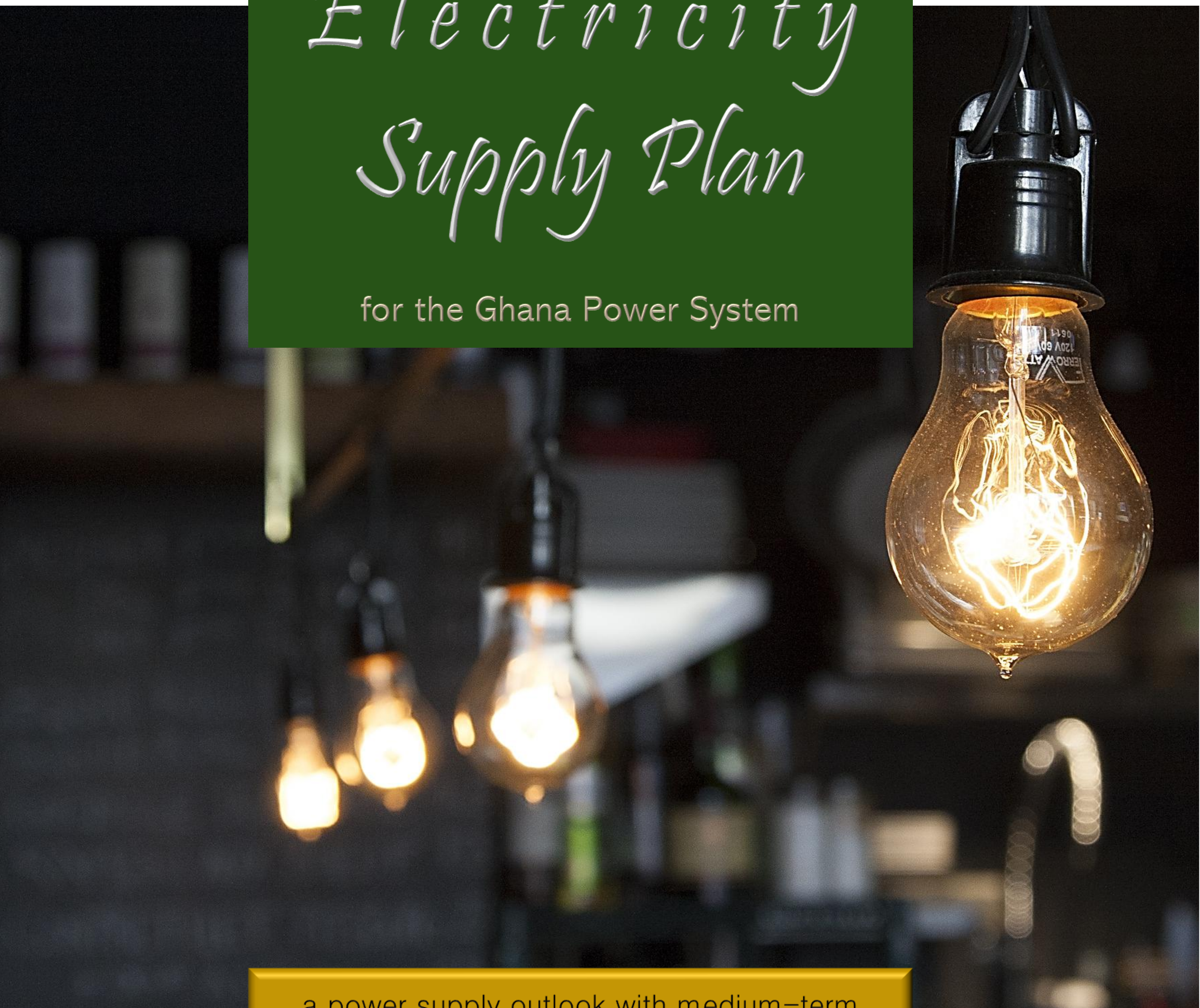
2025

Electricity Supply Plan

for the Ghana Power System



a power supply outlook with medium-term projections for Ghana

PPTC

2025 ELECTRICITY SUPPLY PLAN FOR GHANA

An Operations Planning Outlook for Power Supply in 2025 with Highlights of Medium-Term Power Requirements

REPUBLIC OF GHANA

POWER PLANNING TECHNICAL COMMITTEE

The Power Planning Technical Committee (PPTC) is responsible to, among others, develop planning reports for the Ghana Power System as per the requirement in Section-7 of the National Electricity Grid Code and Section 2 (2)(c) of the Energy Commission Act 1997 (ACT 541). It has worked to develop the 2025 Electricity Supply Plan (ESP).

The Committee is made up of technical experts as follows:

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ACKNOWLEDGEMENT

We hereby acknowledge all Wholesale Suppliers, Bulk Customers and other key stakeholders who provided relevant information for conducting demand forecasts, determine sources of supply, firm up maintenance programs, potential new projects and other information required for developing the 2025 ESP.

We also acknowledge Isaac Adu-Mensah (GRIDCo) and Ing. Obeng Okofo Dartey (GRIDCo) who provided technical support, as well as Mr. Michael Senanu Anku (GRIDCo) who provided administrative support during the development of the 2025 ESP.

EXECUTIVE SUMMARY

The highlights of the 2025 ESP are as follows:

- **2024 Performance Review**

Peak Load

Ghana's power system recorded a coincident peak demand of 3,952 MW on December 19, 2024. This represents an increase of 334 MW (9.2%) over the 2023 coincident peak. The table below shows the projected and actual coincident peak demand for 2024 and the contribution of domestic loads, exports and VALCO to the results.

Load Classification	Ghana Peak Load (MW)		Difference (MW)
	Projected 2024	Actual 2024	(Projection - Actual)
Domestic Demand	3,395.9	3,422.0	-26.1
Export (CEB+SONABEL+CIE)	462.0	438.0	24.0
VALCO	95.0	93.0	2.0
System Peak (Coincident)	3,952.9	3,952.0	0.9

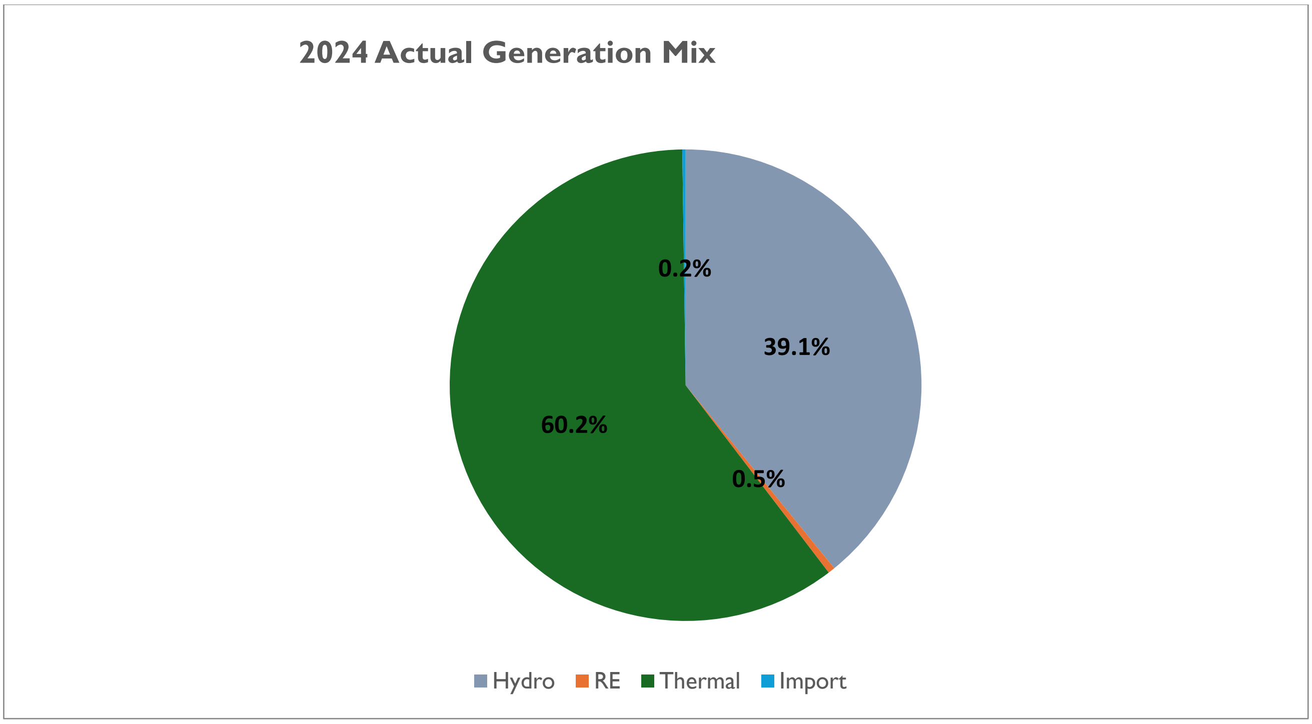
Energy Consumption

The total energy consumed, including losses, was 25,269.3 GWh representing a 7.3% increase over the 2023 consumption of 23,551.0 GWh. The table below details the energy consumed by customer class for 2023 – 2024.

Customer		Actual (GWh)	Actual (GWh)	% Growth
		2023	2024	(2024-2023)
ECG		15,453.9	16,565.6	7.2%
NEDCo		1,926.8	2,113.9	9.7%
Mines		1,379.4	2024.9	4.7%
VALCO		834.3	807.9	-3.2%
EPC		268.7	307.6	14.5%
Export	CEB	983.9	586.9	-40.4%
	SONABEL	1,279.1	1,149.2	-10.2%
	CIE	264.7	376.8	42.3%
	CLSG	0.0	0.0	0.0%
Direct Cust.		241.2	374.2	55.1%
Losses		908.3	951.3	4.7%
Network Usage		10.8	11.0	1.5%
Total Energy Transmitted		23,551.0	25,269.3	4.7%

Energy Generated

The total energy generated over the period was 25,269.3 GWh; this was made up of 9,892.7 GWh (39.1%) from hydro generation, 15,200.3 GWh (60.2%) thermal generation, 119.7 GWh (0.5%) RE generation (directly connected to the NITS) and 56.6 GWh (0.2%) import.



- **2025 Demand Outlook**

The projected Ghana system peak demand for 2025 is 4,338 MW. This represents an increase of 386 MW over the 2024 peak demand of 3,952 MW (growth of 9.8%).

The projected energy consumption for 2025 is 28,339 GWh, including transmission losses. This compared to the actual 2024 consumption of 25,269 GWh represents a projected growth of 12.1 % (an increase of 3,070 GWh).

- **2025 Generation Outlook**

To ensure that there is adequacy generation capacity to serve projected demand in the year 2025, it is crucial to realise additional generation capacity of at least 284 MW by the last quarter of the year.

This could be realized through the timely completion and commissioning of the remaining four (4) units at Anwomaso Thermal Power Station, the AKSA Phase-II Project, as well as the CENIT-II Project all at Anwomaso, Kumasi.

Hydro Generation

The projected total annual hydro generation for 2025 is 8,661 GWh. This is made up of 6,450 GWh from Akosombo Generating Station (GS), 1,000 GWh from Kpong GS and 1,211 GWh from Bui GS.

Thermal Generation

To adequately serve Ghana system demand in 2025, thermal plants are projected to account for 19,394 GWh of energy generation.

Fuel Requirements

Analysis shows that available volumes of natural gas in Ghana are inadequate to fuel all the thermal generation required to serve projected demand. There will be a need to arrange for additional natural gas supply volumes of 136 mmscf in the year to adequately supply projected demand.

Without this, there will be a need to continue to complement available volumes of natural gas with liquid fuel. A total estimated expenditure of US$ 2.02 Billion is required to purchase thermal fuel in 2025. This comprises US$ 1.165 Billion for Gas, US$ 550.15 Million for LCO, US$ 235.79 Million for diesel and US$ 98.32 Million for HFO. The liquid fuel will be required to complement natural gas during normal operations as well as during periods of planned gas facility shutdown.

RE Generation

A total of 284.0 GWh is expected from Renewable Energy sources in 2025. The renewable energy sources include the grid connected VRE solar facilities at Bui and Kaleo, as well as embedded facilities at Winneba (BXC Solar), Mankessim (Meinergy), and VRA's solar facilities (at Navrongo and Lawra). Bui solar is projected to increase its capacity progressively to 105 MWp with the commissioning of additional 40 MWp land based and 10 MWp floating by the end of the second quarter of 2025.

Additionally, the first phase of Yendi Solar PV Plant with a capacity of 20 MWp is expected to be commissioned by the end of the second quarter of 2025.

- **Imports**

There are no contracts for energy imports in 2025. However, inadvertent energy exchanges on tie-lines could result from transient flows. Imports could be required because of short-term capacity shortages caused by thermal fuel supply interruptions or outages to generating units for maintenance or due to fault.

- **2025 Transmission System Outlook**

Based on analyses carried out, it has been observed that power flow on some sections of the NITS have reached congestion levels, especially in the Eastern, Northern & Western corridors of the NITS. Demand requirements on the NITS have doubled over the last decade whereas the transmission network where reinforcement has not matched up with growth in demand. This lag in reinforcement has decreased the reliability and robustness of the NITS and its capacity to evacuate power and provide flexibility for planned outages.

It is crucial to invest quickly to reinforce and upgrade NITS infrastructure in these corridors, to avert congestion in some sections and ensure the security of supply to all consumers.

For example, transmission network analyses show that even under normal conditions, low voltages are observed in some Western portions of the NITS, particularly from Dunkwa through Ayanfuri to Asawinso leading to high transmission losses. There is a need to upgrade some existing transmission lines in those parts of the NITS.

Low voltages are also observed in the Eastern corridor (Ho – Kpeve – Kpando – Kadjebi). This is attributable to the fact that the existing 69 kV transmission network which serves consumers in that corridor is reaching its designs limits. In view of this, it is recommended to reinforce the transmission network in that corridor so that the growing electricity demand in the Oti region as well as part of the Northern & Savannah regions can be adequately and reliably served.

Analyses also show that outages to the following transmission lines will result in severe overloading on adjacent line circuits, increasing transmission loss:

- ✓ 330 kV Takoradi Thermal – Anwomaso line
- ✓ 330 kV Anwomaso – Kintampo line
- ✓ 330 kV Volta-Asogli – B5 Plus line
- ✓ 330 kV B5 Plus– Dawa line
- ✓ 330 kV Adubiyili - Nayagnia line
- ✓ 161 kV Tarkwa – Prestea line
- ✓ 330 kV Kintampo – Adubiyili line
- ✓ 161 kV Takoradi Thermal – Tarkwa line

✓ 161 kV Akosombo – Nkawkaw line

- **Medium Term Outlook Demand Outlook**

The Ghana system demand is projected to increase from a peak of 4,718 MW in 2026 to 6,198 MW in 2030.

Demand (MW)	2026	2027	2028	2029	2030
Domestic	4,021	4,333	4,643	4,979	5,411
VALCO	157	157	157	157	157
Exports	540	550	550	560	630
TOTAL	**4,718**	**5,040**	**5,350**	**5,696**	**6,198**

Total electrical energy consumption in Ghana, including power exports to Togo, Benin, Burkina, and Mali is projected to grow from 30,983 GWh in 2026 to 40,571GWh in 2030 at a Compound Annual Growth Rate (CAGR) of approximately 7%.

Demand GWh	2026	2027	2028	2029	2030
Domestic	26,538	28,624	30,696	32,791	35,594
VALCO	1,265	1,265	1,265	1,265	1,265
Exports	3,141	3,214	3,214	3,287	3,712
TOTAL	**30,944**	**33,103**	**35,175**	**37,343**	**40,571**

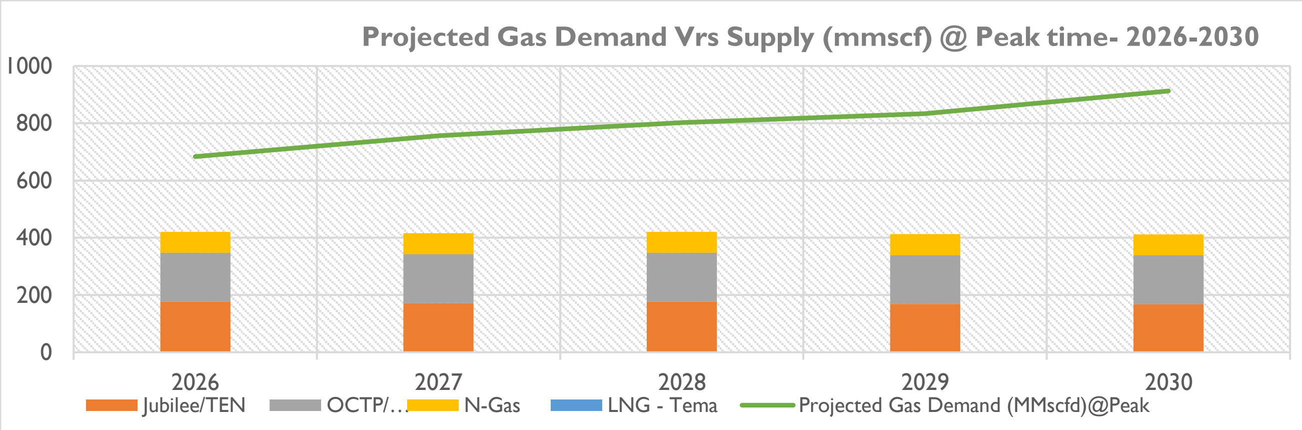
Supply Adequacy Analysis

Supply adequacy analysis conducted indicates that throughout the medium term, there is a need for generation capacity addition of an average of 374 MW annually in order to continue to have generating capacity adequacy and prevent a potential energy crisis.

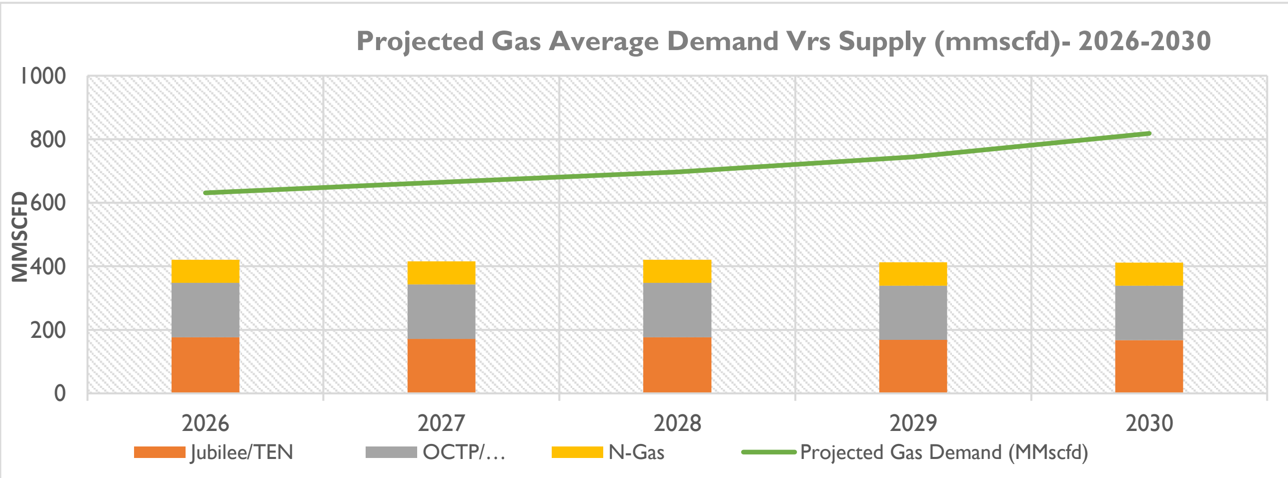
To achieve that, there is a need for the timely completion of committed and planned generation projects, as well as the commencement of new generating facility projects. It is crucial to take into consideration the fact that it takes roughly four (4) to five (5) years to realise a typical power generation facility, ie., from inception to commissioning.

Gas Demand and Supply Balance

The projected average firm natural gas supply from the Jubilee/TEN and OCTP fields over the medium term is estimated at 416 million standard cubic feet per day (mmscf/d). However, peak demand for natural gas in the power sector is expected to reach 684 mmscf/d by 2026 and increase further to approximately 913 mmscf/d by 2030. This points to a significant supply shortfall of about 263 mmscf/d in 2026, rising to a deficit of about 500 mmscf/d by 2030. The figure below show the gas supply demand balance.



On the other hand, the daily average gas demand projection for thermal generation is expected to grow from **631.28** Mmscfd in 2026 to **818.24** Mmscfd in 2030 as shown in the figure below.



Transmission Reinforcement/Expansion requirements

The following transmission reinforcement projects will be required in the medium term:

- A 330kV Awodua – Dunkwa – Kumasi line circuit to increase power transfer between the West and Kumasi. It will also improve the reliability of the NITS.
- Upgrade of 161 kV Aboadze – Cape Coast – Mallam line circuit to improve power evacuate from the Takoradi Thermal generation enclave.
- 330 kV Adubiyili – Bimbila (part of WAPP Median transmission line) to provide reliable power supply to parts of the Northern, Savannah and Oti Regions.

- 330 kV Pokuase – Anwomaso Transmission Line- to complete a 330 kV loop connecting Accra, Takoradi and Kumasi.
- A second 330kV Adubiyili – Nayagnia line circuit to facilitate increased power supply to consumers in the Sahelian regions.
- 330kV Ghana -Cote d'Ivoire reinforcement project. A second interconnection line between Ghana and Cote d'Ivoire from Dunkwa to Bingerville (in Cote d'Ivoire) to boost economic activities between the two countries and electricity trading in the WAPP.
- 161 kV A4BSP – Mallam Link- Improve reliability of power supply in the capital.
- Construction of 330/225kV Prestea Substation- to replace obsolete 225kV interconnection with Cote d'Ivoire. Involves the extension of 330 kV transmission line to Prestea.
- Increase in transformer capacity in major BSP's within the NITS to meet increasing demand

- **Conclusion**

The following conclusions are drawn:

1. The 2025 total system peak demand is projected to be 4,338 MW representing a 9.8 % growth over the 2024 peak demand of 3,952 MW.
2. The corresponding projected energy consumption for 2025 is 28,339 GWh. This compared with actual of 25,269 GWh for 2024 implies a growth of 12.1%.
3. In 2025, generation capacity will be inadequate to reliably supply the projected demand. There is a need for an additional capacity of 284 MW. This could be achieved through the timely completion of construction of the first phases of the AKSA-2 and the CENIT-2 power plant projects as well as the installation of the remaining four (4) units at the Anwomaso Thermal Power Plant all at Anwomaso, Kumasi.
4. The first phases of the AKSA-2 and the CENIT-2 projects, as well as the remaining four (4) units (100 MW) Anwomaso Thermal Power Station (ATPS) are all expected to be commissioned by September 2025.
5. The cost of fuel for firing all thermal generation in 2025 is estimated at US$ 2.02 Billion.
6. The ongoing Bui Solar projects and their expected commissioning dates are listed below:
   a. **Yendi Solar:** Phase I, made up of 20 MWp and Phase II, of additional 30 MWp to be operational by July 2025 and October 2025 respectively.
   b. **Floating Solar @ Bui**: Additional 10 MWp to be operational by July 2025.

c. **Bui (landed) Solar**: 40 MWp to be commissioned by July 2025 and 60 MWp by October 2025.

7. In the medium term, existing generation capacity will not be adequate to supply the projected demand (with the required 18% minimum operating reserve margin).

   a. The generation deficit will increase from 294 MW in 2026 to 1,871 MW in 2030 if additional generation sources are not brought onboard.

   b. An average of 374 MW additional generation capacity is required each year within the medium term.

   c. In the medium term the completion of construction of the 350 MW AKSA-2 plant at Kumasi, the conversion of the simple cycle TT1PP/CENIT and KTPP plants to combined cycles through the addition of a steam turbine unit each by 2028 will be required. Additionally, the commissioning of the second phase of the 315 MW Bridge Power Plant by 2029 is vital, as well as the major retrofit of the T3 plant to replace the damaged GT engines with four (4) new ones by 2027.

8. Total energy requirement for the medium term is projected to grow from 30,983 GWh in 2026 to 40,571 GWh by 2030 at a Compound Annual Growth Rate (CAGR) of approximately 7%.

9. Transmission network reinforcements will be required, especially in the Northern, Western and Eastern corridors to upgrade the NITS, increase its transfer capability, its reliability and robustness to address any potential congestion issues which could require the curtailment of loads to keep the power system stable.

Recommendation

Based on the above conclusions, the following are some of the key recommendations made:

a. Generation

- Procurement of adequate gas and other thermal fuels, estimated at US$2.02 billion, is essential to ensuring a secure and reliable power supply.
- Dispatch of hydropower plants should be strategically managed to ensure optimal utilization of reservoir headwater levels

- Based on the above, the Bui reservoir should always be operated above 169 masl and the Akosombo reservoir should be operated in an optimal way to avoid or minimize any spillage during the inflow season.
- There should also be collaborative efforts to ensure that all power plants (conventional and Variable Renewable Energy [VRE]) earmarked to be commissioned in 2025 as well as those earmarked for the near future are completed on schedule.
- There should be effective coordination between power plant managers, gas suppliers and the system operator so that planned outages and maintenance do not impact smooth power delivery.
- Procure competitively priced power generation to ensure reliability of supply for the short to medium term.

b. Transmission System

To ensure that the grid can reliably transmit power in the immediate to short term, the following transmission projects are urgently required:

1) 330/161 kV Dunkwa II Substation
2) Upgrade of the 161kV Anwomaso-Kumasi transmission line
3) Terminate the 2nd circuit 161kV J2K Konogo -Kumasi at Kumasi
4) 161kV Mallam-Kasoa line
5) 2nd circuit 330kV Awodua-Dunkwa
6) 330/225 kV Prestea II Interconnection Substation
7) Procurement of Power Transformers
8) Repair and installation of Capacitor Banks at various substations

The following transmission projects are also required in the short to medium term:

9) 2nd 330kV Circuit Awodua – Dunkwa - Kumasi
10) Upgrade of 161 kV Aboadze – Cape Coast – Mallam line circuit.
11) 330 kV Adubiyili – Bimbila (part of WAPP Median transmission line) to provide reliable power supply to parts of the Northern, Savannah and Oti Regions.
12) 330 kV Pokuase – Anwomaso Transmission Line.
13) 2nd Circuit 330kV Adubiyili – Nayagnia.
14) 330kV Ghana -Cote d'Ivoire reinforcement project.
15) 161 kV A4BSP – Mallam Link- Improve reliability of power supply in the capital.

16) Industrial mine loads (Ahafo North & Namdini) are required to have their respective SVCs to provide needed dynamic voltage and reactive power support to ensure their operations does not negatively impact grid stability.
17) Complete the transmission master plan study to present a blueprint of transmission infrastructure requirements up to year 2040.

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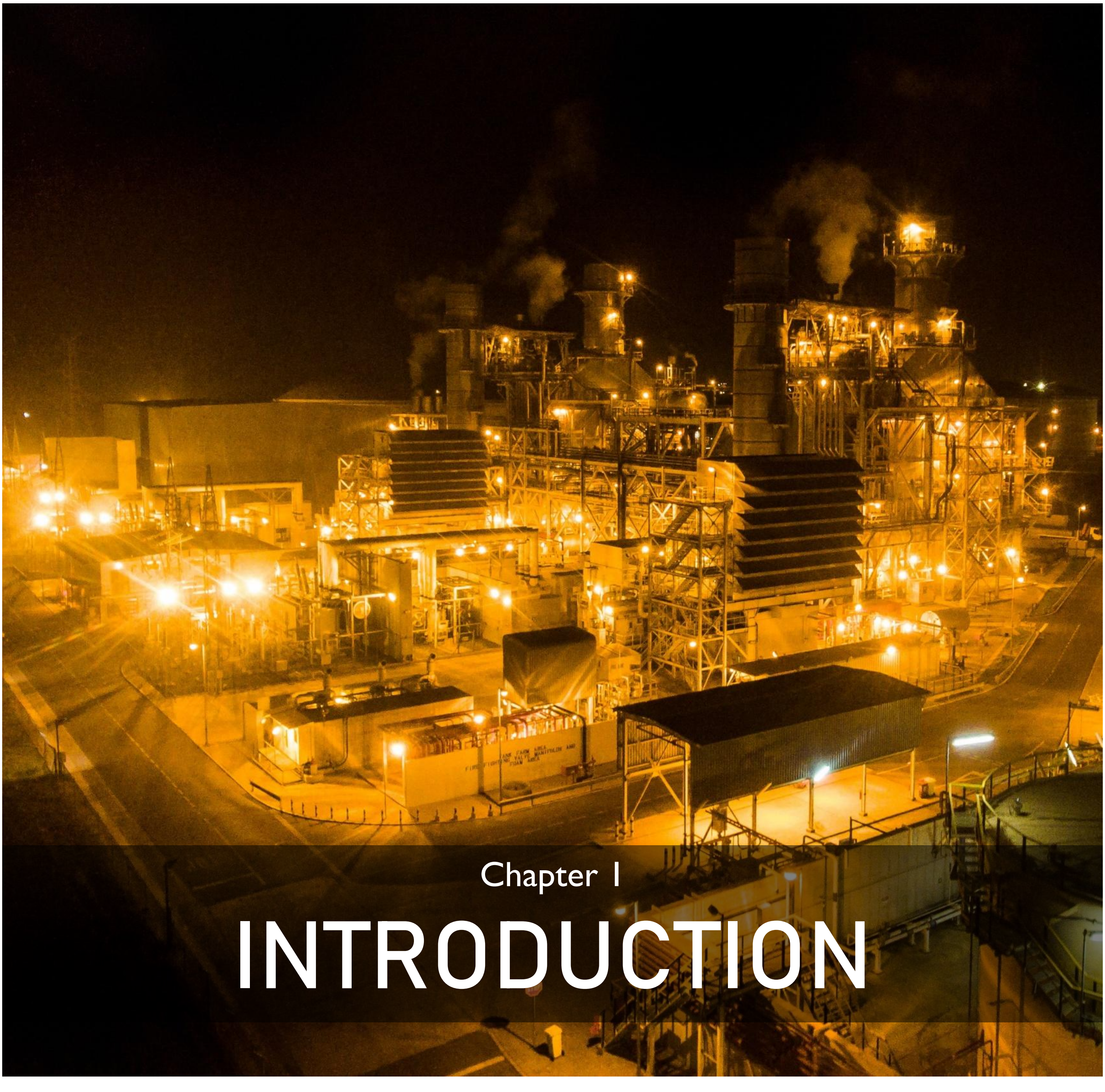

Chapter 1

INTRODUCTION

1 INTRODUCTION

The 2025 Electricity Supply Plan (ESP) outlines the operations plan for the Ghana power system for the year 2025. It outlines projections for electricity demand and supply for the year, as well as highlights the strategy for ensuring reliable electricity transmission services on the Ghana Power System in the year under consideration as well as in the medium term.

The report begins with a review of the performance of the Ghana Power System in 2024. It goes on to present a forecast for the year's electricity demand and supply. The supply outlook highlights the key assumptions underpinning the projections, such as generating unit maintenance schedules and natural gas availability.

The report provides an overview of existing generation facilities that would be available for dispatch to supply projected demand. The Akosombo hydroelectric power plant is expected to continue to play the crucial lead role in providing load following. Energy allocations from the hydropower plants took into account the total inflows into the Akosombo and Bui hydro reservoirs during the inflow season in 2024 and were done to ensure prudent management of headwater in the reservoirs to avert the need for spillage while ensuring that the reservoirs are not depleted below critical levels.

Gas supply sources in Ghana are the Sankofa, Jubilee and TEN fields as well as imported gas from Nigeria. With the ever-increasing proportion of gas-fired thermal generating facilities in Ghana, the adequacy of gas supply for thermal generation is analysed to determine fuel supply security.

Alternative liquid fuel requirements to provide security of supply during the periods of outages to gas infrastructure and to serve as strategic stocks for multi-fuel fired thermal plants have also been analysed.

The report goes on to take a critical look at the Transmission System Outlook for the year and makes recommendations to improve its reliability and adequacy for power evacuation in Ghana. It goes on to outline projections for the medium-term, making recommendations to address identified challenges and conduct analysis into supply adequacy for the medium term.

Finally, the report presents a summary of recommendations for the improvement of power supply on the Ghana power system.

Chapter 2

2024 POWER SYSTEM PERFORMANCE REVIEW

2 2024 POWER SYSTEM PERFORMANCE REVIEW

2.1 Objective

In this chapter, we review the performance of the Ghana Power System in 2024. It compares key parameters such as peak demand, energy consumption, and power generation in 2024 with those of 2023 as well as with projections made in the 2024 Electricity Supply Plan (ESP). It also analyses the trends of some key parameters from 2020 to 2024. The availability and reliability of the transmission network over the period are also evaluated together with the quality of power supply and transmission system losses, to identify trends over the period.

2.2 Peak Load

The Ghana power system peak load for the year 2024 was 3,952.0 MW, which was recorded at 20.00 h on December 19, 2024. This was very close to the 2024 Electricity Supply Plan (ESP) projection of 3,952.9 MW, with a difference of only 0.9 MW. It also represents a 9.2% growth over the 2023 peak load of 3,618.0 MW (an increase of 334 MW).

It is noteworthy that in December 2023, Genser Energy Ghana Limited (GEGL) transferred its Edikan, Wassa, Chirano and Tarkwa power plants from operating in embedded mode to operate from direct connections to the NITS. The mining load (approximately 97 MW) which GEGL supplied in embedded mode, is now consequently supplied directly from the NITS. Table 2.1 compares the details of the projected peak demand for 2024 as per the 2024 ESP with actuals for the various load components.

Table 2.1: 2024 Ghana Peak Load

Load Classification	Ghana Peak Load (MW)		Difference (MW)
	Projected 2024	Actual 2024	(Projection - Actual)
Domestic Demand	3,395.9	3,422.0	-26.1
Export (CEB+SONABEL+CIE)	462.0	438.0	24.0
VALCO	95.0	93.0	2.0
System Peak (Coincident)	3,952.9	3,952.0	0.9

We note that the actuals of the various components of the peak load (Domestic load, Export and VALCO) were appreciably close to projections made in the 2024 ESP.

Table 2.2 and Figure 2.1 compare the actual coincident peak load recorded with the projections for the years 2020 to 2024.

Table 2.2: Ghana Peak Load projections Vs Actuals (2020 - 2024)

Peak Load (MW)					
Year	**2020**	**2021**	**2022**	**2023**	**2024**
Actual	3090.0	3246.0	3469.0	3618.0	3952.0
Projected	3115.2	3303.7	3545.3	3673.4	3953.0

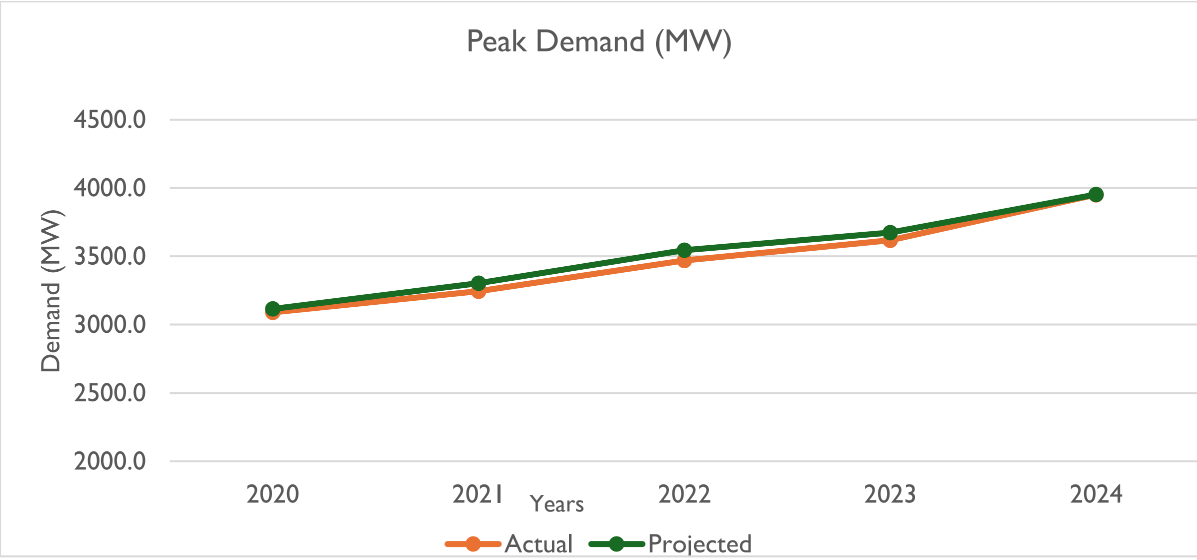

Figure 2.1: Ghana Peak Load Projections Vs Actuals (2020 - 2024)

Ghana's peak load has increased significantly from 3,090.0 MW in 2020 to 3,952.0 MW in 2024, representing a cumulative annual average growth of 6.3%, as shown in Table 2.2 and Figure 2.1.

2.2.1 Peak Domestic Load

Peak Domestic Load refers to the maximum instantaneous amount of power supplied to consumers within Ghana excluding VALCO. This includes residential, commercial, industrial, and mining loads.

