# 2020 Electricity Supply Plan

for the Ghana Power System

**a mid-year review**

a review of the power supply outlook for 2020

## ACKNOWLEDGEMENT

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| | | |
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## EXECUTIVE SUMMARY

The mid-year review of the 2020 ESP presents a review of the Ghana power system performance in the first half of 2020 (January to June), demand projections and the power supply outlook for the second half of 2020 (July to December 2020).

It assesses available hydro generation capacities, taking into consideration reservoir elevations at Akosombo and Bui at the beginning of the year and hydro allocation by the EMOP. Additionally, it presents fuel requirements for thermal generation and associated costs required to supply the projected electricity demand for the remaining half of the year, making and evaluating the associated evacuation requirements to ensure reliable power supply.

The half year review further highlights potential challenges to electricity service delivery in Ghana in the second half of the year and makes recommendations for actions necessary to be taken to mitigate the potential challenges and ensure reliable power supply.

### Review of Performance for January to June 2020

#### Peak and Energy Demand

The projected peak load for the first half of 2020 was 3,083 MW. The system however, recorded a maximum coincident load of 2,957 MW on March 19, 2020 126 MW (4.1%) lower than forecasted. The reduction is mainly attributed to reduced demand from VALCO whose load was only 83 MW due to challenges at the smelter, instead of the projected 150 MW.

The peak domestic load recorded within the period was 2,696 MW which occurred on May 7, 2020. This represents a 10% (246 MW) growth over the 2019 domestic peak load of 2450 MW over the same period.

The total energy consumed, including losses, was 9,919.12 GWh as against the projected total energy consumption of 9,844.49 GWh. The actual energy consumed was higher than the projected by 74.62 GWh (0.76%). This could be attributed to increased consumption motivated by the announcement of the electricity relief package by the Government of Ghana.

#### Energy Supply

A total of 9,919 GWh was generated from hydro (3794 GWh), thermal (6095 GWh) and import (30 GWh) in the first half of 2020. Hydro, thermal and import contributed 38.3%, 61.4% and 0.3% respectively. A total of 208 GWh and 738 GWh were exported to CEB and Burkina Faso respectively

during the period. A net of 106 GWh was also exchanged between Ghana and Cote d'Ivoire. This was made up of 30 GWh imports and 77 GWh exports.

### Transmission Losses

The total system transmission loss recorded in the first half of 2020 was 298 GWh which is 4.5% of total energy transmitted (6,602 GWh) representing a 2.7% increase over the projected transmission loss of 217.13 GWh.

### Transmission Lines and Feeder Availability

The System Average Availability (SAA) for the NITS was 99.75% whereas the System Average Availability (SAA) for the same period in 2019 was 99.44%.

## Demand Outlook for 2020

The Projected Coincident Peak demand for Ghana has been reviewed downwards to 3,061 MW from an initial projection of 3,115 MW (2020 ESP).

Due to the government's electricity relief measures, has motivated a high demand growth despite low GDP forecasts. The projected energy consumption has therefore been reviewed upwards to 19,684.73 GWh, from 19,594.44 GWh.

## 2020 Reviewed Supply Outlook

### Hydro Power Generation for 2020

The total projected hydro generation for 2020 is 7,381.1 GWh. This is made up of 5,142.5 GWh, 857.5 GWh and 1,386.5 GWh from Akosombo, Kpong and Bui Generating Stations respectively.

### Akosombo Hydro Elevation

The lake elevation at the end of the first half of the year was 257.49 feet, which is 5.28 feet higher than the level at the same time in 2019 (252.21 feet). Depending on inflows this year, it is expected to have adequate headwater for operating the plant for the next half year.

### Bui Hydro Elevation

With a year-start elevation of 176.97 MASL in 2020, Bui Hydro elevation ended the first half of the year at 171.04 m, which is 3.04 m above the Minimum Operating Level. This is higher than the elevation at the end of June 2019 (168.8 m).

### Thermal Power Generation for 2020

The Projected Dependable Thermal Capacity for the 2nd half-year is 3,342 MW. This is made up of 3,008 MW existing sources and 144 MW additional capacity from Early Power Plant which is currently

being commissioned and 190 MW from Amandi which is expected to declare commercial operation by August, 2020. The reviewed projected total thermal energy generation for 2020 is 12,264.5 GWh.

### Renewable Energy (RE) Generation for 2020

The total RE generation capacity installed in Ghana as at end of June 2020 is 42.6 MWp. This is made up of 2.5 MWp VRA Solar (Navrongo), 20.0 MWp BXC Solar (Winneba), 20.0 MWp Meinergy Solar (near Saltpond) and 0.1 MW Safisana (W2E plant in Ashaiman).

In addition, a 6 MWp (out of 17 MWp VRA Kaleo and Lawra Solar Power Plants) is expected to come online in the 2nd half of the year. Also, 10 MWp of Bui's solar RE project is scheduled to be commissioned by September 2020, while a second phase of 40 MWp is expected to be commissioned by the end of December 2020.

The projected solar RE energy generation is 33.8 GWh.

### Imports

In 2020, no programmed electrical power import is expected. However, 29.6 GWh was arranged for short term contingencies within the first half year. No import is programmed for the second half of the year.

| Plants | Installed Capacity (MW) | Dependable Capacity (MW) | Capacity @ Peak (MW) | Fuel Type |
|---|---|---|---|---|
| Akosombo GS | 1020 | 900 | 900 | Hydro |
| Kpong GS | 160 | 140 | 140 | Hydro |
| TAPCO (T1) | 330 | 300 | 300 | LCO/Gas |
| TICO (T2) | 340 | 320 | 320 | LCO/Gas |
| TT1PP | 110 | 100 | 100 | LCO/Gas |
| TT2PP | 87 | 70 | 70 | Gas |
| KTPP | 220 | 200 | 200 | Gas/ Diesel |
| VRA Solar Plant | 2.5 | 1.75 | 0 | Solar |
| AMERI | 250 | 230 | 230 | Gas |
| Bui GS | 404 | 360 | 360 | Hydro |
| CENIT | 110 | 100 | 100 | LCO/Gas |
| SAPP 161 | 200 | 180 | 180 | Gas |
| SAPP 330 | 360 | 340 | 340 | LCO/Gas |
| KAR Power | 470 | 450 | 450 | Gas |
| AKSA | 370 | 350 | 350 | HFO |
| BXC Solar | 20 | 14 | 0 | Solar |
| Meinergy Solar | 20 | 14 | 0 | Solar |

| | | | | |
|---|---|---|---|---|
| Trojan | 44 | 39.6 | 39.6 | Diesel/Gas |
| Genser | 89.5 | 18 | 18 | Gas |
| CEN Power | 340 | 340 | 340 | LCO/Gas |
| Amandi | 190 | 190 | 190 | LCO/Gas |
| **TOTAL** | **5,137.0** | **4657.35** | **4627.6** | |

Existing and Committed generation capacity for 2020

## Fuel Availabilities

Two main supplies of natural gas were considered as follows:

**Nigeria Gas** – Average supply of 70 mmscf/day is assumed from July to December 2020,

**Ghana Gas** – Average daily supply in the second half of 2020 is shown below:

- ✓ Jubilee and TEN Fields- an average of 125 mmscf/day in 2020;
- ✓ OCTP/Sankofa Fields –an average of 210 mmscf/day in 2020;

To improve gas supply reliability, GNPC has entered into a substitution agreement with the Jubilee and TEN partners to enable seamless substitution of gas supply between the two fields to meet daily requirements.

The Tema LNG project is expected to be completed by the end of 2020.

## Fuel Volumes and Cost

Based on the projected generation, the total projected natural gas consumption for the period July to December 2020 is 55.425 Million MMbtu.

There would be no significant requirement for LCO for the rest of the year 2020. This is due to anticipated high volumes of gas from Sankofa, Jubilee and TEN fields and adequate stocks of LCO at Takoradi to date.

