 23,869 barrels in 2022 to 18,122 barrels in 2023. Production from the Sankofa field also reduced from an average of 35,921 barrels per day in 2022 to 31,656 barrels per day in 2023.

3.1.2 Crude Oil Production Outlook

Ghana's crude oil production has been on a decline since the onset of the COVID-19 pandemic in 2020, and this downward trend is anticipated to persist into 2024. Crude oil production is expected to reach 44.94 million barrels in 2024. The expected reduction is due to the anticipated significant reduction in production from TEN. Figure 16 presents the expected monthly volumes of crude oil production from the three fields in 2024.

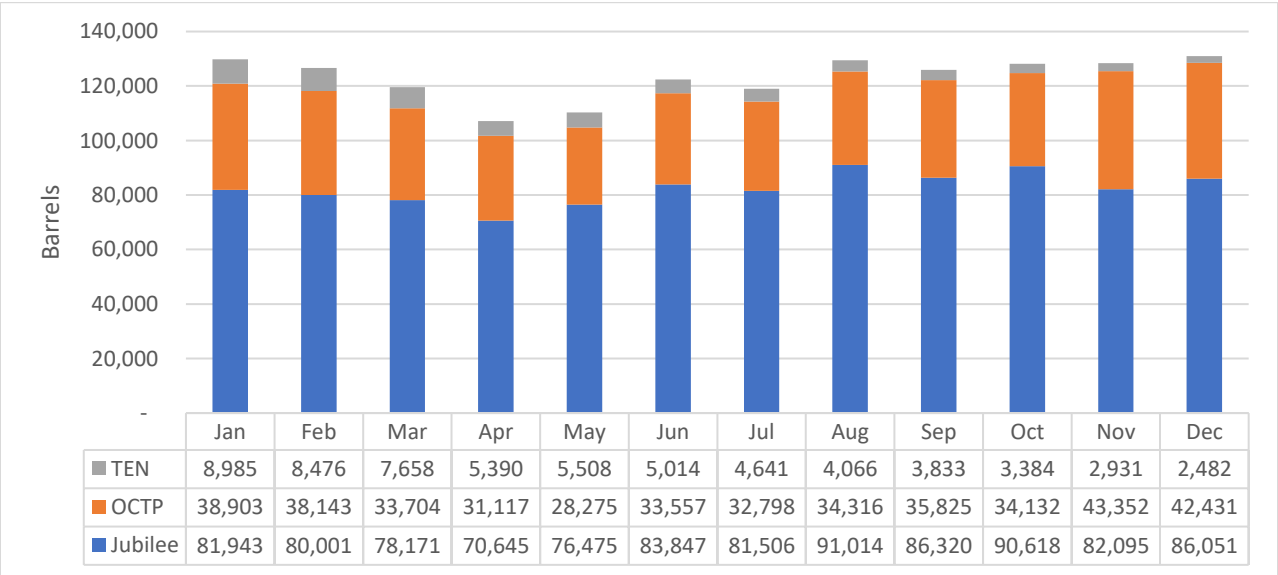
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEN	0.28	0.24	0.24	0.16	0.17	0.15	0.14	0.13	0.11	0.10	0.09	0.08
OCTP	1.21	1.07	1.04	0.93	0.88	1.01	1.02	1.06	1.07	1.06	1.30	1.32
Jubilee	2.54	2.24	2.42	2.12	2.37	2.52	2.53	2.82	2.59	2.81	2.46	2.67

Figure 16: Monthly crude oil production outlook for 2024.

Source: Energy Commission

Production from Jubilee field is expected to be 30.09 million barrels in 2024. Also, production from Sankofa and TEN are expected to be 12.96 1.89 million barrels in 2024.

The average daily production from the three fields combined is expected to be 123,129 barrels per day. Figure 51 presents the expected monthly average daily production of crude oil in 2023.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEN	8,985	8,476	7,658	5,390	5,508	5,014	4,641	4,066	3,833	3,384	2,931	2,482
OCTP	38,903	38,143	33,704	31,117	28,275	33,557	32,798	34,316	35,825	34,132	43,352	42,431
Jubilee	81,943	80,001	78,171	70,645	76,475	83,847	81,506	91,014	86,320	90,618	82,095	86,051

Figure 17: Projected daily average crude oil production for 2023

Source: Energy Commission

The average daily production from the Jubilee, Sankofa and TEN fields will be 82,391, 35,546 and 5,197 bpd respectively in 2024

3.1.2 Crude Oil Price

For the year 2024, the US Energy Information Administration (US EIA) and Goldman Sachs forecasts an increase in the average prices of Brent crude oil and WTI crude oil. Their projection indicates a yearly average of $82.58 and $78.08 per barrel, respectively. This modest upward oil price pressure in the coming months reflects a slight decline in global oil inventories in the first half of 2024 partly driven by recently announced OPEC+ production cuts.[4]

According to Goldman Sachs' December 2023 oil price forecast for 2024, the international crude oil benchmark is expected to peak at $85 a barrel in June 2024.

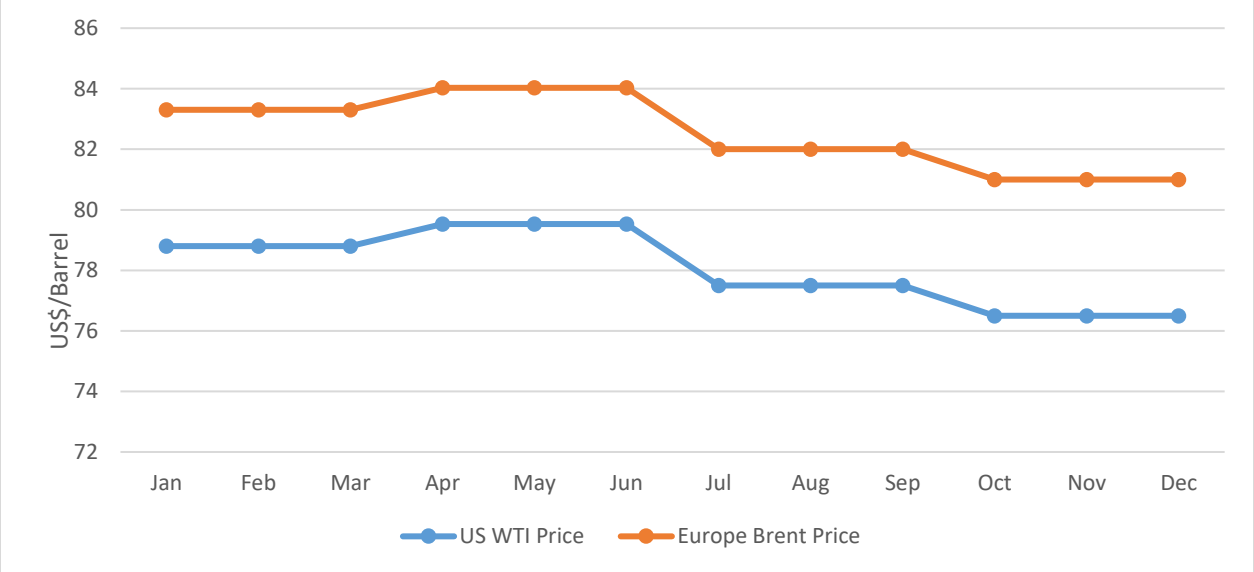


Figure 18: Projected monthly international benchmark crude oil prices for 2024

Source: US Energy Information Administration, Goldman Sachs

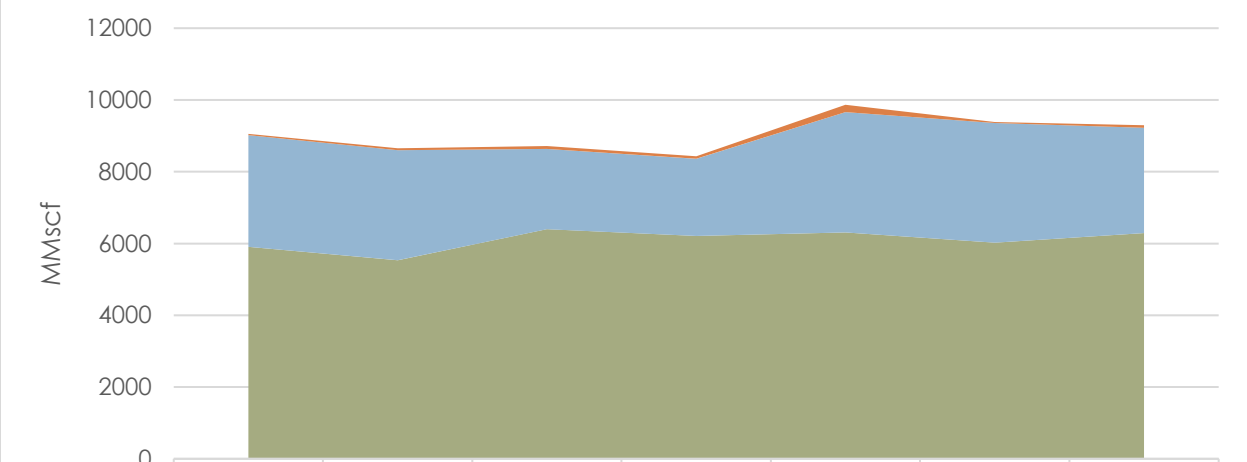
[4] https://www.opec.org/opec_web/en/press_room/7267.html

Ghana's crude oil price will follow the international benchmark price. As such, it is expected that the market price of crude oil from Ghana's fields – Jubilee, TEN and Sankofa will average between US$80-85 per barrel.

3.2 Outlook for Natural Gas

3.2.1 Natural Gas Export Production

The total raw gas exported from Jubilee (associated gas) to the Atuabo Gas Processing Plant (AGPP) and from Sankofa (non-associated gas) to the ENI Offshore Receiving Facility (ENI ORF) witnessed a significant increase from January to July 2023. However, gas exports from TEN (associated gas) to the AGPP witnessed a considerable reduction from 3,262.59 MMscf in 2022 to 550.83 MMscf in 2023. As of July 2023, a total of 63,401.85 MMscf of associated and non-associated gas was exported, an increase of 1.02% over the same period in 2022 volume of 62,760 MMscf. Figure 19 presents monthly gas exports from the three fields in 2023.