On December 19, 2024, when the Ghana peak load occurred, the domestic load at the time was 3,422.0 MW, as shown in Table 2.1. It is worth noting that the Domestic Peak Load for 2024 was 3,568.0 MW, which was recorded at 21:00 h on December 16, 2024.

Table 2.3 and Figure 2.2 show domestic peak demands from 2020 to 2024.

Table 2.3: Actual domestic demand (2020 - 2024)

Domestic Peak Demand (MW)					
Year	2020	2021	2022	2023	2024
Actual (MW)	2857.0	2886.0	3144.0	3171.0	3568.0

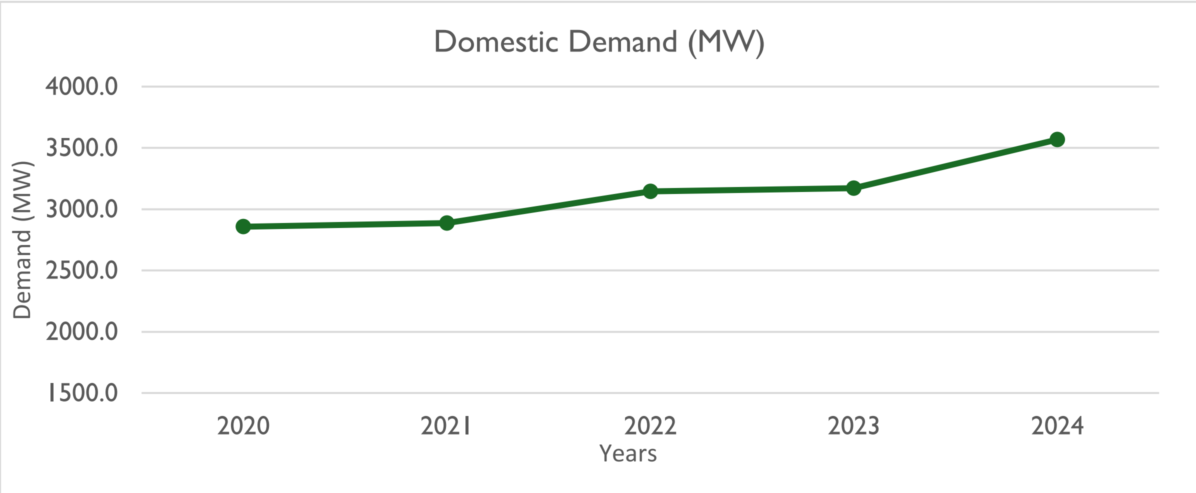

Figure 2.2: Actual domestic Load (2020 - 2024)

The data in Table 2.3 and Figure 2.2 show that domestic load has steadily increased over the period, with an average annual cumulative growth rate of 5.7%.

2.3 Energy Consumption

The total energy consumed in 2024, including losses, was 25,269.3 GWh. The 2024 energy consumption represents an increment of 1,718.3 GWh over the 2023 consumption of **23,551.0 GWh** (**7.3%** growth). This is 4.9% (1,300.1 GWh) lower than the 2024 ESP projection of 26,569.1 GWh. The actual energy consumed was lower than the projected due to load management carried out at certain times during the period to address supply constraints caused mostly by inadequate fuel supply to run thermal plants.

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A summary of 2023 and 2024 energy consumption per consumer is shown in Table 2.4

Table 2.4: Comparison of Energy Consumption (2023 vs 2024)

Customer	Actual (GWh)	Actual (GWh)	% Growth
	2023	2024	(2024-2023)
ECG	15,453.9	16,565.6	7.2%
NEDCo	1,926.8	2,113.9	9.7%
Mines	1,379.4	2,024.9	4.7%

VALCO		834.3	807.9	-3.2%
EPC		268.7	307.6	14.5%
Export	CEB	983.9	586.9	-40.4%
	SONABEL	1,279.1	1,149.2	-10.2%
	CIE	264.7	376.8	42.3%
	CLSG	0.0	0.0	0.0%
Direct Cust.		241.2	374.2	55.1%
Losses		908.3	951.3	4.7%
Network Usage		10.8	11.0	1.5%
Total Energy Transmitted		23,551.0	25,269.3	4.7%

Analysis of the 2023 and 2024 annual consumption by the various consumers indicates the following:

- Direct Customers: This consumer group observed significant growth of **55.1%, which** was driven primarily by the commissioning of a new steel company, **B5 Plus**.
- Exports to Togo/Benin (CEB/CEET/SBEE) and SONABEL saw a decline of **40.4%** and **10.2%** respectively. These reductions are attributed to supply constraints during the period due to deficit in generation capacity caused by inadequate thermal fuel supply.
- Exports to CIE grew by **42.3%** due to the new supply agreement with Genser Energy Ghana Limited (GEGL) for the year 2024.

2.3.1 Trend of Annual Energy Consumption

Table 2.5 and Figure 2.3 show the trend of annual energy consumption from 2020 to 2024.

It can be observed from Table 2.5 that energy consumption increased consistently from **19,716.6 GWh** in 2020 to **25,269.3 GWh** in 2024, reflecting a cumulative annual growth rate of 5.7%.

Table 2.5: Annual Energy Consumption (2020 - 2024)

Energy (GWh)					
Year	2020	2021	2022	2023	2024
Actual	19,716.6	21,466.3	22,478.5	23,551.0	25,269.3

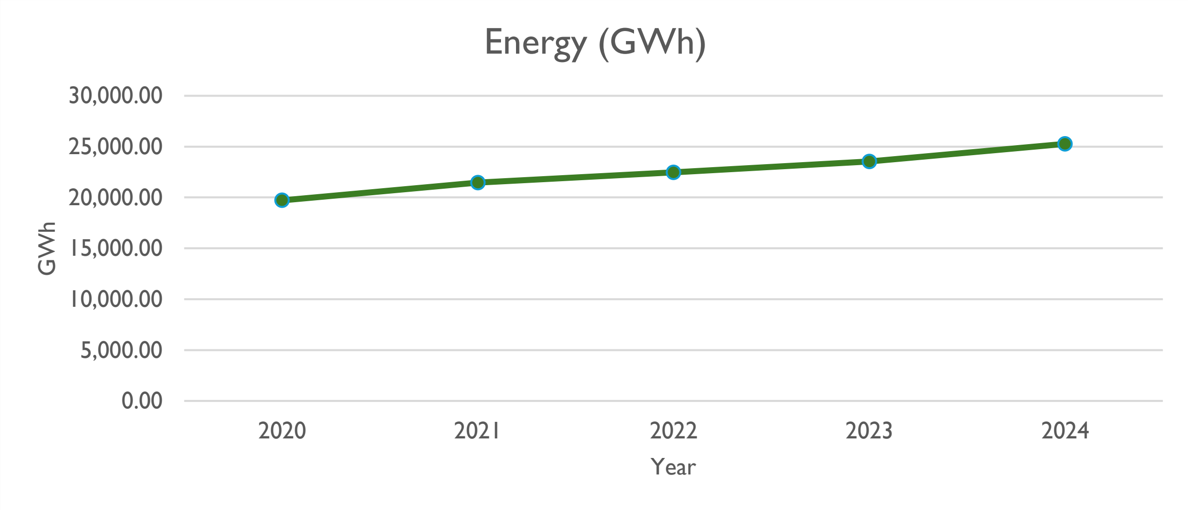


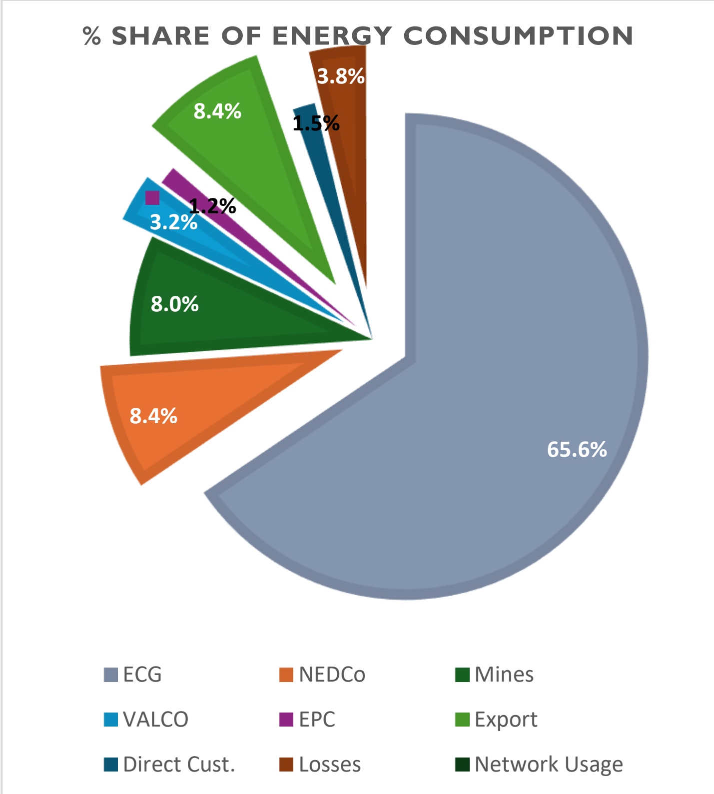
Figure 2.3: Actual Energy Consumption (2020 – 2024)

2.3.2 Domestic Consumption

ECG consumption accounted for 67.2% of the total system consumption while NEDCo consumption was 8.6%. Mines and EPC also accounted for 3.3%, and 5.7% of the total domestic consumption respectively as shown in Table 2.6.

Table 2.6: 2024 Energy Consumption

Consumer	Projection (GWh) 2024	Actual (GWh) 2024
ECG	16,664.7	16565.6
NEDCo	2,159.7	2113.9
Mines	1,963.1	2025.0
VALCO	834.4	807.9
EPC	288.8	307.6
Export	3,243.3	2112.8
Direct Cust.	262.4	374.2
Losses	1,142.1	951.3
Network Usage	11.1	11.0
Total Energy Transmitted	26,569.4	25,269.3



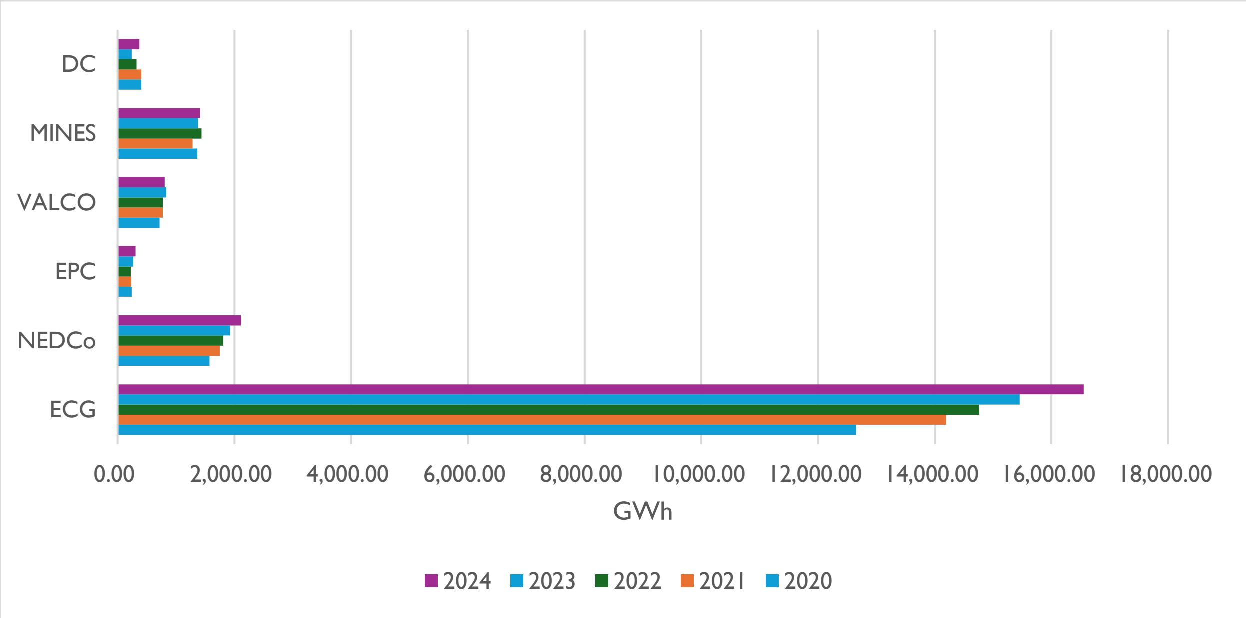


Figure 2.4: Energy Consumption per consumer (2020 - 2024)

Figure 2.4 shows the annual comparison of domestic consumers from the year 2020 to 2024.

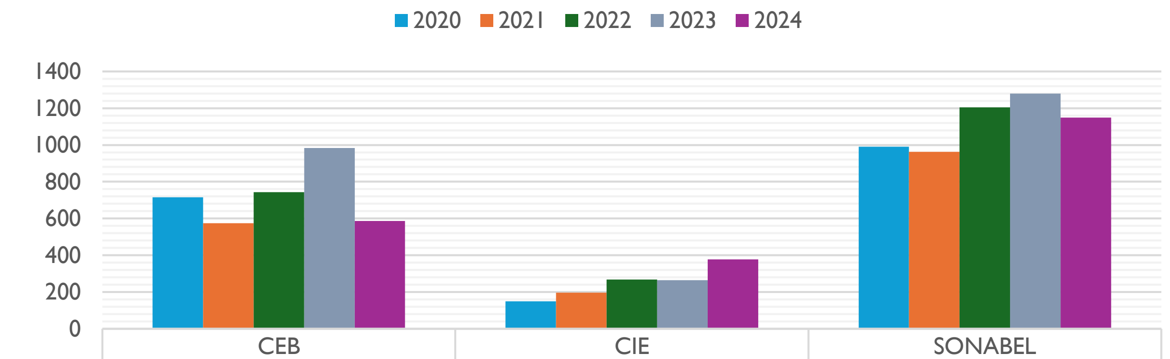
It is seen in Figure 2.4 that the distribution companies (ECG, NEDCo and EPC) have exhibited consistent growth, with cumulative annual growth rates of 7.0%, 7.7% and 6.2% respectively.

2.3.3 Exports

A total of 586.9 GWh and 1,149.2 GWh were exported to Togo/Benin and Burkina respectively during the period. Power exchanges between Ghana and Cote d'Ivoire were made up of 376.8 GWh exports and inadvertent imports of 57.1 GWh (net Export of 319.7 GWh).

Table 2.7: Projected Energy Export vrs. Actual Energy Export in 2024

Customer/Year	Projections 2024	Actual 2024
Export to CEB (GWh)	959.4	586.9
Export to CIE (GWh)	602.7	376.8
Export to SONABEL (GWh)	1681.2	1149.2
Export to CSLG (GWh)	0.0	0.0



	CEB	CIE	SONABEL
2020	715.26187	149.386775	990.472043
2021	574.96274	197.013975	962.003671
2022	743.4611	267.179925	1204.208336
2023	983.90541	264.7051	1279.141991
2024	586.86408	376.8134	1149.15792

Figure 2.5: Trend in Energy Export

Figure 2.5 presents the energy consumption trends for exports (CEB, CIE, and SONABEL) from 2020 to 2024. It is observed that while CIE's demand shows a robust and steady upward trend, CEB and SONABEL experienced declines in 2024.

2.3.4 Transmission Losses

An average transmission loss of 3.86% (951.3 GWh) out of the energy transmitted of 25,269.3 GWh was recorded for the year under review.

Table 2.8 provides a monthly breakdown of transmission losses recorded during the period.

Table 2.8: Monthly Transmission Losses for 2024

Month	Total Generation (GWh)	Losses (GWh)	% Loss
Jan	2,153.7	73.42	3.49%
Feb	2,105.1	74.32	3.62%
Mar	2,193.4	90.01	4.21%
Apr	2,079.8	85.8	4.23%
May	2,127.0	81.28	3.92%
Jun	2,032.5	81.96	4.14%
July	2,055.4	83.16	4.16%
Aug	1,982.8	78.89	4.08%
Sept	1,950.8	77.55	4.07%
Oct	2,072.9	71.11	3.52%
Nov	2,177.5	76.17	3.58%
Dec	2,281.8	77.62	3.46%

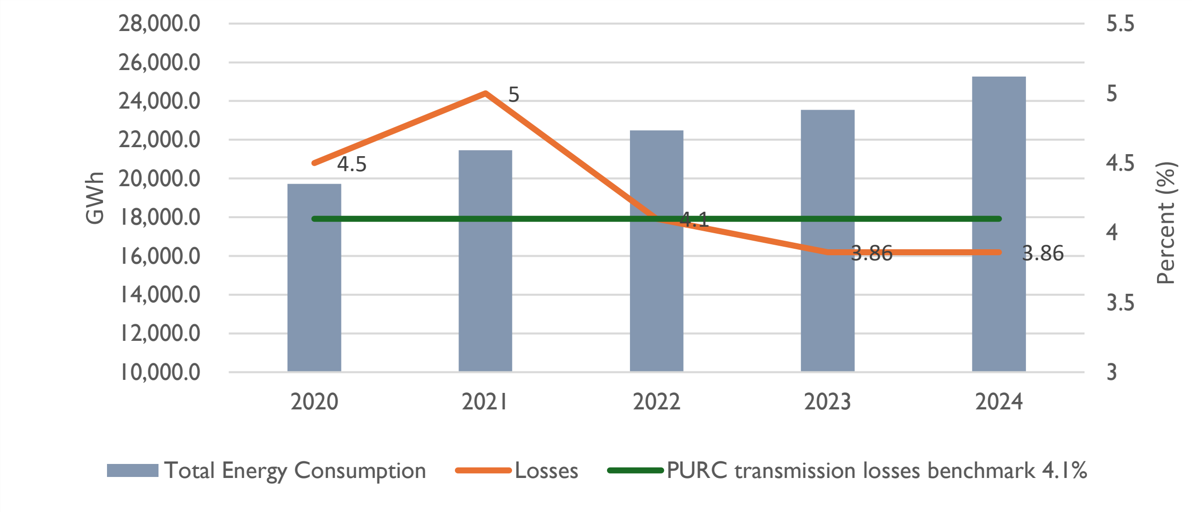


Figure 2.6: Transmission losses (2020 – 2024)

Figure 2.6 shows the trend in transmission losses from the year 2020 to 2024. Notably, transmission losses have decreased significantly from 2022 to 2024 compared to 2020 and 2021. This reduction is attributed to the increased power generation from the Bui plant and the start of operations of the Anwomaso Thermal Power Station in April 2024.

2.4 Energy Generation

Actual monthly energy generation in 2024, are compared with that of 2023 for the various generation sources in Table 2.9.

Table 2.9: Comparison of actual energy generation for 2024 and 2023

Months	2024 (GWh)					2023 (GWh)				
	Hydro	Thermal	RE	Import	Total	Hydro	Thermal	RE	Import	Total
January	879.7	1,263.1	11.0	5.9	2,159.6	781.7	1215.4	8.9	1.2	2007.2
February	888.1	1,206.7	10.3	3.9	2,109.0	729.5	1151.6	7.7	0.9	1889.6
March	884.0	1,300.7	8.7	8.6	2,202.0	784.6	1278.3	9.6	3.7	2076.2
April	789.1	1,279.1	11.6	7.3	2,087.1	821.8	1149.2	11.3	8.2	1990.4
May	790.1	1,326.0	10.9	8.4	2,135.4	748.1	1318.9	9.5	8.6	2085.1
June	710.6	1,312.3	9.6	5.4	2,037.9	572.7	1295.3	3.5	10.0	1881.5
July	683.0	1,364.4	7.9	0.3	2,055.7	630.6	1268.5	1.5	6.0	1906.5
August	766.5	1,208.4	7.8	0.9	1,983.6	680.1	1133.5	1.4	8.6	1823.6
September	828.2	1,113.7	8.8	5.7	1,956.5	823.6	945.5	5.9	9.9	1784.9
October	923.7	1,138.7	10.5	6.7	2,079.6	879.5	1036.2	8.3	10.8	1934.8
November	925.5	1,240.3	11.8	1.2	2,178.8	838.5	1206.6	9.7	5.1	2059.8
December	824.0	1,447.0	10.8	2.3	2,284.1	896.0	1199.8	9.8	5.9	2111.5

The proportions of the various types of generation are presented graphically in Figure 2.7.

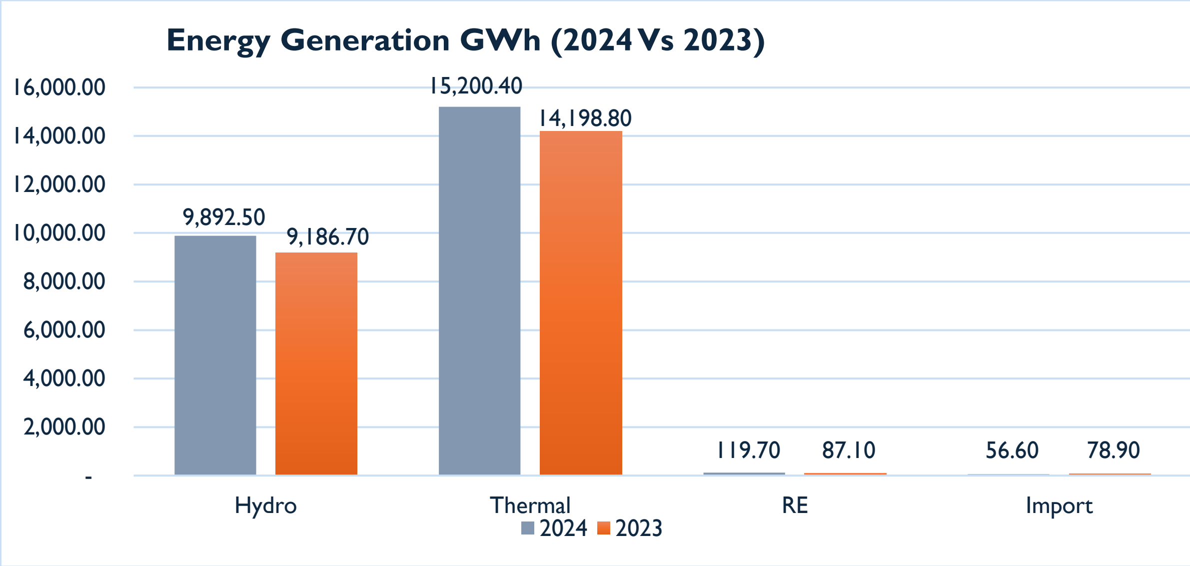


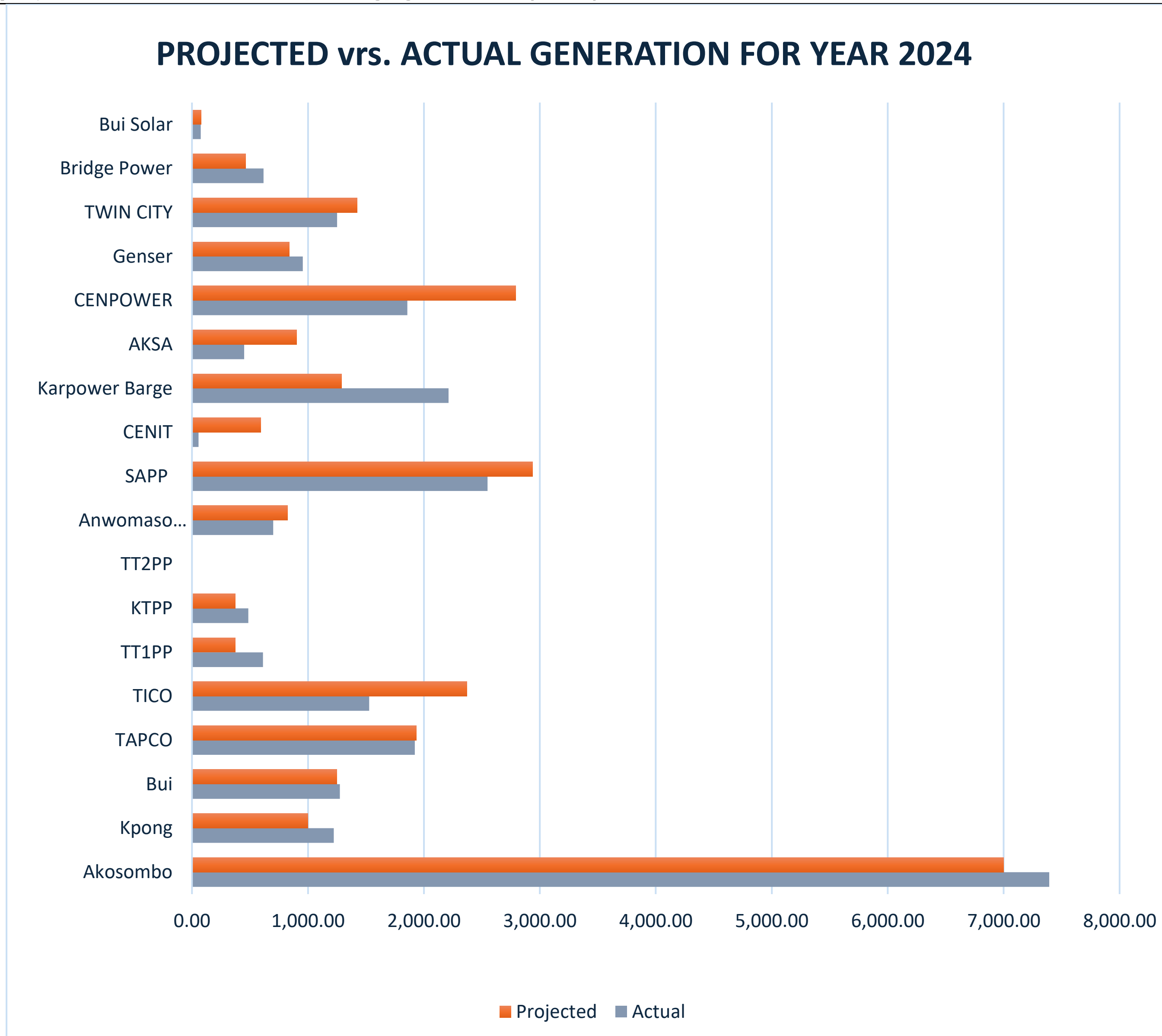
Figure 2.7: Energy Generation GWh (2024 Vs 2023)

Details of the monthly generation by the individual power plants in 2024 is shown in Table 2.10 which also includes plant availability for dispatch over the same period. The projected generation for the TICO plant fell short due to the unavailability of the steam turbine generator for the year 2024. The unit became non-operational on December 13, 2023, following damage to its turbine blades. Additionally, actual generation from the thermal power plants was lower than projected, primarily due to gas supply constraints. This shortfall resulted in an increased dispatch of the hydros to meet demand, coupled with the reduction in consumption especially from export customers. The Karpower plant was dispatched above its projected generation, following the limitation on reverse flow gas to the East which led to more gas availability in the west for use by the plant.

Following the high-water level in the Akosombo reservoir due to excessive inflows during the 2023 inflow season, the Akosombo Plant was dispatched with six (6) units running continuously for the year 2024, except during periods of scheduled maintenance.

Table 2.10: Comparison of projected and actual monthly energy generation (GWh)

Plant	(%) Availability
Akosombo	98.04
Kpong	98.81
Bui	96.87
TAPCO	83.67
TICO	60.53
TT1PP	98.50
KTPP	99.85
TT2PP	0
SAPP	79.86
CENIT	99.98
Anwomaso Thermal	65.94
Karpower	97.40
AKSA	97.07
CENPOWER	96.94
TWIN CITY	93.94
Bridge Power	95.54
Bui Solar	-
Kaleo Solar	-



The total energy generated over the period was 25,269.3 GWh; this was made up of 9,892.7 GWh (39.1%) hydro generation, 15,200.3 GWh (60.2%) thermal generation, 119.7 GWh (0.5%) RE generation (directly connected to the NITS) and 56.6 GWh (0.2%) import. Figure 2.8 shows a graphical illustration of the actual generation mix for 2024.

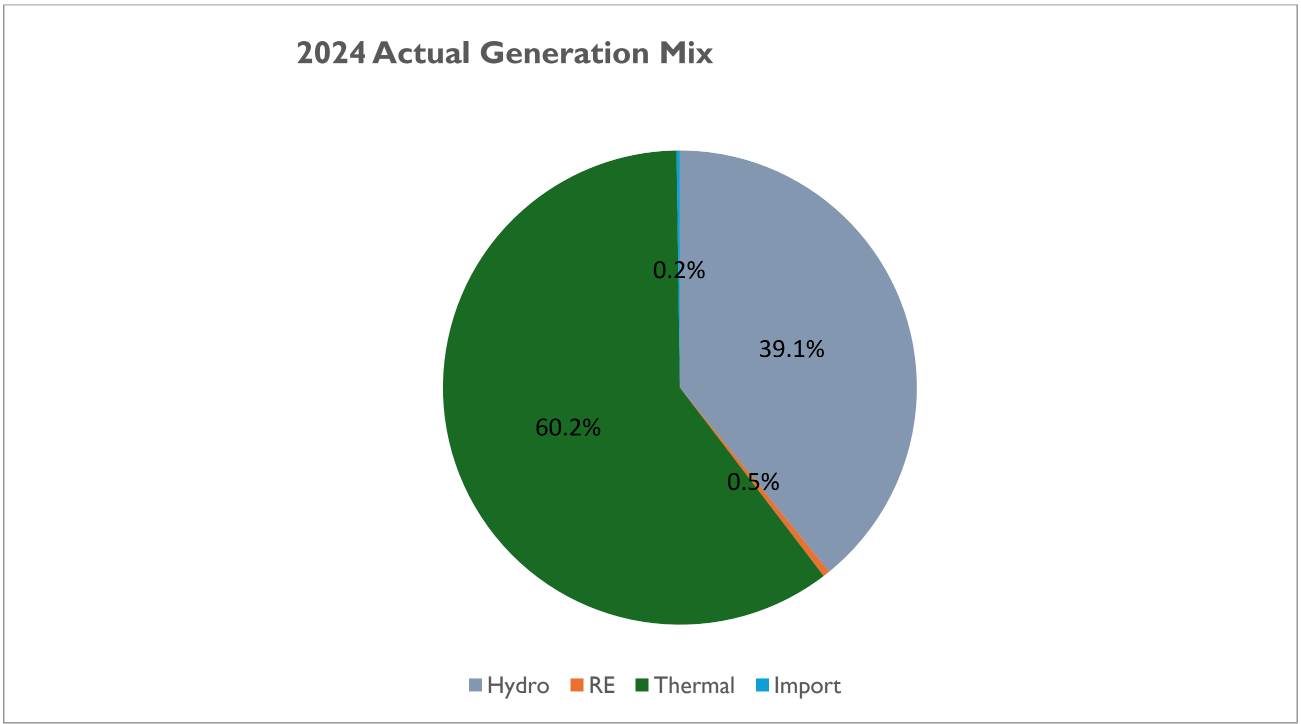


Figure 2.8: Generation Mix for 2024

2.5 2024 Generation and Load Analysis by Enclaves

This subsection analyzes geographically distributed generation with regional demand. For this analysis, a zonal (enclave-based) classification was used to analyze generation, load distribution, and operational efficiency. The power system was divided into four major operational enclaves namely Eastern, Western, Central, and Northern based on the location of generators and major load centers, fuel availability, and network configuration as described in Table 2.11. The analysis enabled us to identify the following issues:

- Contribution of each generation enclave to system demand
- Transmission corridors that were highly utilized or otherwise due to the spread between generation and demand.
- How some generation enclaves drive losses.

Table 2.11: Classification of enclaves on the NITS.

ENCLAVE	CLASSIFICATION
Eastern Enclave	Comprises loads (Including CEB export), hydro (Akosombo and Kpong) and thermal generation in the south east of Ghana, covering Aflao, Akosombo, Nkawkaw, Winneba, Accra and back to Tema.
Western Enclave	All generation and loads (including CIE export) from Cape Coast through Takoradi/Aboadze to the West of Ghana.
Central Enclave	All loads and potential generation around Obuasi, Konongo, Kumasi, Techiman and surrounding substations.
Northern Enclave	All Northern generation and loads beyond Techiman including Bui hydro plant and SONABEL export.
Renewables	All renewables connected to the grid.
Imports	All imports (CIE, CEB, SONABEL)

Table 2.12 shows the monthly total generation including imports and the percentage share recorded by each generation enclave for 2024

Table 2.12: Monthly breakdown of total Energy and % share generation into zones

Month	Total Energy Generated and Imported (GWh)	Eastern Generation		Western Generation		Northern Generation		Central Generation		Imports	
		Energy	% Gen	Energy	% Gen	Energy	% Gen	Energy	% Gen	Energy	% Gen
Jan-24	2,159.6	1,275.6	59.1	685.4	31.7	192.7	8.9	0.0	0.0	5.9	0.3
Feb-24	2,109.0	1,308.3	62.0	620.3	29.4	176.5	8.4	0.0	0.0	3.9	0.2
Mar-24	2,202.1	1,437.0	65.3	641.4	29.1	115.1	5.2	0.0	0.0	8.6	0.4
Apr-24	2,087.1	1,304.0	62.5	691.9	33.1	53.2	2.5	30.7	1.5	7.3	0.3
May-24	2,135.4	1,336.0	62.6	652.3	30.5	43.1	2.0	95.5	4.5	8.4	0.4
Jun-24	2,037.9	1,270.7	62.4	626.0	30.7	38.6	1.9	97.3	4.8	5.4	0.3
Jul-24	2,055.8	1,203.6	58.5	720.3	35.0	34.8	1.7	96.7	4.7	0.3	0.0
Aug-24	1,983.7	1,190.2	60.0	650.2	32.8	42.1	2.1	100.3	5.1	0.9	0.0
Sep-24	1,956.5	1,217.3	62.2	576.4	29.5	118.9	6.1	38.2	2.0	5.7	0.3
Oct-24	2,079.5	1,148.7	55.2	667.6	32.1	187.2	9.0	69.4	3.3	6.7	0.3
Nov-24	2,178.8	1,280.9	58.8	575.1	26.4	230.9	10.6	90.7	4.2	1.2	0.1
Dec-24	2,284.1	1,275.2	55.8	762.3	33.4	162.3	7.1	82.0	3.6	2.3	0.1

Table 2.12 shows that the Eastern Enclave remained the dominant contributor, averaging over 60% of total generation due to Akosombo, Kpong (hydro plants), and Tema-based thermal plants. The Western Enclave followed with about 30%, but limited local demand led to heavy power transfers to the central enclave, stressing transmission corridors and increasing losses.

The Central Enclave, with the commercial operation of Anwomaso Thermal in April, averaged 2.8% and helped reduce dependence on southern plants for central demand. The Northern Enclave and cross-border exports (SONABEL) provided minimal but strategic contributions to grid stability.

2.5.1 System Generation and Losses

The correlation between the generation enclaves and losses for the year 2024 is shown in Figure 2.9.

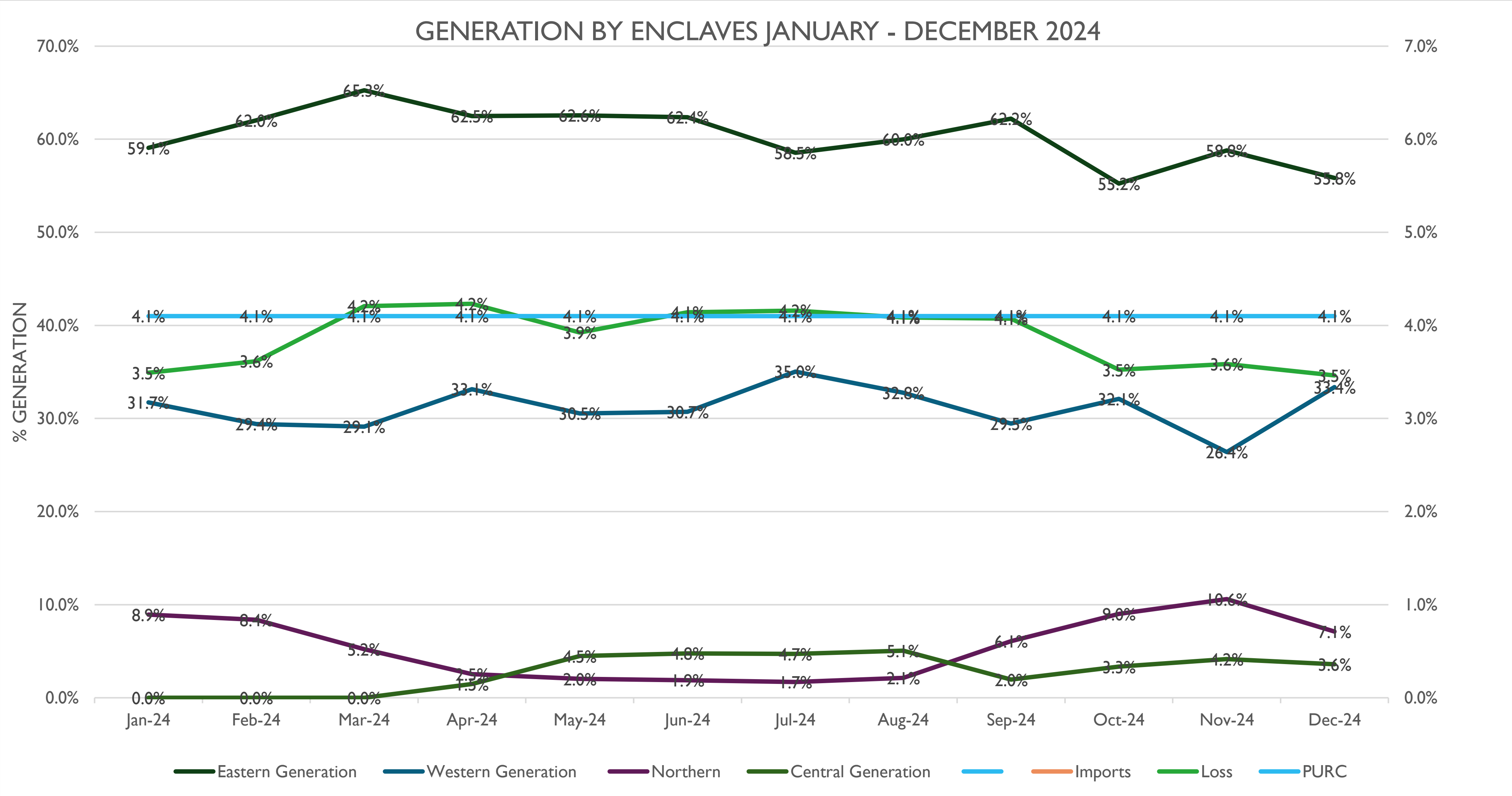


Figure 2.9: Share of generation per enclave wrt. total energy generated and imported for 2024

Figure 2.9 reviews the total generation share against energy imports by enclaves. The analysis showed imbalances between generation and demand, especially in the Wethern zone that led to increased system losses. Localized generations like in the Central and Northern enclaves improved efficiency. Aligning generation with demand growth areas remains key to reducing losses and ensuring grid reliability.