The total estimated fuel cost is therefore US$ 336.99 million. This translates into an approximate monthly average of US$ 56.17 million.

## National Interconnected Transmission System

The total circuit length of National Interconnected Transmission System (NITS) from the beginning of 2020 is 6,472.23 km with a total transformation capacity of 8,959.6 MVA with some 65 Bulk Supply Points.

The NITS is capable of evacuating all the power that is projected to be generated from all generating enclaves to the major load centres. Nevertheless, a study conducted in the second quarter of the year revealed low voltages especially in the Southern parts of the country.

The low voltages experienced on are primarily caused by congestion in some transmission corridors, inadequate reactive power compensation at some nodes and poor customer end power factor.

Congestion was found on the Anwomaso-Kumasi, Volta-Achimota-Mallam, Aboadze-Prestea-Dunkwa and Dunkwa-Ayanfuri-Asawinso 161kV corridors. Also, the 40MVAr Statcom at Tamale remains out of service due to a fault, so there is no dynamic voltage regulation in the North.

Overall system losses are at 150.89 MW constituting 5.28% of total power generated due to low voltages on the NITS. Studies further show that upon completion of the ongoing transmission projects (ie., the new 330 kV Kumasi – Kintampo line and 161 kV Volta – Achimota - Mallam upgrade) congestion is removed, thereby reducing losses significantly by 37.3%.

## Distribution Outlook in 2020

### ECG Network

Based on sub-transmission reliability studies undertaken by ECG, a number of interventions and projects were initiated in 2019 and are expected to be completed in 2020 to resolve various constraints of low voltages, feeder and transformer overloads during firm and non-firm conditions. Some of the key projects completed are:

- ✓ Reconstruction of the Inchaban, Daboase and Awaso substations;
- ✓ Expansion of the Weija, Tokuse and Winneba Outdoor Substations;
- ✓ Construction of critical 33kV sub-transmission circuit from Diamond Cement to Agona Nkwanta;
- ✓ Provision of a dedicated 33kV circuit from the ECG Takoradi Harbour substation to the on-dock container terminal Takoradi Port;
- ✓ Reinforcement and upgrade of existing 33kV double circuit tower lines in Accra; and
- ✓ 33kV board replacement & expansion work at the Accra Ridge substation and construction of an indoor substation at Agbogba.

The completion of these projects is expected to improve supply reliability to the various ECG customers.

Electricity distribution losses for the quarter was 26.63%, about 3.43% higher than the regulatory benchmark of 23.2%. Technical loss was about 10% whilst commercial loss was 16.63%.

# CONCLUSION

## Demand and Supply Outlook

a) The Projected Coincident Peak demand for Ghana has been reviewed downwards to 3,061 MW from an initial projection of 3,115 MW.

b) The Electricity relief package is influencing high energy consumption. The projected energy consumption has therefore been reviewed upwards to 19,684.73 GWh, from 19,594.44 GWh.

c) The Supply Outlook is as follows:
   - ✓ Hydro supply will be 7,386.5 GWh representing 37.3% of the total energy supply;
   - ✓ Thermal supply will be 12,264.5 GWh representing 62.5% of total energy supply; and
   - ✓ Renewables supply will be 33.8 GWh representing 0.2% of total energy supply

d) Total projected energy exports are 1,864 GWh for 2020.

e) VALCO is expected to continue operating on one pot-line with a projected total consumption of 702 GWh.

f) In terms of fuel, the following quantities of the various fuel types are required for the 2nd half of the year:
   - ✓ Natural Gas - 55.43 million MMBtu
   - ✓ HFO - 0 barrels

g) Annual total fuel cost of **USD 336.99** million is required, averaging a monthly total of some **USD 56.17** million.

h) When generating at maximum capacity from the western enclave, the autotransformers at Volta will become overloaded with low voltages in the East (Accra/Tema Area).

## Requirements for Grid Reinforcement

a) The transmission system has some constraints. This situation sometimes results in low voltages, overloading of lines and increased overall transmission system losses.

b) Losses will be reduced upon:
   - ✓ Completion of 161kV Anwomaso-Kumasi, 161kV Volta-Achimota-Mallam 161kV Aboadze-Prestea-Dunkwa and 161kV Dunkwa-Ayanfuri-Asawinso transmission corridors.
   - ✓ Repair and restoration of the capacitor banks will reduce overall system losses.

   In absolute terms completing the ongoing transmission projects and restoration of capacitor banks will save 62.53 MW losses at peak.

c) For radial lines and single transformer stations, significant percentage of network loads could be islanded in the event of outage of such lines and transformers.

d) In normal operation, there would be congestion on the Volta–Accra East–Achimota–Mallam transmission corridor, especially when there is high generation in the east.

e) Low voltages could be experienced at Kumasi, Accra and surrounding areas due to poor customer-end power factors.

f) A fair East-West balance in generation provides better system stability and minimal overall transmission system losses.

### Distribution Systems

a) The commissioning of the Accra Central BSP has increased the level of reliability and distribution capacity to meet the growing demand within the ECG network in Accra. This has resolved the loading constraints on selected 33 kV feeders and reduce technical losses within the ECG Accra network.

b) In a bid to improve voltages in Nsawam and Aburi, ECG has installed a number of Voltage Regulators to improve on reliability and quality of supply. Furthermore, a number of upgrade projects have either been commissioned into service or under construction. This is to increase distribution capacity and reliability of supply customers.

c) Electricity distribution losses for the quarter was 26.63%, about 3.43% higher than the regulatory benchmark of 23.2%. Technical loss was about 10% whilst commercial loss was 16.63%.

## RECOMMENDATIONS

Based on the above conclusions, the following recommendations are made:

a) Fuel supply security and adequacy remains the single most important risk to power supply reliability in Ghana. In this vein, it is strongly recommended that all the relevant sector agencies and stakeholders work conscientiously together to ensure that fuel supply is adequate, secure and low cost at all times.

b) The following ongoing transmission expansion projects:

- ✓ Volta – Achimota – Mallam Transmission Line Upgrade Project
- ✓ Kumasi – Kintampo 330 kV transmission line Project;

should be expedited and completed in 2020 to ensure adequacy of evacuation capacity.

c) In order to meet the transmission reliability benchmarks, the following are the critical transmissions additions and upgrades required in the medium term:
   - ✓ Upgrade of 161kV Aboadze – Takoradi – Tarkwa – Prestea circuit;
   - ✓ Construction of a second 330 kV Prestea – Dunkwa – Kumasi circuit;
   - ✓ Upgrade of 161kV Aboadze – Mallam transmission lines;
   - ✓ 161 kV Mallam – A4BSP transmission line;
   - ✓ Construction of a second 330 kV Aboadze – A4 BSP circuit
   - ✓ Construction of a double circuit 330 kV line from A4BSP to Kumasi
   - ✓ Break-into the 330 kV Takoradi Thermal – Anwomaso line at Dunkwa with a link to the existing 161 kV substation.