	Jan	Feb	Mar	Apr	May	Jun	Jul
TEN	39.34	60.08	83.96	68.73	204.76	24.31	69.65
Jubilee	3112.55	3063.42	2233.44	2151.29	3352.55	3339.73	2931.47
Sankofa	5904.19	5533.77	6399.56	6210.91	6307.88	6018.99	6291.27

Figure 19: Monthly raw gas exported from Jubilee, TEN and Sankofa in 2023

Source: PC

AGPP continues to receive a steady supply of raw gas from the Jubilee field. However, process upsets and maintenance activities carried out at the Ghana National Gas Company (GNGC) plant

from March to April 2023 resulted in a significant decrease in gas export rate from 100.40 MMscf/day in February to the lowest recorded export rate of 69.40 MMSCF/d in April. Normal gas export resumed in June, with an average rate of 100.70 MMscf/day.

As of July 2023, the Jubilee field had exported a total of 20,184 MMscf of raw gas to AGPP in 2023, representing 48.3% of gas produced, with the remainder re-injected, used as fuel or flared. The raw gas exported was 2.03% higher than that of 2022 over the same period.

There was a significant reduction in raw gas supplied from the TEN field to the AGPP from January to July 2023. The field exported 550.8 MMscf to the AGPP in 2023, down from 3,262.59 MMscf exported over the same period in 2022. A greater portion of raw gas produced from the TEN field was either re-injected (66.7%), used as fuel on the FPSO (6.2%), or flared (25.2%). The TEN field-associated gas is treated as a Jubilee foundation gas under a substitution agreement between the Jubilee and TEN field's partners that might have accounted for the low export.

The Sankofa field exported 42,667 MMscf, representing 93.3% of the non-associated gas produced to the ORF from January to July 2023. The gas exported from the field represented a 7.4% increase over the volumes exported over the same period in 2022 (39,715 MMscf). The remaining volume of gas was re-injected, flared or used for electricity generation on the FPSO.

From January to July 2023, the average daily export of gas from the three fields combined was 299 MMscf/day, an increase of 4.3% over 2022 average daily export but a decrease of 0.3% from what was projected for the year (Figure 20)[5]. Figure 20 presents the monthly average daily export of gas from the three fields in 2023.

[5] 2023 Energy (Supply and Demand) Outlook for Ghana: http://energycom.gov.gh/planning/data-center/energy-outlook-for-ghana

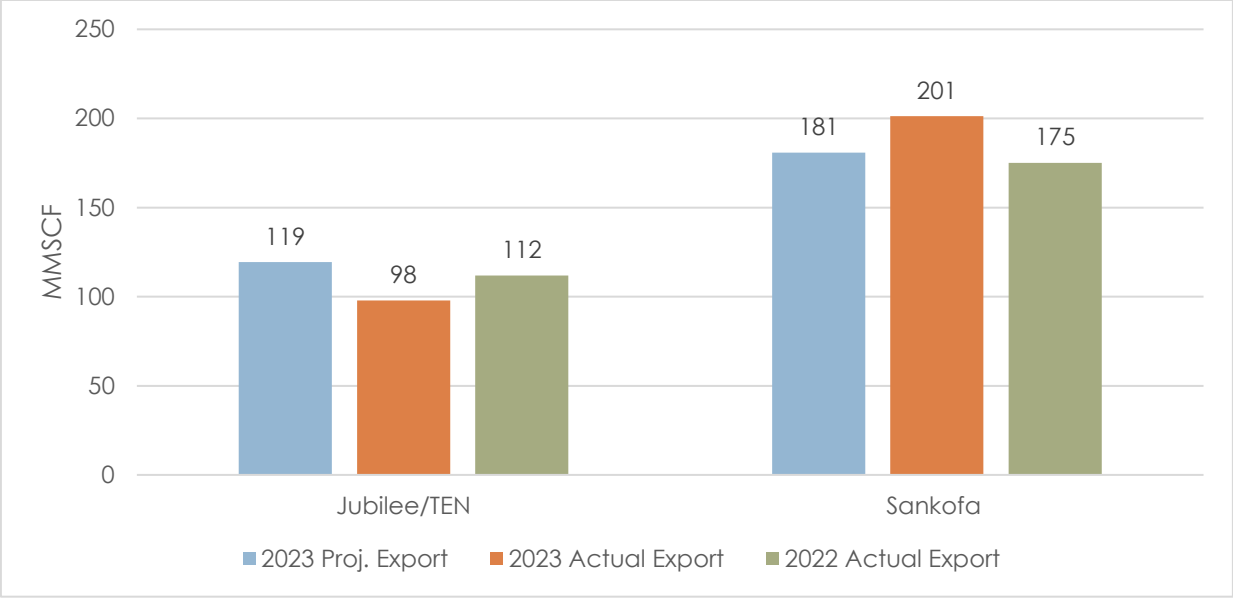
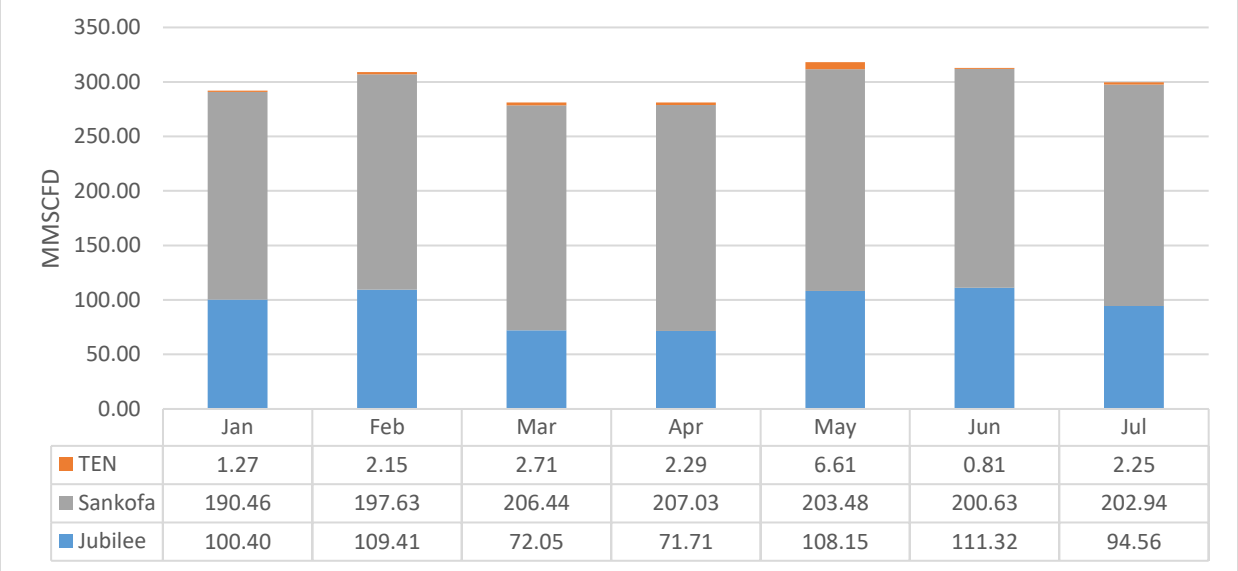


Figure 20: Projected and actual average daily gas exported from the three fields from January-July 2023



	Jan	Feb	Mar	Apr	May	Jun	Jul
TEN	1.27	2.15	2.71	2.29	6.61	0.81	2.25
Sankofa	190.46	197.63	206.44	207.03	203.48	200.63	202.94
Jubilee	100.40	109.41	72.05	71.71	108.15	111.32	94.56

Figure 21: Monthly average daily export of gas from the three fields from January-July in 2023

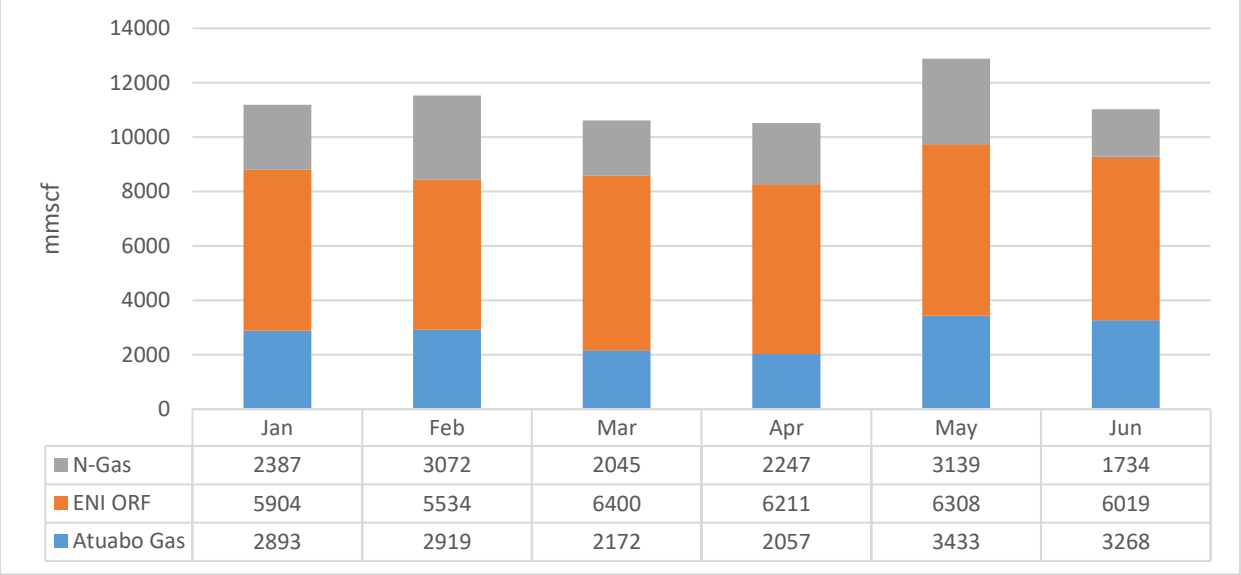
Source: PC

Daily export of raw gas from the Jubilee field in 2023 (January-July) was 95.4 MMscf/day, up from 93.5 MMscf/day over the same period in 2022. The average daily export from the TEN field

decreased from 15.2 MMscf/day in 2022 to 2.6 MMscf/day in 2023. The average daily export from both Jubilee and TEN was 98 MMscf/day, which was lower than the average daily export of 119 MMscf/day projected for 2023. The gas exported from Jubilee/TEN was 17.4% higher than the 2021 export. Daily average export from Sankofa field (non-associated) increased to 201 MMscf/day in 2023 from 175 MMscf/day in 2022 and was lower than projected.