2.6 Generation Facilities

2.6.1 Hydro Facilities

The projected dependable capacities and energies against the actual for the individual hydro plants are shown in Table 2.13.

Table 2.13: Projected and Actual Hydro Generation

Plants	Dependable Capacity	Projected Energy	Actual Energy	Variations	% Variations
	(MW)	(GWh)	(GWh)		
Akosombo GS	900.0	7,000.0	7,394.4	-394.4	-5.63%
Kpong GS	140.0	1,000.0	1,222.6	-222.6	-22.26%
Bui GS	345.0	1,225.0	1,275.7	-50.7	-4.13%

The total hydro generation (9,186.52 GWh) was made up of 7,394.4 GWh, 1,222.6 GWh and 1,257.7 GWh from Akosombo, Kpong and Bui generating stations, respectively. This was 7.2% higher than the projected hydro generation of 9,225.0 GWh.

a. Akosombo Reservoir

The year start elevation of the Volta Lake at Akosombo in 2024 was 274.75 ft. The reservoir elevation dropped to a level of 263.70 ft at the end of the dry season. The reservoir rose to maximum elevation of 82.74 m (271.46 ft) at the end of the inflow season. This represents a rise of 7.76 ft from the minimum recorded in 2024. The maximum elevation recorded at the end of 2024 was 31.46 feet above the minimum operating level of 240 feet. The total net inflow recorded in 2024 was 24.63 MAF, which implies that net inflow obtained was below the long-term average of 25.91 MAF. Figure 2.10 shows the Akosombo reservoir trajectory for 2024 plotted against the trajectory for 2023.

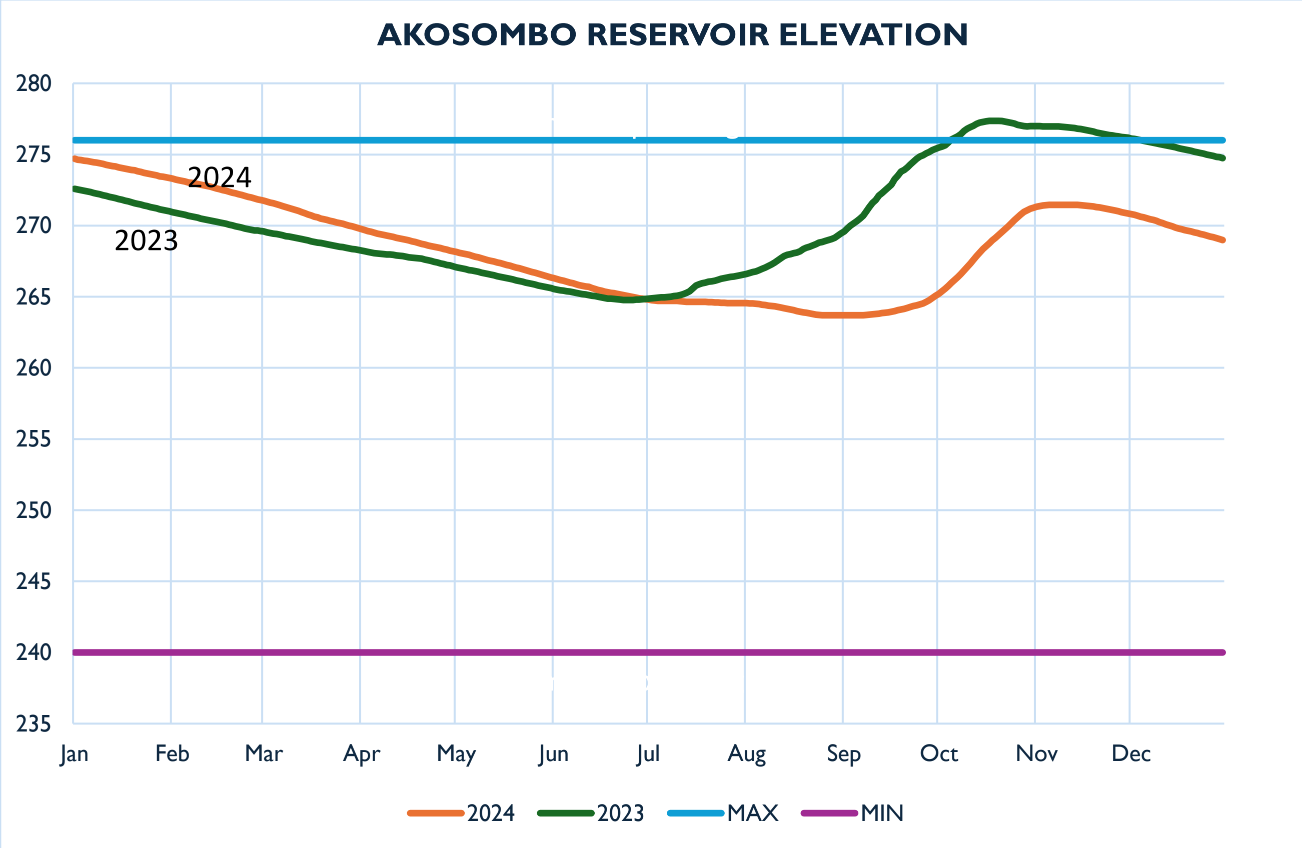


Figure 2.10: Comparison of Akosombo Reservoir Trajectory for 2024 with 2023

b. Bui Reservoir

The Bui Reservoir elevation was 176.4 masl at the start of the 2024 season and 178.8 masl at the end. The reservoir recorded a minimum elevation of 166.2 masl on June 16, 2024, at the end of the dry season. The lowest level reached was 3.3 m lower than the planned minimum of 169.5 masl for the year. The maximum Bui reservoir elevation attained at the end of the inflow season was 181.2 masl which occurred on November 9, 2024.

The net inflow yielded a rise in elevation of 13.2 m above the minimum operating level (168.0 masl). The rise was due to the relatively high cumulative inflow volumes which was about 154% of long-term average and representing an increase of 34% recorded in the previous year. The Bui Power Authority, per the standard operating procedure, conducted a spillway dry test exercise from June 24 to 29, 2024, to ensure the readiness of the gates for discharging excess flood water where necessary.

Figure 2.11 shows the Bui Reservoir trajectory for 2024 plotted against the trajectory for 2023.

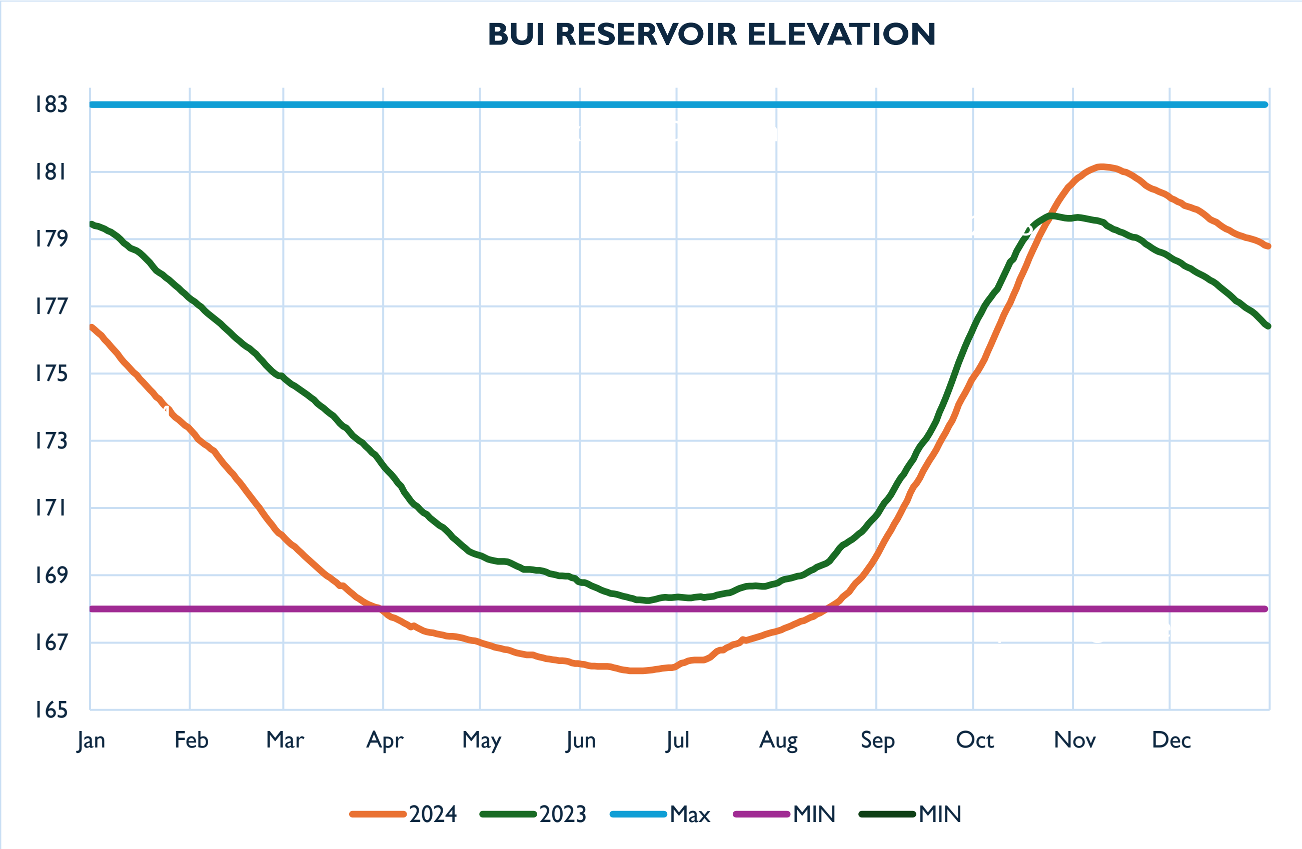


Figure 2.11: Bui Reservoir Trajectory for 2023 and 2024

2.6.2 Thermal Facilities

The dependable thermal capacity for 2024 was 3,221 MW which was made up of 1,428 MW, and 1,655 MW and 138 MW from the Western, Eastern and Central Enclaves, respectively. The total thermal energy generated for the year was 14,585.0 GWh. The Anwomaso Thermal Plant, formerly connected to the Western Enclave as the Ameri Plant, relocated six (6) units to the Central Enclave and commissioned the units in April 2024. Table 2.14 details the capacities of the individual thermal plants and their energy generated.

Table 2.14: 2024 Thermal Capacities and Energy generated

Enclave	Plants	Dependable Capacity (MW)	Generated Energy (GWh)
Western	TAPCO (T1)	300	1920.6
	TICO (T2)	320	1527.4
	Twin City	198	1250.7
	Karpower	450	2213.7
	GENSER	160	956.7
	Sub-Total	**1,428**	**7,869.1**
Eastern	TT1PP	100	612.5
	TT2PP	70	0.0

Enclave	Plants	Dependable Capacity (MW)	Generated Energy (GWh)
	KTPP	200	486.3
	Sunon Asogli	530	2549.5
	CENIT	100	55.5
	AKSA	330	451.2
	Cenpower	325	1857.9
	Bridge Power	0	617.5
	Sub-Total	**1,655**	**6,630.4**
Central	ATPS	138	700.8
	Sub-Total	**138**	**700.8**
TOTAL SUPPLY		**3,221**	**15,200.3**

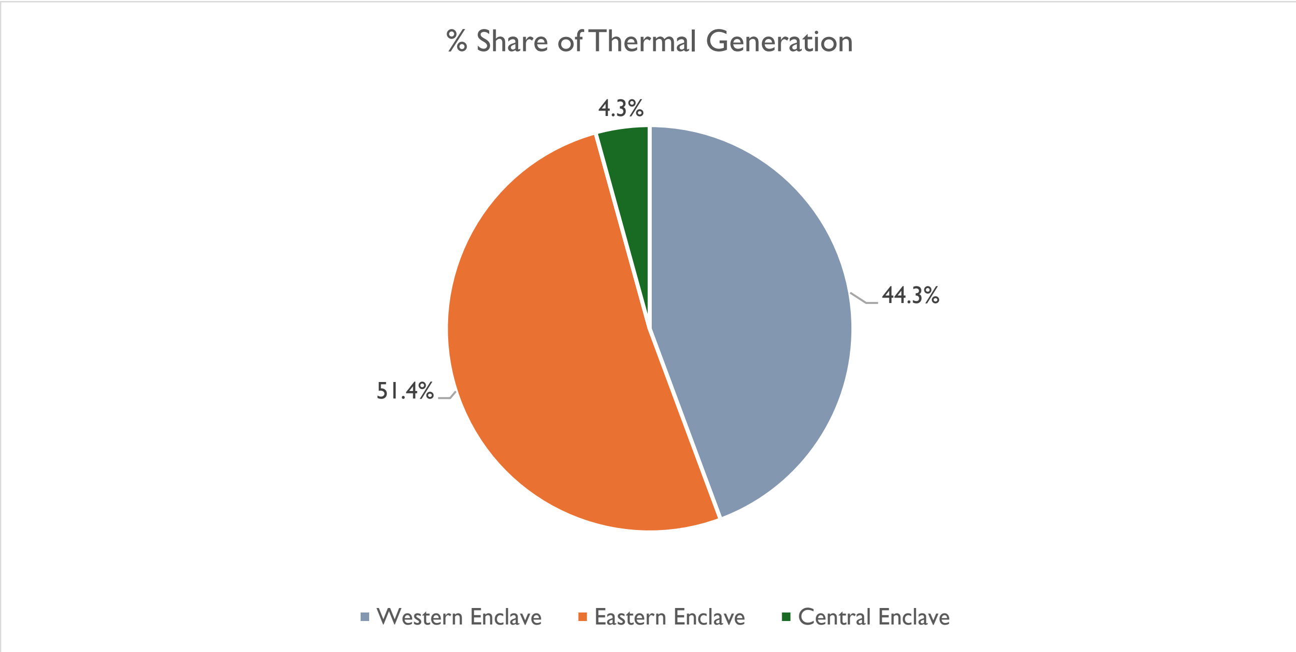


Figure 2.12: Eastern vs Western Thermal Generation Capacity for 2024

2.6.3 Renewables

The Ghana power system has an installed renewable capacity of 123.1 MWp connected variously at the transmission and distribution levels. During 2024, it contributed 182.8 GWh to the generation mix, 119.7 GWh at the transmission level and 37.3 GWh embedded in the distribution level Table 2.15 presents contribution of renewable energy generation for 2024.

Table 2.15: Renewables Capacities and Energy generated

Plants	Source	Capacity (MWp)	Projected Energy (GWh)	Actual Energy (GWh)
Connected on NITS				
BUI	SOLAR	55.0	80.2	76.3
KALEO	SOLAR	28.0	47.9	43.5
Embedded				
BXC	SOLAR	20.0	27.0	16.4
MEINERGY	SOLAR	20.0	27.0	20.3
NAVRONGO	SOLAR	2.5	3.0	
SAFISANA	BIOGAS	0.1	0.7	0.5

2.7 Fuel Usage

In the 2024 ESP, it was projected that the total gas available from both domestic (GNGC & ENI) and Nigeria was inadequate to run all thermal plants to meet electricity demand. There was therefore a recommendation to increase gas volumes from Nigeria and also procure liquid fuels as alternate source especially during gas infrastructure shutdowns. Thermal fuels therefore used for power generation in 2024 was natural gas, Light Crude Oil (LCO), Heavy Fuel Oil (HFO) and Diesel Fuel oil (DFO).

2.7.1 Natural Gas Supply

The total aggregate gas supply reached approximately 141,983.02 MMscf. Of this amount, 114,180.55 MMscf was utilized by thermal power plants for electricity generation, while industrial consumers accounted for about 24,206.43 MMscf.

Domestic natural gas supply totaled 115,454.49 MMscf in 2024, representing a 10% increase compared to the 104,953 MMscf supplied in 2023. However, the total gas consumption for the year stood at 138,386.98 MMscf, exceeding domestic supply by approximately 22,932.49 MMscf.

Ghana imported natural gas from Nigeria (N-Gas) via the West African Gas Pipeline (WAGP). In 2024, 26,528.53 MMscf of N-Gas was imported, marking a 25% increase over the 21,274 MMscf imported in 2023.

Figure 2.13 shows the average actual gas supply volumes from the three domestic sources in 2024.

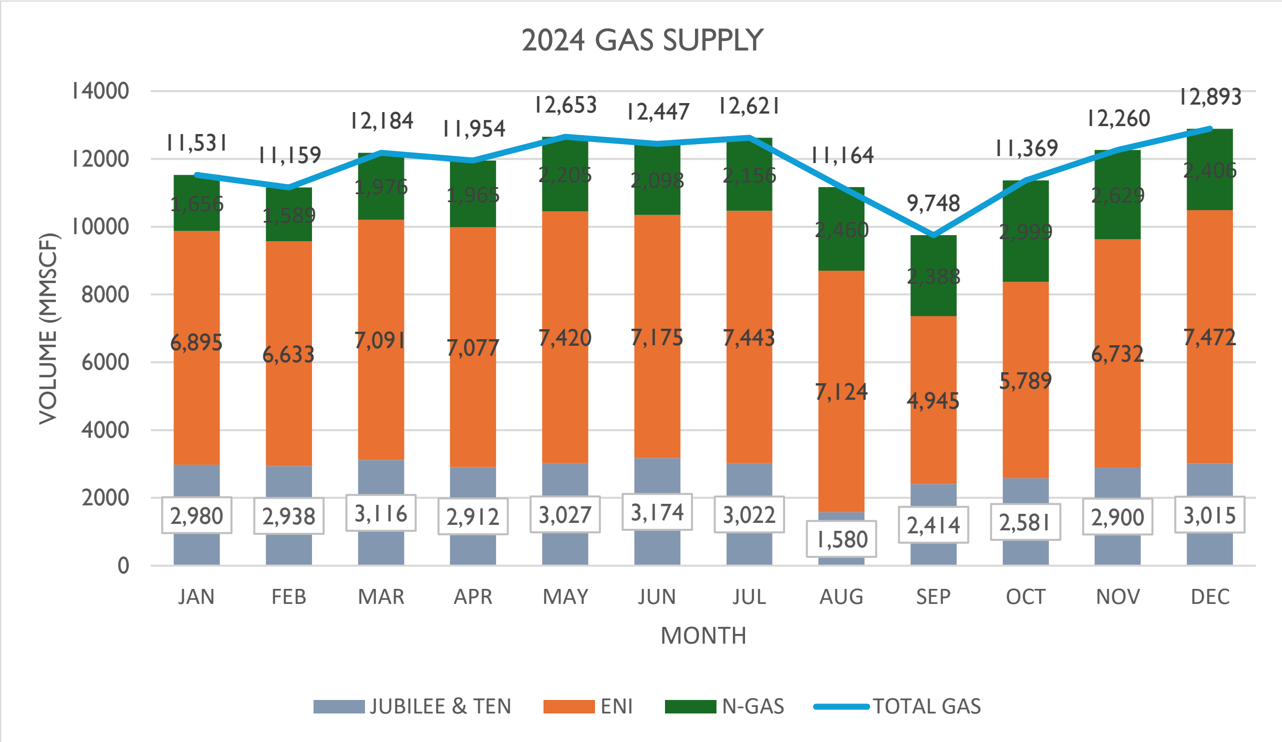


Figure 2.13: 2024 Monthly Actual Gas Supply Volumes

a. Natural Gas Usage

The gas consumption by thermal plants in the year 2024 is shown in Table 2.16.

Table 2.16: Gas Consumption by Plants in 2024

Plant	Planned Gas (MMBtu)	Actual Gas (MMBtu)	Deviation (Planned – Actual)	%
TAPCO	17,959,264.0	18,265,646.0	-306,382.0	-1.7%
TICO	18,726,079.0	16,479,889.0	2,246,190.0	12.0%
TT1PP	4,391,712.0	6,968,295.0	-2,576,583.0	-58.7%
TT2PP	-	-	-	-
KTPP	4,397,710.0	5,302,635.0	-904,925.0	-20.6%
ATPS	9,294,075.0	7,665,137.0	1,628,938.0	17.5%
Sunon Asogli	24,334,873.0	19,408,671.0	4,926,202.0	20.2%
Cenit	7,021,579.0	239,927.4	6,781,651.6	96.6%
Cenpower	22,974,078.0	13,198,369.9	9,775,708.1	42.6%
Karpower	10,421,116.0	20,377,966.6	-9,956,850.6	-95.5%
Twin City	11,729,074.0	10,929,798.3	799,275.7	6.8%
AKSA	10,656,876.0	2,742,856.2	7,914,019.8	74.3%
Bridge Power	5,286,503.0	1,910,725.1	3,375,777.9	63.9%
Total	**147,192,939.0**	**123,489,916.4**	**23,703,022.6**	16.1%

b. **Maintenance of Natural Gas Supply Facilities**

WAPCO Mandatory Emergency Shut Down Tests

WAPCO carried out mandatory emergency shut down tests at its Regulatory and Metering stations at Takoradi on January 28, 2024 & July 5, 2024 and at Tema on January 28, 2024 & July 14, 2024.

Atuabo Gas Processing Plant (GPP)

The Ghana National Gas Company Limited shut down its Gas Processing Plant at Atuabo on August 1 - 15, 2024 for mandatory maintenance. About 94 mmscfd of lean gas was therefore not available during that period.

ENI's Onshore Receiving Facility (ORF)

ENI's Onshore Receiving Facility (ORF) located at Sanzule in the Western Region was shut down September 12 – 17, 2024 to undertake a planned maintenance work. There was a loss of 245 mmscfd in gas supply during the period.

2.7.2 Liquid Fuel Usage

There are other power plants which have multiple fuel firing capabilities: these are TAPCO, TICO, TT1PP, Sunon Asogli, Cenpower and Twin City which can run on Natural gas, Light Crude Oil and DFO whilst KTPP runs on DFO and Natural Gas.

Table 2.17 below shows the volumes of Liquid Fuel used by these power plants in 2024. This was necessary due to the consistent limitation on gas supply to the Eastern enclave.

Table 2.17: Liquid Fuel Consumed 2024

Plant	Fuel type	Actual Volume (bbls)
Cenpower	LCO	115,204.4
	DFO	194,094.5
Sunon Asogli	LCO	27,130.8
	DFO	8,398.1
AKSA	HFO	222,105.5
KTPP	DFO	177,142.0

2.8 System Disturbances

The Ghana Power System was stable in the year 2024 and recording only two (2) major disturbances triggered on the transmission system. Below is a brief on the disturbances that occurred and their causes.

i. **Sunday March 03, 2024**: At 20:38 h, the Ghana power system experienced a disturbance when the 161 kV Kasoa–Mallam line No.1 (KS6M) tripped together with the Aboadze 330/161 kV auto transformers, causing power supply interruption to Mallam, Takoradi, Tarkwa, Kasoa and Winneba. The interconnections with Burkina and Côte d'Ivoire also tripped.

   Restoration commenced immediately and by 23:11 h, supply had been restored to all affected customers on the NITS.

ii. **Thursday June 27, 2024:** At 14:41 h, the Ghana power system experienced a major disturbance when the 161 kV Nkawkaw – Anwomaso (N2AW) line tripped while Achimota – Mallam (H4M), Konongo – Kumasi (J2K) and Tafo – Akwatia (F2Q) lines were already out of service for maintenance work. The ensuing disturbance led to the tripping of all generating units at Aboadze and Anwomaso causing cascaded tripping of other lines and resulted in interruption of power supply to customers in the western and northern parts of Ghana as well as some parts of Accra and Tema.

   Restoration commenced promptly and by 19:43 h the NITS had been restored with power supply restored to all affected bulk supply points.

2.9 Quality of Supply

The Ghana Electricity Grid Code requires that system frequency be maintained between 49.8 Hz and 50.2 Hz at all times under normal state of operation. Voltage magnitudes on the NITS are also to be kept within ±5% of the nominal voltage at all times under normal state. In this section, the performance of the NITS based on key parameters for the year 2024 are analysed.

2.9.1 System Frequency

In the year 2024, system frequency was within the normal range of 49.8 Hz - 50.2 Hz for 28.56% of the time as compared to the 62.60% recorded in 2022.

The others are:

- 49.5 Hz - 49.8 Hz – 6.25% of the time.
- 50.2 Hz - 50.5 Hz – 64.74% of the time.

Figure 2.14 shows the details of system frequency performance for the year.

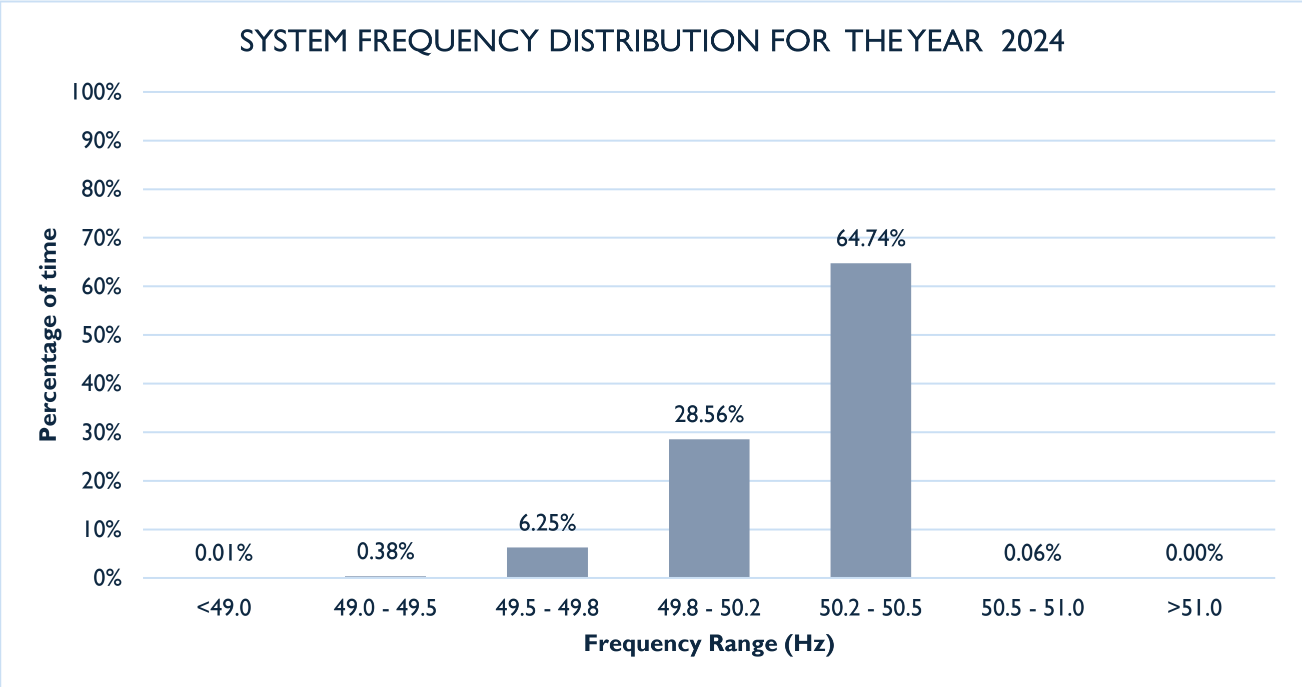


Figure 2.14: System Frequency for 2024

A month-on-month analysis of the system frequency performance shows poor performance throughout the year. The poor performance is attributed to inadequate participation in primary frequency regulation by power plants within the sub-region. The graph below shows the percentage of time frequency was within the normal range of 49.8 Hz - 50.2 Hz for each month in the year.

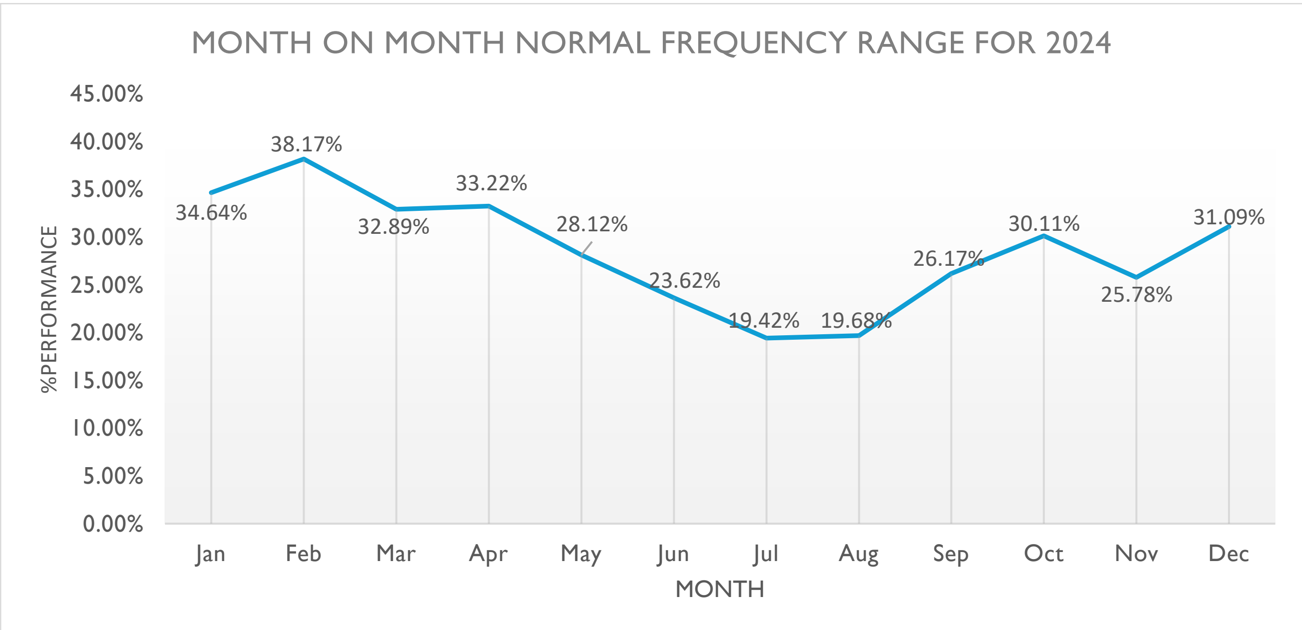
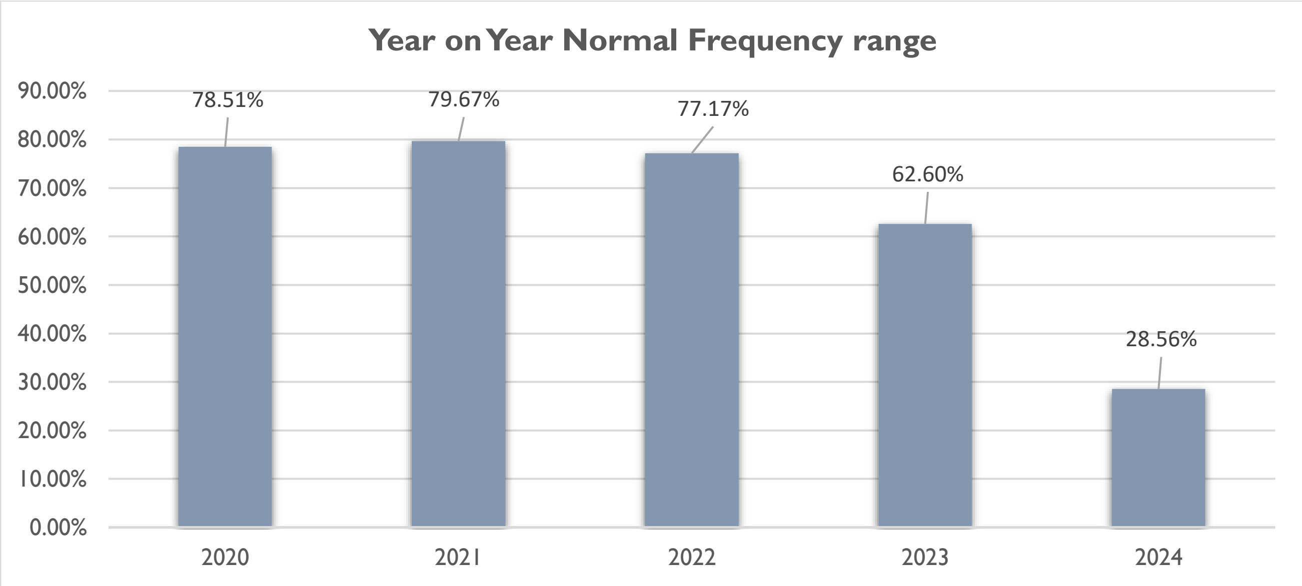


Figure 2.15: Month on Month Normal Frequency Range



The frequency performance started to see a decline from 2023 and performed worse in 2024. It has therefore become necessary for measures to be put in place to incentivize power plants to contribute to primary frequency regulation and ensure better quality of service to consumers.

2.9.2 System Voltages

An analysis of voltage statistics at selected Bulk Supply Points (BSP) at peak time shows that voltages were largely within the normal limits throughout the year except the voltages at New Tema which was above the normal limit for 81.12% of the period. Table 2.18: System Voltages shows the details from the selected substations.

Table 2.18: System Voltages

Station	Number Of Days			Percentage		
	Normal	Below Normal	Above Normal	Normal	Below Normal	Above Normal
Achimota	365	0	0	100.00%	0.00%	0.00%
Mallam	364	1	0	99.73%	0.27%	0.00%
New Tema	66	0	299	18.08%	0.00%	81.92%
Kumasi	295	70	0	80.82%	19.18%	0.00%
Takoradi	363	2	0	99.45%	0.55%	0.00%
Tamale	365	0	0	100.00%	0.00%	0.00%

2.10 Transmission Network Performance

2.10.1 Power Supply (Feeder) Availability

The NITS registered an average feeder availability of 99.92% for the year. This performance was above the PURC approved benchmark of 95%.

2.10.2 Transmission Line Availability

The transmission lines recorded an average availability of 98.99% for the period, as shown in Table 2.19. The Table also shows average availability for the transmission lines of the various voltage classes.

Table 2.19: Transmission line availability for 2024

Voltage Class	Availability %
69kV	99.78%
161kV	98.92%
225kV	95.26%
330kV	99.41%
System Average Availability	**98.99%**

POWER PLANNING
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2025 ELECTRICITY
SUPPLY PLAN

Chapter 3

2025 DEMAND FORECAST

3 2025 LOAD FORECAST

3.1 Introduction

Determining annual load forecasts is an important step in Ghana's electricity supply planning process. The load forecasting methodology employs various socioeconomic and policy-driven indices to estimate the total electrical load for residential, commercial, and industrial consumers for the forecast period.

Demand for electricity in Ghana continues to increase due to population growth, urbanization, industrialisation, and ongoing national electrification initiative aimed at achieving universal access to electricity by the year 2030. An accurate load forecast is important for realising the government's commitment to foster economic growth and support energy-intensive sectors.

Electricity demand in Ghana can be classified into:

- Domestic load – refers to electricity demand within the Ghana control area, excluding VALCO, made up of residential, commercial and industrial loads.
- VALCO; and
- Exports to Cote d'Ivoire (CIE), Burkina (SONABEL) and Togo/Benin (CEB).

The month-by-month peak load will vary depending on the impact of load drivers such as seasonal changes in weather, sporting events, etc. This chapter presents the electricity load forecast for Ghana for 2025.