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## ABBREVIATIONS

| | |
|---|---|
| BSP | Bulk Supply Points |
| CEB | Communauté Electrique du Bénin |
| CIE | Compagnie Ivoirienne d' Electricité |
| COVID-19 | Corona Virus Disease |
| ECG | Electricity Company of Ghana |
| EDM | Énergie du Mali |
| EMOP | Electricity Market Oversight Panel |
| EPC | Enclave Power Company |
| ESP | Electricity Supply Plan |
| FPSO | Floating Production Storage Offloading |
| GDP | Gross Domestic Product |
| GNGC | Ghana National Gas Company |
| GNPC | Ghana National Petroleum Company |
| GPP | Gas Processing Plant |
| GRIDCo | Ghana Grid Company |
| GS | Generation Station |
| GWh | Gigawatthour |
| HFO | Heavy Fuel Oil |
| HV | High Voltage |
| IMF | International Monetary Fund |
| IPPs | Independent Power Plants |
| KTPP | Kpone Thermal Power Plant |
| kV | Kilovolt |
| LCO | Light Crude Oil |
| LNG | Liquefied Natural Gas |
| LPG | Liquefied Petroleum Gas |
| LV | Low Voltage |
| MMBtu | Million British Thermal Unit |
| MMscfd | Million standard cubic feet day |
| MVA | Megavolt ampere |

| | |
|---|---|
| MVAr | Megavolt ampere of reactive power |
| MW | Megawatt |
| MWp | Megawatt peak |
| NEDCo | Northern Electricity Company |
| NG | Natural Gas |
| NITS | National Interconnected Transmission System |
| OCTP | Offshore Cape Three Point |
| PURC | Public Utility Regulatory Commission |
| SAPP | Sunon Asogli Power Plant |
| SVC | Static VAR Compensator |
| TAPCO | Takoradi Thermal Power Company |
| TEN | Tweneboa, Enyenra, Ntomme fields |
| TICO | Takoradi International Company |
| TT1PP | Tema Thermal Power Plant 1 |
| TT2PP | Tema Thermal Power Plant 2 |
| TTIP | Takoradi-Tema Interconnected Project |
| TUF | Transformer Utilization Factor |
| USD | United State Dollars |
| VALCO | Volta Aluminum Company Limited |
| VRA | Volta River Authority |
| WAGP | West African Gas Pipeline |
| WAGPCO | West African Gas Pipeline Company |

# 1 INTRODUCTION

The 2020 Electricity Supply Plan (ESP) released at the beginning of the year presented an outlook of electricity demand and supply on the Ghana power system for the year 2020, basing on assumptions for demand, projected available generation resources and transmission infrastructure.

In accordance with prudent practice, we present per this report a mid-year review of the 2020 Electricity Supply Plan. It presents an assessment of the power system performance in the first half of the year including an analysis of the year-to-date hydrology at the Akosombo and Bui dams. It also considers thermal generation and fuel usage.

It then makes projections for the rest of 2020 making adjustments to assumptions in the 2020 ESP where necessary. Projections for system demand and the generation outlook are accordingly reviewed.

Additionally, the Supply Plan takes a look at the NITS analysing its resilience and ability to supply the projected Ghana demand in 2020.

# 2 SYSTEM PERFORMANCE REVIEW FOR THE FIRST HALF OF 2020

## 2.1 Objective

The mid-year review of the 2020 Electricity Supply Plan analyses the power system performance for the period January 1 – June 30, 2020. It compares the projected peak demand, energy consumption and the corresponding generation scenario against the actual figures recorded. Further analysis is carried out on system voltages and transmission system losses.

## 2.2 Major Events that affected Electricity Service Delivery

### 2.2.1 The Impact of the WAGP Intelligent Pigging Operation

The West African Gas Pipeline Company (WAPCO) carried out a mandatory intelligent pigging operation on the offshore segment of the West African Gas Pipeline (WAGP) starting January 20, 2020. This was both a regulatory requirement and a pipeline integrity assessment process to assure continued transportation of natural gas to offtakers in the sub-region in a safe and reliable manner. It involved the launch of five (5) pigs in all from Itoki to Takoradi.

Taking advantage of the outage at the Tema metering skid for the Pigging exercise, work was carried out concurrently to upgrade the WAPCo Metering Skid in Tema, increasing its capacity from 140 mmscf to 235 mmscf. This was part of work under the Takoradi-Tema Interconnection Project to enable the reverse-flow of domestic gas via the WAGP from Takoradi to Tema for use to augment supply from Nigeria.

The operation interrupted gas supply for thermal power generation in Tema over the period. Consequently, the Sunon Asogli Power Plant (560 MW), CENIT Plant (100 MW), and VRAs TT1PP (100 MW) and TT2PP (70 MW) became inoperable over the period. VRAs Kpone Thermal Power Plant (220 MW) also became inoperable on gas, but switched fuel to run on DFO over the period.

Unfortunately, the TICO gas turbine unit no. 1 (110 MW), their steam unit (120 MW) as well as Bui unit no. 1 (110 MW) which had been planned to be in operation over the period became faulted and unavailable over the period. The Cenpower Plant, which was also planned to run on LCO at 360MW capacity over the period could only generate at 180 MW due to LCO fuel challenges. Also, HFO fuel supply to AKSA was not regular therefore AKSA generation during the period was lower than planned.

The unavailability of these plants resulted in some periods of generation inadequacy requiring some load management. There were also periods where load management was required to manage very low voltages caused mainly by the low levels of generation in Tema.

Notwithstanding, the pigging operation was completed ahead of schedule and gas supply to thermal plants in Tema resumed on Thursday, March 5, 2020.

### 2.2.2 The Impact of the COVID-19 Pandemic

Worldwide, the Corona Virus Disease (COVID-19) pandemic has brought about disruptions in economies as a result of restrictions and containment measures taken to manage it. Consequently, it has affected activities in the transport, industrial and service sectors etc., such that most of their operations have slowed down or grounded to a halt.

In Ghana some of the measures put in place to mitigate the spread of the pandemic included the closure of all educational institutions in the country on March 16, 2020. People were advised to as much as possible stay at home. In addition, a partial lockdown was imposed on the Greater Accra Metropolitan Area, Greater Kumasi Metropolitan Area and Kasoa in the Central Region from March 30 to April 20 2020 with restriction on the movement of people. During this period, only essential services such as hospitals and the food chain sectors were allowed to operate.

It resulted in the slowdown of some industrial and service sector activities as people stayed at home. As most of these sectors rely on the use of electricity for their operations there was a consequential reduction in electricity demand from these sectors especially during the lockdown period.

An analysis was conducted by comparing data on the daily domestic[1] peak load trends for the periods January 01 to May 19 in 2018, 2019 and 2020.

The trend analysis showed that, over the period January to May in 2020, there was an overall growth of approximately 8% in load over same period in 2019. Load in 2019 increased by 9% over that of 2018 for the period under consideration, while 2020 witnessed an increase of 10% over 2019 for the same period. It therefore suggests that COVID_19 did not affect load much as there has not been any significant change in the load trend for the period January to May in 2020.

Figure 2.1 illustrates domestic peak load trends in 2018, 2019 and 2020 for the periods January 01 to May 19.

[1] 'Domestic load' refers to total System load in Ghana less Exports and VALCO.

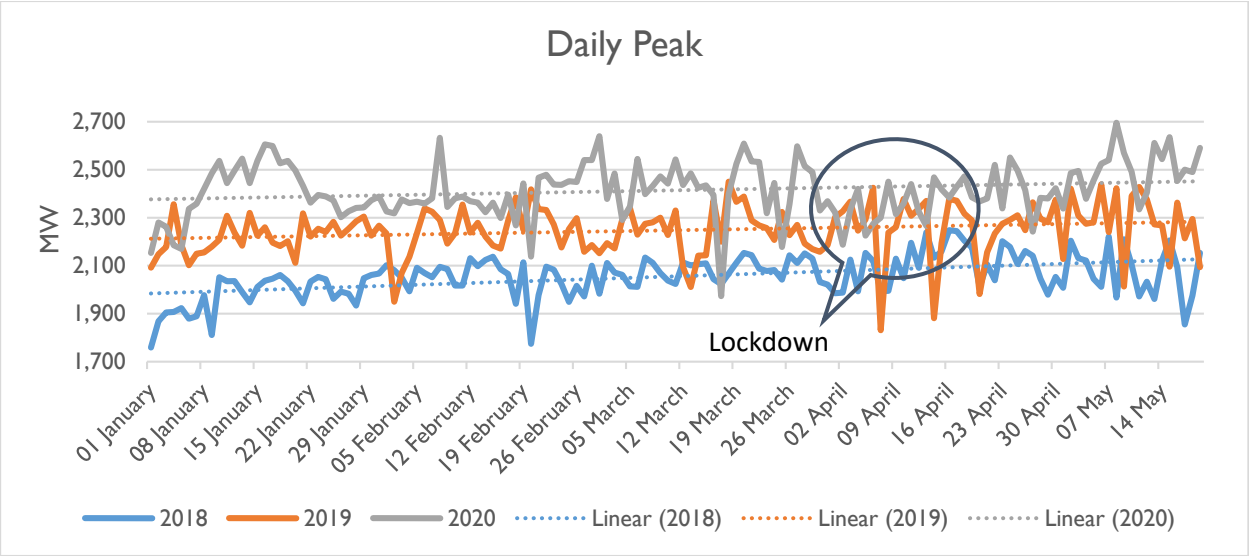


*Figure 2.1 Daily domestic peak demand January 1 – May 19 for 2018, 2019 and 2020*