3.2.2 Lean Gas Supplied in 2023

Total lean gas supplied from three main domestic sources - AGPP, ENI ORF, and import from Nigeria as of June 2023 rose to 67,738 MMscf, up from 62,061 MMscf over the same period in 2022. The total lean gas in 2023 is made up of 16,741 MMscf supplied by AGPP from processing raw gas exported from Jubilee and TEN fields and 36,375 MMscf of non-associated gas received at the ENI ORF. The remaining 14,622 MMscf was imported from Nigeria via WAGPCo. The increase in the supply of lean gas in 2023 was a result of increased offtake for electricity generation and an appreciable increase in demand for non-power purposes. Monthly supplies of lean gas from the three sources are presented in Figure 42.



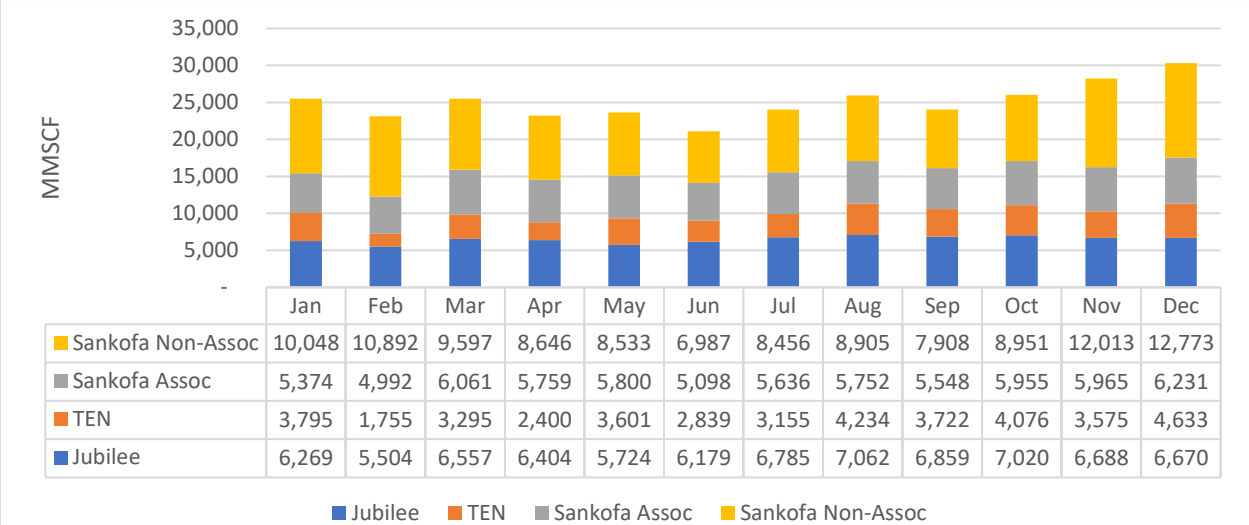
	Jan	Feb	Mar	Apr	May	Jun
N-Gas	2387	3072	2045	2247	3139	1734
ENI ORF	5904	5534	6400	6211	6308	6019
Atuabo Gas	2893	2919	2172	2057	3433	3268

Figure 22: 2023 Monthly lean gas supplied by AGPP, ENI ORF and WAGPCo

Source: GNGC, VRA

3.2.3 Natural Gas Export Production Outlook

The expected natural gas production from the three fields in 2024 is expected to reach 300,680 MMscf. Figure 23 displays the monthly gas production from the three fields in Ghana.

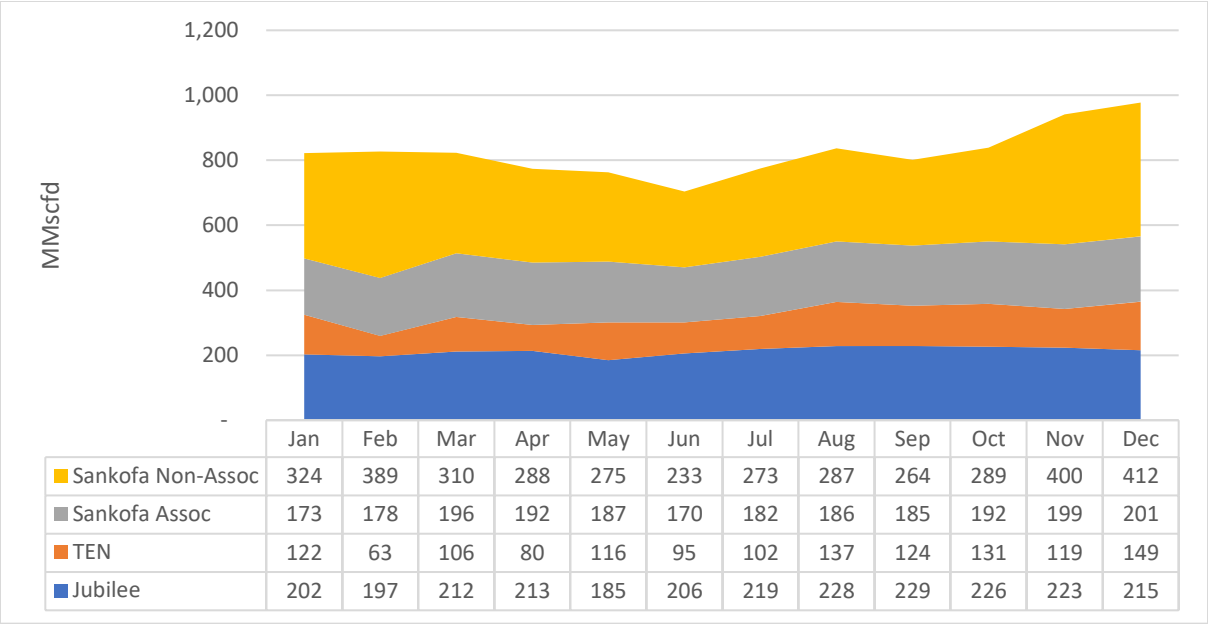


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sankofa Non-Assoc	10,048	10,892	9,597	8,646	8,533	6,987	8,456	8,905	7,908	8,951	12,013	12,773
Sankofa Assoc	5,374	4,992	6,061	5,759	5,800	5,098	5,636	5,752	5,548	5,955	5,965	6,231
TEN	3,795	1,755	3,295	2,400	3,601	2,839	3,155	4,234	3,722	4,076	3,575	4,633
Jubilee	6,269	5,504	6,557	6,404	5,724	6,179	6,785	7,062	6,859	7,020	6,688	6,670

Figure 23: Expected natural gas production for 2024

Gas production from the Jubilee and TEN fields are expected to be 77,721 MMscf, and 41,080 MMscf respectively in 2024, while Sankofa production from associated and non-associated sources are expected to be 68,171 MMscf and 113,708 MMscf respectively.

Daily production from the three fields combined is expected to be high in 2024, averaging 824 MMscf/day. Figure 24 presents the expected monthly average daily production of gas in 2024.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sankofa Non-Assoc	324	389	310	288	275	233	273	287	264	289	400	412
Sankofa Assoc	173	178	196	192	187	170	182	186	185	192	199	201
TEN	122	63	106	80	116	95	102	137	124	131	119	149
Jubilee	202	197	212	213	185	206	219	228	229	226	223	215

Figure 24: Projected daily average gas production for 2024

The average daily production of gas from the Jubilee fields will be 213 MMscfd compared to the projected 204 MMscfd in 2023. TEN's average daily production will reduce from the projected 135 MMscf in 2023 to 112 MMscf in 2024 while that of Sankofa associated and non-associated will be 187 MMscf and 312 MMscf.

3.2.2 Natural Gas Export from Production Fields

In 2024, raw gas export from Jubilee/TEN (associated) to the AGPP is expected to decrease by 2.5% to 36,600 MMscf. Sankofa (non-associated gas) export to the ENI ORF will also see a significant increase of 30% to 86,010 MMscf in 2024. In all, a total of 122,610 MMscf of associated

and non-associated gas will be exported in 2024 (Figure 25). Sankofa is expected to maintain its capacity to supply up to 235 MMscf/day, while Jubilee and TEN together are expected to supply 100 MMscf/day.

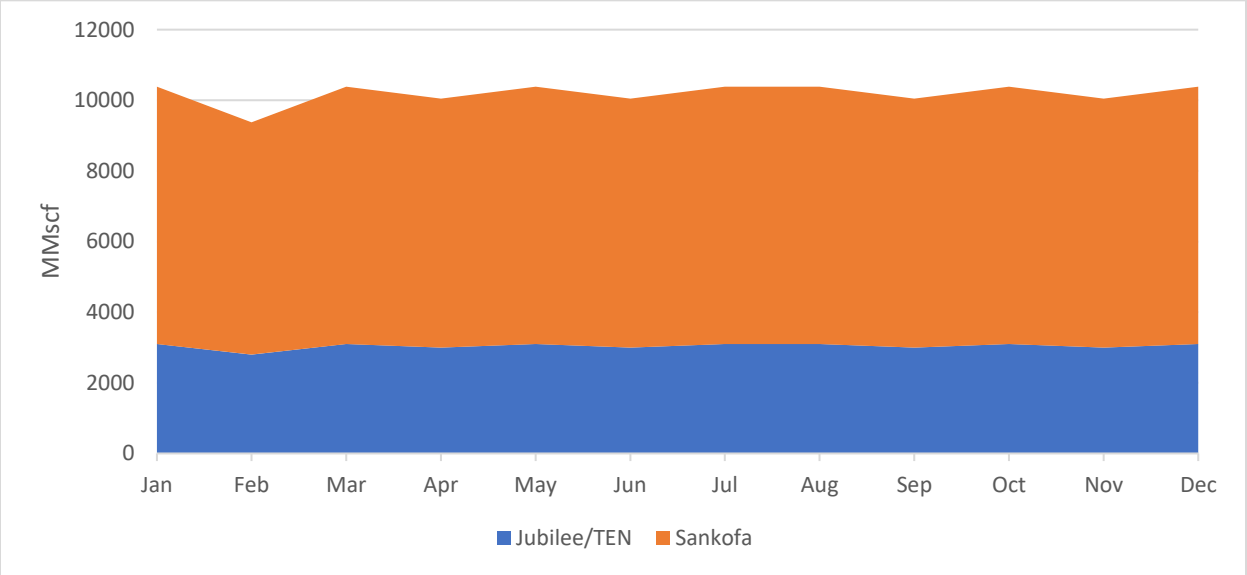


Figure 25: Expected natural gas export from production fields in 2024

Source: GNGC

3.2.3 Natural Gas Import

Natural gas import from Nigeria is expected to be about 60 MMscf/day up to July 2024. Based on the expected increase in consumption by Genser and other non-power uses, N-gas is expected to increase its supply to Ghana to 90 MMscf/d from August to December 2024, with a total estimated import of 26,550 MMscf in 2024. The Tema LNG facility was expected to receive its maiden import of LNG in the last quarter of 2023, but this has been postponed, and LNG import is not expected in 2024.