3.2 **2025 Peak Load (base case)**

The 2025 projected coincident peak load for the Ghana Power System is 4,338 MW. This represents an increase of 386 MW (9.8% growth) over the 2024 peak demand of 3,952 MW which occurred on December 19, 2024.

The following assumptions drive the 2025 base case peak load:

- ➢ VALCO one and half-cell-line operation at 105.95 MW.
- ➢ Mine loads: Namdini 46 MW, Newmont Ahafo North 42 MW.
- ➢ Export to:
    - o Burkina (SONABEL) - supply up to a maximum of 240 MW.
    - o Togo/Benin (CEB, SBEE and CEET) - supply is projected at 120 MW.
    - o Cote d'Ivoire (CIE) - supply is projected to be 140 MW at peak.
- ➢ Integration of Genser's 36 MW captive generation to the grid for delivery to Damang and Chirano Gold Mine

- On-going distribution network expansion works to extend coverage and improve service quality to ECG and NEDCo customers including on-going rural electrification projects.

3.3 2025 High Case Peak Load

The 2025 projected high case coincident peak load for the Ghana Power System is 4,454 MW. This represents an increase of 502 MW (12.7% growth) over the 2024 peak demand of 3,952 MW which occurred on December 19, 2024.

The following assumptions drive the 2025 high case peak load:

- VALCO one and half-cell-line operation at 120 MW.
- Mine loads: Namdini 46 MW, Newmont Ahafo North 42 MW.
- Export to:
  - Burkina (SONABEL) - supply up to a maximum of 240 MW.
  - Togo/Benin (CEB, SBEE and CEET) - supply is projected at 150 MW.
  - Cote d'Ivoire (CIE) - supply is projected to be 200 MW at peak.
- Integration of Genser's 36 MW captive generation to the grid for delivery to Damang and Chirano Gold Mine
- On-going distribution network expansion works to extend coverage and improve service quality to ECG and NEDCo customers including on-going rural electrification projects.

3.4 Distribution System Load Forecast Methodology

Distribution network demand typically accounts for approximately 80% of total Ghana demand. The demand forecast for the distribution system (i.e. ECG, NEDCo and EPC) was based on projection for GDP growth (4.4%) in Ghana, as determined by the Ministry of Finance.

Customers of the distributing companies have been classified into categories. ECG customers are categorized into Special Load Tariff (SLT) customers and Non – Special Load Tariff (NSLT) customers. The SLT customers include industrial customers who consume a demand of 100 kVA and above whilst the Non SLT customers include both residential and commercial customers who consume a demand less than 100 kVA.

For NEDCo, there are three categories of customers. These are Residential, Non-Residential and SLT customers. NEDCo's operational area covers about 64% of the geographical area of Ghana (including the northern parts of Volta, Ashanti, and Western regions) however, the customer density of the operational area is low.

EPC customers, typically industrial, distribute power within the Free Zones enclave and the Dawa industrial zone.

The forecast model takes into consideration projections for losses as well as the different growth patterns of various domestic customer categories.

3.5 Suppressed Demand

Ghana has inherent suppressed demand for electricity, attributed to several factors, including:

i. Inadequate generation capacity, resulting in systemwide load management.
ii. Low voltage levels at the load - end result in the inability of some consumers to operate voltage-sensitive appliances that would otherwise function under optimal voltage conditions. Additionally, low voltage leads to suboptimal performance and reduced output from certain electrical devices, ultimately contributing to lower overall energy consumption.
iii. Limited access to electricity caused by delays in new consumer connections, especially by distribution companies.
iv. Poor reliability and inadequate redundancy in some segments of transmission and distribution networks, leading to prolonged outages for consumers.

3.5.1 Inadequate Generation Capacity

A significant amount of suppressed demand stems from insufficient generation capacity, which periodically necessitates load management. This especially affected exports and to some extent the two major distribution companies, ECG and NEDCo. The 2025 demand forecast accounted for suppressed demand attributable to inadequate supply, under the assumption that sufficient generation capacity will be made available in 2025 to meet unconstrained projected demand.

3.5.2 Poor End-User Voltage Levels

Poor voltage levels at the consumer end prevent electrical appliances from operating at their nominal ratings, resulting in suboptimal performance and hence reduced energy consumption. In some cases, appliances disconnect from the grid when voltages fall below some minimum voltage thresholds. Historical analyses carried out by NEDCo on some of its feeders show that improving poor voltage levels resulted in a 24% increase in consumption. Suppressed demand on these feeders estimated to be released on the network is 25.78 MW, translating into 151.28 GWh in energy.

3.5.3 Export to Burkina (SONABEL)

Burkina has formally requested for supply of 2,227 GWh of electricity from Ghana for the year 2025, at an average peak demand of 290 MW (maximum peak demand of 430 MW). However, due to constraints with transmission capacity, it is projected that only **1,555** GWh of electricity can be exported to SONABEL, with a maximum peak demand of **240 MW**. This results in a suppressed export demand of 672 GWh in 2025.

3.6 Details of 2025 Base Peak Load Projections

Table 3.1 shows the contribution of the various Load Entities to the projected 2025 base case Peak Load:

Table 3.1: Summary of 2025 Projected Peak Load

Demand	Customer		2025 – Projected Coincident Peak (MW)
Domestic Peak Demand	ECG		2,689.73
	NEDCo		354.52
	Enclave Power		48.00
	Mines	AngloGold Goldfields Sankofa Kenyase, New Abirim & Ahafo (Newmont) Golden Star (Wasa) Perseus (Ayanfuri) Golden Star Bogosu Akwatia Diamond Talos Adamus Asanko Gold Drill Works Earl Int Namdini	386.50
	Other Bulk Customers	Akosombo Textiles Aluworks GWCL Enclave Power Company Diamond Cement B5plus Volta Hotel Savana Cement (Buipe) VRA Townships	82.19
	Losses +Network Usage		205.78
Total Domestic Peak Demand			3,766.96
Exports	CEB+SBEE+CET	120	
	CIE	140	
	CLSG	0	
	SONABEL	205	
Total Exports			465.00
VALCO			105.95
Coincident Peak load MW			4,337.73

The pie-chart in Figure 3.1 illustrates the composition of the projected 2025 Peak Load, showing the percentage share of each customer class. As shown in the chart, ECG has the highest load, constituting 62.0% of the total system peak load followed by exports 10.7%, NEDCo 8.2%, the Mines at 8.9%, VALCO at 2.4%, EPC at 1.1% and Other Bulk Consumers at 1.9% of total peak load. Transmission System losses and network usage constitute 4.7% of total consumption.

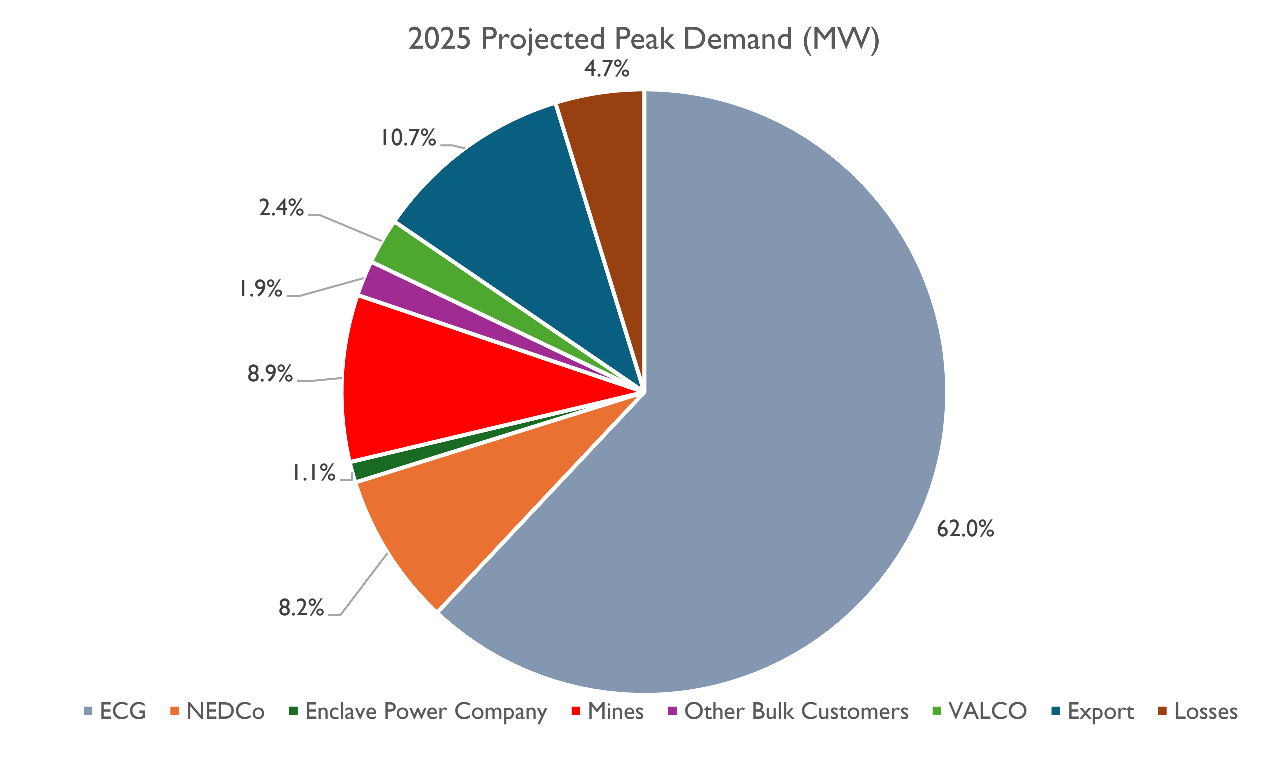


Figure 3.1: 2025 projected peak load

3.7 2025 Energy Consumption Projections

In 2025, the projected base case energy consumption is estimated at **28,339 GWh**, which includes transmission network losses and network usage of **1,211 GWh**, accounting for **4.3%** of the total projected energy consumed. This represents an increase of **3,685 GWh**, or a growth of **12.1%**, compared to the 2024 consumption of **25,269 GWh**. A summary of the 2025 energy consumption by customers on the grid is presented in Table 3.2.

Table 3.2: Summary of 2025 Energy Consumption by Consumer class

Energy	Customer	2025 – Projected Consumption (GWh)
Domestic Consumption	ECG	17,545.5
	NEDCo	2,296.2
	Enclave Power Company	317.7
	Mines	2,577.0
	Other Bulk Customers	424.1
	Losses + Network Usage	1,211.2
Total Domestic		24,371.6
Exports	CEB	959.4

Energy	Customer	2025 – Projected Consumption (GWh)
	CIE	602.7
	CLSG	0.0
	SONABEL	1,555.1
VALCO		850.0
Total Energy (GWh)		28,338.9

Figure 3.2 presents a pie chart illustrating the projected energy consumption by various consumers in 2025 and their respective percentage shares. ECG's consumption is projected at **17,546 GWh**, accounting for 61.9% of the total energy consumption for 2025. This is followed by exports and the mining sector, with projected consumptions of **3,117 GWh** (11%) and **2,577 GWh** (9.1%), respectively

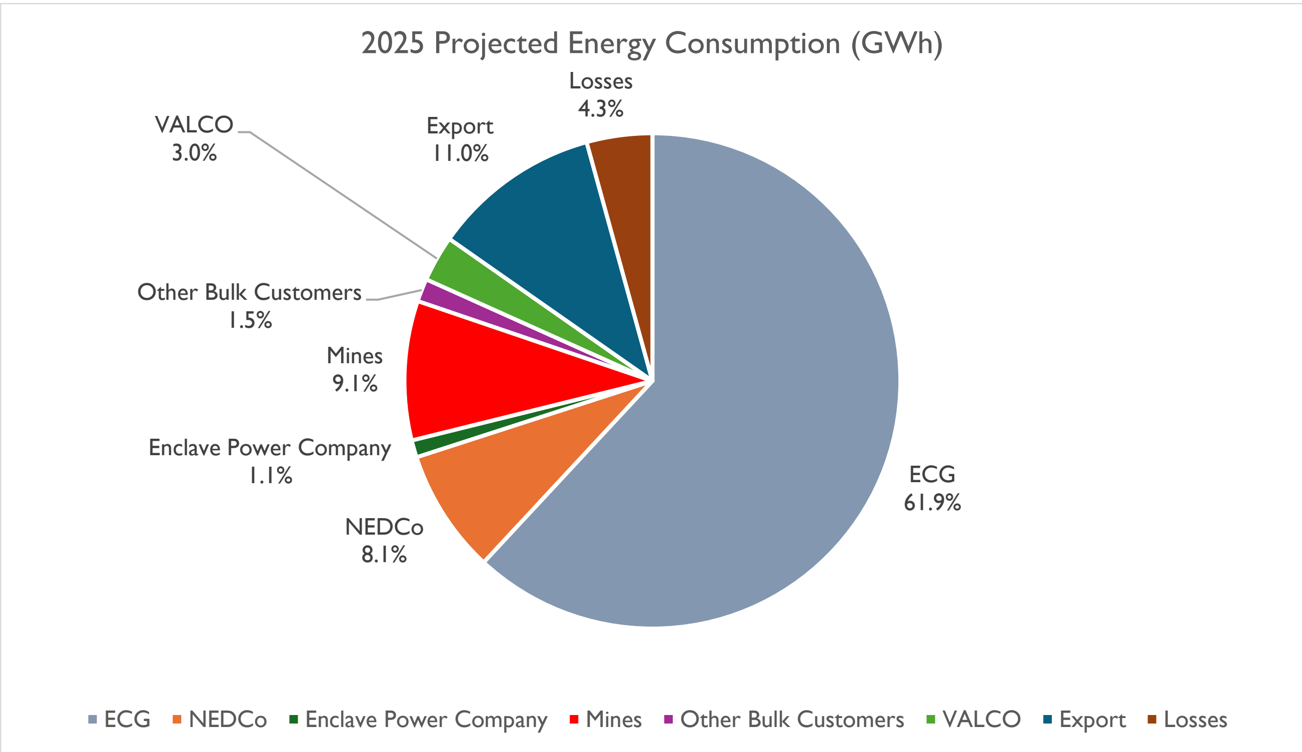


Figure 3.2: 2025 Projected Energy consumption by Customer

3.8 Projected Monthly Energy Consumption for 2025

A summary of monthly energy consumption and the corresponding peak demand for the various consumer classes is shown in Table 3.3.

Table 3.3: Projected 2025 Monthly Energy (GWh) Consumption – Base Case Scenario

Energy Forecast (GWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total GWh
ECG	1522.51	1437.76	1559.99	1490.33	1554.94	1373.87	1384.73	1328.69	1319.44	1456.40	1511.00	1605.88	17,545.53
NEDCo	180.98	184.70	214.06	208.31	204.51	184.48	183.90	175.50	176.65	194.52	203.37	185.19	2,296.17
Enclave Power Company	23.43	23.71	24.25	24.79	25.78	26.10	26.43	27.49	28.18	28.81	29.17	29.53	317.67
MINES	189.78	178.23	192.70	194.97	206.37	202.29	236.81	236.45	232.20	235.51	231.73	239.93	2,576.98
Other Bulk Customers	34.22	32.75	36.79	34.69	33.60	33.78	37.76	36.26	34.70	36.61	36.17	36.76	424.07
VALCO	72.19	65.21	72.19	69.86	72.19	69.86	72.19	72.19	69.86	72.19	69.86	72.19	850.00
CEB(Togo/Benin)	84.82	79.34	84.82	82.08	84.82	82.08	70.68	70.68	68.40	84.82	82.08	84.82	959.42
SONABEL(Burkina)	107.51	102.82	120.53	116.64	149.99	137.70	135.59	135.59	131.22	146.31	141.59	129.64	1,555.13
CIE (Ivory Coast)	58.00	63.82	61.46	51.15	43.85	40.86	49.55	45.45	42.20	41.66	51.51	53.22	602.73
CSLG								0.00	0.00	0.00	0.00	0.00	0.00
Network Usage	1.19	1.14	1.24	1.19	1.24	1.13	1.15	1.11	1.10	1.20	1.23	1.28	14.20
LOSSES	100.32	95.68	104.44	100.29	104.84	94.91	96.97	93.91	92.79	101.35	103.98	107.54	1,197.02
Total	2,374.94	2,265.14	2,472.47	2,374.30	2,482.13	2,247.06	2,295.76	2,223.33	2,196.74	2,399.37	2,461.69	2,545.98	28,338.92

3.9 Projected Monthly Peak Load for 2025

Coincident Peak Demand (MW)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ECG	2,589.8	2,613.6	2,676.2	2,644.3	2,619.2	2,446.7	2,335.8	2,298.9	2,360.0	2,609.9	2,650.3	2,689.7
NEDCo	325.9	331.1	332.2	361.0	336.8	333.6	319.3	322.5	325.7	343.2	354.5	354.5
Enclave Power Company	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
MINES	316.1	316.1	315.6	315.9	333.7	351.1	380.6	386.0	385.9	387.6	387.3	386.5
Other Bulk Customers	76.3	76.3	77.3	81.3	81.3	81.0	79.4	79.5	79.5	82.3	82.4	82.2
VALCO	91.8	94.2	98.1	102.0	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9
CEB(Togo/Benin)	120.0	120.0	120.0	120.0	120.0	120.0	100.0	100.0	100.0	120.0	120.0	120.0
SONABEL(Burkina)	170.0	180.0	180.0	240.0	240.0	225.0	225.0	225.0	225.0	240.0	230.0	205.0
CIE (Ivory Coast)	123.0	140.0	190.0	190.0	190.0	190.0	140.0	140.0	140.0	140.0	140.0	140.0
CSLG	-	-	-	-	-	-	-	-	-	-	-	-
Network Usage	2.3	2.3	2.4	2.4	2.4	2.3	2.2	2.2	2.2	2.4	2.4	2.4
LOSSES	190.0	192.9	198.7	201.9	200.5	192.0	183.8	182.4	185.5	200.6	202.7	203.3
System Peak (Coincident)	4,053.2	4,114.4	4,238.3	4,306.9	4,277.9	4,095.6	3,920.1	3,890.4	3,957.7	4,279.9	4,323.6	4,337.7

Chapter 4

2025 GENERATION OUTLOOK

4 2025 GENERATION OUTLOOK

4.1 Generation Sources

Generating facilities form the first stage of the electricity supply chain, which transform energy from a primary form into useful electrical energy. Accordingly, generating facilities are used, for example, to transform potential energy such as is latent in water contained in a dam; thermal energy latent in fossil fuels or Renewable Energy (Solar, Wind, Biomass, etc.) into electrical energy. Electrical energy is required for industrial production, commercial operations, and residential activities, thereby fueling modern economies and enhancing the quality of life.

The sources of generation considered in the 2025 ESP are primarily the existing Hydro, Thermal and Renewable Energy Plants, as well as committed power generation projects expected to be completed and start operating during the year.

4.2 2025 Supply Outlook

4.2.1 Key Assumptions Underpinning the Supply Outlook

In developing the 2025 Supply Outlook, the following key assumptions were made:

4.2.1.1 Existing Grid Connected Generation Sources

Table 4.1 shows a summary of the existing generation plants as at December 2024. A total installed existing grid connected generation capacity of 5,738 MW with a dependable capacity of 4,742.35 MW is considered for 2025.

Table 4.1: Existing Grid Connected Generation Sources for 2025

Plants	Installed Capacity (MW)	Dependable Capacity (MW)	Fuel Type
Grid Connected			
Akosombo GS	1020	900	Hydro
Kpong GS	160	140	Hydro
TAPCO (T1)	330	320	LCO/Gas
TICO (T2)	340	220	LCO/Gas
TT1PP	110	100	LCO/Gas
TT2PP	80	0	Gas
KTPP	220	200	Gas/ Diesel

Plants	Installed Capacity (MW)	Dependable Capacity (MW)	Fuel Type
Anwomaso Thermal Power Station (ATPS)	250[1]	230	Gas
Takoradi Thermal Extension (T3)	132	0	Gas
Bui GS	404	360	Hydro
VRA Solar Plant (Kaleo)	28.8	0	Solar
Bui Solar	50	0	Solar
5MW Phase I Floating Solar @ BGS	5	0	Solar
CENIT	110	100	LCO/Gas
SAPP 161	200	180	Gas
SAPP 330	360	340	LCO/Gas
Karpower	470	450	Gas
AKSA	370	330	HFO/Gas
Cenpower	360	325	LCO/Gas
Twin City	200	198	LCO/Gas
Bridge Power	200	190	Gas
GP Tarkwa Plant	98.55	79.85	Gas
GP Damang Plant	37.5	30.38	Gas
GP Edikan Plant	58.05	47.04	Gas
GP Wassa Plant	58.05	47.04	Gas
GP Chirano Plant	58.05	47.04	Gas
Total NITS Generation	**5,738**	**4,834.35**	

4.2.1.1.1 Commissioning of the remaining four units at Anwomaso Thermal Power Plant

The Ameri plant which had been in operation at Aboadze since January 2016, has since April 2024 been relocated to Anwomaso, Kumasi. Six (6) out of the ten (10) units have been commissioned and are currently in operation under the new name, Anwomaso Thermal Power Station (ATPS). It is expected that the installation of the remaining four units (100 MW) will be completed by the end of the second quarter of 2025.

4.2.1.2 Existing Embedded Generation Sources

The total existing generation from embedded sources is 49.22 MW. Details of this is shown in *Table 4.2*.

[1] 4 units (100 MW) at ATPS, decommissioned from Aboadze and relocated to Anwomaso are expected to be commissioned by end of 2nd Quarter 2025

Table 4.2: Existing Embedded Generation

Plants	Installed Capacity (MW)	Dependable Capacity (MW)	Fuel Type
Embedded			
BXC Solar	20	0	Solar
Meinergy Solar	20	0	Solar
Safisana	0.1	0	Waste-to-Energy
VRA Solar Plant (Navrongo)	2.5	0	Solar
VRA Solar Plant (Lawra)	6.5	0	Solar
Tsatsadu	0.12	0	Mini Hydro
Total Embedded	**49.22**	**0**	

4.2.1.3 Adequacy of Existing Generation Capacity in 2025

The projected peak electricity demand for 2025 is estimated at 4,338 MW**.** This peak is expected to occur in the last quarter of the year. The forecast assumes a VALCO load of 120 MW and total electricity exports amounting to 465 MW.

Table 4.3: 2025 Supply Adequacy

2025 Supply Adequacy Analysis		
A	Forecast Peak Demand for 2025	4,337.70 MW
B	Dependable Generation Capacity as at December 31, 2024	4,834.35 MW
C	Reserve Capacity required for Supply Adequacy (18% of **A**)	780.79 MW
D	Dependable Capacity required for Supply Adequacy (**A + C**)	5,118.49 MW
E	Capacity Shortfall (**D – B**)	284.14 MW

As shown in Table 4.3, the current dependable generation capacity in Ghana is 4,834.35 MW. Though the total dependable capacity can serve the projected peak demand, it falls short of the minimum eighteen percent (18%) reserve capacity margin required for supply adequacy, as determined for the Ghana power system.

For a peak demand of 4,338 MW, the minimum required dependable capacity to satisfy the adequacy criteria is 5,118.49 MW. There is therefore a critical need to ensure additional generation resources with dependable capacity of at least 284 MW by the last quarter of the year to ensure sustained supply adequacy by the end of the year.

4.2.1.4 Committed Generation Projects expected in 2025

The following committed generation capacity addition projects were considered in the 2025 ESP.

- **BPA's Solar Power Plants:** The Bui Power Authority is carrying out several projects aimed at increasing its renewable energy portfolio. The ongoing projects and their expected commissioning dates are listed below:

- **Yendi Solar:** Phase I, made up of 20 MWp and Phase II, of additional 30 MWp to be operational by July 2025 and October 2025 respectively.
- **Floating Solar @ Bui**: Additional 10 MWp to be operational by July 2025.
- **Bui (land) Solar**: 40 MWp to be commissioned by July 2025 and 60 MWp by October 2025.

- **AKSA Phase II:** AKSA Energy is expected to commission an additional capacity of 141 MW (made up of 3 GTs each with a capacity of 47 MW) at the 330 kV Anwomaso substation. The new plant is expected to be commissioned by last quarter of 2025.
- **CENIT Phase II:** CENIT Energy is expected to commission an additional 110 MW capacity at the 330 kV Anwomaso substation. The new plant is expected to be commissioned by the third quarter of 2025.

Table 4.4: Committed Generation for 2025

Plants	Installed Capacity (MW)	Dependable Capacity (MW)	Fuel Type
20 MWp Phase I @ Yendi	20	0	Solar
10 MWp Phase 2 Floating Solar @ BGS	10	0	Solar
40 MWp Phase 2 Land Based @ BGS	40	0	Solar
30 MWp Phase 2 @ Yendi	30	0	Solar
60 MWp Phase 3 Land Based @ BGS	60	0	Solar
AKSA Phase II	141	130	Gas
Cenit Phase II	110	100	Gas
Total	**411**	**230**	

4.2.1.5 Natural Gas Quantities and Availabilities

Gas supply projections for 2025 from the various sources are as follows:

- Sankofa field projects a supply of **245 Mmscfd**.
- The combined output from the Jubilee and TEN fields is expected to average **100 Mmscfd**.
- Nigeria is projected to contribute an additional **73 Mmscfd** of gas supply.

This brings the total estimated natural gas supply for 2025 to **418 Mmscfd**. However, up to **383 Mmscfd** of the total estimated gas supply is available for power generation. **35 Mmscfd** is therefore consumed by other industrial consumers.

To ensure these projections are achieved, sustained efforts and strategic interventions will be necessary to address potential challenges within the supply chain.

4.2.1.6 Gas Infrastructure Maintenance for 2025

A number of gas supply facilities are planned for maintenance activities in 2025. To minimize downtime and enhance the reliability of gas-to-power supply, the Ministry of Energy and Green Transition has facilitated collaborative engagements among upstream, midstream, and downstream stakeholders. These efforts have focused on coordinating and aligning maintenance schedules across the value chain.

The following maintenance schedules seen in Table 4.5 have been successfully synchronized for 2025:

Table 4.5: Gas Infrastructure Maintenance Schedule

No.	Facility	Schedule	Impact on Gas Supply	Mitigation
1.	West African Gas Pipeline Company (WAGP) pigging	Feb 5th - 2nd March	Pigging exercise requires about 80MMsfcd of gas to arrive in Takoradi and the shutting down of Tema R&M station. Domestic gas supply to be reduced by 80mmsfcd.	• LCO for one (1) phase Asogli unit and two (2) Cenpower units • DFO on two (2) KTTP units • HFO on AKSA
2.	Bi-annual Emergency Shutdown Valve (ESDV) maintenance at the Takoradi and Tema R&M stations	Feb 5th and Feb 7th for first half/ July 2025 for second half	No Gas consumption in WAPCo's Tema and Takoradi R&M station	
3.	Jubilee shutdown	16 days from March 22 – April 7	Loss of 100 Mmscfd at Jubilee to be supplemented by TEN	
4.	Atuabo GPP shutdown	15 days in August	Loss of 100 Mmscfd	• Additional N-Gas supply of 30 Mmscfd • LCO for one (1) phase Asogli unit and two (2) Cenpower units • Distillate Fuel Oil (DFO) on one (1) KTTP unit • HFO on AKSA
5.	8 days OCTP FPSO and ORF shutdown	September 2025	Loss of 245 Mmscfd	• Additional N-Gas of 30 Mmscfd • LCO for one (1) phase Asogli unit and two (2) Cenpower units • DFO on two (2) KTTP units • HFO on AKSA
6.	14 days Inline pigging of 26" export line from ENI FPSO to ORF	September 2025	Reduction of supply to 140 mmscfd	• Additional N-Gas of 30 Mmscfd • LCO for one (1) phase Asogli unit and two (2) Cenpower units • DFO on one (1) KTTP unit • HFO on AKSA

The natural gas supply in 2025 from various sources is shown below:

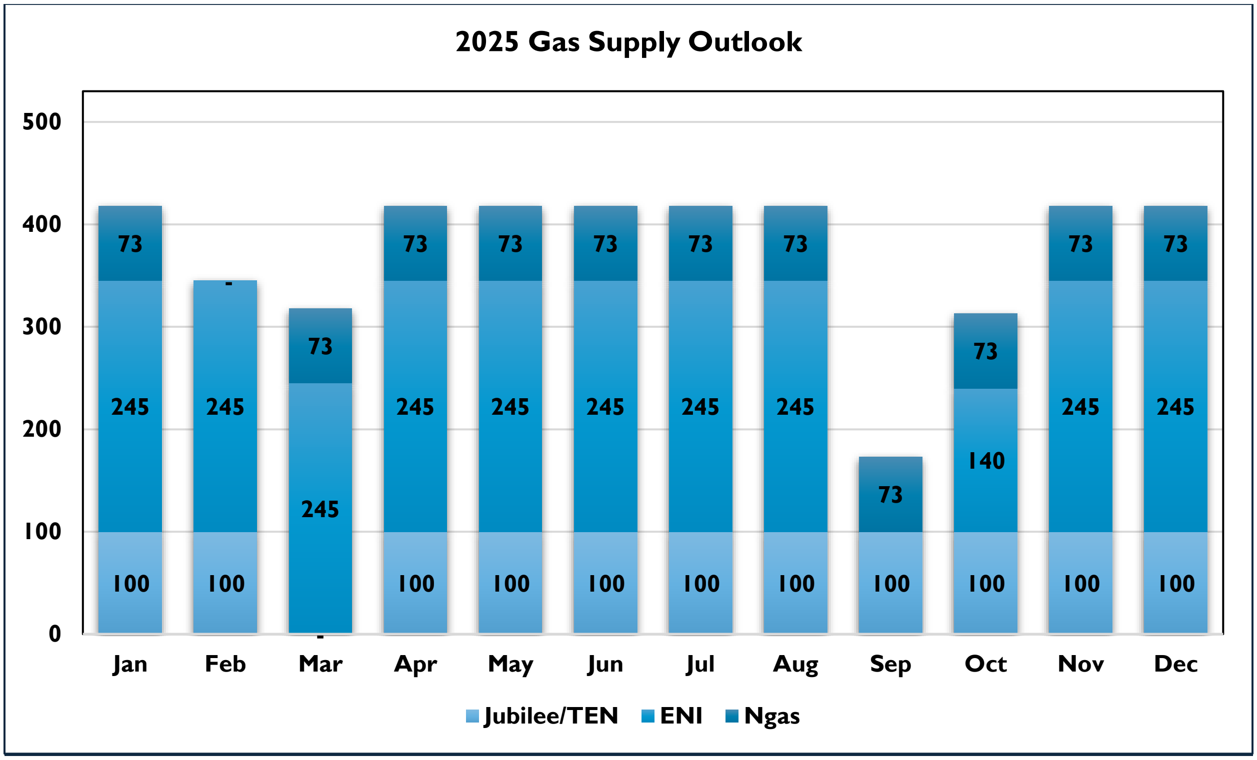


Figure 4.1: 2025 Forecasted Gas Supply

Figure 4.1 shows that the month-by-month gas supply volumes expected from both domestic source and Nigeria. The dips in supply for some months indicate periods of gas infrastructure shutdowns for maintenance in the year 2025.

4.2.2 Hydro Power Generation in 2025

The EMOP approved electricity supply from legacy hydro (Akosombo GS and Kpong GS) for 2025 is 7,450 GWh. This is made up of 6,450 GWh from Akosombo GS, 1,000 GWh from Kpong GS.

Bui GS also projects a total annual hydro generation of 1,211 GWh for 2025. Accordingly, the total projected hydro generation in Ghana in 2025 is 8,661 GWh.

4.2.2.1 Akosombo & Kpong Hydro

A projected generation of 7,450 GWh is the sustainable generation from VRA hydro for 2025 based on a risk analysis conducted. The analysis indicates that with an Akosombo GS year start elevation of 268.86 feet (81.95 m), a total drop in elevation of approximately 10.94 feet (3.33 m) is expected, resulting in a projected minimum elevation of approximately 257.92 feet (78.61 m).

The projected Akosombo reservoir elevation chart for 2025 is shown **Figure 4.2**.

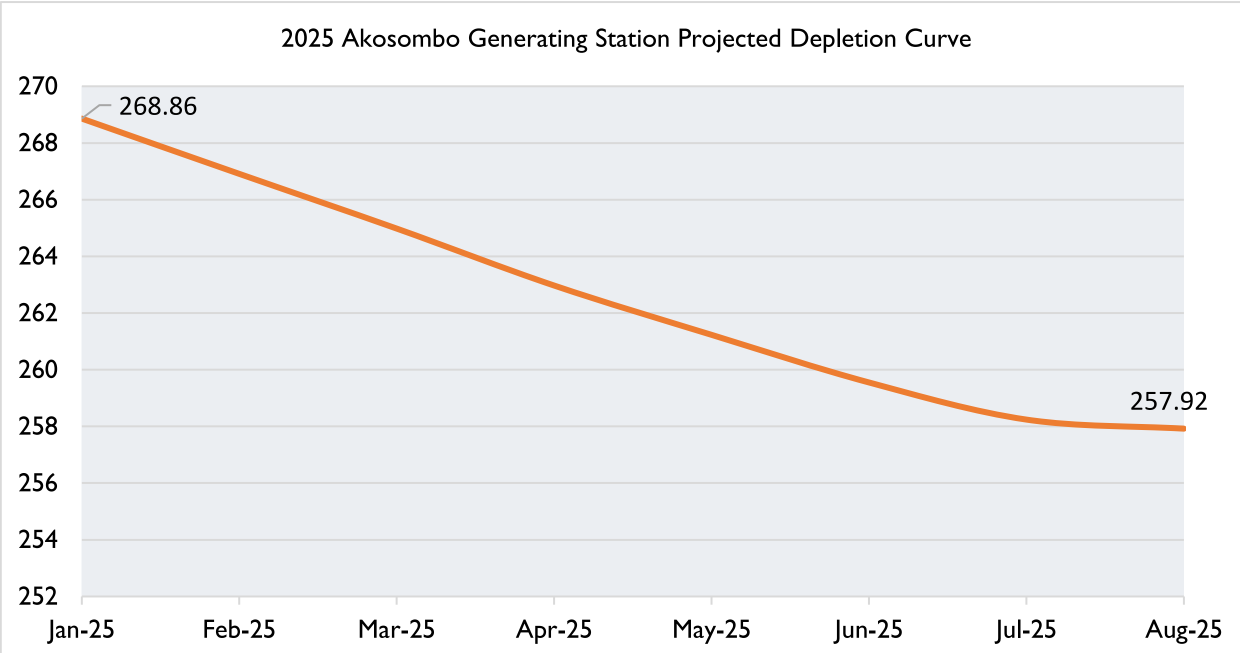


Figure 4.2: 2025 Projected Akosombo Reservoir Trajectory

The Kpong GS is projected to have all four (4) units in service in 2025. The total average capacity that is expected to be available at Kpong GS is 140 MW. The Kpong GS is expected to generate 1,000 GWh in 2025.

The projected total annual hydro generation from Akosombo and Kpong generating stations of 7,450 GWh, is about 33% higher than the firm Akosombo and Kpong hydro generation of 5,600 GWh.

This projection is to mitigate the risk of falling below the dam's Minimum Operating Level in the event of below-average inflows during the 2025 inflow season. By maintaining this balance, the long-term operational sustainability of the Akosombo hydroelectric power plant will be safeguarded.

4.2.2.2 Bui Hydro

In 2025, the projected annual production Bui Hydro Plant is 1,211 GWh. It is estimated that, for continuous and sustainable operation of the Bui GS for 2025, the reservoir level at the end of the dry season in 2025 should not drop below the minimum elevation of 168.00 masl. With a year-start elevation of 178.76 masl in 2025, and the estimated total energy production for 2025, the year-end elevation is projected at 177.53 masl.

Assumptions for projected 2025 generation from the Bui Generating Station:

- ✓ 115% (Long Term Average Inflow (6,167 Mm^3), i.e., 7,092 Mm^3.
- ✓ The 2025 Year start elevation of Bui Reservoir – 177.50 masl.
- ✓ Operate two units in normal mode at 100MW, 110MW or 120MW each for between 8 – 24 hours daily from January to December 2025 depending on the reservoir elevation.
- ✓ Operate the Turbinette at 3.75 MW from January 1 to December 31, 2025
- ✓ Planned maintenance will be carried out on the units as scheduled during the year.