A similar analysis for the shorter period of the lockdown (ie., March 30 to April 20) shows that in 2019, there was an 8% increase in the peak load over that for the same period in 2018. However, for the same period in 2020, the demand increased marginally (only 2%) compared to the same period in 2019.

Further analysis carried out showed that the total energy generated in the lockdown period was 1,061.91 GWh, which represents a marginal 4.9% growth over 2019 generation for the same period. However, the electricity generated during the same period in 2019 was 7.4% higher than that of 2018.

These analyses show that during the period of the lockdown there was stunted growth in load. The stunted growth in load during the lockdown period is attributed to reduced activities in the industrial and service sectors due to the COVID-19 pandemic.

The projected versus actual energy consumed over the period, as illustrated in Figure 2.2 shows that actual consumption tipped below the projected only within the period of the lockdown.

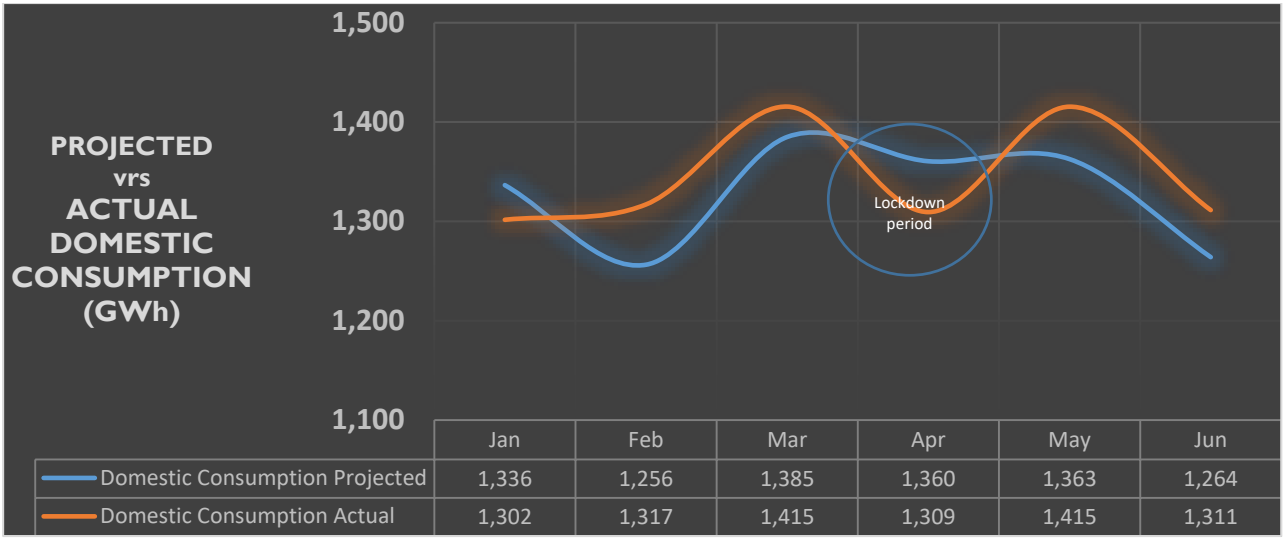


*Figure 2.2 Projected vrs. Actual Domestic Energy Consumption in 1st half of 2020*

Interestingly, the reduction in electricity generation observed from the commencement of the lockdown seems to have recovered fast soon after the lifting of the lockdown. This could partly be because of the electricity relief as announced by the government on April 11, 2020 and the easing of restrictions.

As the COVID-19 related restrictions are gradually being eased and economic activities are steadily returning to normalcy, electricity consumption pattern is not expected to be affected significantly by the COVID-19 pandemic. Furthermore, due to the fact that the country's annual peak load usually occurs in the last quarter, it is projected that the 2020 peak load will not be affected by the COVID-19 pandemic.

### 2.3 Peak Load

The projected peak load for the first half of 2020 was 3,083 MW. The system, however, recorded a maximum coincident load of 2,957 MW on March 19, 2020, which is 126 MW (4.1%) lower than the forecasted peak load for the first half of 2020. The deviation from the projected peak load could be attributed primarily to VALCO whose load was 83 MW instead of 150 MW as projected. Additionally, power exports to Burkina and CEB at the time the peak occurred was low at 265 MW compared to the projected 330 MW.

The peak load recorded also represents a 9.8% (266.8 MW) growth over the 2019 peak load of 2,691.6 MW. The summary of projected and actual peak load as recorded over the period is shown in Table 2.1:

Table 2.1 System Peak Demand for 1st half of 2020 and Projection

| Load Type | System Peak(MW) | System Peak (MW) | Difference (MW) |
|---|---|---|---|

| | Projection 1st half 2020 | Actual 1st half 2020 | (Projection - Actual) |
|---|---|---|---|
| Domestic Peak | 2,623 | 2,609.00 | 125 |
| Export (CEB+ SONABEL) | 330 | 265 | 65 |
| VALCO | 140 | 83 | -13 |
| System Peak (coincident) | 3,093 | 2,957.00 | 107.18 |

Table 2.2 and Figure 2.3 on the other hand compare monthly peak load for the first half years of 2019 and 2020.

Table 2.2: Comparison of Monthly Peak Load for 1st half of 2019 and 2020

| Month | Projected Demand(MW) | Actual Demand (MW) | | Difference |
|---|---|---|---|---|
| | Base case | System | Domestic | ( Projected - System) |
| Jan-20 | 2,908.3 | 2,900.0 | 2606.0 | (8.3) |
| Feb-20 | 2,976.0 | 2,893.0 | 2640.0 | (83) |
| Mar-20 | 3,053.6 | 2,957.0 | 2609.0 | (96.6) |
| Apr-20 | 3,082.6 | 2,825.0 | 2,551.0 | (257.6) |
| May-20 | 3,043.7 | 2,781.0 | 2,439.0 | (262.7) |
| Jun-20 | 3,019.5 | 2,870.0 | 2,584.0 | (149.5) |

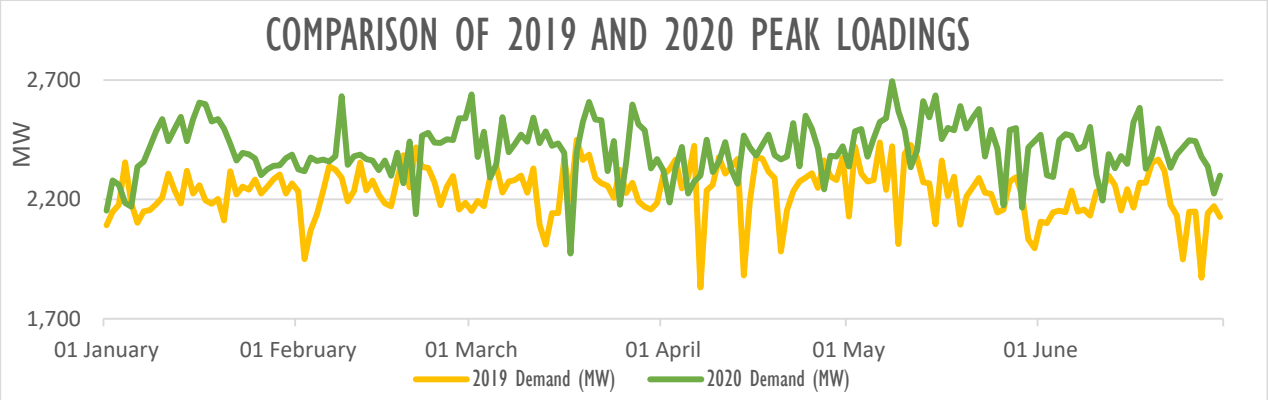


Figure 2.3 2020 vs 2019 monthly peak loadings

### 2.3.1 Domestic Peak Load

Domestic peak load here refers to the maximum amount of power supplied to consumers within Ghana. This includes supplies to residential, commercial, industrial and mining loads in Ghana excluding VALCO.