3.2.3 Non-Power Natural Gas Consumption

Currently, demand for natural gas for industrial purposes is mainly used as a heating fuel in the production of ceramics. Twyford, Wankang, Plot Enterprise, Marco Polo Gh Ltd, Jintao, and Sentuo all in the Western enclave uses natural gas in their industrial processes.

In 2024, a total 13,759 MMscf of natural gas is projected to be consumed by industries in Ghana. Natural gas consumption is expected to peak (40mmscfd) in the last quarter of 2024 as industries increase their production (Figure 26)

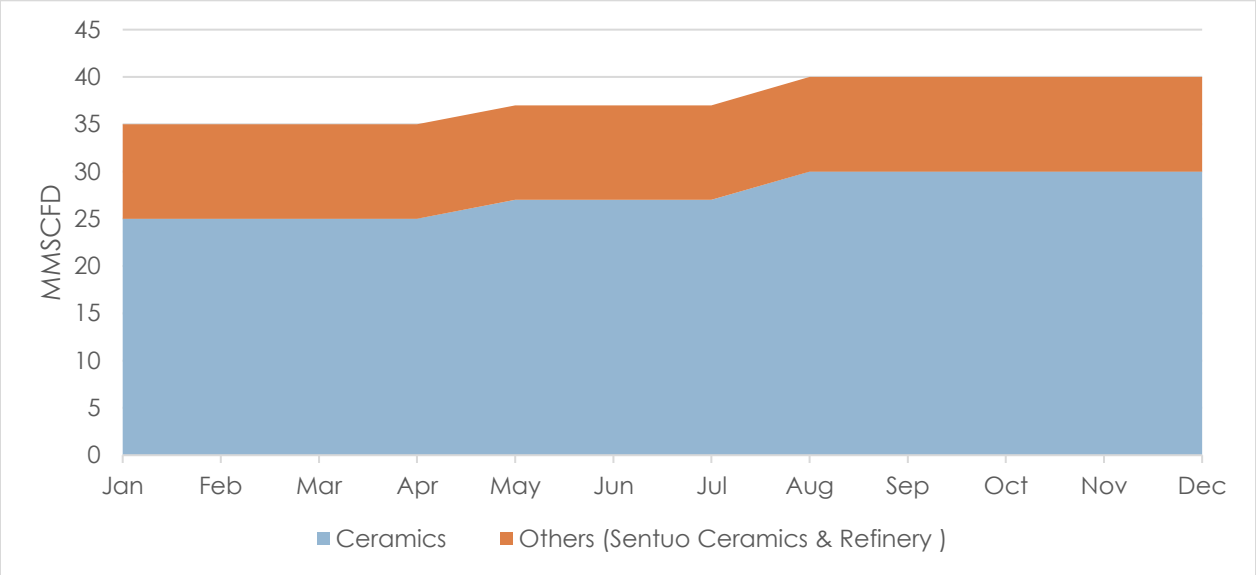
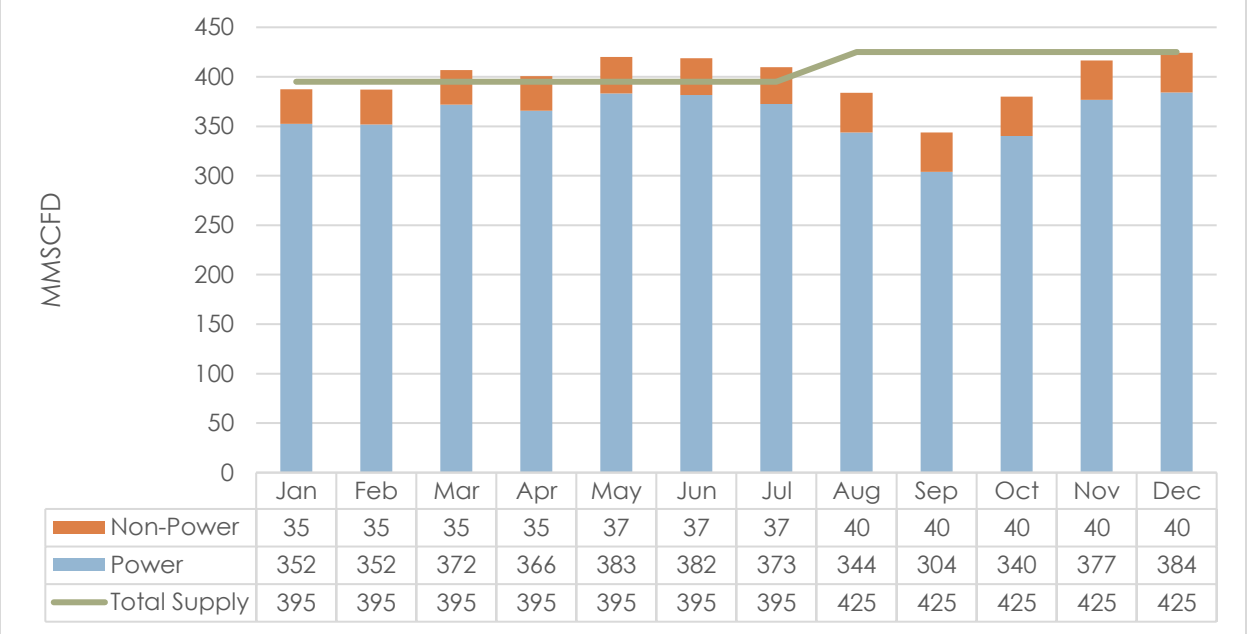


Figure 26: Non-power natural gas demand in 2024

Source: GNGC

3.2.4 Natural Gas Demand Supply Balance

Adding Genser's projected consumption to the expected natural gas consumption by power plants in 2024, the annual average of 361 MMSCFD of natural gas is expected to be used for power generation. Figure 27 shows the natural gas demand-supply balance for 2024.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Non-Power	35	35	35	35	37	37	37	40	40	40	40	40
Power	352	352	372	366	383	382	373	344	304	340	377	384
Total Supply	395	395	395	395	395	395	395	425	425	425	425	425

Figure 27: Natural gas demand-supply balance for 2024

Source: Energy Commission

It is evident from Figure 27 that, natural gas supplied from both domestic sources and imports from Nigeria will not be enough for the expected demand from March to July. However, the nation will be in an oversupply situation from August to November 2023.

3.3 Outlook for Petroleum Products

3.3.1 Petroleum Product Consumption

As of September 2023, the actual total petroleum product consumed deviated by 5.3% from the projected consumption. A total of 3,313 kilotonnes of petroleum products were consumed in

the country against the projected consumption of 3,487 kilotonnes over the same period[6]. The year-on-year consumption increased by some 3% from 2022. However, the total petroleum product consumption is projected to increase by 6.8% in 2023 to 4,501.8 kilotonnes. Figure 46 displays the trend in petroleum product consumption from 2012. Major petroleum products considered include gasoil, gasoline, LPG, ATK, kerosene, premix, RFO and marine gas oil (MGO).