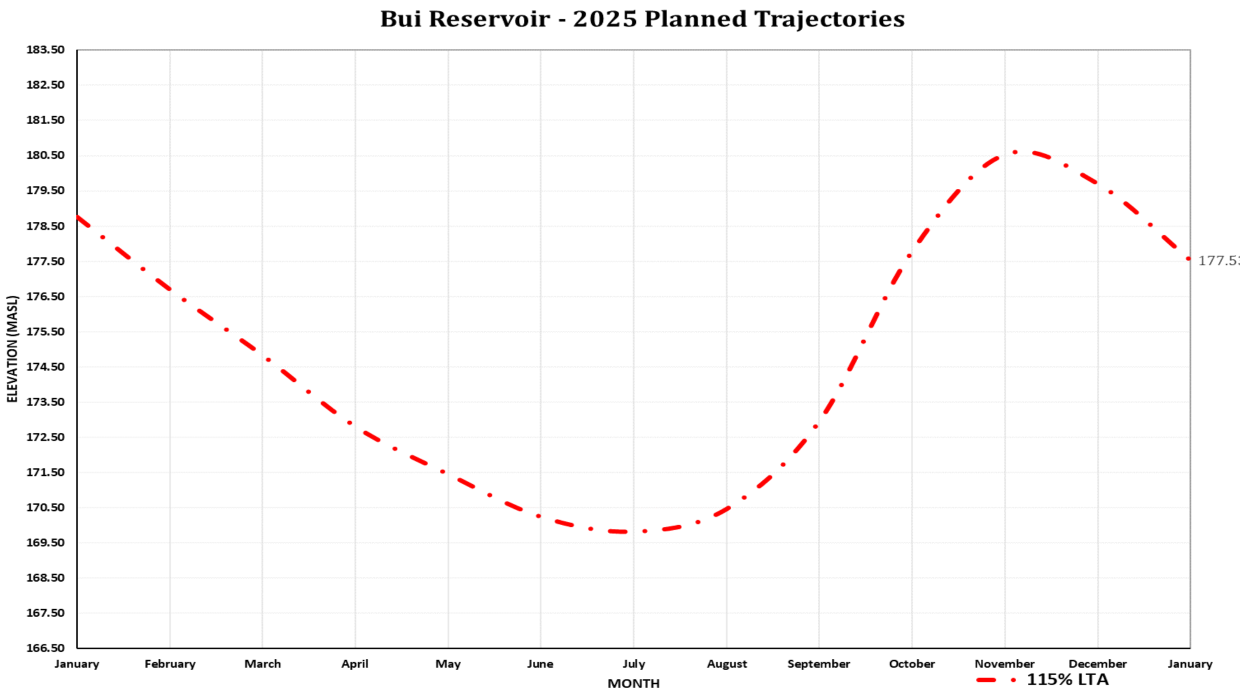


Figure 4.3: Bui Reservoir Trajectory for year 2025

<u>Tsatsadu Microhydro Plant Generation for 2025</u>

The Tsatsadu Microhydro Plant would be operated at a base load of 110 kW from April 2025 to December 2025. The Plant is projected to generate about 0.7 GWh of electricity during the period.

4.2.3 Thermal Power Generation for 2025

The Projected Dependable Thermal Capacity from the existing generation resources is 3,642 MW. The projected total thermal energy generation for 2025 is 19,394 GWh. This is shown in Table: 4.6

Table: 4.6: Summary of Thermal Generation

Generation Sources	2025 Projected Thermal Supply (GWh)
T1	1,866
T2	1,785
TT1PP	383
KTPP	662
ATPS	1,154
Sunon Asogli I	712
Sunon Asogli II	2,282
CENPOWER	2,318
Twin City	1,601
Early Power	1,331
KARPOWER	2,903
AKSA	1,296
CENIT	-
Genser Tarkwa	338
Genser Damang	111
Genser Wassa	170
Genser Edikan	230
Genser Chirano	249
Total Thermal Supply (GWh)	**19,394**

4.2.4 Renewable Energy Generation Sources

The total installed capacity of Renewable Energy in Ghana as at December 31, 2024 is 154.6 MWp. This comprises 88.8 MWp directly connected to the NITS and 65.8 MWp embedded in the distribution network. A total generation of 284 GWh is expected from Renewable Energy sources in 2025.

The Bui Power Authority (BPA) has a 50 MWp Solar PV farm at Bui and a 5 MWp Floating Solar PV. The Bui Solar Plant is projected to dispatch 55 MWp (50 MWp Land based and 5 MWp Floating) from the Bui Solar PV Plant for between 11 – 12 hours daily from January 1, 2025. The capacity is projected to increase progressively to 105 MWp with the commissioning of additional 40 MWp land based and 10 MWp floating by the end of the second quarter of 2025. The first phase of Yendi Solar PV Plant with a capacity of 20 MWp is expected to be commissioned by the end of the second quarter of 2025. Total generation from BPA's Solar PV Plants for the year 2025 is projected to be 173.31 GWh.

VRA has a total of 37.8 MWp solar PV plants made up of a 2.5 MWp Solar power plant and a 6.5 MWp plant embedded in the NEDCo network at Navrongo and Lawra respectively and 28.8 MWp connected to the NITS at Kaleo.

Additional generation is expected from the 20 MWp BXC solar power plant and the 20 MWp Meinergy solar power plant. These are all embedded in the ECG network within the Central region.

The summary of generation from the solar power plant sources is shown in **Table 4.7**

Table 4.7: Summary of Renewable Energy Generation

Generation Sources	2025 Projected Thermal Supply (GWh)
Grid (Direct HV) Connected	
VRA Kaleo Solar Power Plant	44.2
Bui Solar	71.5
5MW Phase 1 Floating Solar @ BGS	6
20 MWp Phase 1 @ Yendi	13
10 MWp Phase 2 Floating Solar @ BGS	6.6
40 MWp Phase 2 Land Based @ BGS	41.2
30 MWp Phase 2 @ Yendi	11.8
60 MWp Phase 3 Land Based @ BGS	23.5
Total Grid Connected Renewable Supply (GWh)	217.8
Embedded	
VRA Navrongo Solar Power Plant	3.9
VRA Lawra Solar Power Plant	10
Meinergy	25
BXC Solar	27
Total Embedded Renewable Supply (GWh)	65.9
Total Renewable Supply (GWh)	**283.7**

4.3 Demand - Supply Analysis

In this sub-section, we carry out a demand-supply balance analysis for the year 2025. The assumptions underpinning the demand-supply projections for the year are shown below. The analysis begins with the projected monthly energy generation from all generating plants. The following considerations are used to determine which plants are dispatched every month:

- Fuel availability for power plants.
- Must-run plants (e.g., Solar).
- System Stability Requirements:
    - Minimum generation of 500 MW required in the Western Enclave (i.e. Aboadze)
    - Minimum generation of 650 MW required in the Eastern Enclave (i.e. Tema)
    - Minimum generation of at least one (1) unit from Bui GS, etc.
- PURC and EMOP (Electricity Market Oversight Panel) hydro energy allocation for the year.
- Dispatch Protocol
- Planned maintenance schedules of power plants.

Hydro Dispatch: For 2025, EMOP has approved an allocation of 7,450 GWh generation for Akosombo and Kpong GS. Dispatch of the Bui hydropower plant takes into consideration the relatively low inflows during the just-ended inflow season and the level of dispatch that will ensure that the plant does not go below the minimum elevation of 168 masl. A total of 8,661 GWh of hydro generation is projected for 2025.

Renewable Energy Dispatch. The solar power plants are must-run. A total of about 284 GWh is expected from all the grid-connected solar and other renewable sources, whereas a total of 66 GWh feeds directly into the distribution network.

Power Imports

No power import is anticipated in 2025. However, inadvertent energy exchanges on tie-lines could result from transient flows or emergency imports necessitated by short-term capacity shortages caused by faults or fuel supply contingencies.

4.4 Planned Maintenance

Some of the key maintenance activities expected to be undertaken in 2025 on generating units are shown below:

- Akosombo GS transformer leakage repairs, annual maintenance work & SCADA Punchlist Resolution on unit one which will last for 12 days in March
- Akosombo GS unit no. 2: Transformer leakage repairs, annual maintenance work & SCADA Punchlist Resolution in May 2025
- Kpong GS transformer re-gasketing work on unit one which will last for 25 days in April 2025
- Tapco unit no. 1 (32G1) hot gas path inspection & diverter damper & exhaust stack works for the month of April 2025
- Asogli Class A maintenance which will last for 39 days from July into August 2025

The detailed maintenance activities are attached as Appendix B.

Based on the above considerations, the 2025 demand/supply balance is illustrated in Table 4.8 and Table 4.9.

Table 4.8: Projected Monthly Generation in GWh (January – June 2025)

	Jan	Feb	Mar	Apr	May	Jun
Akosombo	515.64	535.30	578.11	530.69	548.38	540.38
Kpong	79.94	82.99	89.63	82.28	85.02	83.78
T1	194.18	187.49	207.58	93.74	207.58	200.88
T2	156.25	126.35	152.44	147.52	156.50	147.52
TT1PP	45.36	-	65.77	-	70.31	-
KTPP	43.50	87.36	18.60	55.80	18.60	93.60
ATPS	98.47	92.58	97.19	88.58	98.40	98.81
VRA Navrongo Solar Power Plant	0.33	0.30	0.33	0.32	0.33	0.32
VRA Kaleo Solar Power Plant	3.75	3.39	3.75	3.63	3.75	3.63
VRA Lawra Solar Power Plant	0.87	0.79	0.87	0.84	0.87	0.84
BUI	102.57	97.69	107.10	102.72	106.11	97.79
Sunon Asogli I	60.51	54.65	60.51	58.56	60.51	58.56
Sunon Asogli II	179.82	141.84	169.99	164.56	199.85	192.39
CENPOWER	207.94	111.48	207.94	200.66	207.94	200.66
Twin City	134.34	127.45	134.34	176.01	134.34	130.01
Early Power	113.38	154.83	98.41	149.92	143.71	53.21
KARPOWER	257.62	279.73	283.78	304.17	257.62	176.10
AKSA	82.54	79.69	93.65	110.03	80.96	74.45
CENIT	-	-	-	-	-	-
Genser Tarkwa	29.92	30.73	31.30	29.65	29.18	27.42
Genser Damang						
Genser Wassa	14.91	14.95	15.47	14.71	14.62	13.82
Genser Edikan	20.45	21.44	21.56	20.35	19.86	18.56
Genser Chirano	22.11	24.18	23.68	22.19	21.27	19.65
Bui Solar	6.56	5.99	6.44	6.91	6.35	5.44
5MW Phase 1 Floating Solar @ BGS	0.51	0.45	0.46	0.55	0.50	0.42
20 MWp Phase 1 @ Yendi	-	-	-	-	-	-

	Jan	Feb	Mar	Apr	May	Jun
10 MWp Phase 2 Floating Solar @ BGS	-	-	-	-	-	-
40 MWp Phase 2 Land Based @ BGS	-	-	-	5.43	4.98	4.26
30 MWp Phase 2 @ Yendi	-	-	-	-	-	-
60 MWp Phase 3 Land Based @ BGS	-	-	-	-	-	-
Meinergy	1.65	1.67	1.71	2.16	2.22	2.20
BXC Solar	1.82	1.83	1.88	2.32	2.39	2.36
Total Supply (GWh)	**2,375**	**2,265**	**2,472**	**2,374**	**2,482**	**2,247**

Table 4.9: Projected Monthly Generation in GWh (July – December 2025)

	Jul	Aug	Sept	Oct	Nov	Dec
Akosombo	539.77	543.30	525.83	536.61	519.17	536.83
Kpong	83.69	84.23	81.52	83.19	80.49	83.23
T1	207.58	207.58	70.56	92.99	98.17	97.45
T2	155.94	146.67	138.45	152.44	148.35	156.67
TT1PP	70.31	-	63.50	-	68.04	-
KTPP	18.60	96.72	18.00	96.72	18.00	96.72
ATPS	98.63	98.69	96.17	89.25	98.51	98.45
VRA Navrongo Solar Power Plant	0.33	0.33	0.32	0.33	0.32	0.33
VRA Kaleo Solar Power Plant	3.75	3.75	3.63	3.75	3.63	3.75
VRA Lawra Solar Power Plant	0.87	0.87	0.84	0.87	0.84	0.87
BUI	97.13	94.45	92.63	100.41	102.83	109.57
Sunon Asogli I	60.51	60.51	58.56	60.51	58.56	60.51
Sunon Asogli II	206.04	210.13	203.96	210.29	202.45	200.88
CENPOWER	207.94	187.94	184.66	181.67	205.99	213.27
Twin City	134.34	101.61	130.01	134.34	130.01	134.34
Early Power	39.19	116.20	116.53	158.20	93.26	94.52
KARPOWER	167.35	110.42	227.51	212.29	306.10	320.71
AKSA	90.41	47.33	77.47	159.50	194.57	205.86
CENIT	-	-	-	-	-	-
Genser Tarkwa	27.18	27.07	24.77	26.33	26.99	27.96
Genser Damang	18.75	18.75	18.14	18.75	18.14	18.75
Genser Wassa	13.82	13.77	12.76	13.48	13.65	14.13
Genser Edikan	18.27	18.17	16.45	17.58	18.22	18.88
Genser Chirano	19.81	19.67	17.42	18.83	19.94	20.68
Bui Solar	4.45	4.32	5.03	6.18	7.28	6.55
5MW Phase 1 Floating Solar @ BGS	0.35	0.33	0.40	0.48	0.56	0.50
20 MWp Phase 1 @ Yendi	1.75	1.69	1.97	2.42	2.85	2.56
10 MWp Phase 2 Floating Solar @ BGS	0.87	0.85	0.99	1.21	1.43	1.28
40 MWp Phase 2 Land Based @ BGS	3.49	3.38	3.95	4.84	5.70	5.13
30 MWp Phase 2 @ Yendi	-	-	-	3.63	4.28	3.85
60 MWp Phase 3 Land Based @ BGS	-	-	-	7.27	8.55	7.69
Meinergy	2.24	2.22	2.27	2.42	2.32	1.94
BXC Solar	2.41	2.39	2.43	2.59	2.48	2.11
Total Supply (GWh)	2,296	2,223	2,197	2,399	2,462	2,546

Figure 4.4 is a graphical representation of the above energy generation/consumption balance showing the percentage share of each generation type. The Chart indicates that thermal generation will constitute about 68.44% of projected total generation whilst hydro and Solar PV generation will constitute 30.56% and 1.0% respectively. 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 plays in power supply security and reliability in the Ghana power system.

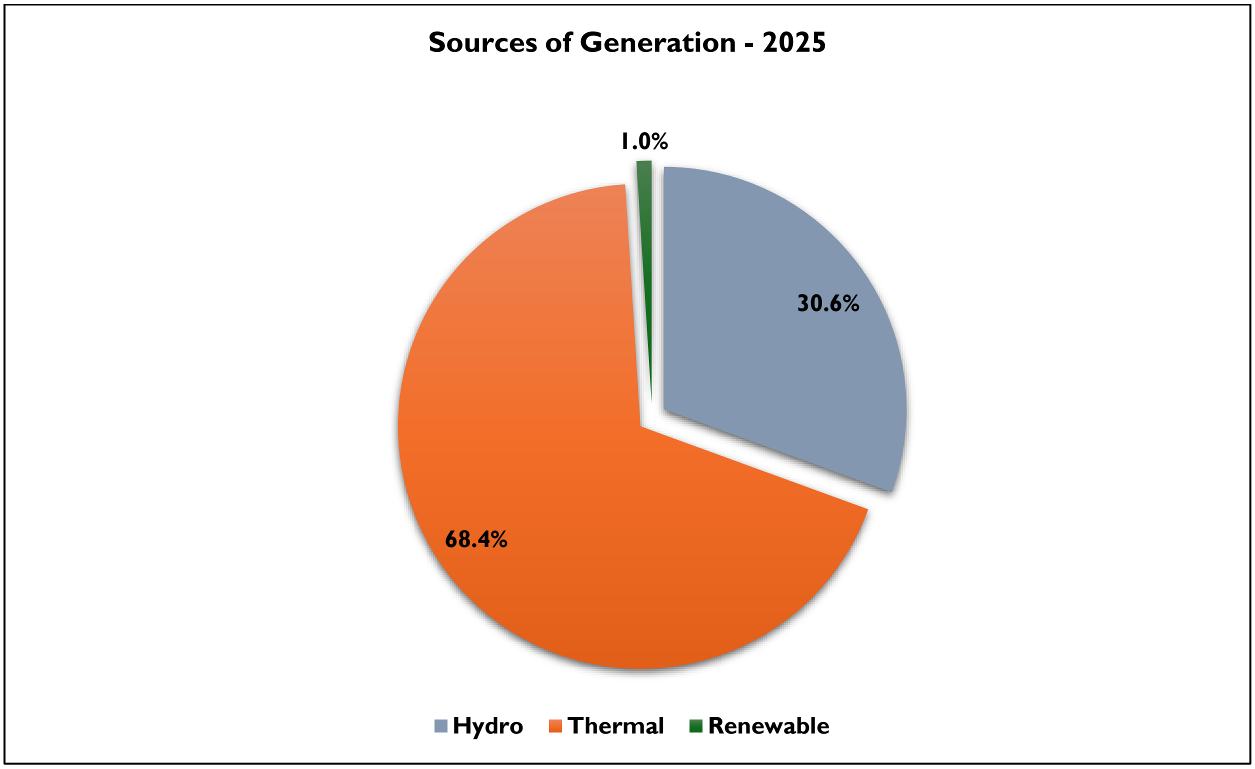


Figure 4.4: Contribution of Supply by Generation

4.5 Operating Reserve

Load-serving entities and bulk consumers are responsible for the arrangement of firm generation capacity that is adequate to reliably meet their projected demand. This implies arranging for sufficient generation to meet firm demand with its corresponding operating reserve requirements.

4.5.1 Operating Reserve Requirement

The 2011 Ghana Generation Adequacy Assessment report and the 2011 Generation Master Plan reports recommended a reserve margin of 18% of the projected peak. Thus, the generation capacity Reserve Margin requirement of 18% was employed in the 2025 Supply Plan.

4.6 Projected Capacity Situation

The projected monthly Supply Capacity levels, taking planned unit maintenance and Fuel Supply into consideration, is shown in **Table 4.10** and **Table 4.11**.

Table 4.10: Projected Monthly Capacity Situation for 2025 (January – June 2025)

Customer Category	2025 Projected System Peak (MW)	Jan	Feb	Mar	Apr	May	Jun
Domestic	3,722	3,548	3,580	3,650	3,655	3,622	3,455
VALCO	106	92	94	98	102	106	106
Export (CEB+SONABEL+CIE)	550	413	440	490	550	550	535
Projected System Demand	4,338	4,053	4,114	4,238	4,307	4,278	4,096
Generation Sources		Projected Available Gen. Capacity (MW)					
Akosombo	960	960	960	800	960	960	800
Kpong GS	140	140	140	140	105	140	105
Bui GS	360	360	240	360	360	240	360
TAPCO	330	295	295	295	150	295	295
TICO	330	210	210	210	210	210	210
TT1PP	100	100	0	100	100	100	100
KTPP	200	200	200	200	100	100	200
TT2PP	70	0	0	0	0	0	0
Anwomanso Power Plant	230	138	138	138	138	230	230
T3 Power Plant	120	0	0	0	0	0	0
VRA Solar Plants	37.7	0	0	0	0	0	0
Imports	0	0	0	0	0	0	0
Bui Solar Farm	220	0	0	0	0	0	0
Bui Mini Unit	4	4	4	4	4	4	4
SAPP 161	180	180	0	150	180	180	180
SAPP 330	350	350	170	350	350	350	350
CENIT	100	100	0	100	100	100	100
Karpowership	450	450	450	450	450	450	450
AKSA	312	312	300	294	312	312	312
Cenpower	350	350	350	350	350	350	350
Twin City	198	198	0	0	0	0	0
Genser	310.2	231	231	231	231	231	231
Bridge Power	190	190	0	190	190	190	190
Safisana	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Meinergy	20						
BXC Solar	20						

Total Dependable Generation (MW)	5,582	4,768	3,688	4,362	4,290	4,442	4,467
Surplus/deficit (MW)	1,244	715	-426	124	-17	164	371
Actual Operating Reserve Margin		18%	-10%	3%	-0.40%	4%	9%

Table 4.11: Projected Monthly Capacity Situation for 2025 (July – December 2025)

Customer Category	2025 Projected System Peak (MW)	Jul	Aug	Sep	Oct	Nov	Dec
Domestic	3,722	3,349	3,319	3,387	3,674	3,728	3,767
VALCO	106	106	106	106	106	106	106
Export (CEB+SONABEL+CIE)	550	465	465	465	500	490	465
Projected System Demand	4,338	3,920	3,890	3,958	4,280	4,324	4,338
Generation Sources		Projected Available Gen. Capacity (MW)					
Akosombo	960	960	960	960	960	960	960
Kpong GS	140	105	140	140	140	140	140
Bui GS	360	360	360	360	360	360	360
TAPCO	330	295	295	295	295	295	295
TICO	330	210	210	210	210	210	210
TT1PP	100	100	100	100	100	100	100
KTPP	200	200	200	200	200	200	200
TT2PP	70	0	0	0	0	0	0
Anwomaso Power Plant	230	230	230	230	230	230	230
T3 Power Plant	120	0	0	0	0	0	0
VRA Solar Plants	37.7	0	0	0	0	0	0
Imports	0	0	0	0	0	0	0
Bui Solar Farm	220	0	0	0	0	0	0
Bui Mini Unit	4	4	4	4	4	4	4
SAPP 161	180	180	180	180	180	180	180
SAPP 330	350	175	175	350	350	350	350
CENIT	100	100	100	100	100	100	100
Karpowership	450	450	450	450	450	450	450
AKSA	312	312	312	312	294	330	330
Cenpower	350	350	350	350	350	350	350
Twin City	198	198	198	198	198	198	198
Genser	310.2	251	251	251	251	251	251
Bridge Power	190	190	190	130	130	190	190
Safisana	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Meinergy	20						
BXC Solar	20						
Total Dependable Generation (MW)	5,582	4,670	4,705	4,820	4,802	4,898	4,898
Surplus/deficit (MW)	1,244	750	815	863	523	575	561
Actual Operating Reserve Margin		19%	21%	22%	12%	13%	13%

In the first half of the year 2025, reserve margins are expected to be low with the month of February recording high deficits of up to 426 MW. This is mostly due to the WAPCO pigging which will result in the curtailment of gas supply to the Tema R&M station, limiting the generation in the East. Consequently, there is the need to procure adequate stocks of liquid fuel for running thermal power plants especially in the Tema to avert the need for load management during the periods of the maintenance.

It is worth noting that the analysis does not factor forced outages to plants over the period of the year 2025. In the event of such forced outages occurring, especially within the periods of low reserve margins, generation may not be adequate to meet demand resulting in shortfalls.

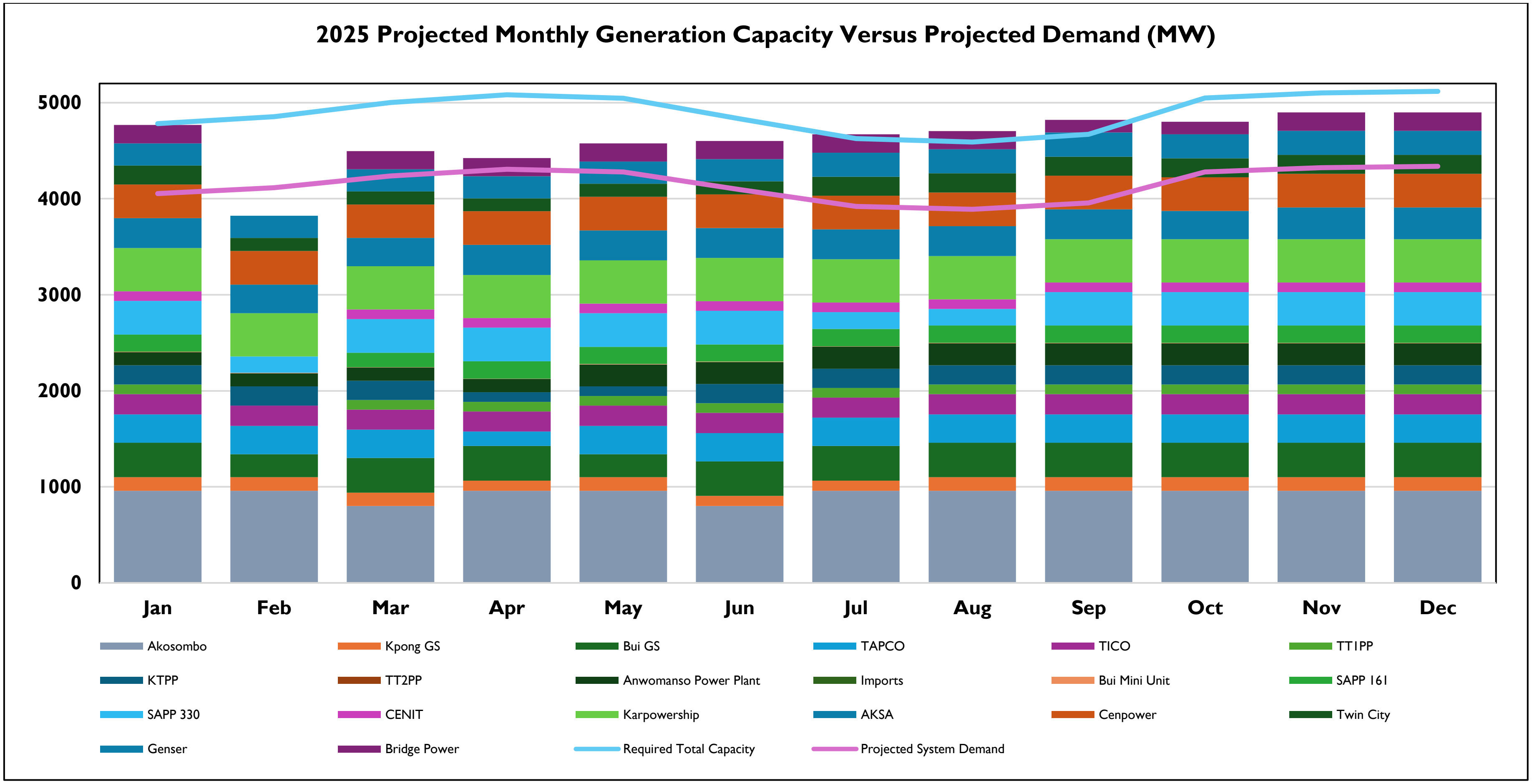


Figure 4.5: 2025 Projected Monthly Generation Vs Projected Demand

4.7 Thermal Fuel Requirements

Currently, most of the thermal plants in Ghana use natural gas as their primary fuel for power generation. Therefore, systems to ensure a high reliability of gas supply for power generation are needed. The breakdown of monthly natural gas requirements is shown in Table 4.12 and Table 4.13.

Table 4.12: Monthly Natural Gas Requirements in MMBtu (January – June 2025)

Estimated Thermal Fuel Requirement	Jan	Feb	Mar	Apr	May	Jun
TAPCO - GAS	1,738,529	1,678,580	1,858,428	839,290	1,858,428	1,798,479
TICO - GAS	1,998,934	1,616,354	1,950,151	1,887,243	2,002,086	1,887,243
TT1PP - GAS	530,712	-	769,532	-	822,604	-
KTPP - GAS	512,430	1,029,101	219,108	657,324	219,108	1,102,608
TT2PP - GAS						
Anwomaso Power Plant - GAS	1,110,676	1,044,340	1,096,245	999,139	1,109,878	1,114,585
Karpowership - GAS	2,193,140	2,381,374	2,415,797	2,589,367	2,193,140	1,499,162
SAPP - GAS	1,990,862	1,627,681	1,909,407	1,848,245	2,156,807	2,078,794
CENIT - GAS	-	-	-	-	-	-
TWIN CITY - GAS	1,104,118	1,047,499	1,104,118	1,446,607	1,104,118	1,068,533
CENPOWER - GAS	1,719,454	921,823	1,719,454	1,659,237	1,719,454	1,659,237
Early Power - GAS	1,292,476	1,765,103	1,121,828	1,709,126	1,638,269	606,624
AKSA - GAS	680,984	657,443	772,643	907,766	667,960	614,244
AKSA - HFO	-	-	-	-	-	-
Genser Tarkwa	329,092	337,982	344,280	326,152	320,950	301,572
Genser Damang	-	-	-	-	-	-
Genser Wassa	178,959	179,416	185,586	176,535	175,406	165,809
Genser Edikan	238,199	249,654	251,064	237,017	231,302	216,197
Genser Chirano	262,322	286,872	280,939	263,269	252,341	233,138
Total Natural Gas Volume (MMBtu)	**15,880,887**	**14,823,223**	**15,998,582**	**15,546,317**	**16,471,850**	**14,346,226**

Table 4.13: Monthly Natural Gas Requirements in MMBtu (June – December 2025)

Estimated Thermal Fuel Requirement	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
TAPCO - GAS	2,560,450	2,560,450	870,358	1,147,007	1,210,952	1,202,070	**19,323,020**
TICO - GAS	1,995,002	1,876,292	1,771,185	1,950,151	1,897,859	2,004,333	**22,836,832**
TT1PP - GAS	822,604	-	742,997	-	796,068	-	**4,484,516**
KTPP - GAS	219,108	1,139,362	212,040	1,139,362	212,040	1,139,362	**7,800,952**
TT2PP - GAS							**-**
Anwomaso Power Plant - GAS	1,112,557	1,113,151	1,084,819	1,006,702	1,111,228	1,110,481	**13,013,801**
Karpowership - GAS	1,424,682	940,037	1,936,782	1,807,245	2,605,797	2,730,225	**24,716,747**
SAPP - GAS	2,208,054	2,241,897	2,174,643	2,243,291	2,162,160	2,165,340	**24,807,182**
CENIT - GAS	-	-	-	-	-	-	**-**
TWIN CITY - GAS	1,104,118	835,153	1,068,533	1,104,118	1,068,533	1,104,118	**13,159,566**
CENPOWER - GAS	1,719,454	1,554,074	1,526,933	1,502,268	1,703,338	1,763,555	**19,168,280**
Early Power - GAS	446,748	1,324,644	1,328,403	1,803,475	1,063,162	1,077,504	**15,177,362**
AKSA - GAS	745,868	390,461	639,140	1,315,911	1,605,177	1,698,362	**10,695,960**
AKSA - HFO	-	-	-	-	-	-	**-**
Genser Tarkwa	299,033	297,762	272,515	289,606	296,892	307,525	**3,723,362**
Genser Damang	237,779	237,779	230,109	237,779	230,109	237,779	**1,411,335**
Genser Wassa	165,842	165,288	153,130	161,728	163,767	169,548	**2,041,015**
Genser Edikan	212,738	211,662	191,585	204,753	212,233	219,932	**2,676,336**
Genser Chirano	234,968	233,411	206,707	223,413	236,589	245,378	**2,959,348**
Total Natural Gas Volume (MMBtu)	**15,509,004**	**15,121,423**	**14,409,877**	**16,136,809**	**16,575,904**	**17,175,512**	**187,995,615**

From Table 4.12 and Table 4.13 the total projected natural gas requirement for generation in 2025 is about 187,995,615 MMBtu.

4.7.1 Additional Gas Requirement

The projected natural gas requirement for the Ghana power system in 2025 is 519 mmscfd, whilst the projected supply is 418 mmscfd (383 mmscfd is for power generation and 35 mmscfd is used by non-power industries). This implies that there is a shortfall in gas supply of 136 mmscfd in 2025.

However, it is worth stating that between July and September, electricity demand is expected to dip during the heavy rainy season thereby reducing gas consumption within that period.

Figure 4.6 shows the projected natural gas demand and supply outlook for 2025. The chart shows that in 2025, there is a need to secure additional gas supply to adequately serve projected system demand. In the absence of that, alternate fuel (liquid fuel) will be required to compliment the available natural gas supply.

The hydro resources and other thermal plants that operate on liquid fuel will then play a critical role in ensuring power supply adequacy in 2025.

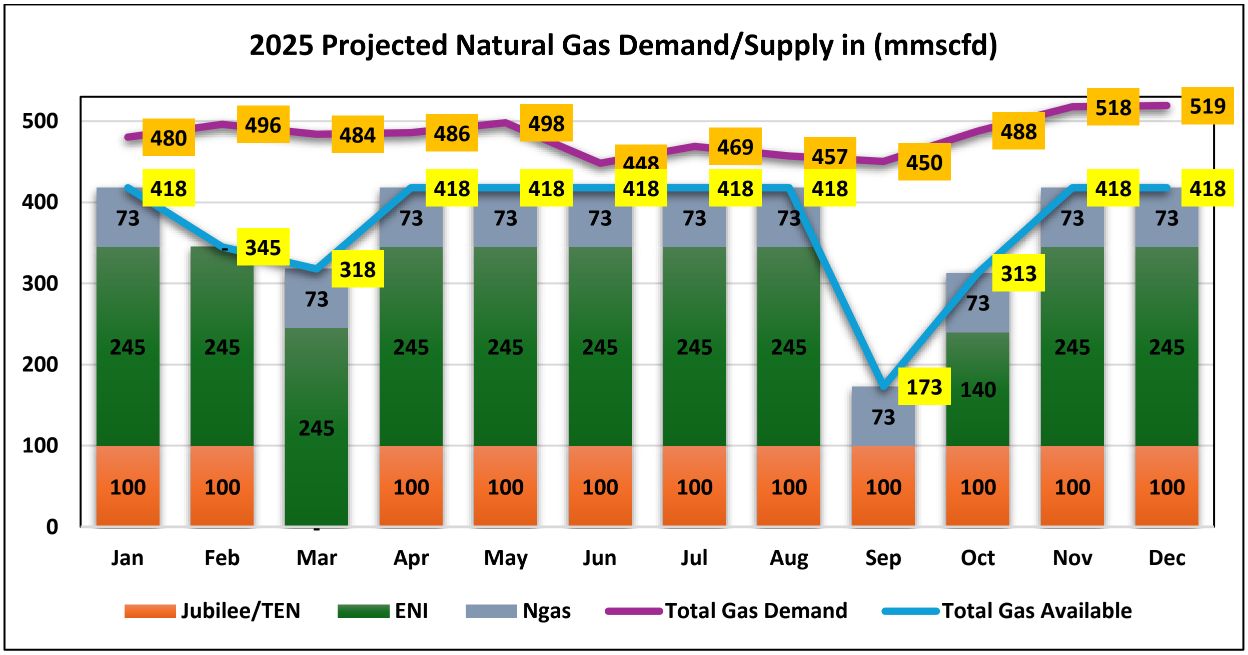


Figure 4.6: 2025 Projected Monthly Generation Vs Projected Demand

A few thermal plants can also run on either Light Crude Oil (LCO) or Diesel Fuel Oil (DFO) as secondary fuel. The AKSA plant has converted 185 MW of its 330 MW capacity to operate on natural gas. The following assumptions on the price of fuel delivered were made:

- Natural Gas (WACOG) – US$ 8.0422/MMBtu
- Delivered LCO – US$ 100/barrel.
- Delivered Diesel – US$ 1600/MT.
- Delivered HFO – US$ 605/MT.

A summary of major fuel requirements for 2025 is presented below:

- Natural Gas: Based on the assumed gas supply from the domestic suppliers in Ghana and imports from Nigeria, the total natural gas consumption for 2025 is projected to be about

144.97 TBtu. Based on an estimated natural gas price of US$8.0422/MMBtu, the projected cost of natural gas for the year 2025 is US$ 1.165 Billion.

- LCO: During the scheduled West African Gas Pipeline (WAGP) pigging exercise from February 3 to March 2, 2025, a generation shortfall is anticipated, such that the minimum required generation of 650 MW from the eastern generation enclave, which is essential for grid stability is not met. Additionally, a significant supply-demand deficit is expected.

  To mitigate this shortfall, it is necessary to procure supplementary Light Crude Oil (LCO) to sustain thermal power plant operations in the eastern enclave (Tema) and ensure uninterrupted electricity supply. The estimated LCO requirement for the pigging period is approximately **339,600 barrels**, with an associated cost of **US$ 33.96 million**.

  Furthermore, due to inadequate natural gas supply throughout the year (as illustrated in Figure 4.5), an additional **5,161,920 barrels** of LCO will be required to supplement thermal generation from natural gas. At an estimated delivered LCO price of **US$ 100 per barrel**, the projected cost for this supplementary fuel is **US$ 516.19 million**.

  In total, **US$ 550.15 million** will be required to procure the necessary LCO to complement natural gas supply and maintain grid reliability.

- HFO: The AKSA plant is scheduled to operate on HFO to complement the available gas to support peak demand as well as during gas maintenance shutdowns. Up to about 162,520 MT of HFO will be required to support generation in 2025. At an estimated delivered HFO price of US$605/MT, the projected cost of HFO for the year 2025 is **US$ 98.32 Million**.
- Diesel: Based on the anticipated gas supply deficits and gas infrastructure outages it will be necessary to make provision for about 147,369 MT of diesel in 2025. At an estimated delivered Diesel price of US$ 1600/MT, the projected cost of diesel for the year 2025 is **US$ 235.79 Million**.

Based on the above, the estimated annual fuel cost to operate the thermal power plants is **US$ 2.02 Billion**.

Chapter 5

2025 TRANSMISSION SYSTEM OUTLOOK

5.1 State of the Ghana Power System and Transmission Challenges

The Ghana Power System has grown from a peak load of 1,933 MW in 2015 to 3,952 MW in 2024 with an accumulated annual average growth rate of 9.4%. However, despite this rapid growth in demand, investment in the transmission network has not kept pace, due mainly to financing challenges.

The relatively slow pace of investment in the transmission infrastructure has resulted in gradual emergence of congested corridors on the NITS and the increasing numbers of old and obsolete equipment which require urgent replacement.