The peak domestic load recorded within the period was 2,640 MW which occurred on February 29, 2020. This represents a 7.2% (190 MW) growth over the 2019 domestic peak load of 2,450 MW over the same period.

Table 2.3: System Peak Demand for 1st half 2020 & 2019

| Type of Peak | System Peak (MW) 1st half 2020 | System Peak (MW) 1st half 2019 | % Growth |
|---|---|---|---|
| Domestic Peak | 2,640.00 | 2,450.00 | 7.76% |
| System Peak (Coincident) | 2,957.00 | 2,691.00 | 9.88% |

## 2.4 Energy Consumption

The total energy consumed, including losses, was 9,919.12 GWh as against the projected total energy consumption of 9,844.49 GWh. The actual energy consumed was higher than the projected by 0.76% or 74.62 GWh. A total of 9,002.98 GWh was consumed during the same period in 2019: thus, the 2020 energy consumption represents a 10.18% or 916.14 GWh increase over that of 2019.

A summary of 2019 and 2020 first half year energy consumption data is shown in Table 2.4.

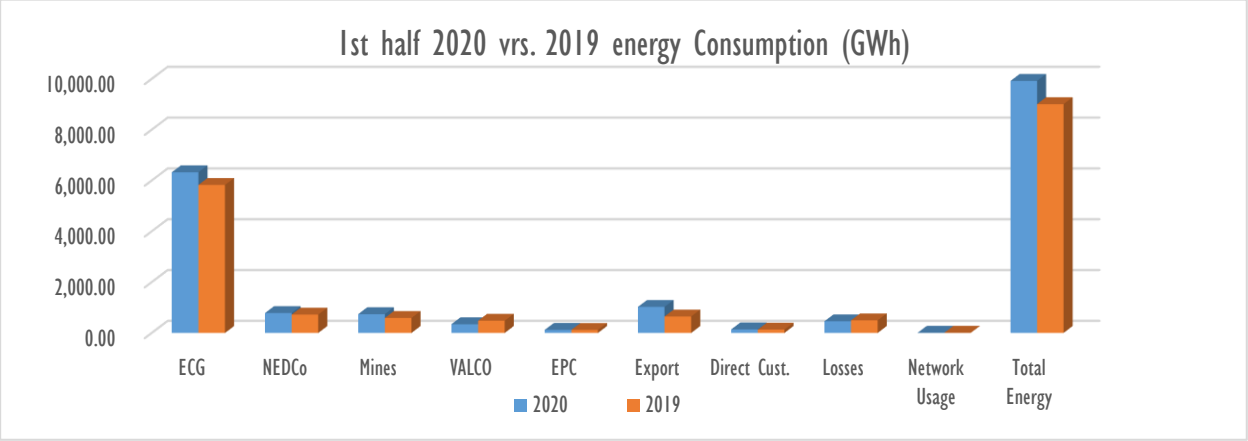


Figure 2.4: Energy Consumption for 1st half of 2020 compared with 2019

Table 2.4: Summary of Energy Consumption for 1st half 2020: actual vrs. projected

| Customer | Projection (GWh) 1st half 2020 | Actual (GWh) 1st half 2020 | Actual (GWh) 1st half 2019 | % Growth (2020-2019) |
|---|---|---|---|---|
| ECG | 6161.82 | 6,321.25 | 5824.43 | 8.53% |
| NEDCo | 743.12 | 781.37 | 719.57 | 8.59% |
| Mines | 790.66 | 737.43 | 587.35 | 25.55% |
| VALCO | 567.36 | 341.46 | 480.91 | -29.00% |
| EPC | 143.36 | 117.70 | 116.41 | 1.11% |
| Export | 877.01 | 1,022.20 | 645.70 | 58.31% |
| Direct Cust. | 120.93 | 137.27 | 130.01 | 5.58% |
| Losses | 435.38 | 455.63 | 493.83 | -7.74% |
| Network Usage | 4.85 | 4.83 | 4.77 | 1.10% |
| Total Energy Transmitted | 9,844.49 | 9,919.12 | 9,002.98 | 10.18% |

The data shows tremendous growth in exports which is primarily due to increased supply to Burkina. Mining load has also grown appreciably. Transmission losses are also seen to have reduced significantly. On the contrary, VALCO consumption reduced significantly due to challenges they encountered at the smelter beginning in the last quarter of 2019.

### 2.4.1 Exports

A total of 207.55 GWh and 738.12 GWh were exported to Togo/Benin and Burkina respectively during the period. A net of 106.14 GWh was also exchanged between Ghana and Cote d'Ivoire. This was made up of 29.61 GWh imports and 76.53 GWh exports.

## 2.5 Energy Generation

The projected 2020 first half monthly energy generation based on the estimated availability factors of the generating plants are compared in Table 2.5 with the actuals recorded over the period.

Table 2.5: Projected versus Actual Energy generation for 1st half of 2020

| Months | Projected (GWh) | | | | | Actual (GWh) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Hydro (GWh) | Total Thermal (GWh) | Total Solar (GWh) | Import (GWh) | Total (GWh) | Hydro (GWh) | Thermal (GWh) | Import (GWh) | Total (GWh) |
| January | 639.3 | 974.2 | 4.8 | 0.00 | 1,618.35 | 639.28 | 993.65 | 3.50 | 1,636.43 |
| February | 622.4 | 939.3 | 4.4 | 0.00 | 1,566.07 | 760.48 | 858.51 | 5.66 | 1,624.65 |
| March | 583.5 | 1,136.7 | 4.8 | 0.00 | 1,725.07 | 732.73 | 1,002.63 | 3.51 | 1,738.88 |
| April | 508.0 | 1,162.7 | 4.7 | 0.00 | 1,675.37 | 562.80 | 1,035.02 | 4.58 | 1,602.40 |
| May | 484.8 | 1,196.3 | 4.8 | 0.00 | 1,685.94 | 616.26 | 1,098.97 | 6.91 | 1,722.14 |
| June | 466.5 | 1,102.1 | 4.7 | 0.00 | 1,573.34 | 482.75 | 1,106.39 | 5.50 | 1,594.63 |

The hydro/thermal proportions for the 1st half of 2020 is presented graphically in Figure 2.5.