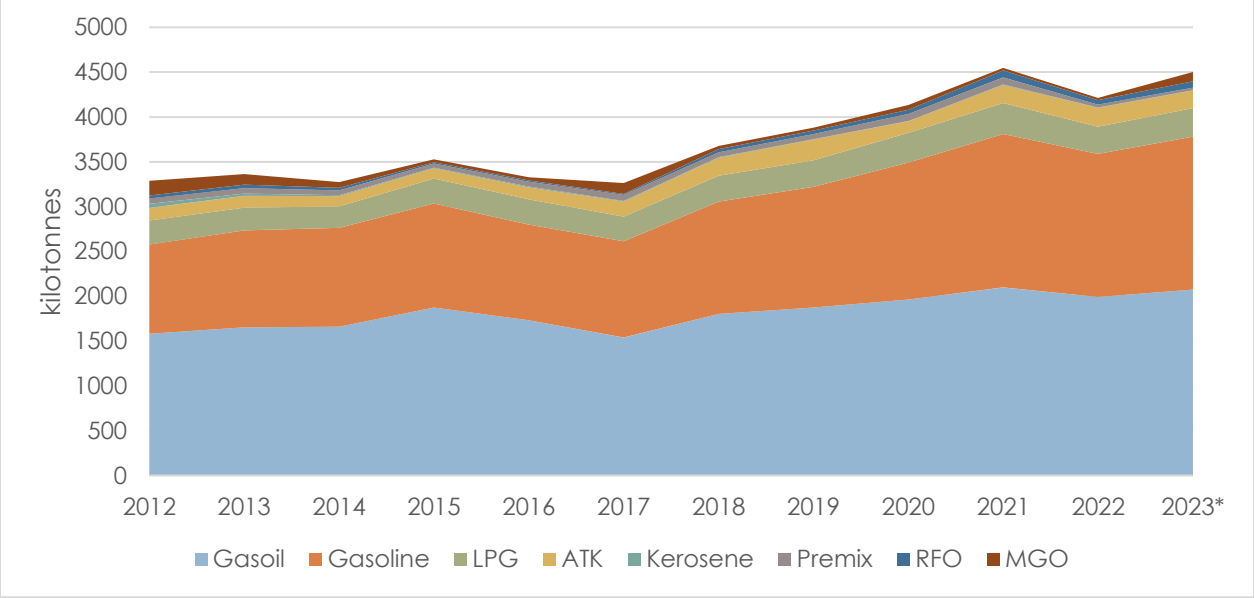
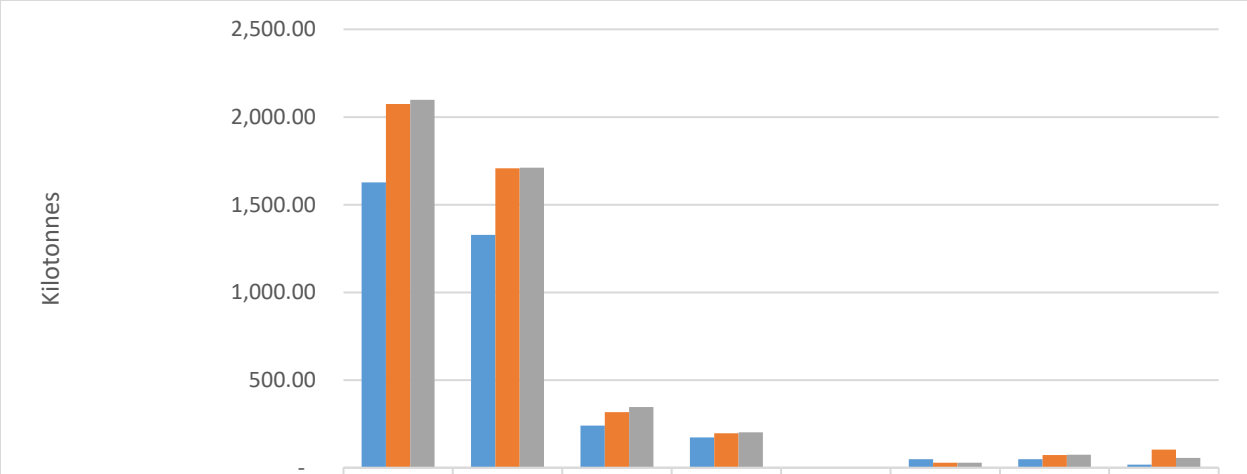


Figure 28: Trend in petroleum products consumption from 2012-2023*

Source: NPA

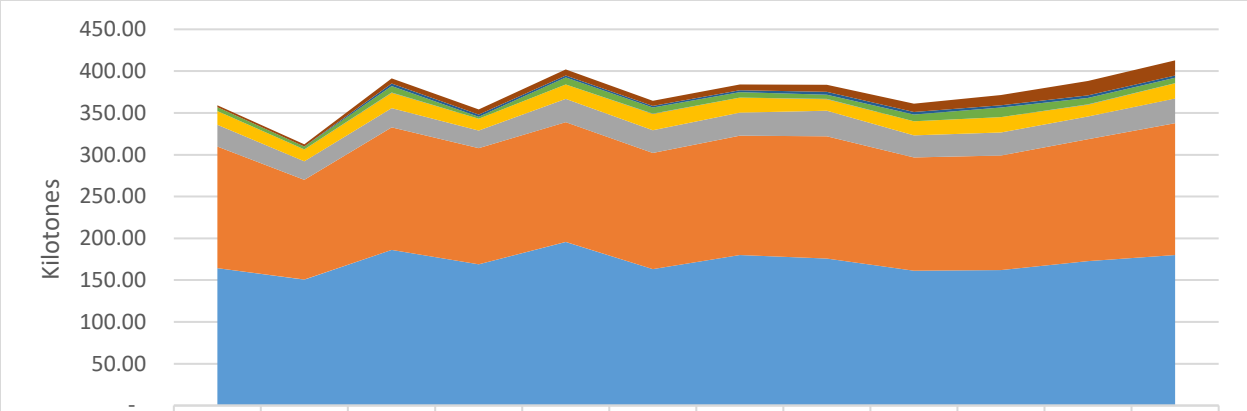
[6]2023 Energy (Supply and Demand) Outlook for Ghana: http://energycom.gov.gh/planning/data-center/energy-outlook-for-ghana



	Gasoil	Gasoline	LPG	ATK	Kerosene	Premix	RFO	MGO
2023 Proj. Consumption	1,627.87	1,328.47	239.98	172.65	3.65	48.08	48.36	18.38
2023* Actual Consumption	2,074.72	1,707.15	316.06	196.49	2.40	28.60	73.20	103.17
2022 Actual Consumption	2,097.85	1,711.59	345.48	201.96	1.94	28.64	73.21	55.63

Figure 29: Projected versus actual consumption of major petroleum products in 2023

Gasoil consumption was 1546 kilotonnes in 2023, a decrease of 22% over 2022 consumption of 1993 kilotonnes and a 5% decrease in projected consumption of 1627 kilotonnes. Similarly, gasoline consumption as of September 2023 was 1257 kilotonnes, down from 1595 kilotonnes in 2022. The consumption of gasoline in 2023 was down by only 6% from the projected consumption of 1,328 kilotonnes (Figure 47). LPG, ATK, Kerosene, and premix consumptions also decreased by 24%, 29%, 51%, 35% and 11.5% respectively from their 2022 consumptions. Figure 30 depicts the trend in monthly petroleum products actual consumption from January to October with November and December being the projected consumption in 2023.



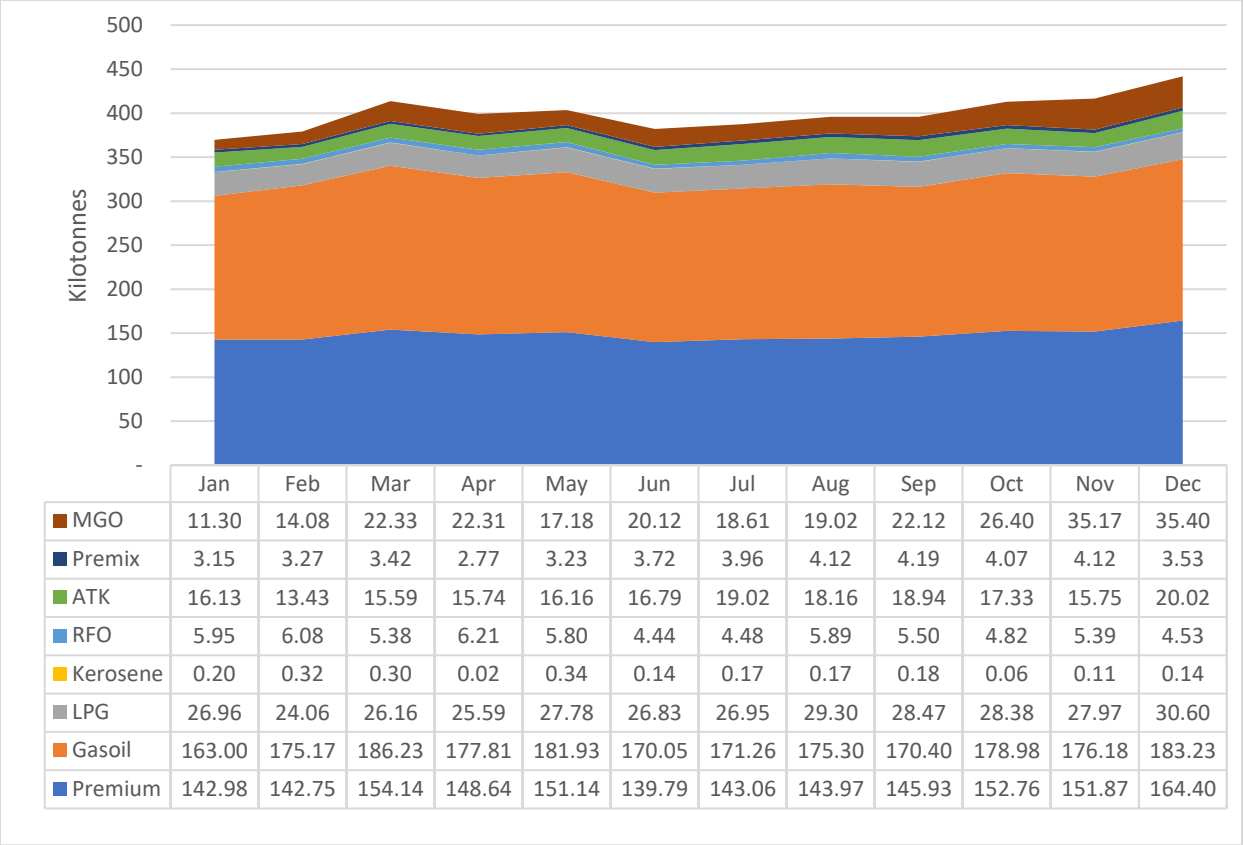
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov*	Dec*
MGO	2.30	2.58	6.13	6.24	7.10	6.05	7.08	8.17	10.00	12.30	17.19	18.04
Premix	0.19	0.21	3.06	2.89	2.27	2.03	2.17	3.59	3.13	2.55	3.20	2.75
RFO	4.38	3.19	7.80	1.96	8.41	7.21	6.46	4.95	8.15	11.44	7.57	6.42
Kerosene	0.08	0.22	0.39	0.02	0.25	0.42	0.15	0.30	0.11	0.15	0.14	0.19
ATK	16.41	14.10	18.49	14.26	17.16	19.48	18.15	13.75	16.72	18.25	14.22	18.08
LPG	25.86	22.15	23.02	21.15	27.75	27.41	27.53	30.66	26.32	27.53	27.09	29.64
Gasoline	145.56	119.23	146.44	138.79	143.33	138.81	142.67	146.29	135.59	137.24	145.842	157.903
Gasoil	164.39	150.73	186.14	169.03	195.62	163.19	180.00	175.77	161.21	161.865	172.908	179.836