As demand is projected to continue to grow, it is expedient to take urgent steps to realise the necessary investments to reinforce the NITS. This is to ensure that the NITS continues to have adequate capacity and the robustness to maintain grid stability, and to ensure reliable and efficient power supply in Ghana.

5.1.1 National Interconnected Transmission System (NITS)

As at the end of 2024, the NITS comprised a total circuit length of 6,719.6 km of transmission lines. This is made up of transmission circuits at the following voltage levels: 161 kV (5,207.9 km), 225 kV (92.2 km), 330 kV (1,206.6 km), and 69 kV (212.8 km).

The NITS also comprised 72 Bulk Supply Points (BSPs) with a total transformation capacity of 9,799.8 MVA. It also had installed reactive power compensation devices as follows: 589.9 MVAr of fixed capacitive devices, 230 MVAr of reactors, and two Static VAR Compensators (1x40 MVAr at the Tamale substation, and 1x50 MVAr at the Kasoa substation).

The Ghana power system is interconnected with the power systems of Côte d'Ivoire and Burkina Faso at 225 kV and with Togo at both 161 kV and 330 kV, facilitating cross-border power exchanges.

5.2 Network Analysis

Network analyses were carried out to determine transmission line loadings, substation bus voltages and network loss levels across the transmission network. Load Flow analyses were therefore carried out to determine the transfer capability of the NITS and assess the level of reliability of the transmission network to evacuate power from the generation centers to the various Bulk Supply Points.

Loadings on transmission lines and voltage levels of some key substations were monitored to determine whether there were any limit violations. In addition, transmission system losses were monitored to determine the impact of generation and transmission investments on grid performance.

The following assumptions were considered in the analyses carried out:

a. Development of Load Flow Cases

The study was carried out on the 2025 network model of the Ghana power system which was developed using the 2025 peak and off-peak demand forecast data. The study was conducted on the expected state of the power system within two periods of the year being, the first half year (January – June) and the second half year (July – December).

b. Generation Additions

The following power plants, expected to be commissioned in 2025 (See Chapter 4: "Committed Generation Projects expected in 2025") were considered:

- 50 MWp Yendi solar PV.
- 110 MWp additional solar PV at Bui.
- 100 MW additional capacity at Anwomaso Thermal Power Station. An in first Half of the year.

Sensitivity analysis was carried out on the 205 MW AKSA Phase II at Anwomaso in the second half of the year.

c. Load Additions

The load additions considered in developing the base case, as outlined in the Demand Outlook chapter of this report, are as follows:

- Ahafo North Mine Load: 18 MW in the first half of the year, increasing to 42 MW by the end of 2025.

- Namdini Mine Load: Increasing to 46 MW by the second half of 2025..

5.3 Scope of Analysis

The network analyses sought to determine:

- ✓ Transmission line constraints to power evacuation from the generating stations to the Bulk Supply Points.
- ✓ The ability of the entire power system to withstand an N-1 contingency (i.e. forced outage of a single network element) e.g. transmission line, generator, transformer, etc.;
- ✓ Adequacy of reactive power compensation in the transmission network in achieving acceptable system voltages;
- ✓ Overall transmission system losses during peak and off-peak periods;
- ✓ The impact of locational imbalance in generation resources.

5.3.1 Technical Adequacy Criteria

The following criteria were used to assess the performance of the system under both normal and contingency conditions.

a. Normal Condition

Table 5.1: Criteria, normal condition

Parameter	Range
Bus Voltages	0.95 pu to 1.05 pu
Transmission Line Power flows	not exceeding 85% of Line Capacity
Transformers	Not exceeding 100% (nameplate rating)
Generators	Not exceeding their Capability Curves

b. Contingency Conditions

Table 5.2: Criteria, contingency condition

Parameter	Range
Bus Voltages	0.90 pu to 1.10 pu
Transmission Line Power flows	not exceeding 100% of Line Capacity
Transformers	Not exceeding 120% of Nameplate Rating for a short time
Generators	Not exceeding their Capability Curve

5.4 Results of the Technical Analyses

The analyses were carried out on the following scenarios:

- 2025 Case (Off Peak scenarios) for the 1st and 2nd half of the year
- 2025 Case (Peak scenarios) for the 1st and 2nd half of the year
- 2025 Case with Gas Contingency (Off Peak & Peak scenarios)
- System Contingency Analyses

Details of the results of the analyses are enumerated as follows:

5.4.1 2025 Case (Peak and Off-Peak Analyses)

This analysis was conducted based on the agreed dispatch protocols which have both commercial and technical consideration to develop the generation schedule for the cases.

a. Off-Peak Condition – 1st Half of 2025:

In this scenario, analyses were carried out during the off-peak. The off-peak demand is estimated to be 3,660.9 MW (85% of projected system peak demand of 4,306.9 MW) in the 1st Half of the year. Table 5.3 shows the generation schedule from each enclave that was used to model this scenario. Table 5.4 shows the internal demand, power export to neighbouring countries, and transmission losses for this scenario. Voltages at some selected substations are shown in Table 5.5. Transmission losses recorded for this scenario is **3.7% (**133.7 MW) of total generation of 3,660.9 MW.

No line loading violations are observed. Low voltages are recorded in the Western and Eastern corridors of the transmission grid. This is depicted in the voltage contour in Figure 5.1.

The contour shows the voltage profile of the power system on a Single Line Diagram (SLD) of the load flow analysis. The areas shaded red show substations that are in violation of the voltage criteria ie, voltages less than 95% of nominal. Pale yellow to Green show bus voltages which are in the range of 95% to 98% of the nominal. Blue shows voltages above 98% of the nominal. This standard of contour drawings is applied to other scenarios.

Table 5.3: Generation dispatch from Generation Enclaves (Off-peak conditions 1st Half Nomination)

GENERATION ENCLAVE	OUTPUT (MW)
EASTERN	1,853.1
WESTERN	1,254.2
MIDDLE	229.5
NORTHERN	324.1
TOTAL	3,660.9

Table 5.4: Off-Peak Demand Distribution – 1st Half 2025

	OUTPUT (MW)	REMARKS
DOMESTIC PEAK	3,028.8	
GHANA SUPPLY TO CEB	120.3	Voltage@Dawa 330 kV is 1.01 pu Voltage@Lome 161 kV is 0.99 pu
GHANA SUPPLY TO CIE	166.9	Voltage@Prestea 225 kV is 0.96 pu
GHANA SUPPLY TO SONABEL	211.2	Voltage@Nayagnia 225 kV is 0.97 pu
TRANSMISSION LOSSES	133.7	
TOTAL	3,660.9	

Table 5.5: Voltages at some selected Substations (1st Half Off-peak conditions)

Station	Asawinso	Volta	Kedjebi	Cape Coast	Konongo	Achimota	Kumasi	Yendi
Voltage (kV)	152.1	160.2	61.6	160.2	157.7	156.9	158.4	161.0

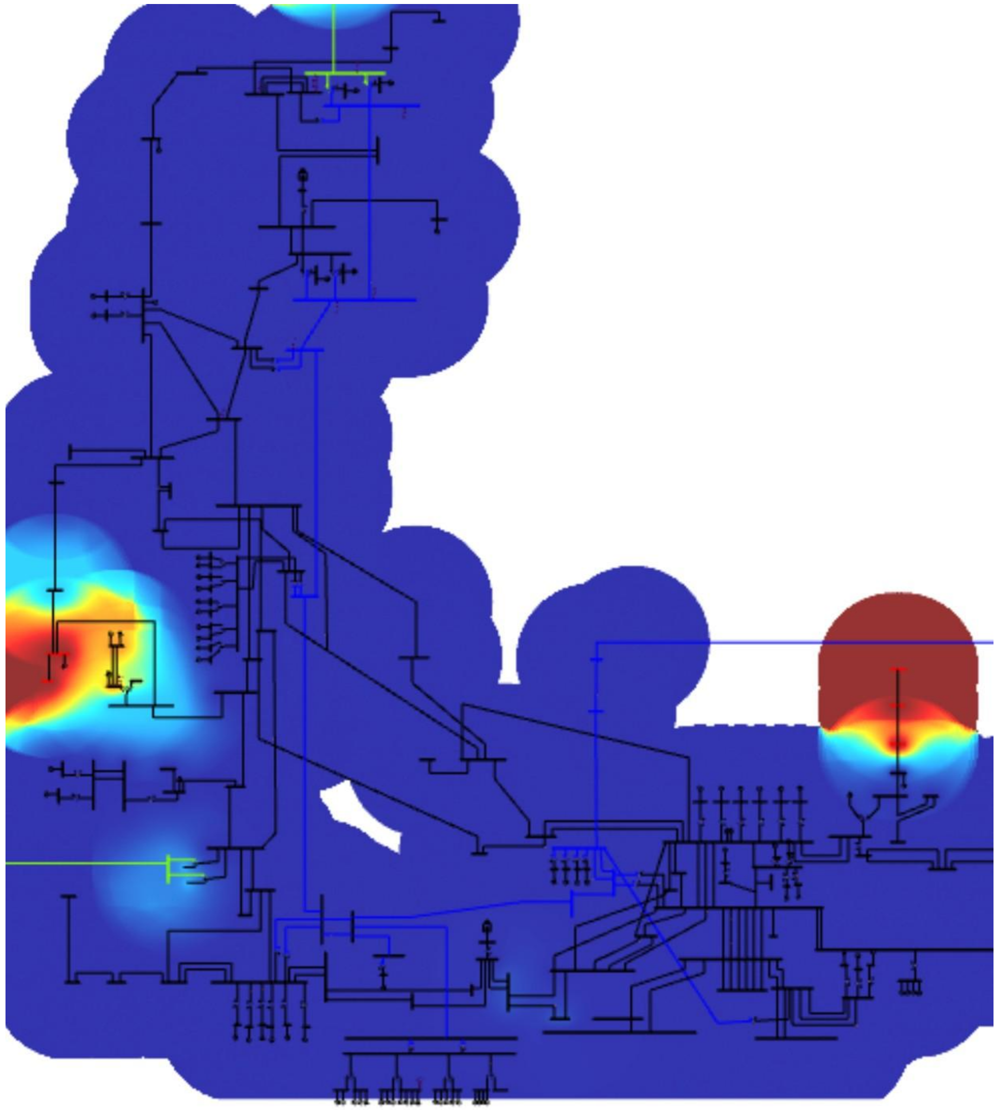


Figure 5.1: Voltage Contour for 1st Half Off Peak Nomination Scenario

b. Off-Peak Condition – 2nd Half of 2025:

Two scenarios are considered in the second half of the year. The first scenario considers the conditions with all transmission lines in service. The second scenario considers conditions where the 161 kV Anwomaso – Kumasi and the 161 kV Kasoa – Mallam lines are taken out of service for reconstruction. The second scenario also considers 120 MW generation from AKSA Phase II plant from Anwomaso. Voltages and line loadings will be monitored for the two scenarios.

Scenario 1: All lines in service

The off-peak demand is estimated to be 3,687.1 MW (85% of projected system peak demand of 4,337.7 MW) in the 2nd Half of the year. Table 5.6 shows the generation schedule from each enclave that was used to model this scenario. Voltages at some selected substations are shown in Table 5.8. Low voltages are recorded in the Western and Eastern corridors of the transmission grid as shown in the contour in Figure 5.2.

Transmission losses recorded for this scenario is **3.4%** corresponding to 125.1 MW of total generation of 3,687.1 MW.

Voltage at the 161 kV Kumasi substation is 159.2 kV (0.99 pu). Voltages at 161 kV Kasoa, Mallam and Accra Central are 154.8 kV (0.97 pu), 155.0 kV (0.96 pu) and 154.9 kV (0.96 pu) respectively. Maximum power flow on lines between Aboadze and Kasoa is 115.2 MW (71.3%). The 330 kV Takoradi Thermal – Pokuase line is loaded 153.8 MW (19.6%). The 161 kV Anwomaso – Kumasi line is loaded 129.3 MW (39.4%). The 161 kV Nkawkaw – Anwomaso tap off to Kumasi is loaded at 68.2 MW (15.7%).

Table 5.6: Scenario 1 Generation dispatch (Off-peak conditions 2nd Half Nomination)

GENERATION ENCLAVE	OUTPUT (MW)
EASTERN	1,862.9
WESTERN	1,186.4
MIDDLE	228.3
NORTHERN	430.7
TOTAL	3,687.1

Table 5.7: Scenario 1 Off-Peak Demand Distribution

	OUTPUT (MW)	REMARKS
DOMESTIC PEAK	3,053.8	
GHANA SUPPLY TO CEB	140.6	Voltage@Dawa 330 kV is 1.01 pu Voltage@Lome 161 kV is 0.98 pu
GHANA SUPPLY TO CIE	156.5	Voltage@Prestea 225 kV is 0.97 pu
GHANA SUPPLY TO SONABEL	210.2	Voltage@Nayagnia 225 kV is 0.98 pu
TRANSMISSION LOSSES	126.0	
TOTAL	3,687.1	

Table 5.8: Voltages at some selected Substations (Off-peak conditions 2nd Half Nomination)

Station	Asawinso	Volta	Kedjebi	Cape Coast	Konongo	Achimota	Kumasi	Yendi
Voltage (kV)	152.2	160.0	62.8	159.8	158.5	155.8	159.2	164.4

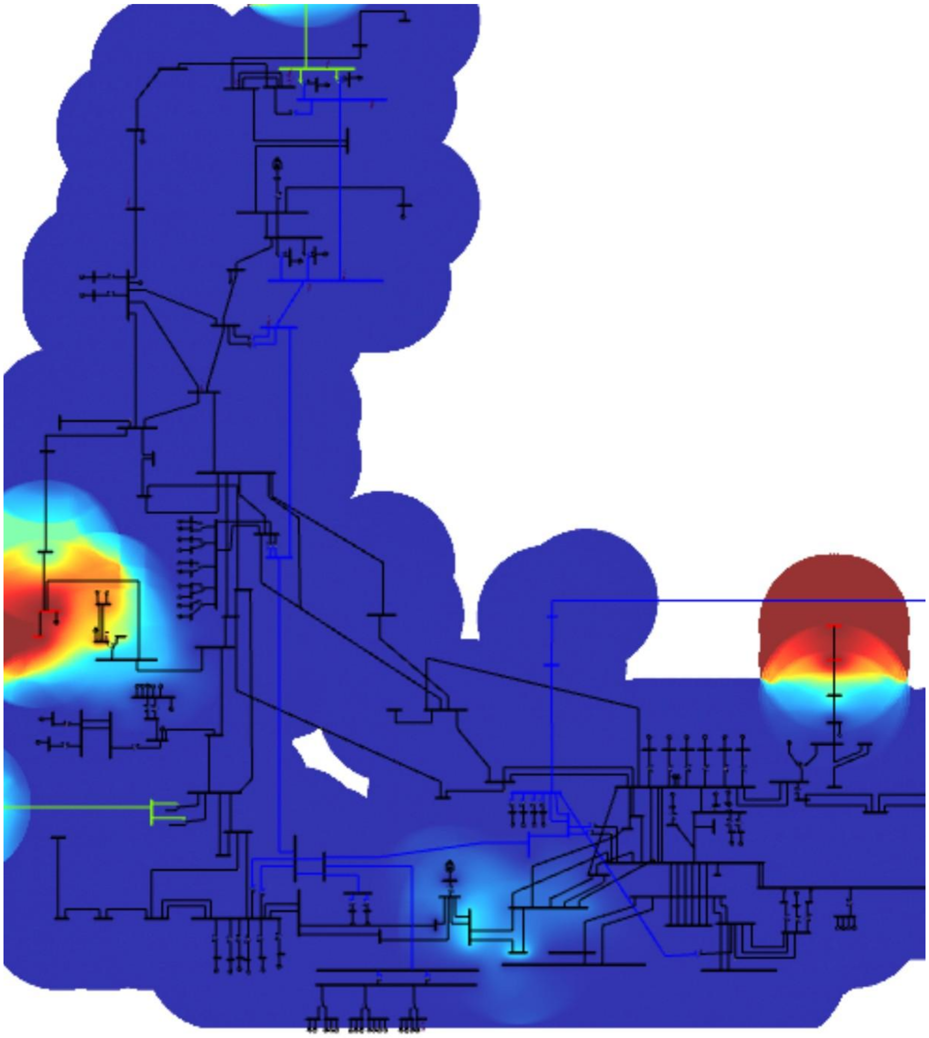


Figure 5.2: Voltage Contour for Off Peak 2nd Half Nomination Scenario 1

Scenario 2: 161kV Anwomaso – Kumasi and 161 kV Kasoa – Mallam Lines taken out of service

In this scenario, the 161 kV Anwomaso – Kumasi and the 161 kV Kasoa – Mallam lines are taken out of service for upgrade works with the same demand considered in Scenario 1 i.e. 3,687.1 MW. This scenario also considers generation of 120 MW from the proposed AKSA Phase II plant in Anwomaso. The internal demand and power supply to neighbouring countries are similar to Scenario 1. Transmission losses recorded for this scenario is **3.3%,** corresponding to 122.0 MW of total generation of 3,687.1 MW. Low voltages are recorded in some parts of the Western and Eastern corridors of the grid. Voltages at some selected substations are shown in Table 5.10.

Table 5.9 Scenario 2 Generation dispatch (Off-peak conditions 2nd Half Nomination)

GENERATION ENCLAVE	OUTPUT (MW)
EASTERN	1,845.1
WESTERN	1,062.5
MIDDLE	348.8
NORTHERN	430.7
TOTAL	3,687.1

Table 5.10: Voltages at some selected Substations (Off-peak conditions 2nd Half Nomination)

Station	Asawinso	Volta	Kedjebi	Cape Coast	Konongo	Achimota	Kumasi	Yendi
Voltage (kV)	152.7	158.5	62.8	162.8	158.6	154.9	158.9	166.7

Voltage at the 161 kV Kumasi substation is 158.9 kV (0.99 pu). Voltage at the 161 kV Kasoa substation increases from 154.8 kV (0.97 pu) to 161.0 kV (1.00 pu), Voltage at Mallam and Accra Central reduce from 154.0 kV (0.96 pu) and 154.9 kV (0.96 pu) in Scenario 1 to 153.6 kV (0.95 pu) and 153.7 kV (0.95 pu) in Scenario 2 respectively. Highest power flow on lines between Aboadze and Kasoa is 111.0 MW (67.5%). Power flow on the 161 kV Nkawkaw – Anwomaso tap off to Kumasi increases from 68.2 MW (15.7%) in Scenario 1 to 179.4 MW (40.2%) in Scenario 2.

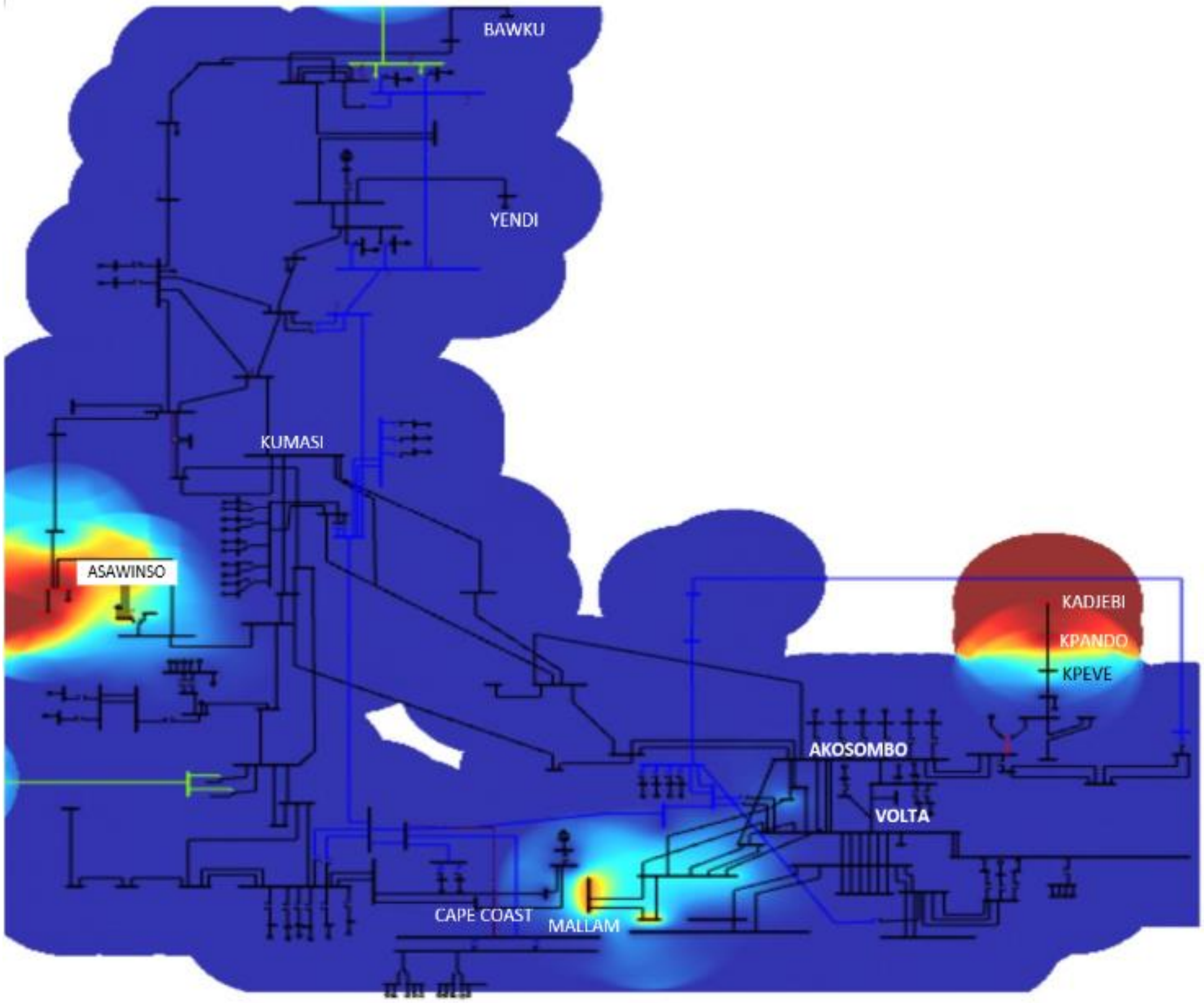


Figure 5.3: Voltage Contour for Off Peak 2nd Half Nomination Scenario 2

a. Peak Condition - 1st Half of 2025:

From the 2025 load and energy demand forecast, the projected peak for the first half of 2025 is **4,306.9 MW**. Table 5.11 shows the generation schedule from each enclave that was used to model this scenario.

Low voltages are recorded in some sections of Western, Central and Eastern Corridors of the grid as shown in the contour in Figure 5.4.

The 161 kV New Tarkwa – Prestea line is 89.5% loaded. The line loading contour is shown in Figure 5.4. Transmission losses recorded for this scenario is **4.0%** corresponding to 172.4 MW of total generation of 4,306.9 MW.

Table 5.11: Generation dispatch from Generation Enclaves (Peak conditions 1st Half Nomination)

GENERATION ENCLAVE	OUTPUT (MW)
EASTERN	2,595.5
WESTERN	1,167.7
MIDDLE	227.0
NORTHERN	316.7
TOTAL	4,306.9

Table 5.12: 1st Half Peak Demand Distribution

	OUTPUT (MW)	REMARKS
DOMESTIC PEAK	3,741.8	
GHANA SUPPLY TO CEB	120.3	Voltage@Dawa 330 kV is 1.02 pu Voltage@Lome 161 kV is 0.98 pu
GHANA SUPPLY TO CIE	116.9	Voltage@Prestea 225 kV is 0.95 pu
GHANA SUPPLY TO SONABEL	155.5	Voltage@Nayagnia 225 kV is 0.95 pu
TRANSMISSION LOSSES	172.4	
TOTAL	4,306.9	

Table 5.13: Voltages at some selected Substations (Peak conditions 1st Half Nomination)

Station	Asawinso	Volta	Kedjebi	Cape Coast	Konongo	Achimota	Kumasi	Yendi
Voltage (kV)	134.2	160.6	38.6	157.5	147.1	155.9	147.3	148.2

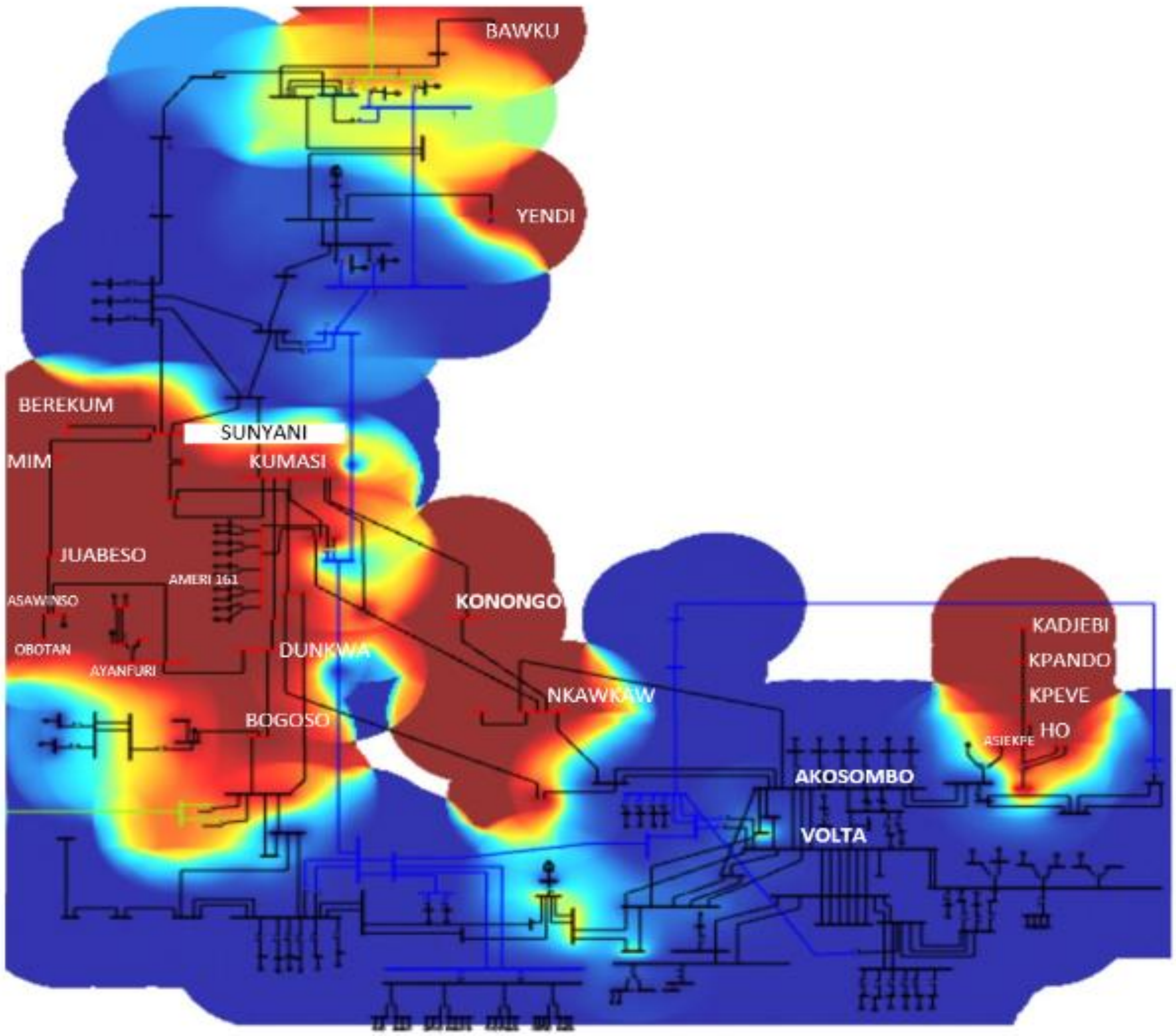


Figure 5.4: Voltage Contour for Peak Conditions 1st Half Nomination Scenario.

b. Peak Case - 2nd Half of 2025:

Two scenarios are considered in the second half of the year. The first scenario considers the conditions where all transmission lines are in service and the second scenario considers conditions where 161 kV Anwomaso – Kumasi and 161 kV Kasoa – Mallam lines are taken out of service for reconstruction. The second scenario also considers 120 MW generation from AKSA Phase II plant. Voltage and line loadings will be monitored for the two scenarios.

Scenario 1: All lines in service

The projected peak load for 2025 (ie, 4,337.7 MW) is expected to be realised in the fourth quarter of the year. Table 5.14 shows the generation schedule from each enclave that was used to model this scenario. Voltages at some selected substations are shown in Table 5.14. Low voltages are recorded in the Ashanti, Western and Eastern corridors of the transmission grid as shown in the contour in Figure 5.2.

Transmission losses recorded for this scenario is **4.0%** corresponding to 173.1 MW of total generation of 4,337.7 MW.

Voltage at 161 kV Kumasi substation is 148.7 kV (0.92 pu). Voltages at 161 kV Kasoa, Mallam and Accra Central are 153.9 kV (0.96 pu), 153.8 kV (0.96 pu) and 153.9 kV (0.96 pu) respectively.

Maximum power flow on lines between Aboadze and Kasoa is 114.2 MW (72.4%). 330 kV Takoradi Thermal – Pokuase line is loaded 96.14 MW (12.2%). 161 kV Anwomaso – Kumasi line is loaded 131.7 MW (41.7%). 161 kV Nkawkaw – Anwomaso tap off to Kumasi is loaded 83.7 MW (19.4%).

Table 5.14: Generation dispatch from Generation Enclaves (Peak condition 2nd Half Nomination)

GENERATION ENCLAVE	OUTPUT (MW)
EASTERN	2389.0
WESTERN	1,381.6
MIDDLE	232.9
NORTHERN	334.2
TOTAL	4,337.7

Table 5.15: Scenario 1 Peak Demand Distribution

	OUTPUT (MW)	REMARKS
DOMESTIC PEAK	3,759.3	
GHANA SUPPLY TO CEB	120.4	Voltage@Dawa 330 kV is 1.02 pu Voltage@Lome 161 kV is 0.98 pu
GHANA SUPPLY TO CIE	123.7	Voltage@Prestea 225 kV is 0.95 pu
GHANA SUPPLY TO SONABEL	160.6	Voltage@Nayagnia 225 kV is 0.95 pu
TRANSMISSION LOSSES	173.7	
TOTAL	4,337.7	

Table 5.16: Voltages at some selected Substations (Peak conditions 2nd Half Nomination)

Station	Asawinso	Volta	Kedjebi	Cape Coast	Konongo	Achimota	Kumasi	Yendi
Voltage (kV)	138.6	160.2	38.5	157.3	148.3	155.5	148.7	149.3

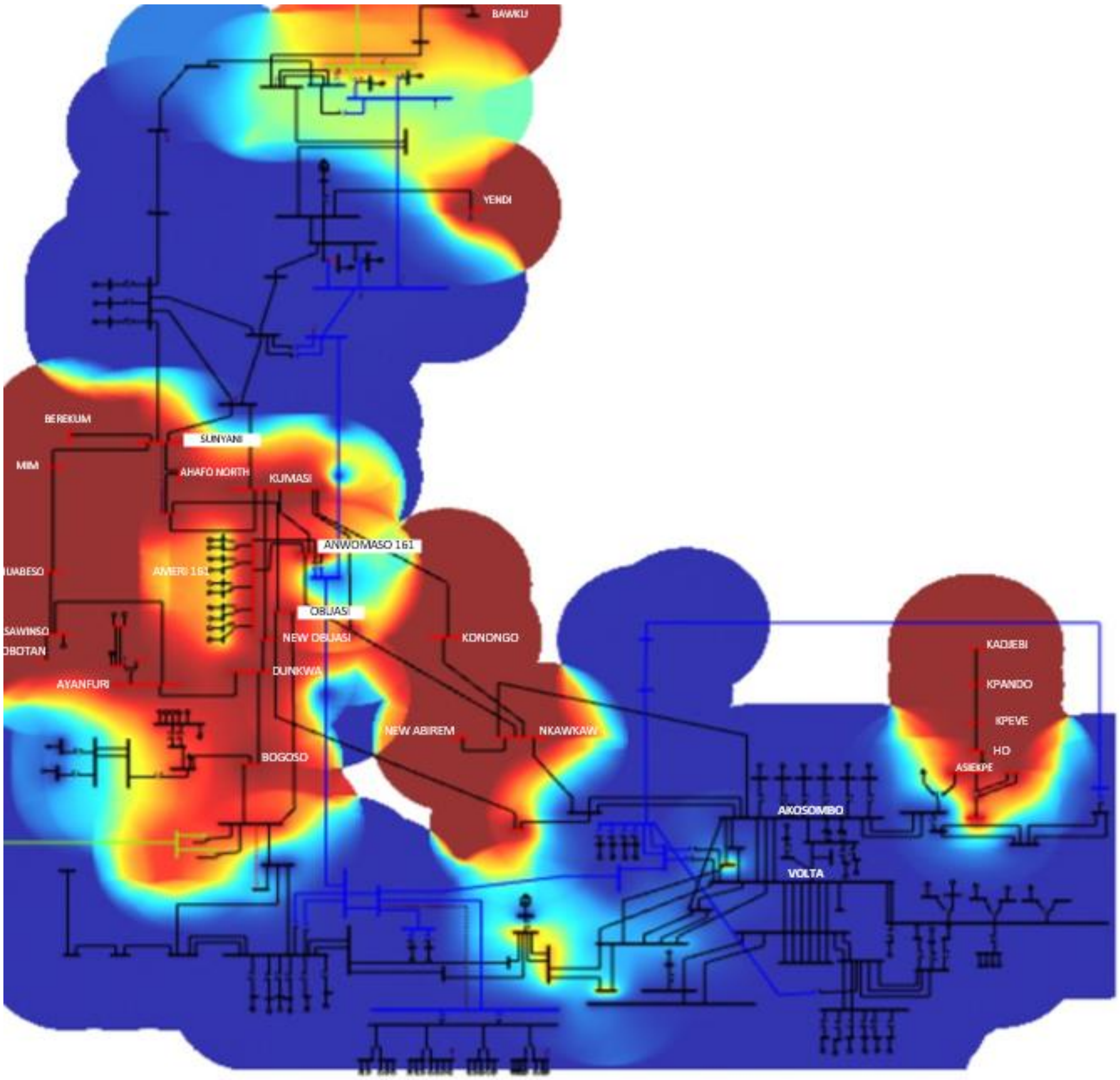


Figure 5.5: Voltage Contour for Peak Conditions 2nd Half Nomination Scenario 1

Scenario 2: 161kV Anwomaso – Kumasi and 161 kV Kasoa – Mallam Lines taken out of service, 120 MW Generation from AKSA Phase II

In this scenario, 161 kV Anwomaso – Kumasi and 161 kV Kasoa - Mallam lines are taken out of service for upgrade works with the same considered peak as in Scenario 1 (ie, 4,337.7 MW). This scenario also considers 120 MW generation from proposed AKSA Phase II plant in Anwomaso. The domestic peak and power supply to neighbouring countries are similar to Scenario 1 except that this scenario allows export of 176.4 MW to Sonabel compared to Scenario 1 export of 160.6 MW. Transmission losses recorded for this scenario is **4.1%** corresponding to 175.6 MW of total generation of 4,337.7 MW. Low voltages are recorded in some parts of the Ashanti, Western and Eastern corridors of the grid. Voltages at some selected substations are shown in Table 5.18.