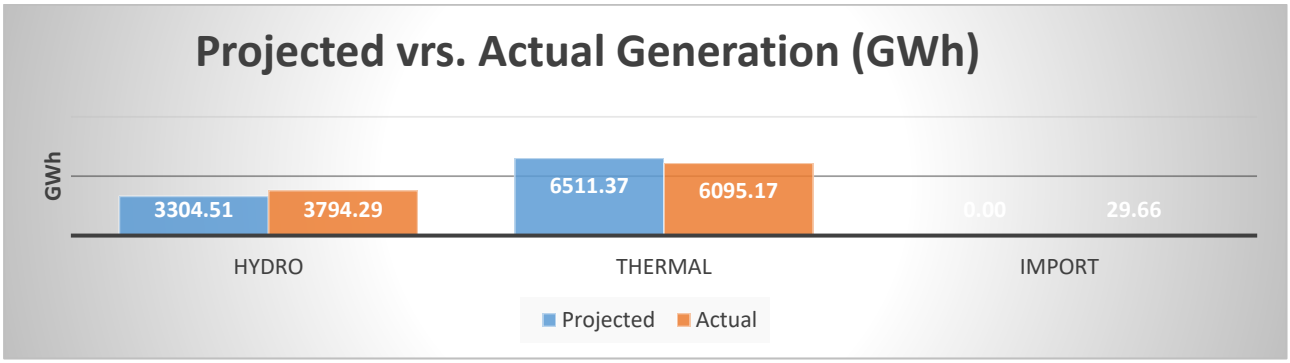


Figure 2.5: Projected versus Actual Energy Generation for 1st half of 2020

Table 2.6 gives a monthly generation breakdown of the individual plants.

Table 2.6: Comparison of projected and actual monthly energy generation (GWh)

| Plant/Months | Projection 2020 ( GWh) | | | | | | Actuals 2020 (GWh) | | | | | | Plant Availability (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jan | Feb | Mar | Apr | May | Jun | Projected | Actual |
| Akosombo | 495.4 | 430.5 | 393.4 | 362.9 | 375.0 | 362.9 | 495.4 | 566.2 | 530.7 | 385.8 | 431.1 | 326.5 | 90 | 98.68 |
| Kpong | 62.5 | 71.9 | 80.1 | 70.4 | 67.6 | 65.4 | 62.5 | 71.6 | 77.0 | 72.1 | 77.3 | 63.4 | 72 | 74.32 |
| Bui | 81.3 | 120.0 | 110.0 | 74.7 | 42.3 | 38.3 | 81.3 | 122.6 | 125.0 | 104.9 | 107.8 | 92.9 | 85 | 87.25 |
| TAPCO | 90.8 | 78.6 | 83.7 | 81.0 | 83.7 | 81.0 | 90.8 | 104.5 | 110.7 | 104.8 | 110.0 | 107.5 | 65 | 71.10 |
| TICO | 100.3 | 176.3 | 156.2 | 188.9 | 195.2 | 188.9 | 100.3 | 91.8 | 125.0 | 156.4 | 153.1 | 106.3 | 85 | 79.88 |
| TT1PP | 38.5 | 0.0 | 0.0 | 31.5 | 27.4 | 0.0 | 38.5 | 0.0 | 6.4 | 36.5 | 51.8 | 6.4 | 85 | 66.00 |
| CENIT | 45.8 | 0.0 | 76.9 | 74.5 | 76.9 | 74.5 | 5.3 | 0.0 | 4.7 | 249.7 | 262.1 | 349.7 | 90 | 58.66 |
| Karpower | 247.9 | 266.2 | 284.6 | 259.2 | 267.8 | 259.2 | 247.9 | 294.5 | 272.1 | 233.7 | 246.4 | 262.1 | 90 | 99.79 |
| TT2PP | 5.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.3 | 0.0 | 4.7 | 31.3 | 14.5 | 63.3 | 85 | 79.18 |
| SAPP | 149.1 | 0.0 | 238.7 | 266.0 | 274.9 | 266.0 | 149.1 | 0.0 | 180.0 | 68.4 | 78.4 | 74.8 | 90 | 74.62 |
| AMERI | 134.3 | 130.2 | 139.1 | 121.2 | 125.2 | 121.2 | 134.3 | 126.7 | 127.2 | 116.1 | 117.8 | 116.2 | 90 | 99.60 |
| KTPP | 9.6 | 0.0 | 38.3 | 72.0 | 74.4 | 42.9 | 9.6 | 21.5 | 28.3 | 15.7 | 8.9 | 8.7 | 85 | 99.96 |
| AKSA | 93.5 | 63.9 | 0.0 | 0.0 | 0.0 | 0.0 | 93.5 | 90.2 | 47.5 | 17.4 | 22.5 | 11.3 | 90 | 99.99 |
| CENPOWER | 59.2 | 224.1 | 33.7 | 0.0 | 0.0 | 0.0 | 60.7 | 121.0 | 65.8 | 0.0 | 0.9 | 0.0 | 90 | 20.62 |
| AMANDI | 0.0 | 0.0 | 85.5 | 68.4 | 70.7 | 68.4 | 14.4 | 2.3 | 10.3 | 4.8 | 32.6 | 0.0 | 72 | - |
| Early Power | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 6.1 | 0.0 | 0.0 | 0.0 | 0.0 | 85 | 87.25 |

The total energy generated over the period was 9,919.12 GWh; this was made up of 3,794.29 GWh (38.25%) from hydro generation, 6,095.17 GWh (61.45%) from thermal generation and 29.66 GWh (0.30%) from Imports.

The significant variations between the projected and actual energy generated for the Akosombo plant are due to the unavailability of plants which were scheduled to be run during the pigging exercise carried out by the WAGPCO. Generation from Akosombo GS was therefore increased to make up for the shortfall in supply.

Figure 2.6 shows a graphical illustration of the actual generation mix for the first half of 2020.

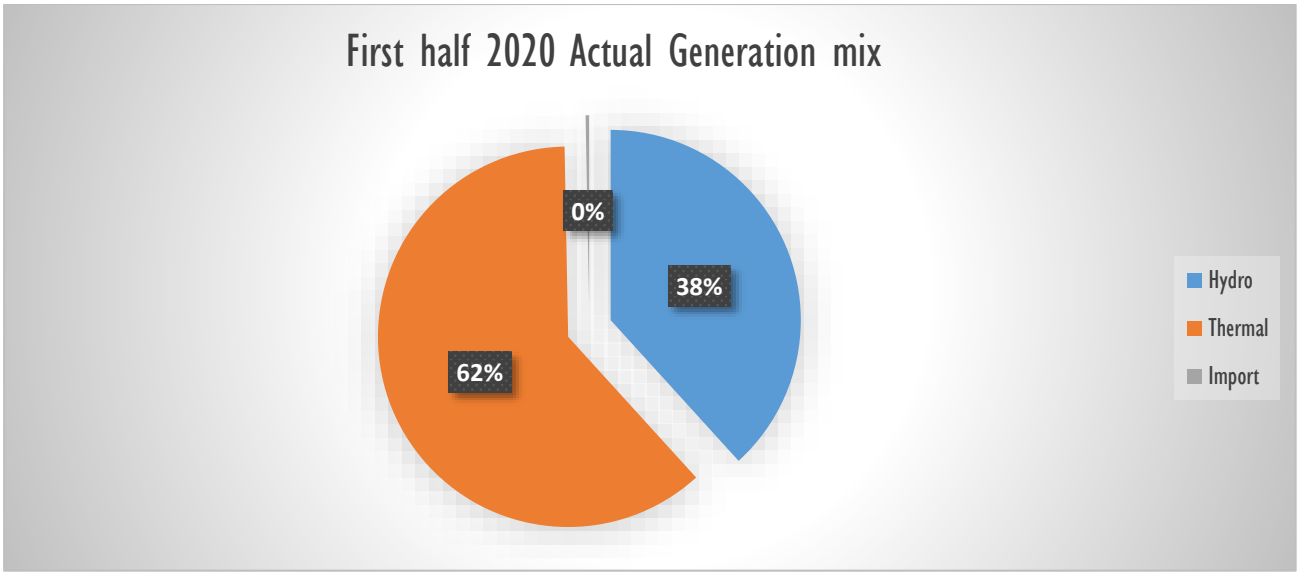


Figure 2.6: Generation Mix for 1st half of 2020

## 2.6 Hydro Reservoir Performance

The Akosombo and Bui reservoir performances as at the end of June 2020 are shown in Table 2.7. The head water trajectories for Akosombo and Bui for the period are also shown in Figures 2.7 and 2.8 respectively.