Figure 30: Monthly consumption of petroleum products in 2023

Source: NPA, EC

3.3.2 Petroleum Products Outlook

Total petroleum products consumption in 2024 is projected to be 4,797.32 kilotonnes, an increase of 6.6% over 2023 consumption. Figure 31 presents the monthly forecast for petroleum products for 2024.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MGO	11.30	14.08	22.33	22.31	17.18	20.12	18.61	19.02	22.12	26.40	35.17	35.40
Premix	3.15	3.27	3.42	2.77	3.23	3.72	3.96	4.12	4.19	4.07	4.12	3.53
ATK	16.13	13.43	15.59	15.74	16.16	16.79	19.02	18.16	18.94	17.33	15.75	20.02
RFO	5.95	6.08	5.38	6.21	5.80	4.44	4.48	5.89	5.50	4.82	5.39	4.53
Kerosene	0.20	0.32	0.30	0.02	0.34	0.14	0.17	0.17	0.18	0.06	0.11	0.14
LPG	26.96	24.06	26.16	25.59	27.78	26.83	26.95	29.30	28.47	28.38	27.97	30.60
Gasoil	163.00	175.17	186.23	177.81	181.93	170.05	171.26	175.30	170.40	178.98	176.18	183.23
Premium	142.98	142.75	154.14	148.64	151.14	139.79	143.06	143.97	145.93	152.76	151.87	164.40

Figure 31: Monthly outlook for petroleum product consumption

Source: Energy Commission

Gasoil consumption is projected to be about 2,109.5 kilotonnes in 2024, an increase of about 1.7% over the 2023 consumption. Total gasoline consumption for 2024, is projected to be about 1,781.4 kilotonnes in 2024, also up by 4.4% from the 2023 consumption. LPG is expected to increase by 4.1%, from 316.1 kilotonnes in 2023 to about 329.05 kilotonnes in 2024. ATK consumption is expected to increase by 3.3% in 2024 to 203.05 kilotonnes. Consumption of other petroleum products such as Premix and MGO is expected to increase to 43.6 kilotonnes and 264.06 kilotonnes respectively.

However, the consumption of Kerosene and RFO is projected to decline in 2024 as power plants and industries switch to clean fuels. Kerosene consumption is expected to reduce to 2.16 kilotonnes in 2024 from 2.3 kilotonnes in 2023. Likewise, RFO consumption is expected to decrease to 64.46 kilotonnes in 2024 from 73.2 kilotonnes in 2023

Chapter Four: Woodfuel Sub-sector

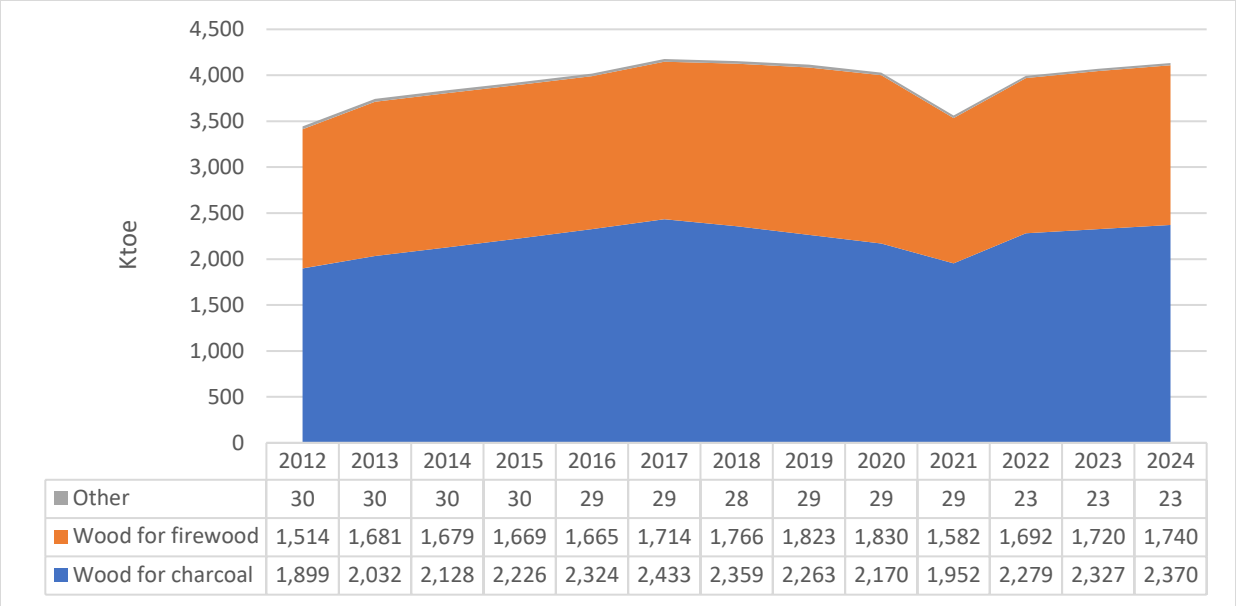
Woodfuel, comprising firewood and charcoal, has served as a longstanding and integral energy source for cooking and heating in Ghana. Derived primarily from forests, the production involves extracting firewood or converting wood into charcoal through pyrolysis. In numerous Ghanaian households, especially in rural areas, woodfuel remains a fundamental energy source for daily cooking and heating necessities. Beyond domestic use, the woodfuel sub-sector plays a pivotal role in providing the energy needs of diverse businesses, including those engaged in bread-baking, oil-palm processing, local breweries, traditional textiles, soap manufacturing, fish smoking, and local catering services.

Despite concerted efforts to promote the transition to cleaner energy, the enduring cultural and economic significance of woodfuel contributes to its continued use. Notably, woodfuel remains readily accessible for households, particularly in areas where alternative energy options are limited. Additionally, the price of woodfuel, often lower compared to alternatives such as LPG, significantly influences consumer choices, particularly in economically constrained households. This affordability factor remains a critical determinant in the ongoing preference for woodfuel.

4.1 Woodfuel Production and Consumption

4.1.1 Woodfuel Production

The total production of woodfuel, primarily driven by firewood and charcoal production, witnessed growth over the years. From 3,443 Ktoe in 2012, it rose to 4,070 Ktoe in 2023, representing an average annual growth rate of 1.9%. In 2024, a further increase is anticipated, reaching 4,133 Ktoe, reflecting a growth rate of 1.6% from 2023 production.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Other	30	30	30	30	29	29	28	29	29	29	23	23	23
Wood for firewood	1,514	1,681	1,679	1,669	1,665	1,714	1,766	1,823	1,830	1,582	1,692	1,720	1,740
Wood for charcoal	1,899	2,032	2,128	2,226	2,324	2,433	2,359	2,263	2,170	1,952	2,279	2,327	2,370

Figure 32**:** Woodfuel production

Charcoal Production

The predominant use of wood as a fuel source across various economic sectors is in the form of charcoal, mainly for cooking and in small-scale industries. Charcoal production was 1,899 Ktoe in 2012, and has experienced a consistent annual growth rate of 1.9%, reaching 2,327 Ktoe in 2023. Meanwhile, production in 2023 exhibited a 2.1% increase from 2022, likely attributed to a surge in charcoal demand. Anticipating a continued rise in demand, charcoal production is expected to increase by 1.9%, reaching 2,370 Ktoe in 2024.

Firewood production

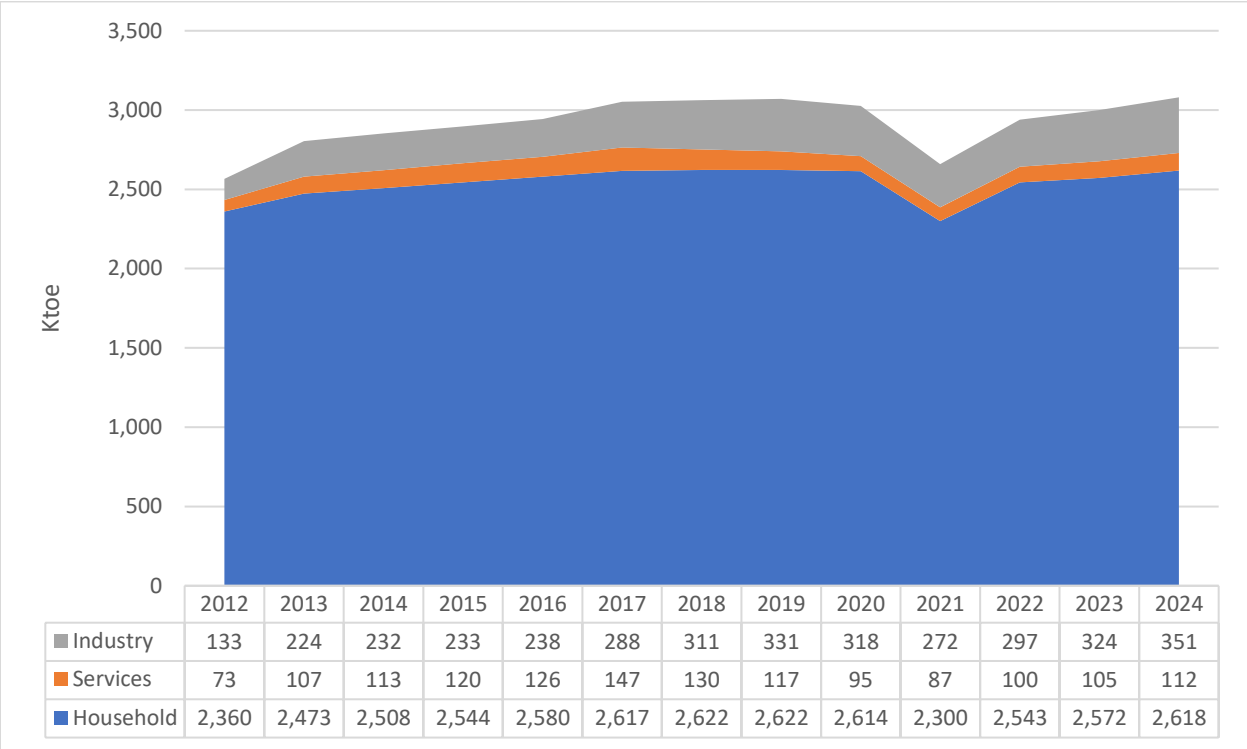
In 2012, the overall production of firewood amounted to 1,514 Ktoe reaching 1,720 Ktoe in 2023, with an annual growth rate of 1.2%. It is expected that firewood production will be 1,740 Ktoe in 2024.