Table 5.17: Generation dispatch from Generation Enclaves (Peak condition 2nd Half Nomination)

GENERATION ENCLAVE	OUTPUT (MW)
EASTERN	2,255.6
WESTERN	1,397.9
MIDDLE	351.7
NORTHERN	332.5
TOTAL	4,337.7

Table 5.18: Voltages at some selected Substations (Peak conditions 2nd Half Nomination)

Station	Asawinso	Volta	Kadjebi	Cape Coast	Konongo	Achimota	Kumasi	Yendi
Voltage (kV)	138.7	159.7	38.9	155.4	147.8	155.0	147.4	150.3

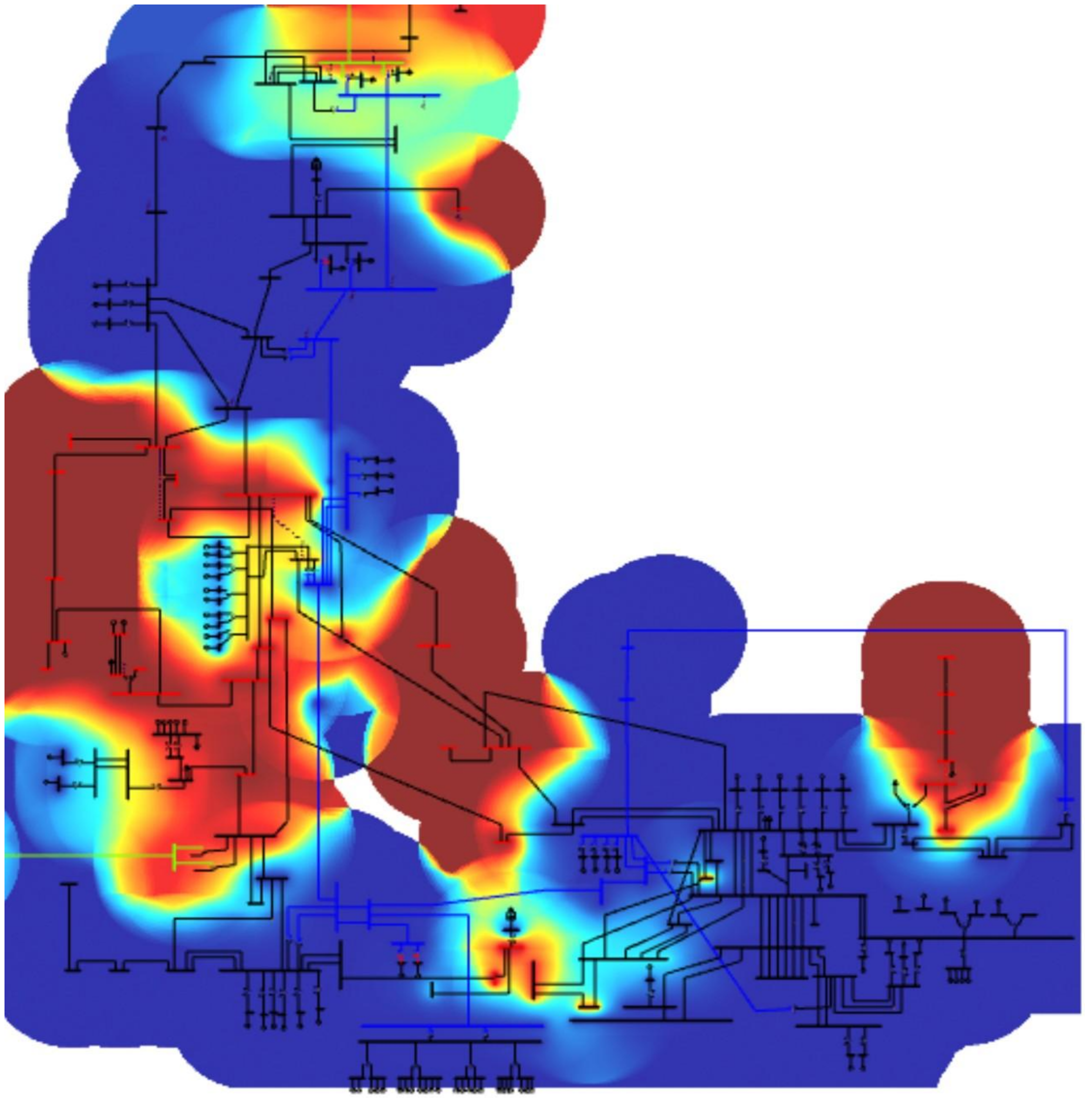


Figure 5.6: Voltage Contour for Peak Conditions 2nd Half Nomination Scenario 2

Voltage at 161 kV Kumasi substation is 147.4 kV (0.92 pu). Voltages at 161 kV Kasoa reduces from 153.9 kV (0.96 pu) to 151.5 kV (0.94 pu), Voltage at Mallam and Accra Central reduce from 153.8 kV (0.96 pu) and 153.9 kV (0.96 pu) in Scenario 1 to 153.2 kV (0.95 pu) and 153.4 kV (0.95 pu) in Scenario 2 respectively.

Maximum power flow on lines between Aboadze and Kasoa is 149.4 MW (94.3%).

Power flow on 161 kV Nkawkaw – Anwomaso tap off to Kumasi increases from 57.15 MW (15.7%) in Scenario 1 to 197.6 MW (45.8%) in Scenario 2.

5.4.2 2025 Case with Gas Contingencies

Simulations were conducted to assess typical scenarios in which domestic gas supply and N-Gas experience contingencies, leading to reduced dispatch of thermal plants. Consequently, the dispatch of the Hydro units is maximized while some thermal units in the eastern enclave operate on liquid fuel to maintain system stability.

a. WAGPCO Shutdown for Pigging – February 2025

WAGPCO is planned to shut down for pigging in February 2025. The outage will impact both off-peak and peak periods, however, the available generation will largely support internal demand, with some necessary adjustments to power exports and internal load shedding.

Off Peak

With estimated demand at 3,497.2 MW (85% of the projected peak demand of 4,114.4 MW) during the off-peak, the total available generation will be sufficient to meet internal consumption. However, power exports will be reduced by approximately 247 MW. No line loading violations are expected, apart from the existing voltage challenges in the Eastern Corridor of the transmission grid.

Peak

For the peak period, with an estimated demand of 4,114.4 MW, the WAGPCO shutdown will reduce the total available generation to 3,640.7 MW. This shortfall could require significantly reducing exports and up to 256 MW of internal demand load management.
No line loading violations are observed, except for the pre-existing poor voltage conditions in the Eastern Corridor of the transmission grid.

b. Ghana Gas Shutdown – August 2025

The planned 15-day maintenance shutdown of Ghana Gas in August 2025 will not disrupt power supply, as thermal plants in the eastern generation enclave will operate on liquid fuel to compensate for the gas shortfall.

c. ENI Shutdown – September 2025

The scheduled 8-day shutdown of ENI for Turnaround maintenance in September 2025 will require the use of liquid fuel for thermal plants that have dual-fuel capabilities. However, the

Anwomaso Thermal Power Station and the Genser plants will be unavailable due to lack of gas supply.

Off Peak

During the off-peak period, when demand is estimated at 3,364 MW (85% of the projected peak demand of 3,957.7 MW), the available generation capacity will be sufficient to meet internal demand. System losses are expected to increase from 3.34% to 4.03%.

No line loading violations are anticipated, except for existing voltage issues in the Eastern Corridor of the transmission grid.

Peak

The projected peak demand is 3,957.7 MW in September 2025. As indicated above, the Anwomaso Thermal Power Station and Genser plants will be unavailable for the 8-day period. Analysis carried out on the dispatch of available plants during the peak period indicate that system losses increased from 3.68% to 4.64%.

d. ENI Shutdown for Inline Pigging Work – September 2025

ENI is scheduled to shut down for line pigging work in September 2025, affecting both off-peak and peak periods. Despite the shutdown, the available generation capacity will be sufficient to supply load, ensuring system stability.

Off peak

During the off-peak period, with an estimated demand of 3,364 MW, some thermal plants in the eastern generation enclave will operate on liquid fuel. Total available generation will be adequate to meet both internal demand and export commitments.

Peak

With an estimated demand of 3,957.7 MW, the ENI shutdown for line pigging will not lead to any power shortages, eliminating the need for load shedding. Poor voltages persist in certain sections of the Western, Central, and Eastern Corridors of the grid, consistent with previous contingency analyses.

5.4.3 System Contingency (N-1) Analyses

N-1 contingency analyses were conducted on the power system to determine the capability of the NITS to provide reliable power in the event of an outage to a single element/equipment, e.g. transmission line, transformer, etc.

Single line contingency (N-1) analyses were conducted on the 2025 power flow model. The contingencies are ranked in order of severity. The analyses considered the following criteria:

- Contingencies causing severe line overloads.
- Contingencies causing voltage collapse issues.

i. Contingencies that cause line overloads

a. 330 kV Takoradi Thermal – Anwomaso line

This transmission line, when in service, evacuates most of the power that flows from the Takoradi Thermal enclave towards Kumasi. The loss of this line therefore results in a major disturbance. This requires rerouting an equivalent of this amount of power on the western corridor (161kV Takoradi Thermal – Prestea – Kumasi lines). Since these 161 kV lines are aged and of low capacity, they will be unable to deliver the power and could therefore lead to cascaded trips in many substations in Ghana.

b. 330 kV Anwomaso – Kintampo line

A contingency on the 330 kV Anwomaso – Kintampo line will lead to a disturbance curtailing power supply to the Northern parts of the NITS and to Burkina (SONABEL). To keep the power supply to the North, export to Burkina will require to be reduced. This is because all the power evacuated on this line will be rerouted through the 161 kV Anwomaso – Kumasi transmission line, severely overloading the 330/161 kV autotransformers at Anwomaso.

c. 330 kV Kintampo – Adubiyili line

This single circuit line forms part of Ghana's power evacuation corridor in the North of Ghana towards Burkina (SONABEL). When the line is out of service, the power-flow attempts to be re-routed via the 161 kV circuit between Kintampo – Buipe – Adubiyili, severely overloading the line, leading to a disturbance.

d. 330 kV Adubiyili - Nayagnia line

This line forms part of Ghana's power evacuation corridor in the Northern parts of the NITS towards Burkina (SONABEL). When the line is out of service, the power-flow attempts to be re-routed on the 161 kV circuit between Adubiyili and Nayagnia, severely overloading the lines, leading to a disturbance.

e. 330 kV Asogli – B5 Plus line

This is a section of the second interconnection between Ghana and Togo/Benin. When the line is out of service, there is a temporary loss of supply to CEB. The power-flow attempts to be re-routed on the 161 kV circuit between Akosombo and Lome, severely overloading the lines. There is a tendency for a reverse flow from Davie to B5Plus.

f. 161 kV Tarkwa – Prestea line

This is a high capacity line (364 MVA) in parallel with the low capacity 170 MVA 161KV Tarkwa-New Tarkwa – Prestea line. The loss of this line severely overloads this parallel line. Operationally, this will also trigger overload relays to trip the 161 kV lines from Tarkwa through New Tarkwa to Prestea.

g. 161 kV Takoradi Thermal – Tarkwa line

A contingency on this line overloads the smaller capacity 161 kV Takoradi Thermal – Takoradi and Takoradi – Tarkwa lines (western corridor lines). This will eventually cause the small capacity lines to trip on overload. In order to mitigate the contingency, there must be a reduction of generation in the west, an increase in generation from other enclaves and a reduction in exports to Cote d'Ivoire.

ii. Contingencies that cause voltage violation

h. 161 kV Dunkwa – Ayanfuri Line

The loss of 161 kV Dunkwa – Ayanfuri line aggravates the already poor voltages experienced in Dunkwa – Ayanfuri – Asawinso corridor.

i. 161 kV Akosombo - Nkawkaw

With the loss of 161 kV Akosombo – Nkawkaw line, power is re-routed through the low-capacity middle corridor lines to Kumasi. This results in poor voltages in the Ashanti and Western regions of Ghana.

j. 161 kV Tafo – Akwatia Line

With the loss of 161 kV Tafo – Akwatia line, the demand in Akwatia would have to be supplied from the western region through the Dunkwa – New Obuasi – Akwatia line circuit. The flow of power to Kumasi through low-capacity lines and demand in Akwatia served through long distance result in deteriorated voltage in the Ashanti and Western regions of Ghana.

5.5 Status of Ongoing Transmission Projects

A number of projects are on-going to improve the reliability of the NITS. The projects are listed below:

a. Reconstruction of 24 km 161 kV Konongo – Kumasi Transmission Line project

This project involves an upgrade of 24 km of the existing 161 kV Konongo – Kumasi Mistletoe Conductor(170 MVA) transmission line from the Kumasi end to a double circuit twin tern(2x488 MVA). The project will strengthen the transmission grid in the Kumasi area, this will help evacuate power from the Anwomaso into central Kumasi. It is also to create an alternate path for power flow during the upgrade of 161 kV Anwomaso-Kumasi single circuit to a double circuit transmission line.

Status of project:

The Konongo–Kumasi section has been energized. The remaining work will include the termination of the second circuit in Kumasi.

b. 161 kV High Voltage and Substation Ahafo North Project

Newmont Ghana Gold Limited (NGGL), a Bulk Customer (BC), is a Mining Company in Ghana with operations in Ahafo and Akyem in the Brong Ahafo and Eastern Regions respectively. Newmont is expanding its operations with the development of a third mine at Ahafo North. The mine will be supplied with power from a 161 kV substation which is currently under development. The substation will be connected through a line in-line out configuration on the 161 kV Kenyase

– Sunyani line. The substation is also expected to have a 30 MVAr SVC which will provide dynamic reactive power and voltage support from the mine.

Status of project:

Transmission line and substation works are near completion with minor works outstanding. Pre commissioning is ongoing and expected to be operationalized in Q2 2025.

c. 161kV Anwomaso - Kumasi (AW1K) Transmission Line Project

Anwomaso substation has transitioned from a power-consuming point in the grid to a generation hub. In view of this there is a need to strengthen the transmission infrastructure from Anwomaso to the rest of the grid. The 161 kV Anwomaso – Kumasi (AW1K) transmission line upgrade is to strengthen the transmission link between the two Bulk Supply Points in Kumasi to allow for onward export to the North.

The upgrade of this line complemented with the upgrade of the J2K is expected to support the grid during contingencies on the 330 kV Anwomaso – Kintampo line.

Status of project as at end of 2024:

Tower pegging and soil investigation on the various tower locations is in progress.

d. Emergency Procurement of Two (2No.) 330/225 kV, 200/250 MVA Auto Transformers with Phase Shifting Capabilities

Nayagnia Substation was developed under the 225 kV Nayagnia – Ouagadougou Interconnection Project to export minimum of 100MW to Burkina and future export to Mali. The substation is equipped with 330/225kV and 330/161kV Autotransformers. GRIDCo has procured two 330/225 kV 200/225 MVA autotransformers with phase shifting capabilities to improve power export and limit loop flows.

Status of project as at end of 2024:

The two (2) no. phase shifting transformers have been delivered to the Nayagnia substation with one currently undergoing installation. The installation requires some modifications to be carried out on the substation equipment to allow for the physical connection of the transformer.

e. Green House Project

Greenhouse Power Limited Company (GPLC) was established to provide electricity distribution and retail services within the industrial enclave at Shai Hills in the Shai Osudoku district of the Greater Accra region of Ghana. The development comprises a 60 MVA 161/11 kV Bulk Supply Point within the enclave for the purpose of supplying quality and reliable power at the Shai Hills.

Status of project as at end of 2024:

Transmission line completed, protection and control cabling for the substation is ongoing.

f. Installation of 5 No. 161/34.5 kV 120/145 MVA

Delivery of 1No. each of 161/34.5 kV 120/145 MVA at the following substations:

- Anwomaso,
- Kumasi,
- Accra East,
- Smelter and
- Afienya.

Status of project as at end of 2024:

The transformer at Anwomaso has been energized and awaiting ECG to pick up load, whereas those of Kumasi, Accra East, Smelter and Afienya substations are yet to be installed.

5.6 Transmission constraints to Power Supply in 2025

Through a comprehensive load flow analysis of existing and expected loading condition of the transmission network, the underlisted constraints to reliable power supply have been identified:

a. Eastern Corridor

The existing transmission network in the eastern corridor is largely 69 kV. The network, which was designed to supply a load far below the current demand. This has resulted in poor voltages on buses at Kpando and Kadjebi substations, with the latter recording as low as 38.5 kV (nominal voltage of 69 kV). This situation has resulted in poor end user voltages, reduced quality and reliability of supply.

Furthermore, the Oti and Northern Regions have reported low customer end voltages (instead of the nominal 240 V). This makes it impossible or unsafe to operate some domestic and industrial loads. Towns such as Bimbila, Kpandai, Salaga and Kete Krachi are currently being supplied by long 34.5 kV feeders in excess of 200 km from Yendi with numerous tee-offs resulting in massive voltage drops, frequent outages and high distribution losses.

b. Tamale – Bolgatanga Area

Analyses have shown that voltage instability persists in the area evidence as high voltages during off-peak and low voltages during peak. Demand is expected to increase in the Bolgatanga Area driven by domestic needs and exports to SONABEL and later on, Mali. There is a need for infrastructure upgrades for power evacuation and reactive power support. Currently the Namdini substation needs to install an SVC to provide reactive power support for its load.

c. Western Corridor

The Western Corridor refers to 161 kV transmission lines from Aboadze through Prestea to Kumasi. Loads in this corridor are mainly mining and industrial areas, as well domestic loads to supply towns and communities. The corridor has experienced demand growth and increased mining activities, resulting in overloading the infrastructure. The situation worsens during a transmission line contingency as the remaining lines are unable to supply the demand. This situation is even more critical with a contingency on the major 330 kV Aboadze - Anwomaso transmission line.

Chapter 6

OVERVIEW OF MEDIUM TERM SUPPLY

6 OVERVIEW OF MEDIUM-TERM SUPPLY: 2026 - 2030

A reliable power system must always maintain sufficient generating capacity to meet electricity demand. On average, it takes about five years for a conventional power plant to progress from conception through funding arrangements, detailed design, construction, and commissioning before commencing commercial operations.

In a developing country like Ghana, electricity demand is expected to continue growing. Therefore, it is essential to conduct regular analyses to assess the adequacy of generation resources. These assessments provide timely indication of potential capacity shortages, allowing sufficient time to plan, secure funding, and procure additional capacity to serve projected demand.

Beyond identifying capacity gaps, such analyses also highlight other challenges that could impact the reliability, security, and quality of electricity supply. Addressing these challenges proactively ensures a high level of reliability of power supply to consumers.

Medium-term power system planning evaluates electricity demand projections over a five-year period and assesses the capability of existing generation and transmission resources to meet that demand. The analysis determines additional generating capacity required and examines the need for transmission network reinforcements or modifications to support reliable supply.

In this chapter, we present demand projections as well as generation adequacy analysis for the medium-term (2026–2030). This assessment will serve as a crucial guide for power system investment planning, ensuring security of supply in the planning period.

6.1 Demand Outlook

The Projected demand for the period 2026-2030 was determined using data collated from a load forecasting exercise conducted. It takes into consideration projections for natural growth in domestic demand over the period. It also incorporates some spot loads expected to be added in the medium term.

The spot loads expected in the medium term are as follows:

- ✓ **Development of an Integrated Aluminum Industry in Ghana:**

As part of efforts to develop an Integrated Aluminum Industry in Ghana, the Volta Aluminum Company Limited (VALCO) projects to increase their operations to two potlines (156 MW) in 2026 through to 2028 and three potlines (304 MW) in 2029 and beyond.

However, the operations of VALCO are dependent on the availability of a low-priced electricity.

✓ **Mines:**

Total mines demand is expected to increase from 396.1 MW in 2026 to 589.0 MW in 2030. Some of the specific mine loads are as follows:

- Azumah Mines - 18 MW by 2028 at Yagha (50 km North-West of Wa).
- Earl International - demand is expected to increase from 5 MW in 2026 to 50 MW by 2028.
- TMC and TW Mines – 50 MW and 15 MW respectively, to be connected to the NITS in the Western Region by 2027.
- New Mines (various) locations to increase from 20.5 MW 2028 to 64.5 MW by 2030.

✓ **Other Bulk Customers**

- B5 Plus - Expected to increase from 30 MW in 2025 to 60 MW by 2029.
- Rider steel – Expected to increase from 25 MW to 30 MW by 2029.
- Green House – Expected to increase from 23.8 MW in 2026 MW to 38.3 MW by 2030.

✓ **Potential Exports:**

Total export is expected to increase from 540 MW in 2026 to 570 MW in 2030, comprising:

- 150 MW of export to CIE throughout the period.
- 150 MW export to CEB throughout the period.

- Export to SONABEL is expected to increase from 240 MW in 2026 to 270 MW in 2030.
- 60 MW export to Mali is expected to begin by 2029.

Total electricity requirement for Ghana, including power exports to Togo, Benin, CIE, Burkina Faso and Mali is projected to grow from **30,983** GWh in 2026 to **40,571**GWh by 2030 at a Compound Annual Growth Rate (CAGR) of approximately 7.88%. The Ghana system peak demand is projected to increase from **4,718** MW in 2026 to **6,198** MW in 2030. The summary of projected demand for the medium term is illustrated in Table 6.1and Table 6.2.

Table 6.1: Projected Energy Demand (GWh) (2026-2030)

Demand GWh	2026	2027	2028	2029	2030
Domestic	26,538	28,624	30,696	32,791	35,594
VALCO	1,265	1,265	1,265	1,265	1,265
Exports	3,141	3,214	3,214	3,287	3,712
TOTAL	**30,944**	**33,103**	**35,175**	**37,343**	**40,571**

Table 6.2: Projected Peak Demand (MW) (2026-2030)

	2026	2027	2028	2029	2030
Domestic	4,021	4,333	4,643	4,979	5,411
VALCO	157	157	157	157	157
Exports	540	550	550	560	630
TOTAL	**4,718**	**5,040**	**5,350**	**5,696**	**6,198**

6.2 Supply Adequacy: 2026 - 2030

In this section, we carry out an analysis to determine whether projected dependable generation capacity in the medium-term (2026 to 2030) will be adequate to serve projected demand within the period.

Studies[2] conducted on the Ghana power system have recommended that we must always have dependable generation capacity that is at least eighteen percent (18%) more than projected demand.

The power supply adequacy analysis was prepared taking into consideration existing generation capacities. The criteria for generation adequacy ensured that sufficient generation resources will

[2] The Loss Of Load Expectation Study carried out in 2011

be available to always serve the forecast demand with the required 18% minimum operating reserve margin.

6.2.1 Existing Generation

The existing generating facilities in Ghana are made up of hydro, thermal and renewable energy sources. The breakdown of projected demand versus expected supply from the existing generation resources is as shown in Table 6.3.

Table 6.3 Projected Demand and Existing Generating Capacity

Projected Demand (MW)		2026	2027	2028	2029	2030
Domestic		4,021	4,333	4,643	4,979	5,412
VALCO		156	156	156	156	156
Exports		540	550	550	560	630
TOTAL		**4,718**	**5,040**	**5,350**	**5,696**	**6,198**
Projected Demand + 18% Operating Reserve Margin		**5,567**	**5,947**	**6,313**	**6,721**	**7,314**
Existing Generation Plants	**Installed Capacity (MW)**	**Dependable Capacity (MW)**				
Akosombo	1020	960	960	960	960	960
Kpong GS	160	140	140	140	140	140
Bui GS	404	360	360	360	360	360
TAPCO	330	300	300	300	300	300
TICO	340	320	320	320	320	320
TT1PP	110	100	100	100	100	100
KTPP	220	200	200	200	200	200
TT2PP(Tema)	80	20	70	70	70	70
Anwomanso thermal (ATPS)	250	230	230	230	230	230
Karpower Barge	470	450	450	450	450	450
Asogli (SAPP(Phase 1))	200	180	180	180	180	180
Asogli (SAPP (Phase 2))	360	350	350	350	350	350
CENIT	110	100	100	100	100	100
AKSA	370	332	332	332	332	332
CENPOWER	360	350	350	350	350	350
Twin City	202	200	200	200	200	200
Takoradi Extension (VRA T3)	132		120	120	120	120
Bridge Power	200	190	190	190	190	190
GP Tarkwa (Genser)	98.55	72	72	72	72	72
Edikan (Genser)	58.05	39	39	39	39	39
Darmang (Genser)	37.5	28	28	28	28	28

Wassa (Genser)	58.05	37	37	37	37	37
Chirano (Genser)	58.05	39	39	39	39	39
GP Prestea	38.7	35	35	35	35	35
AKSA Ph 2(Anwomanso)	141	140	140	140	140	140
CENIT Ph 2(Anwomanso)	110	100	100	100	100	100
Bui Solar	50					
VRA Solar Lawra	6.5					
VRA Solar Kaleo	13					
Bui Yendi Solar	50					
Bui Solar Ph 2	170					
Embeded Generation						
VRA Solar Navrongo	2.5					
BXC Solar	20					
Meinergy Solar	20					
Total Existing Generation	**6,250**	**5,273**	**5,443**	**5,443**	**5,443**	**5,443**
Cumulative Generation Deficit (MW)		**-294**	**-504**	**-870**	**-1,278**	**-1,871**
Additional Generation Required (MW)		**294**	**210**	**366**	**408**	**593**

From the table, it can be observed that the existing generation will not be adequate to supply the projected demand (with the required 18% operating reserve) over the medium term.

For 2026, the total existing capacity (5,273 MW) will not be adequate to serve projected peak demand for the year with the required 18% operating reserve (5,567 MW). This implies that there is a generation capacity deficit which requires additional capacity of 294 MW in the year.

Generation capacity additions of 210 MW in 2027, 366 MW in 2028, 408 MW in 2029 and 593 MW in 2030 are required each year to continue to have adequate generation capacity to serve projected demand. **This implies that on average, 374 MW additional generation capacity is required each year within the medium term.**

There is the need to aggressively pursue additional generation projects in a competitive manner to make up for the deficit. We note that, there are a few on-going generation facility projects as well as some other planned generation projects whose capacity additions, if commissioned as scheduled within the medium term, will contribute to realising the required capacity additions.

6.2.2 Committed Generation Projects

The following are the committed generation facility projects expected to be completed within the medium-term:

- ✓ **VRA T3:** The plant is scheduled to undergo a major retrofit to replace the damaged engines with four (4) new ones. The project is expected to be completed in 2027. **AKSA Phase II:** A Power Purchase Agreement (PPA) has been signed for the construction of a power plant in Kumasi with an initial simple cycle capacity of 141 MW in 2025. This will be expanded into a 205 MW combined cycle plant by the addition of 64 MW steam turbine units in 2026.

6.2.3 Other Planned Generation Expansion Projects

There are some other generation projects for which, per information received, are planned for construction within the medium term. These projects are as follows:

- ✓ **Bridge Power:** The second phase of Bridge Power Plant (315 MW) is expected to be commissioned into service in September 2029, bringing the total installed capacity of the plant to 515 MW
- ✓ **KTPP Conversion to Combined Cycle:** A 110 MW steam turbine unit is planned to be installed at KTPP to convert the existing 220 MW simple cycle plant into a 330 MW combined cycle plant. The steam unit is expected to be in operation by 1st quarter, 2028.
- ✓ **AKSA Phase II:** The 205 MW AKSA phase II plant is expected to be expanded into a 350 MW combined cycle plant by 2028.
- ✓ **Rotan- 600 MW:** A PPA has been signed with ECG for the construction of a 600 MW power plant at Aboadze, 450 MW firm capacity is committed. The project is expected to be commissioned into service by 2028.
- ✓ **SAPP Solar-200 MWp:** A PPA for the construction of a 200 MWp solar plant in Northern Ghana has been signed with ECG. The first phase of 50 MWp is to be completed by the last quarter of 2025 and the second phase of 150 MWp would be commissioned in 2026.
- ✓ **CENIT (Anwomaso):** The 110 MW CENIT Simple Cycle Gas Turbine (SCGT) power plant currently under construction at Anwomaso is scheduled for commissioning in the

last quarter of 2025. The facility is planned for an expansion into a 330 MW Combined Cycle Gas Turbine (CCGT) plant by 2027. The conversion will involve the installation of an additional 110 MW gas turbine and a 110 MW steam turbine, enabling the plant to operate in combined cycle mode for improved thermal efficiency and increased output capacity.

Table 6.4: Committed and Anticipated Generation Projects

Plant	Capacity to be Installed Capacity	Dependable Capacity				
		2026	2027	2028	2029	2030
Committed Generation Projects						
AKSA Phase II Anwomanso(Steam)	64	60	60	60	60	60
Total Committed Generation	**64**	**60**	**60**	**60**	**60**	**60**
Planned Generation Projects						
KTPP (Steam)	110		100	100	100	100
CENIT (Anwomanso) Ph II	220		200	200	200	200
AKSA Ph III	150			150	150	150
Bridge Power Ph II	315				300	300
SAAP Solar	200					
Rotan	600			450	450	450
Total Planned Generation (Cumulative)	**1595**	**0**	**300**	**900**	**1200**	**1200**

6.2.4 Results: Supply Adequacy Analysis

In conclusion, the results of the supply adequacy analysis (Refer table 6.4) indicate that from 2026 onwards, the timely completion of committed and planned generation projects, as well as the initiation of new ones, will be necessary to ensure generation capacity adequacy and prevent a potential energy crisis.

6.3 Medium Term Gas Demand and Supply Balance

The section below presents the medium-term gas demand and supply analysis.

6.3.1 Projected Gas Demand for Electricity Generation

The gas demand for thermal generation is projected to grow from **631.28** Mmscfd in 2026 to **818.24** Mmscfd in 2030. A firm hydro generation of **6,650.75** GWh from Akosombo, Kpong and Bui is assumed for the gas demand projection. Renewable energy generation is projected to increase from **323.24** GWh in 2026 to **1,009.15** GWh by 2030 as shown in Table 6.5.

6.3.2 Projected Gas Supply

Information shared by GNPC indicates a firm Natural Gas supply from Jubilee, TEN and OCTP fields of 420.9 Mmscfd in 2026. This is projected to slightly decline to 411.89 Mmscfd by 2030. There is also an LNG regasification facility located in Tema which has the capacity to process up to 400 mmscfd of gas. This has not been factored in the analysis since decisions on it has not been firmed up. Table 6.5 and Table 6.6. show the gas to power supply demand balance.

Table 6.5: Demand/Supply Balance (Electricity + Gas)

Generation	2026	2027	2028	2029	2030
Projected Demand	**30,943.72**	**33,102.82**	**35,175.28**	**37,342.85**	**40,571.42**
Hydro	6,650.75	6,650.75	6,650.75	6,650.75	6,650.75
Renewable	323.24	599.18	772.63	890.89	1,009.15
Total (Hydro+Renewable)	**6,973.99**	**7,249.93**	**7,423.38**	**7,541.64**	**7,659.90**
Total Thermal (Gas Fired)	**23,969.73**	**25,852.89**	**27,751.90**	**29,801.21**	**32,911.52**
Projected Gas Demand (Mmscfd)	**631.28**	**664.43**	**697.04**	**744.22**	**818.24**
Gas Volumes (Mmscfd)					
Jubilee/TEN	176.89	171.63	176.76	168.40	167.98
OCTP/ Sankofa	171.00	171.00	171.00	171.00	171.00
N-Gas	73.00	73.00	73.00	73.00	73.00
LNG - Tema					
Total Gas Supply (Mmscfd)	**420.89**	**415.63**	**420.76**	**412.40**	**411.98**
Suplus/Deficit	**(210.39)**	**(248.80)**	**(276.28)**	**(331.82)**	**(406.26)**

Table 6.6: Demand/Supply Balance (Electricity + Gas) @ peak time

Generation	2026	2027	2028	2029	2030
Projected Demand (MW)	**4,718.00**	**5,040.00**	**5,350.00**	**5,696.00**	**6,198.00**
Hydro @Peak	**1,270.00**	**1,270.00**	**1,270.00**	**1,270.00**	**1,270.00**
Renewable @Peak					

Total (Hydro+Renewable)	1,270.00	1,270.00	1,270.00	1,270.00	1,270.00
Total Thermal (Gas Fired)	3,448.00	3,770.00	4,080.00	4,426.00	4,928.00
Projected Gas Demand (Mmscfd)@Peak	683.50	756.17	802.50	834.10	912.68
Gas Supply Volumes (Mmscfd)					
Jubilee/TEN	177	172	177	168	167.98
OCTP/ Sankofa	171	171	171	171	171
N-Gas	73	73	73	73	73
LNG - Tema					
Total Gas Supply (Mmscfd)	421	416	421	412	411.98
Suplus/Deficit	(262.61)	(340.54)	(381.74)	(421.70)	(500.70)

6.3.3 Gas Demand and Supply Balance

The projected average gas demand per day and for the peak demand period for the medium term is plotted against the projected supply as indicated by GNPC. This is presented in Figure 6.1and Figure 6.2

As shown in Figure 6.1, there would be a gas supply deficit of about 210.39 mmscfd in 2026 which increases to 406.32 mmscfd by 2030 if the supply remains constant.

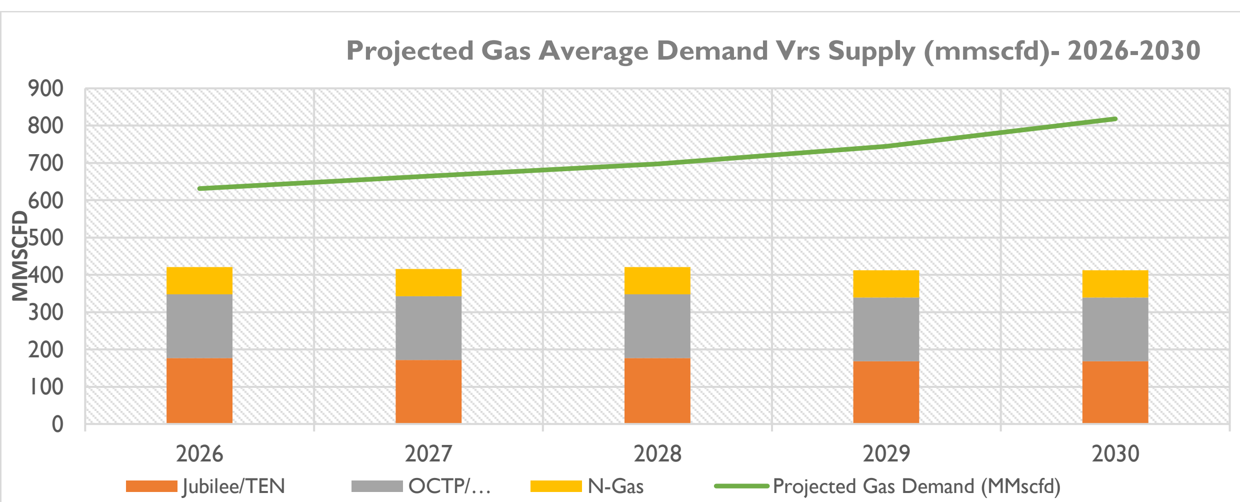


Figure 6.1: Projected Gas Demand Versus Supply balance (2026-2030)

For the peak demand periods, the deficit is 262.61 mmscfd in 2026 and this shortage increases to 500.7 MMscf by 2030 if supply remains constant. This is shown in Figure 6.2.

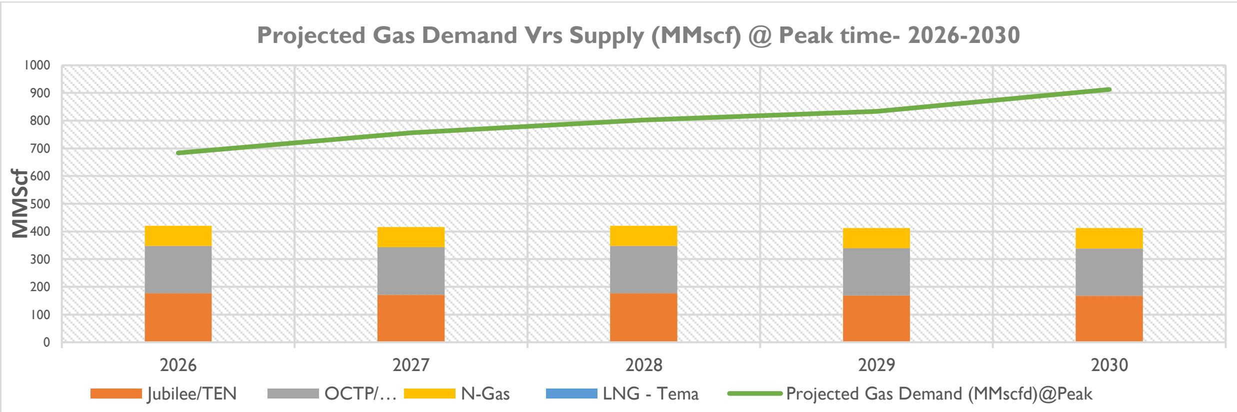


Figure 6.2: Projected Gas Demand Versus Supply balance (2026-2030) @ Peak time

6.4 Medium Term Transmission Network Upgrade Requirements

Extensive system network analyses were carried out using the projected demand and supply scenario for the medium term. Results indicate a need for intensive transmission network reinforcement works in the medium term to meet demand in an optimal and reliable manner.

The following critical transmission reinforcement projects are required to ensure power supply reliability in the medium term:

a) 2nd 330kV Circuit Awodua – Dunkwa - Kumasi to increase power transfer from the West towards Kumasi. It will improve the reliability of the NITS.

b) Upgrade of 161 kV Aboadze – Cape Coast – Mallam Line- to help evacuate additional power from the Takoradi Thermal generation enclave.

c) 330 kV Adubiyili – Bimbila (part of WAPP Median transmission line) to provide reliable power supply to parts of the Northern, Savannah and Oti Regions.

d) 330 kV Pokuase – Anwomaso Transmission Line- to create a 330 kV ring connecting Accra, Takoradi and Kumasi.

e) 2nd Circuit 330kV Adubiyili – Nayagnia- Increase power transfer to Sahelian regions. Resolve poor voltages within the Nayagnia area.

f) 330kV Ghana -Cote d'Ivoire reinforcement project. A second interconnection line between Ghana and Cote d'Ivoire from Dunkwa to Bingerville (in Cote d'Ivoire) to boost economic activities between the two countries and electricity trading in the WAPP.
g) 161 kV A4BSP – Mallam Link- Improve reliability of power supply in the capital.
h) Construction of 330/225kV Prestea Substation- to replace obsolete 225kV interconnection with Cote d'Ivoire. Involves the extension of 330 kV transmission line to Prestea.
i) Increase in transformer capacity in major BSP's within the NITS to meet increasing demand.