Table 2.7: Akosombo and Bui Reservoir Elevations for 1st half-year

| *Level* | *Akosombo Height (ft.)* | *Bui Height (m)* |
|---|---|---|
| Maximum design elevation | 278.00 (84.73 m) | 183.00 |
| Elevation at January 01, 2020 | 264.76 (80.70 m) | 180.37 |
| Elevation at the end of June, 2020 | 257.49 (78.48 m) | 171.04 |

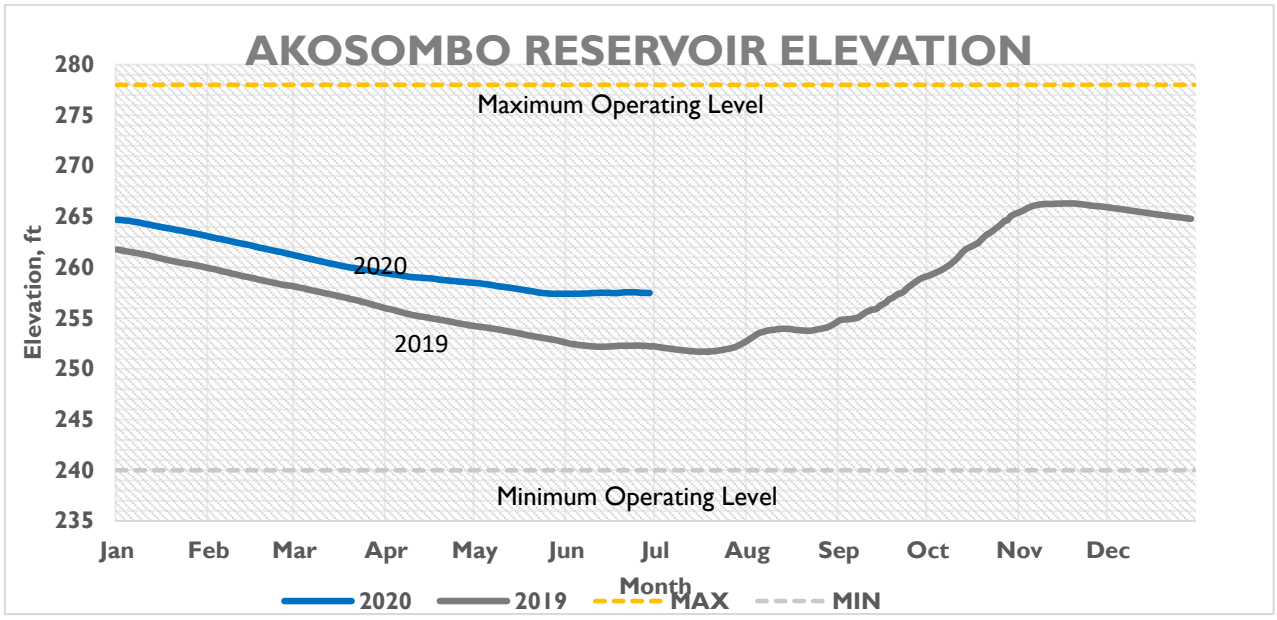


Figure 2.7: Akosombo Reservoir Trajectory

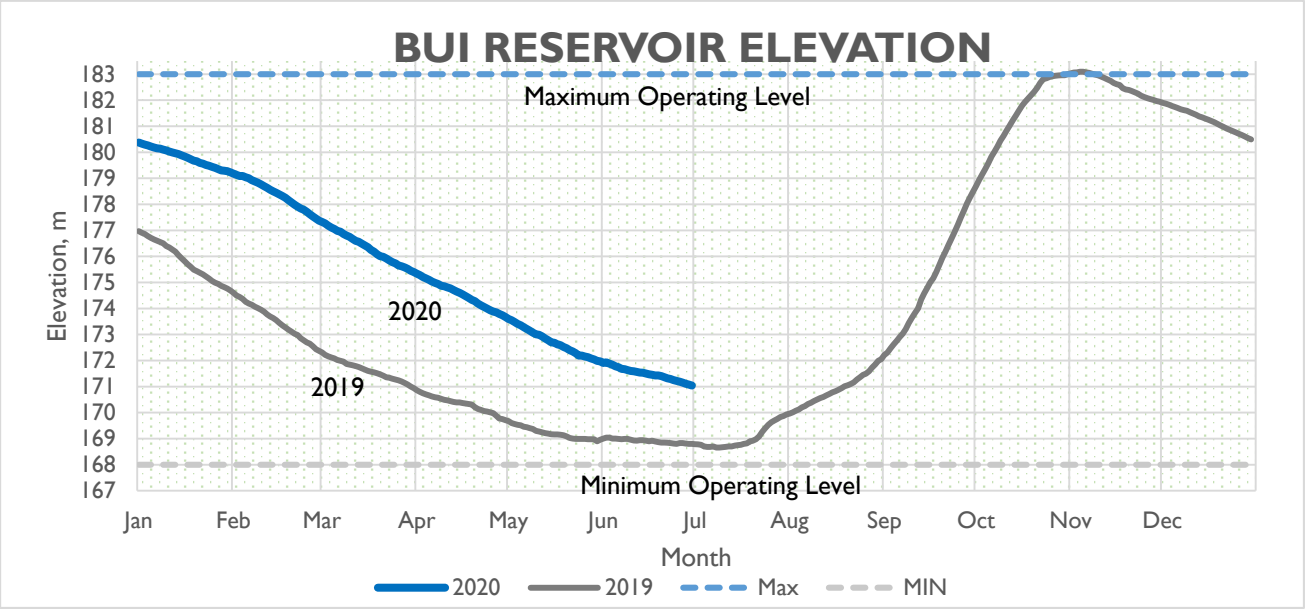


Figure 2.8: Bui Reservoir Trajectory

## 2.7 Fuel Supply

The fuel supply security as well as the fuel consumed by the thermal plants for the first half-year is highlighted below:

### 2.7.1 Fuel Usage

#### a. Natural Gas Usage

Gas supply data from the three domestic sources in the first half of 2020 is shown below:

*Table 2.8:* Quantities of Natural Gas Supplied for the 1st half of 2020

| | Quantity (MMBtu) |
|---|---|
| Jubilee/TEN | 12,487,292.66 |
| Sankofa | 32,434,823.36 |
| GNPC | 587,872.34 |
| WAGP | 11,952,864.04 |
| Total | 57,462,852.40 |

Gas utilization by power producers amounted to a total of 45,509,988.36 MMBtu at the total cost of **US$ 258,342,553.06.** Tables 2.9 and 2.10 show the breakdown of the quantities of domestic and WAGP gas consumed by various plants.

Table 2.9: Domestic Gas Consumption by Plants in the 1st half of 2020

| GAS USER | QUANTITY (MMBTU) |
|---|---|
| TAPCO | **5,978,714.56** |
| TICO | **5,658,516.33** |
| AMERI | **8,789,517.11** |
| KARPOWERSHIP | **12,859,503.20** |
| SUNON ASOGLI | **3,542,103.40** |
| CENIT | **3,242,223.88** |
| AMANDI | **573,088.47** |
| GENSER | **1,952,487.54** |
| TOTAL | **42,596,154.49** |

*Table 2.10:* WAGP Gas Consumption by Plants in the 1st half of 2020

| GAS USER | QUANTITY (MMBTU) |
|---|---|
| TT1PP | 1,909,924.80 |
| TT2PP | 579,772.33 |
| KTPP | 1,747,367.87 |
| SUNON ASOGLI | 7,715,799.04 |
| Total | 11,952,864.04 |

### b. Liquid Fuel Usage

Liquid fuel used in the first-half year is shown in Table 2.11.