Other Biomass production

The production of alternative biomass, derived mainly from crop residue, reached 23 Ktoe in 2023, and it is anticipated to remain at a similar quantity in 2024.

4.1.2 Biomass Consumption

The total biomass consumption in the economy reached 3,000 Ktoe in 2023, reflecting a 2.1% increase from the consumption in 2022. In 2024, an anticipated further rise to 3,080 Ktoe is expected.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Industry	133	224	232	233	238	288	311	331	318	272	297	324	351
Services	73	107	113	120	126	147	130	117	95	87	100	105	112
Household	2,360	2,473	2,508	2,544	2,580	2,617	2,622	2,622	2,614	2,300	2,543	2,572	2,618

Figure 33: Biomass consumption by sectors

Residential Sector

Consistently, this sector has maintained its position as the leading consumer of biomass, with an average consumption of 2,530 Ktoe between 2012 and 2023. The annual growth rate for biomass consumption during this period stood at 1.8%. In 2024, a further increase in biomass consumption by 46 Ktoe is anticipated, reaching a total of 2,618 Ktoe.

Industrial Sector

Experiencing the most rapid growth at a rate of 8.4% per annum, the informal industrial sector saw a significant surge in biomass consumption. Starting at 133 Ktoe in 2012, it climbed to 324 Ktoe in 2023, and it is expected to further increase to 351 Ktoe in 2024.

Service Sector

The service sector exhibits the lowest biomass consumption among the sectors of the economy. With an average annual consumption of 110 Ktoe from 2012 to 2023, experiencing a growth rate of 6.4% per annum, the service sector's estimated consumption for 2024 is 112 Ktoe.

4.2 Charcoal Price

In Ghana, charcoal is sold in volume, not by weight. In comparison with alternative fuels such as LPG which is priced in kilogram[7], the charcoal price was analysed per weight in all the markets visited as depicted in Figure 35. The average national price per kilogram of charcoal stands at GH₵ 2.84. Ho reported the highest price per kilogram at GH₵ 4.73, followed by Cape Coast and Hohoe. Conversely, Mim recorded the lowest price per kilogram at GH₵ 1.28, followed by Tamale at GH₵ 1.61, and then Damongo at GH₵ 1.63.

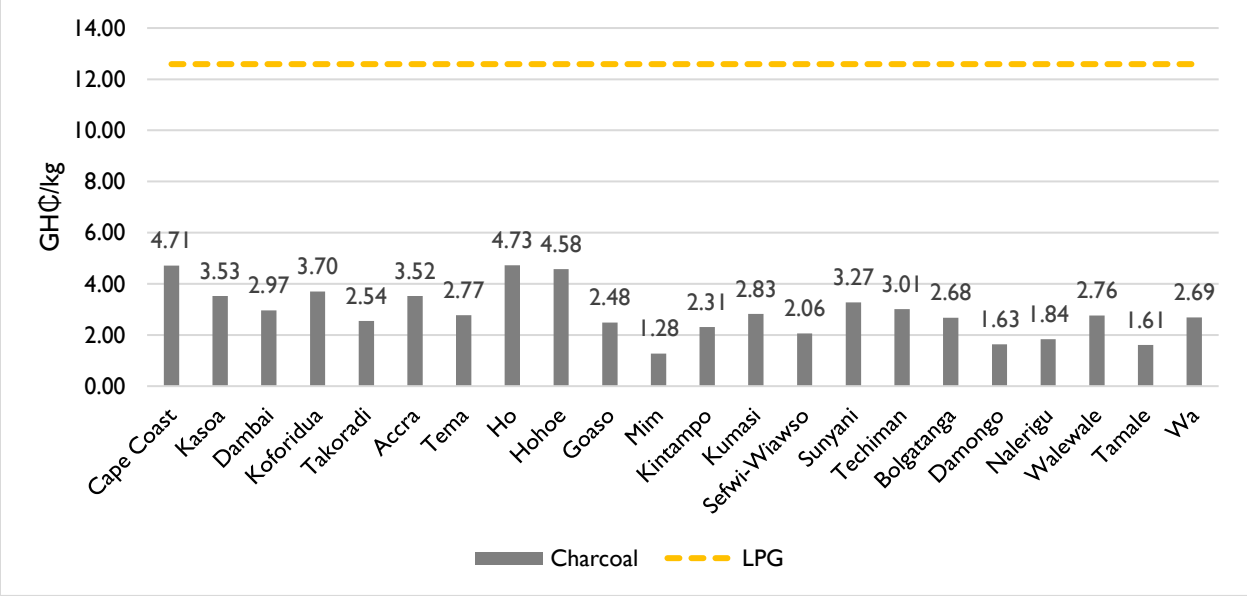


Figure 34: Average price per kilogram of charcoal across major market centres in Ghana in 2023

Source: Survey data

[7] Ghana has uniform pricing policy for all petroleum products. As such the price of LPG per kilogramme sold to consumers is the same irrespective of location in the country.

For energy use purposes, fuel is utilised because of its energy content. Figure 35, therefore, presents the price of energy (measured in MMBtu) of LPG versus charcoal.

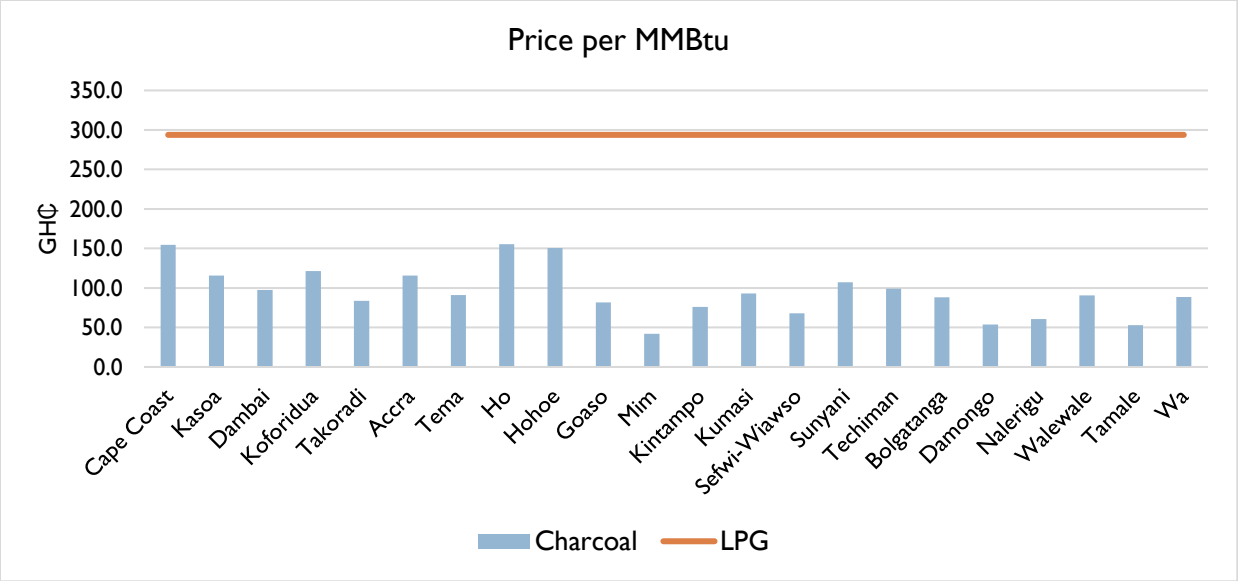


Figure 35: Price per MMBtu of LPG and Charcoal

Source: Energy Commission Survey data

As evident in Figure 35, the price of charcoal per MMBtu is lower than that of LPG in all locations.

Different technologies are used in burning these fuels. Whilst LPG uses the LPG stove, charcoal is used mainly in traditional stoves or improved cookstoves. One of the popular improved cookstoves is the Gyapa. These appliances have different thermal efficiencies. Therefore, the useful energy from LPG and charcoal when used in these end-use appliances is varied. Using a thermal efficiency of 60.7%[8], 33.3% and 23.4%[9] for LPG stoves, improved cookstoves (Gyapa) and traditional charcoal stoves respectively, the effective cost of MMBtu of useful energy is shown in Figure 36.

[8] Lather, R. S. (2019, November). Performance Analysis of an LPG Cooking Stove for Improvements and Future Usability Perspective. In *National Conference on IC Engines and Combustion* (pp. 633-643). Springer, Singapore.
[9] Boafo-Mensah, G., Amponsah-Benefo, K., Animpong, M. A. B., Oduro, W. O., Kotey, E. N., Akufo-Kumi, K., & Laryea, G. N. (2013). Thermal efficiency of charcoal fired cookstoves in Ghana.