Chapter 7

CONCLUSIONS

7 CONCLUSIONS

The following conclusions are drawn in respect of the Electricity Supply Plan for 2025:

a. 2024 System Performance Review

- The Ghana Peak load for 2024 was 3,952.0 MW which represents a 9.2% (334.0 MW) growth over the 2023 peak load of 3,618.0 MW. Similarly, energy consumed in 2024 was 25,269.3 GWh which represents a 7.3% growth over the 2023 energy consumption of 23,551.0 GWh.
- Transmission losses for 2024 was 951.3 GWh which accounted for 3.9% of the energy transmitted.
- Due to limitations on gas supply during the year, projected generation for some power plants could not be met hence the need for load management.
- Six (6) out of the ten (10) relocated Ameri plant units have been successfully commissioned and are in operation at the Anwomaso Thermal Power Station in Kumasi. Work is currently underway to commission the remaining four units, totaling 100 MW, into service.

b. 2025 Demand and Supply Outlook

- The total system peak demand in 2025 is projected to be **4,337.7** MW, representing a 9.8% growth over the 2024 peak demand of 3,952.0 MW. The projected energy consumption for 2025 is **28,338.9** GWh, representing a 12.1% growth compared to the actual consumption of 25,269.3 GWh in 2024. The increase in demand expected in 2025 is driven by:
  - ✓ the natural growth in domestic demand
  - ✓ increase in exports to SONABEL and Cote d'Ivoire
  - ✓ embedded mining loads now fully connected to the NITS
  - ✓ Newmont Ahafo North and Cardinal Namdini Mines operations
- The projected energy consumption of **28,338.9** GWh for 2025 is planned to be supplied as follows:
  - ✓ Hydro supply of 8,661 GWh representing 30.6% of the total energy supply,
  - ✓ Thermal supply of 19,394 GWh representing 68.4% of total energy supply, and

- ✓ Grid Connected RE supply of 283.7.61 GWh representing 1.0% of total energy supply.

- VALCO is expected to operate one and half pot lines within the year with a projected consumption of 850 GWh.
- Projected exports are 3,117.3 GWh for 2025.
- Projected system transmission losses in 2025 will be 1,197.0 GWh, which is 4.2% of the projected energy to be supplied.
- In 2025 there could be periods where operating reserve margin will be inadequate.
- In 2025, gas supply to fuel thermal plants will be inadequate.
- Projected gas requirement for the year is 144.97 TBtu. Based on an estimated natural gas price of USD 8.0422 /MMBtu, the projected cost of natural gas for 2025 is US$ 1.165 Billion. (i.e., a monthly average of US$ 97.08 Million).
- In order to meet the projected Ghana demand in 2025, Ghana's power system requires average gas capacity of 519 mmscfd. The available gas supply for power generation as at December 31, 2024 was 383 mmscfd. There is therefore a natural gas supply shortfall of 136 mmscfd.
- To complement the natural gas requirements, a projected 5,501,520 barrels of LCO, 162,520 MT of HFO and 147,369 MT of diesel will be required by some thermal plants.
- Bui Power Authority is expected to commission an additional 160 MWp of solar power RE plants in 2025.
- A pigging exercise (pipeline cleaning and inspection) is scheduled to be carried out from February 3- March 2, 2025. This is expected to result in significant gas shortages during the outage period.
- The GNGC has scheduled to shut down its gas processing plant at Atuabo for 15 days in August 2025. ENI has also scheduled a shutdown of its gas facility in September 2025 for maintenance and pigging exercise.
- No power import is anticipated in 2025.

c. Summary of Transmission Outlook

- Considering the 2025 projected demand of 4,337.7 MW, the NITS will experience severe challenges to reliably evacuate power to all load centers under normal and contingency conditions. The NITS has reached its limits especially in the Eastern, Northern and Western corridors.

- Over the last decade demand requirements on the NITS have doubled from near 2,000MW to over 4,000MW whereas the transmission infrastructure development has not matched up. This lag in development has eroded the reliability and robustness of the NITS to conveniently evacuate power and provide flexibility for planned outages.

- The low voltage situation in the Eastern corridor (69kV Ho – Kpeve – Kpando – Kadjebi) of the grid will further deteriorate with increased demand in the corridor. The low capacity 69 kV transmission network has reached its limit. Also, the transmission network is unable to provide adequate power supply from Yendi towards Kpandae, Bimbilla and Salaga due to very long low distribution networks in excess of 200km. In view of this situation, additional power demand requirements in the Oti and parts of the Northern & Savannah regions cannot be reliably served.

- Under normal conditions, there are low voltages in the western parts of the NITS, particularly from Dunkwa through Ayanfuri to Asawinso leading to high system losses. This is due to low-capacity transmission lines in that part of the grid.

- Voltage instability in the North of Ghana still persists with high voltages during low loading conditions and low voltages under peak situations.

- Critical contingencies which will lead to disturbance are primarily the single circuit 330kV infrastructure from Aboadze through Anwomaso to Nayagnia. A contingency on any section of the corridor results in severe overloads on adjacent 161kV transmission lines which leading to trips on the 161kV system. Also, some contingencies result in poor voltages or a brownout of nearby stations or buses leading to loss of loads. Both categories of contingencies increase transmission loss.

  The following contingencies result in severe line overloads:

  ✓ 330 kV Takoradi Thermal – Anwomaso line

  ✓ 330 kV Anwomaso – Kintampo line

- ✓ 330 kV Kintampo – Adubiyili line
- ✓ 330 kV Adubiyili - Nayagnia line
- ✓ 330 kV Asogli – B5 Plus line
- ✓ 161 kV Tarkwa – Prestea line
- ✓ 161 kV Takoradi Thermal – Tarkwa line

The following contingencies result poor bus voltages:

- ✓ 161 kV Dunkwa – Ayanfuri Line
- ✓ 161 kV Akosombo – Nkawkaw
- ✓ 161 kV Tafo – Akwatia Line

d. Medium Term Supply

- The Ghana system peak demand is projected to increase from 4,718.00 MW in 2026 to 6,198 MW in 2030. The demand is driven by rising domestic consumption, expansion of commercial and service sectors, accelerated industrialization initiatives and regional electricity exports.
- Total energy requirement for the medium term is projected to increase from 30,943.72 GWh in 2026 to 40,571.42 GWh by 2030 at a Compound Annual Growth Rate (CAGR) of approximately 7.0 %.
- Current generation capacity is inadequate to reliably meet the medium-term requirement (including 18% operating reserve margin). To ensure reliable power supply and meet projected demand, the country requires annual generation capacity additions of 294 MW in 2026, 210 MW in 2027, 366 MW in 2028, 408 MW in 2029, and 593 MW in 2030.
- An average of 374 MW additional generation capacity is required each year within the medium term.

Chapter 8

RECOMMENDATIONS

8 RECOMMENDATIONS

Based on the 2025 supply analysis and conclusions, the following recommendations are made;

a. Generation

1. Budgetary allocation be made to secure US$ 2.02 Billion to procure gas and other fuels to complement hydro and renewable resources to meet electricity demand and ensure security of supply. This is made up of:
    i. USD 1.165 Billion (USD 8.0422 per MMBtu) for a total of 144.97 TBtu, equivalent to a monthly average of USD 97.08 million.
    ii. USD 550.15 Million to procure LCO (5,501,520 barrels).
    iii. USD 98.32 Million for HFO (162,520 MT).
    iv. US$ 235.79 Million for diesel (147,369 MT).

2. Due to the projected growth in demand in 2025, it is expedient to ensure that all generation capacity addition projects such as the AKSA-2 plant, the CENIT-2 plant as well as the installation of the remaining four units at Anwomaso Thermal Power Station, all in Kumasi, are commissioned as scheduled in the third quarter of 2025.

3. There should be good coordination between power plant owners, gas suppliers and the system operator so that outages and maintenance do not impact smooth power delivery.

4. To ensure energy security and supply reliability, Ghana should procure competitively priced generation capacity. At least 350 MW of new capacity must be added annually in the medium term. Emphasis should be placed on high-efficiency thermal and renewables technologies.

b. Transmission System

5. To ensure that the grid can reliably transmit power in 2025 and in the short term, the following transmission projects needs to be expedited:
    a. 330/161 kV Dunkwa II Substation
    b. Upgrade of the 161kV Anwomaso-Kumasi transmission line
    c. Terminate the 2nd circuit 161kV J2K Konongo -Kumasi at Kumasi
    d. 161kV Mallam-Kasoa line

e. 2nd circuit 330kV Awodua-Dunkwa
f. 330/225 kV Prestea II Interconnection Substation
g. Procurement of Power Transformers
h. Repair and installation of Capacitor Banks at various substations

6. The following transmission projects are also required in the short to medium term:
   a) 2nd 330kV Circuit Awodua – Dunkwa - Kumasi
   b) Upgrade of 161 kV Aboadze – Cape Coast – Mallam Line.
   c) 330 kV Adubiyili – Bimbila (part of WAPP Median transmission line) to provide reliable power supply to parts of the Northern, Savannah and Oti Regions.
   d) 330 kV Pokuase – Anwomaso Transmission Line.
   e) 2nd Circuit 330kV Adubiyili – Nayagnia.
   f) 330kV Ghana -Cote d'Ivoire reinforcement project.
   g) 161 kV A4BSP – Mallam Link- Improve reliability of power supply in the capital.

7. Complete the transmission master plan study to present a blueprint of transmission infrastructure requirements up to year 2040.

8. Continuous operational studies and strategies to optimize power transmission and reduce losses.

9. Coordinate the study, development and deployment of renewable power plants to complement conventional power generation towards a green transition of the power system.

   a. Carry out Variable Renewable Energy integration studies
   b. Develop a Grid Renewable Control Centre.
   c. Incentivize conventional power plant owners to contribute to frequency support.

10. Industrial mine loads (Ahafo North & Namdini) are required to have their respective SVCs to provide needed dynamic voltage and reactive power support to ensure their operations does not negatively impact grid stability.

Appendix A – Forecast: Peak and Energy Demand

A1: Base Case - Peak Demand Forecast (MW): 2025 - 2034

A2: Base Case - Energy Demand Forecast (GWh) -2025 – 2034

Appendix B – Generator Planned Maintenance Schedule

- **i** **1st Quarter 2025 Schedule**
- **ii** **1st Quarter 2025 Schedule**
- **iii** **1st Quarter 2025 Schedule**
- **iv** **1st Quarter 2025 Schedule**

Appendix C – Glossary of Electrical Utility Terms

Appendix D – Grid Map

APPENDIX A - FORECAST PEAK DEMAND AND ENERGY CONSUMPTION

A1: Base Case - Projected Energy Demand [2025 – 2034]

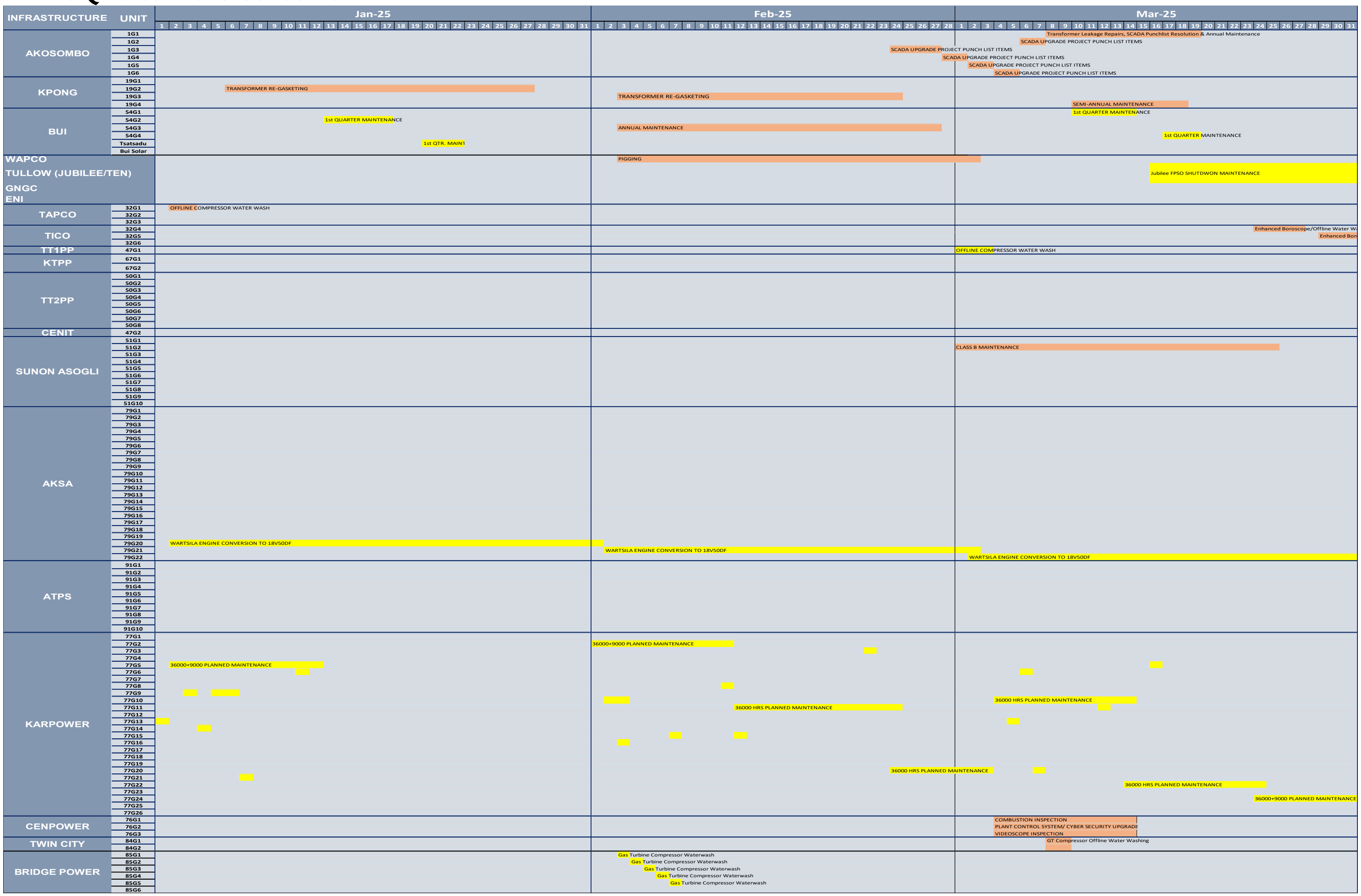
Energy (GWh)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
ECG	17,545.5	18,679.9	19,486.2	20,880.9	22,334.0	23,885.2	25,306.3	26,809.8	28,400.4	30,083.4
NEDCo	2,296.2	2,481.5	2,681.7	2,898.2	3,132.1	3,384.8	3,611.6	3,853.6	4,111.8	4,387.3
ENCLAVE POWER COMPANY	317.7	331.3	377.4	393.2	411.1	462.2	482.9	505.9	531.0	589.7
MINES	2,577.0	3,060.2	3,758.6	4,080.8	4,236.3	4,401.3	4,596.4	4,779.0	4,990.1	5,210.0
DIRECT	424.1	602.5	843.2	875.8	979.0	1,601.7	1,779.2	1,954.2	1,990.8	2,031.1
VALCO	850.0	1,265.0	1,265.0	1,265.0	1,265.0	1,265.0	1,265.0	1,265.0	1,265.0	1,265.0
CEB(Togo/Benin)	959.4	743.6	743.6	743.6	743.6	743.6	743.6	743.6	743.6	743.6
SONABEL(Burkina)	1,555.1	1,752.0	1,825.0	1,825.0	1,898.0	1,971.0	2,227.0	2,227.0	2,227.0	2,227.0
CIE (Ivory Coast)	602.7	645.1	645.1	645.1	645.1	645.1	645.1	645.1	645.1	645.1
EDM(Mali)		-	-	-	-	352.2	469.5	586.9	645.6	704.3
Network Usage	14.2	14.4	15.4	16.3	17.8	19.2	20.4	21.8	23.3	24.4
LOSSES	1,197.0	1,368.0	1,461.3	1,551.3	1,680.9	1,840.0	1,947.6	2,083.6	2,214.7	2,322.2
Total	28,338.9	30,943.5	33,102.5	35,175.2	37,342.9	40,571.3	43,094.6	45,475.5	47,788.4	50,233.1

A2: Base Case - Peak Demand Forecast [2025 – 2034]

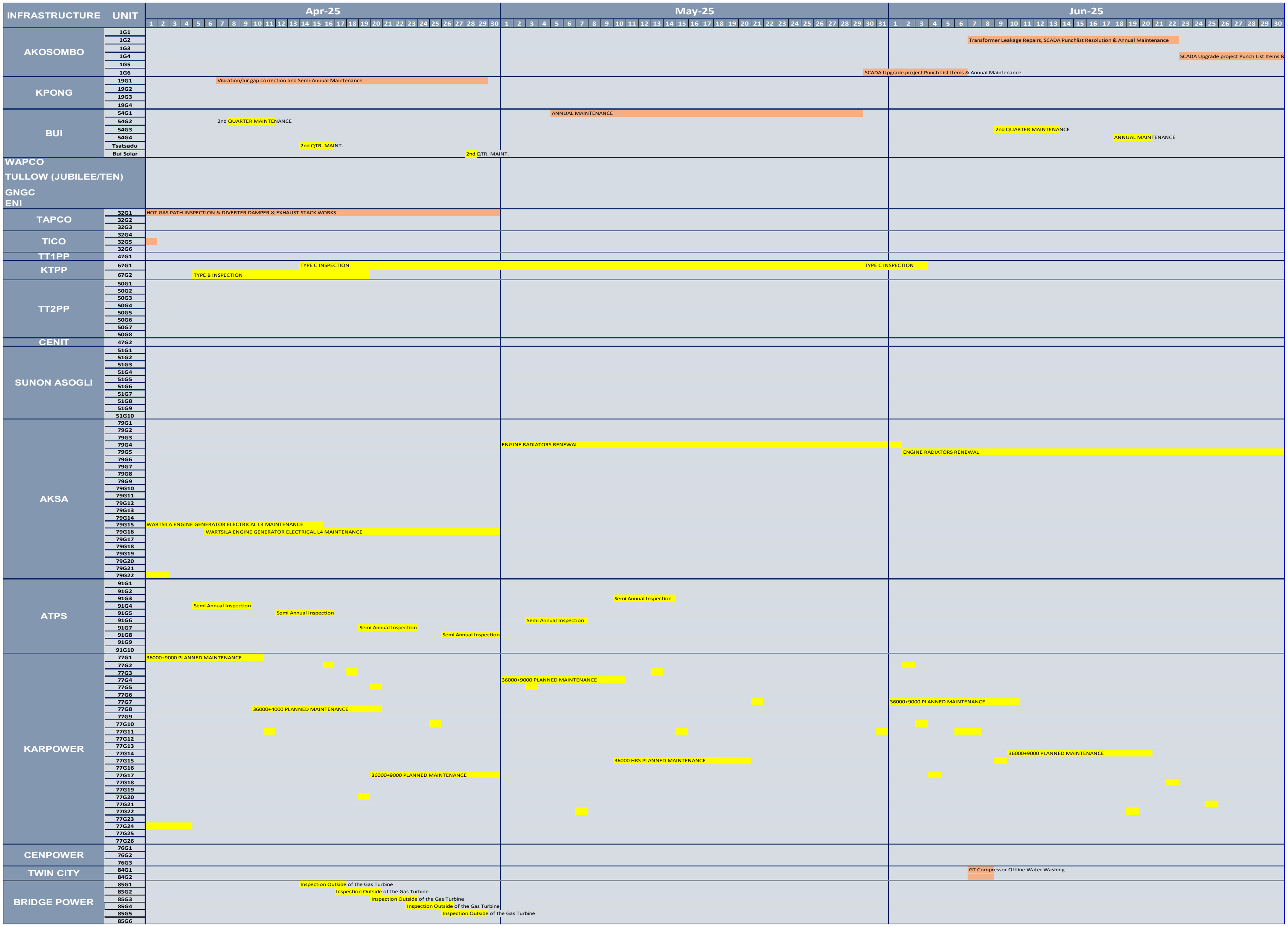
Peak demand (MW)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
ECG	2,689.70	2,862.30	2,985.80	3,199.60	3,422.20	3,659.90	3,877.60	4,108.00	4,351.80	4,609.60
NEDCo	354.5	372.3	402.3	434.8	469.9	507.8	541.9	578.2	616.9	658.2
ENCLAVE POWER COMPANY	48	50.5	57.4	59.7	62.3	69.9	72.9	76.2	79.9	88.6
MINES	386.5	396.1	487.7	528.9	567.1	589	613.9	638.6	665.2	692.8
Other Bulk Customers	82.2	110.7	154.8	160.1	175.6	276.5	310	340.2	346.5	353.5
VALCO	105.9	157	157	157	157	157	303.6	404.8	506	506
CEB(Togo/Benin)	120	150	150	150	150	150	150	150	150	150
SONABEL(Burkina)	205	240	250	250	260	270	290	290	290	290
CIE (Ivory Coast)	140	150	150	150	150	150	150	150	150	150
EDM(Mali)	-	-	-	-	-	60	80	100	110	120
Network Usage	2.4	2.1	2.3	2.4	2.6	2.8	3	3.2	3.4	3.5
LOSSES	203.3	227.5	243	258	279.5	306	323.9	346.5	368.3	386.2
Total	4,337.50	4,718.50	5,040.30	5,350.50	5,696.20	6,198.90	6,716.80	7,185.70	7,638.00	8,008.40

APPENDIX B: GENERATOR PLANNED MAINTENANCE SCHEDULE

i. 1st Quarter 2025 Schedule:

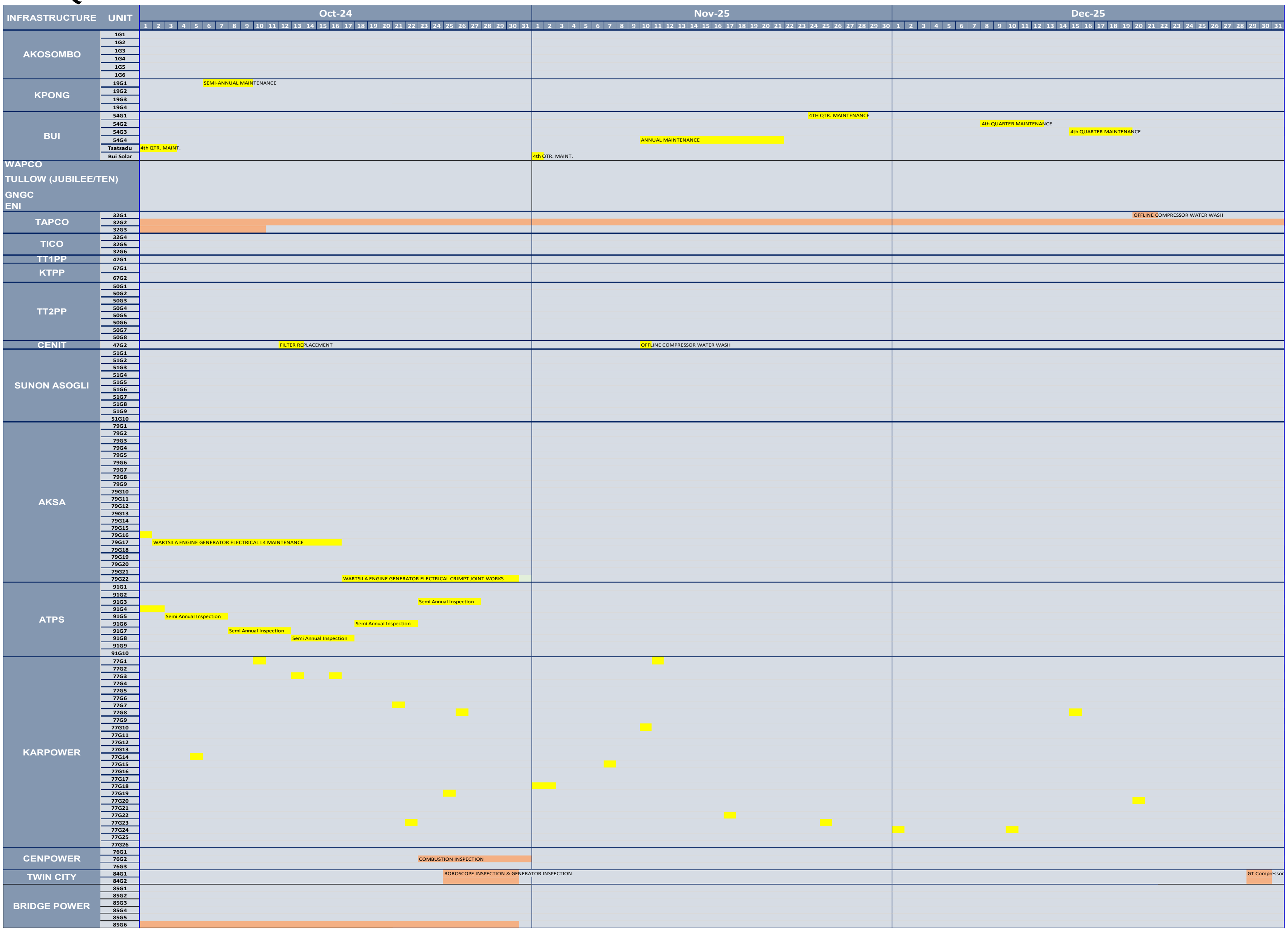


ii. 2nd Quarter 2025 Schedule:



iii. 3rd Quarter 2025 Schedule:

iv. *4th Quarter 2025 Schedule*



APPENDIX C: GLOSSARY OF ELECTRICAL UTILITY TERMS

1000 Watt-hours	=	1 Kilo Watt-hour (kWh)
1000 Kilo Watt-hour	=	1 Mega Watt-hour (MWh)
1000 Mega Watt-hour	=	1 Giga Watt-hour (GWh)
1000 Giga Watt-hour	=	1 Tera Watt-hour (TWh)

Average Day Load

The average system demand is indicative of the system's load during most parts of the day that is from 7: am – 5: pm apart from the peak load.

Capability

The maximum load a generator, piece of equipment, substation, or system can carry under specified (standardized) conditions for a given time interval without exceeding approved limits.

Capacitor

1) In a power system, installed to supply reactive power.

2) A device to store an electrical charge (usually made of two or more conductors separated by a non-conductor such as glass, paper, air, oil, or mica) that will not pass direct current and whose impedance for alternating current frequencies is inversely proportional to frequency. 3) In a power system, capacitors consist of metal-foil plates separated by paper or plastic insulation in oil or other suitable insulating fluid and sealed in metal tanks.

Capacitor bank

A grouping of capacitors used to maintain or increase voltages in power lines and to improve system efficiency by reducing inductive losses.

Capacity

The rated continuous load-carrying ability, expressed in megawatts (MW) or megavolt-amperes (MVA) of generation, transmission, or other electrical equipment.

Installed Capacity

The total of the capacities shown by the name plate ratings of similar kinds of apparatus, such as generators, transformers, or other equipment in a station or system.

Combined Cycle

An electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for utilization by a steam turbine in the production of electricity. Such designs increase the efficiency of the electric generating unit.

Conductor

A substance or body that allows an electric current to pass continuously along it.

Contingency

In a power system, the possibility of a fault or equipment failure. First contingency disturbances (outages) involve only one system element, such as a transmission line fault or a transformer failure. A second contingency disturbance would have one system element out of service and subject the system to a fault and loss of a second element.

Demand

The rate at which electric energy is delivered to or by the System or part of the System and is the sum of both Active and Reactive Power, unless otherwise stated.

Demand, Peak:

The highest electric requirement occurring in a given period (e.g., an hour, a day, month, season, or year). For an electric system, it is equal to the sum of the metered net outputs of all generators within a system and the metered line flows into the system, less the metered line flows out of the system.

Dispatch

The operating control of an integrated electric system to: (1) assign specific generating units and other sources of supply to meet the relevant area Demand taken as load rises or falls; (2) control operations and maintenance of high voltage lines, substations and equipment, including administration of safety procedures; (3) operate interconnections; (4) manage energy transactions with other interconnected Control Areas; and (5) curtail Demand.

Disturbance

An unplanned event that produces an abnormal system condition. Any occurrence that adversely affects normal power flow in a system

Fault

An event occurring on an electric system such as a short circuit, a broken wire, or an intermittent connection.

Generation (Electricity)

The process of producing electric energy from other forms of energy; also, the amount of electric energy produced, expressed in watthours (Wh).

Giga (G)

A prefix indicating a billion (1,000,000,000); 109 in scientific notation. Hence Gigawatt (GW) and Gigawatt-hour (GWh).

Grid

The transmission network (or "highway") over which electricity moves from suppliers to customers.

Grid Operator

An entity that oversees the delivery of electricity over the grid to the customer, ensuring reliability and safety.

High voltage:

Descriptive of transmission lines and electrical equipment with voltage levels from 100 kV through 287 kV.

Independent Power Producer (IPP):

A private entity that operates a generation facility and sells power to electric utilities for resale to retail customers.

Insulator:

The porcelain support used to insulate electric service wires from the pole. All electric lines require an insulator to attach the wires to the pole or to a residence.

Interconnected System

A system consisting of two or more individual electric systems that normally operate in synchronism (matching frequency, voltage, phase angles, etc.) and have connecting tie lines.

Kilowatt (kW)

One thousand watts of electricity (See Watt).

Kilo watthour (kWh):

One thousand watthours.

Load

The amount of power carried by a utility system or subsystem, or amount of power consumed by an electric device at a specified time. May also be referred to as demand. A connection point or defined set of connection points at which electrical power is delivered to a person or to another network or the amount of electrical power delivered at a defined instant at a connection point or aggregated over a defined set of connection points.

Load Centers

A geographical area where large amounts of power are drawn by end-users.

Losses

Electric energy losses in the electric system which occur principally as energy transformation from kilowatt-hours (kWh) to waste heat in electrical conductors and apparatus.

Maximum Demand:

The highest amount of electrical power delivered, or forecast to be delivered, over a defined period (day, week, month, season, or year) at a defined.

Megawatt (MW)

One million watts of electricity (See Watt).

masl

Metres above sea level

Overload

Operation of equipment in excess of its normal, full load rating or operation of a conductor in excess of ampacity, and if continued for a sufficient length of time, would cause damage or overheating.

System Planning

The process by which the performance of the electric system is evaluated and future changes and additions to the bulk electric systems are determined.

Power System

The electricity power system of the national grid including associated generation and transmission and distribution networks for the supply of electricity, operated as an integrated arrangement.

Reactive Power

Means the product of voltage and current and the sine of the phase angle between them measured in units of volt-amperes reactive and standard multiples thereof. Reactive power is a necessary component of alternating current electricity which is separate from active power and is predominantly consumed in the creation of magnetic fields in motors and transformers and produced by plant such as: (a) alternating current generators (b) capacitors, including the capacitive effect of parallel transmission wires;(c) synchronous condensers.

Reliability

The degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired. It is a measure of the ability of a power system to provide uninterrupted service, even while that system is under stress. Reliability may be measured by the frequency, duration, and magnitude of adverse effects on the electric supply. Electric system reliability has two components -- adequacy and security.

Adequacy is the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.

Security is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system facilities.

Single Contingency

The sudden, unexpected failure or outage of a system facility(s) or element(s) (generating unit, transmission line, transformer, etc.). Elements removed from service as part of the operation of a remedial action scheme are considered part of a single contingency.

Stability

The ability of an electric system to maintain a state of equilibrium during normal and abnormal system conditions or disturbances.

Supervisory Control and Data Acquisition (SCADA)

A computer system that allows an electric system operator to remotely monitor and control elements of an electric system.

Switching Station

An installation of equipment where several transmission lines are interconnected. Does not include equipment for transforming voltage levels.

Power System

An interconnected combination of generation, transmission, and distribution components comprising an electric utility, an electric utility and independent power producer(s) (IPP), or group of utilities and IPP(s).

Right of Way (ROW)

A corridor of land on which electric lines may be located. The Transmission Owner may own the land in fee, own an easement, or have certain franchise, prescription, or license rights to construct and maintain lines.

Thermal Limit

The maximum amount of electrical current that a transmission line or electrical facility can conduct over a specified time period before it sustains permanent damage by overheating or before it violates public safety requirements.

Transfer Capability

The amount of power, usually the maximum amount, that can be transmitted between one system and another; power flow and stability studies determine transfer capability under various outage, system loading, and system operating conditions.

Transformer

A device for transferring electrical energy from one circuit to another by magnetic induction, usually between circuits of different voltages. Consists of a magnetic core on which there are two or more windings. In power systems, they are most frequently used for changing voltage levels.

Transmission System (Electric)

An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers or is delivered to other electric systems.

Utility

A public or private organization created for the purpose of selling or supplying for general public use water, electric energy, telephone service, or other items or services.

Voltage

The electronic force or electric potential between two points that gives rise to the flow of electricity.

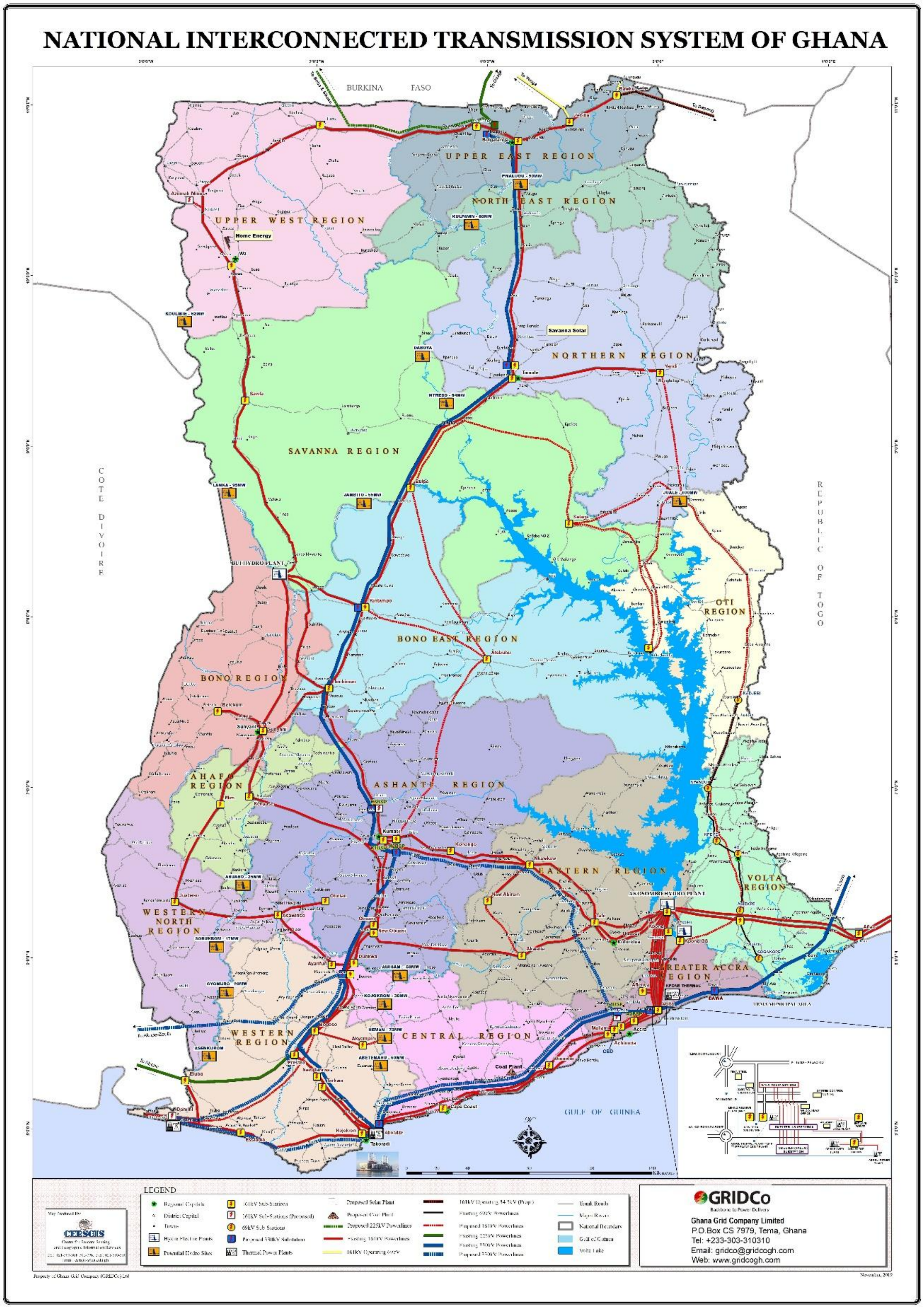
Voltage Stability

The condition of an electric system in which the sustained voltage level is controllable and within predetermined limits.

Wheeling

The use of the facilities of one transmission system to transmit power and energy from one power system to another.

APPENDIX D – GRID MAP


NATIONAL INTERCONNECTED TRANSMISSION SYSTEM OF GHANA
BURKINA FASO
UPPER EAST REGION
NORTH EAST REGION
UPPER WEST REGION
NORTHERN REGION
SAVANNA REGION
COTE D'IVOIRE
REPUBLIC OF TOGO
OTI REGION
BONO EAST REGION
BONO REGION
AHAFO REGION
ASHANTI REGION
EASTERN REGION
VOLTA REGION
WESTERN NORTH REGION
GREATER ACCRA REGION
WESTERN REGION
CENTRAL REGION
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