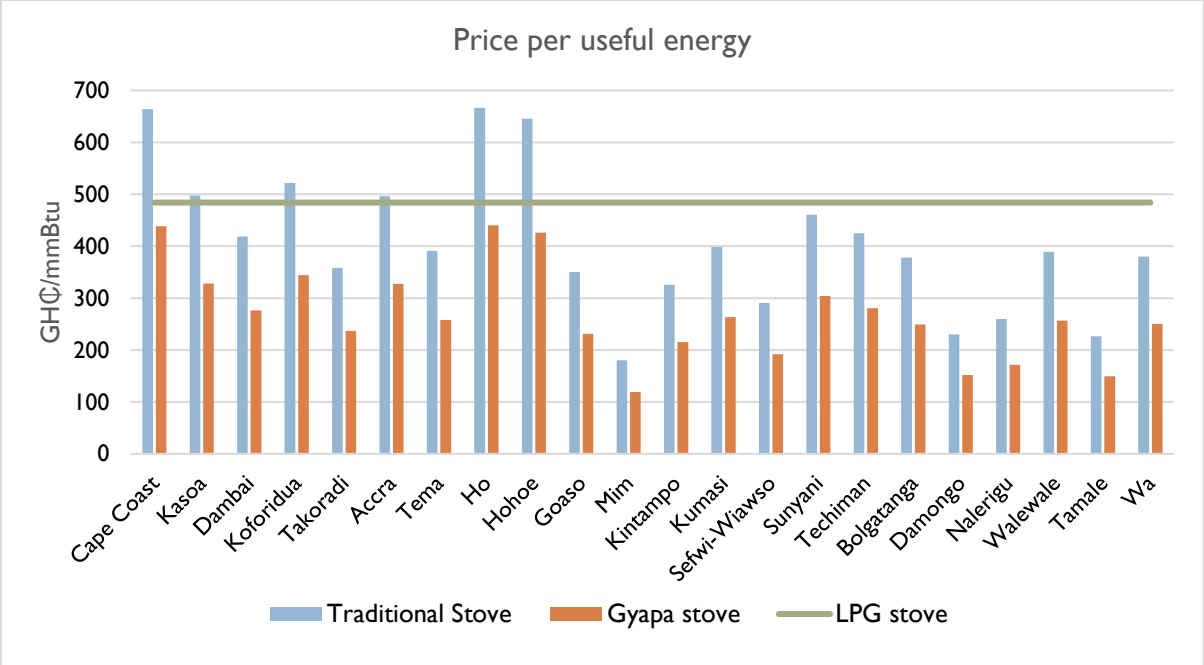


Figure 36: Price per MMBtu of useful energy of LPG and Charcoal stove

Source: Survey data

Generally, it costs households less to use traditional charcoal stove or Gyapa stove than to use LPG stove as shown in the Figure above. The cost of useful energy from LPG stove is GH₵484 per MMBtu. However, on average, it will cost a household about GH₵ (349-451) per MMBtu of useful energy if the household uses the traditional cookstove, giving a cost reduction of (7-28)%. This cost savings will further increase to about (34-52)% translating to GH₵ (230-298) if an improved cookstove is used.

The price of LPG is driven by developments in the global crude oil market and the depreciation of the Ghanaian Cedi. Anticipated for 2024 is a modest increase in charcoal prices, with the potential for growth aligning closely with the national inflation rate for the year at worst.

Chapter Five: Conclusions and Recommendations

5.1 Conclusions

5.1.1 Electricity

The anticipated system peak demand for 2024 would rise by 4.7%, reaching 3,788 MW. Concurrently, the energy consumption for 2024 is estimated at 24,997 GWh, reflecting a 5.8% increase compared to the consumption in 2023. Domestic consumption, encompassing VALCO and losses, is expected to constitute 89.3% of the total consumption, with energy export accounting for the remaining 10.7%. In 2024, VALCO is expected to operate on two potlines.

To fulfill the expected demand, hydroelectric and thermal power plants are projected to produce 8,734 GWh (34.9%) and 16,091 GWh (64.4%), respectively. The remaining 172 GWh, constituting 0.7%, is anticipated to be supplied by embedded generation, predominantly sourced from renewable energy.

In 2024, the grid-connected power generation capacity will be 5,194 MW, with a total dependable capacity of 4,756 MW for electricity generation. However, factoring in scheduled maintenance for planned units and fuel supply situation, it is expected that up to 4,400 MW of the total dependable capacity will be utilized to meet the projected system peak demand of 3,788 MW, ensuring a reserve margin of 16%, less than the minimum reserve margin requirement of 18%.

In 2024, the primary fuel for thermal power plants is expected to be natural gas, sourced both locally and through imports. The projected total natural gas consumption for the year is 137.5 TBtu. The AKSA plant is estimated to require 341,190 barrels of HFO in 2024. The overall fuel expenditure is estimated to be US$1,147.23 million, with US$1,116.50 million allocated for the procurement of natural gas and the remaining amount designated for the acquisition of HFO to fuel the AKSA plant.

5.1.2 Petroleum

In 2024, a further decline in total crude oil production is anticipated, reaching 44.94 million barrels due to expected reductions in output from all three oil-producing fields. Specifically, the Jubilee field is projected to decrease its production to 30.09 million barrels, while the TEN and Sankofa fields are expected to lower their production to 1.89 million barrels and 12.96 million barrels, respectively. The average daily production from these three fields is forecasted to be 123,129 barrels, with the Jubilee fields contributing the highest at 82,391 barrels per day, and the TEN and Sankofa fields each expected to contribute 5,197 barrels per day and 35,546 barrels per day, respectively.

The average Brent crude oil prices for 2024, as projected by both the US EIA and Goldman Sachs, are set at US$82.58 per barrel. It is expected that the average realized price of Ghana's crude oil from the Jubilee, TEN, and Sankofa fields will align closely with the international benchmark price.

In 2024, the anticipated natural gas production from the three fields is projected to reach 300,680 MMscf. The combined average daily production from these fields would be 824 MMscf. The Jubilee field is expected to increase its gas production to 77,721 MMscf in 2024. The TEN field is projected to produce 41,080 MMscf in 2024, while the Sankofa field's production from associated and non-associated sources is expected to reach 68,171 MMscf and 113,708 MMscf, respectively. The average daily production of gas from the Jubilee fields will be 213 MMscfd. TEN's average daily production will decrease to 112 MMscf in 2024, while that of Sankofa associated and non-associated will be 187 MMscf and 312 MMscf.

The projected raw gas export from Jubilee/TEN (associated) to the AGPP is anticipated to reach 36,600 MMscf. Simultaneously, Sankofa's (non-associated gas) export to the ENI ORF is expected reach 86,010 MMscf in 2024. Consequently, a total of 122,610 MMscf of associated and non-associated gas is expected to be exported to the AGPP and ENI ORF in 2024. On a daily basis, Sankofa is expected to maintain its capacity, supplying up to 235 MMscf/day to the ORF in 2024, while Jubilee and TEN together are expected to provide up to 100 MMscf/day to the AGPP. The anticipated import from Nigeria is set at 73 MMscf/day.

In 2024, non-power industries in Ghana are expected to consume a total of 13,759 MMscf of natural gas, with an average daily flow rate of 38 MMscf. Simultaneously, power plants on the grid are projected to consume 121,650 MMscf, averaging a daily flow rate of 332 MMscf. Considering Genser's projected consumption of 28 MMscf/day, the total required natural gas for power generation in 2024 is estimated to be an average of 361 MMscf/day.

The total consumption of petroleum products in 2024 is estimated to be 4,797.3 kilotonnes. Out of this, gasoil consumption is forecasted to be 2,109.5 kilotonnes, while gasoline is expected to be 1,781.4 kilotonnes. LPG consumption is anticipated to grow to around 329.05 kilotonnes in 2024. ATK and kerosene consumption for the same year are projected to be 203.1 kilotonnes and 2.16 kilotonnes, respectively. Other petroleum products, including Premix, RFO, and MGO, are expected to witness an increase in their consumption levels to 43.6 kilotonnes, 64.5 kilotonnes, and 264.1 kilotonnes, respectively.

5.1.3 Woodfuel

In 2024, the estimated extraction of wood for firewood usage would be 1,740 Ktoe, representing a 1.2% increase from 2023. Similarly, the extraction of wood for charcoal production is anticipated to reach 2,370 Ktoe in 2024, representing a 1.9% increase from the previous year. The production of other biomass, primarily crop residue, is expected to be around 23 Ktoe in 2023.

The residential sector will maintain its position as the largest consumer of biomass. Household biomass consumption is forecasted to reach 2,618 Ktoe in 2024, while the services and industrial sectors are expected to consume 112 Ktoe and 351 Ktoe, respectively.

In 2023, the national average price for a bag of charcoal was GH¢2.84, more than double the price in 2022. For 2024, charcoal prices will change at a rate consistent with the national inflation rate for the country.

5.2 Recommendations

The following recommendations are made.

5.2.1 Electricity

1. Projected hydro generation levels are to be adhered to in order to keep fuel costs at projected levels.

2. Security and adequacy of fuel supply to thermal plants remain the single most important risk to power supply reliability in the country. In this regard, it is strongly recommended that all stakeholders work together to ensure that the fuel supply is adequate and secure at all times.

3. Quantities of liquid fuels (LCO, HFO and Diesel) therefore need to be procured and stored for use at the respective dual-fired thermal power plants in case of instances of gas supply interruption.

4. Notwithstanding recommendations 1 and 3, generation from hydro can be increased above the allocated to mitigate any short-term gas supply challenges.

5. Due to the growing electricity demand, there is a need to make medium to long term arrangements to increase gas supply volumes to enable more thermal generation to avoid excessive drawdown on Akosombo and Bui hydro facilities.

6. Government should make necessary investments towards improved gas supply reliability owing to the increasing dependency on natural gas for power generation. Therefore, Government should expedise action on the proposed construction of gas pipeline connecting Tema and Tarkoradi power enclaves.

7. The government should expedite action on the creation of a generation enclave in Kumasi for network stability. This will help address voltage limit violations in the mid-sections of the power system in situations where Bui units are not in service and to reduce line loadings between Kumasi and Tema Enclave as well as Kumasi and Takoradi Enclave. This

will boost supply reliability to bulk customers such as the mines in the West and also give Ghana a competitive advantage for power export to Burkina, Mali and other potential customers north of Ghana.

5.2.2 Petroleum

1. The government is targeting 50% LPG penetration in households by 2030, but the achievement of this target might be a challenge if limited distribution outlets nationwide remain the same and LPG prices continue to remain high. Hence, investment incentives are needed to encourage OMCs and other interested investors to set up more LPG storage and distribution outlets nationwide to increase access and affordability. Also, the government should expedite the rollout of the cylinder recirculation model to help increase access.
2. Enhancing the dependability of domestically produced petroleum products is crucial. Beyond various economic benefits, domestic production will bolster our fuel supply security. Therefore, government, should urgently address all impediments at TOR to ensure its the efficient operation.

5.2.3 Woodfuel

1. Biomass consumption has been estimated to be increasing over the last decade. It is recommended that government intensify measures that will increase LPG penetration, especially in rural areas, to reverse the increasing demand for woody biomass.
2. A comparison of charcoal and LPG prices per MMBtu revealed that it costs more to get a unit of useful energy from LPG than from charcoal, regardless of stove efficiency. To encourage and increase LPG use (which is more efficient and environmentally friendly), the Ministry of Energy, through relevant stakeholders such as NPA, take necessary steps to reduce the price of LPG. The price intervention will also help realise the government's policy of achieving 50% of households using LPG by 2030.


ENERGY COMMISSION