*Table 2.11:* Quantities of Liquid Fuel Consumed for the 1st half of 2020

| HISTORICAL FUEL USAGE BY GENCOS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Name of Genco | Liquid Fuel Type | Unit of Measurement | Jan-20 | Feb-20 | Mar-20 | Apr-20 | May-20 | Jun-20 | Comments |
| Asogli | LCO | Bbl | 0 | 0 | 0 | 0 | 0 | 0 | Asogli used only Natural Gas |
| Aksa | HFO | MT | 19,679 | 18,711 | 9,905 | 3,567 | 4,683 | 2,378 | |
| Cenpower | DFO | MMBTU | 88,651 | 8,198 | 1,701 | 0 | 450 | 0 | Operations on DFO |
| | LCO | MMBTU | 339,926 | 992,026 | 73,464 | 0 | 10,367 | 0 | Operations on LCO |
| Amandi | LCO | MMBTU | 0 | 0 | 0 | 0 | 0 | 0 | Amandi is commissioning and expected to start full operations in a month. They used only NG |
| Early Power | LPG | kg | 688,083.6 | 1,510,004 | 6,786.4 | 0 | 0 | 0 | Early Power is commissioning and expected to start full operations in August 2020 |

### 2.7.2 Natural Gas Supply Security

Supply of gas in the first half of 2020 was beset with few midstream and downstream challenges. Firstly, natural gas supply curtailment to the Tema power enclave due to the pigging exercise as projected in the 2020 Electricity Supply Plan. During the period there was no supply of gas to Tema hence the thermal power plants that operate on gas were all shut down. The works commenced in January 20, 2020 and lasted for a period of 46 days on the West African Gas Pipeline (WAGP). Secondly, due to a restriction in the GNGC gas export pipeline, there were challenges with gas supply from the Jubilee and TEN Fields to the Gas Processing Plant (GPP). Sankofa gas increased production to make up most of the supply requirements to mitigate the challenge, thereby largely preserving the reliability of domestic gas supply in Ghana.

## 2.8 System Disturbances - 1st Half of 2020

The power system experienced four (4) major system disturbances during the 1st half of the year. These disturbances were mainly caused by challenges in the transmission network and generation deficiency. The disturbances resulted in outages to customers on the NITS. Supply was however restored averagely within four (4) hours from the time of the disturbance.

## 2.9 System Reliability

### 2.9.1 Quality of Supply

The quality of supply to consumers on the NITS is assessed based on the frequency of the system for the period and the voltage at which power was delivered. Substations with substantive amount of demand are considered.

### 2.9.2 System Frequency

Fig 2.9 shows system frequency performance for the first half of the year. It is seen from the graph that system frequency was within the normal range of 49.8Hz - 50.2Hz, 78.56% of the time which is slightly higher than the 75.62% recorded in the same period in 2019.

The others are:

- 49.5Hz - 49.8Hz – 1.20% of the time.
- 50.2 Hz - 50.5 Hz - 20.23% of the time.

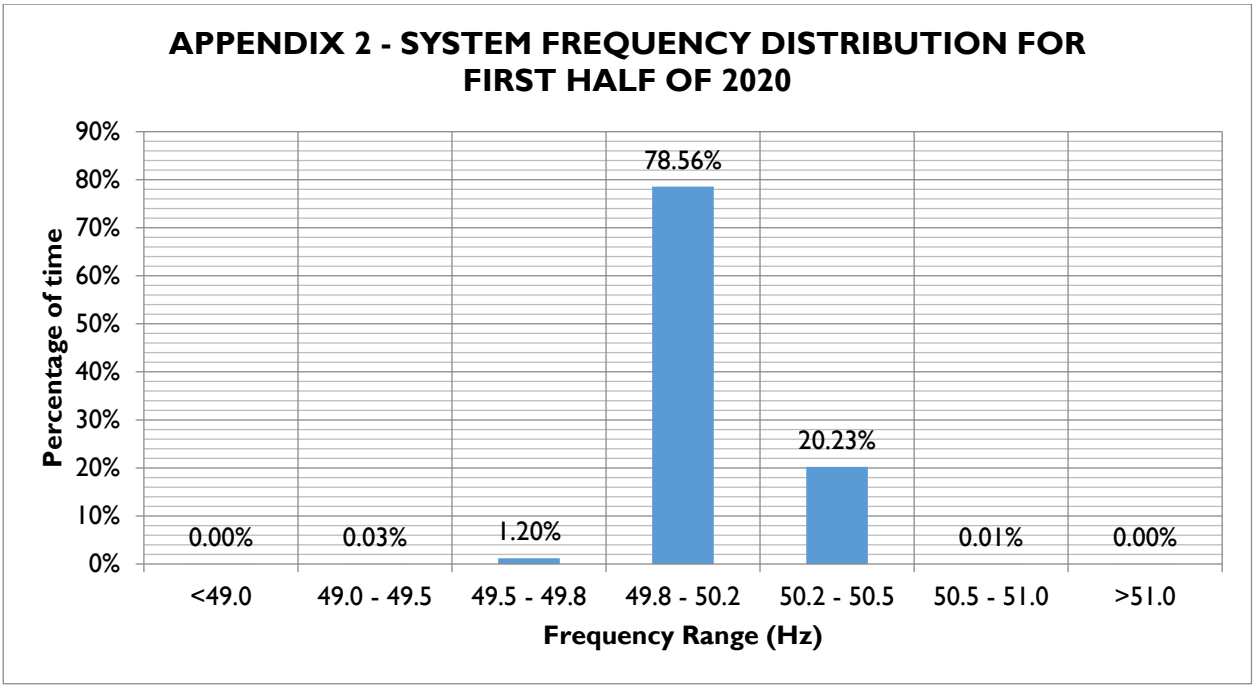


Figure 2.9: System Frequency for 1st half of 2020

### 2.9.3 System Voltages

An analysis of voltages at selected Bulk Supply Points (BSP) at peak time indicated that voltages across the NITS were largely within normal (acceptable) limits. There was however, a significant period where voltages below the normal limits were recorded except Takoradi, where voltage violations occurred about 4% of the time as shown in Table 2.12. Voltages in Kumasi has however seen significant improvements. It is observed that voltages in Accra and Tema were poor for most parts of the period. The cause of the low voltages is attributable to congestion on the Volta – Achimota line circuits and the pigging period when generation in the Tema Enclave was less than the 650 MW requirement.

Table 2.12: System Voltages

| Station | Number Of Days in the 1st Half of 2020 | | | Percentage for the 1st Half of 2020 | | |
|---|---|---|---|---|---|---|
| | Normal | Below Normal | Above Normal | Normal | Below Normal | Above Normal |
| Achimota | 144 | 38 | 0 | 79% | 21% | 0% |
| Mallam | 120 | 42 | 20 | 66% | 23% | 11% |
| New Tema | 104 | 73 | 5 | 57% | 40% | 3% |
| Kumasi | 147 | 35 | 0 | 81% | 19% | 0% |
| Takoradi | 175 | 7 | 0 | 96% | 4% | 0% |
| Tamale | 113 | 67 | 2 | 62% | 37% | 1% |

## 2.10 Transmission Network Performance

### 2.10.1 Power Supply (Feeder) Availability

The GRIDCo network registered an average feeder availability of 99.88% and 99.98% for the Southern and Northern Networks respectively, during the period. This performance was above the approved PURC 95% benchmark.

Table 2.13 shows the availability of feeders for first half of 2020.

Table 2.13: Feeder Availability for 1st half of 2020

| Feeder Availability (%) per Operational Area | | |
|---|---|---|
| Months | Southern Network Service | Northern Network Service |
| Average | 99.88 | 99.98 |

### 2.10.2 Transmission Line Availability

The transmission lines recorded an average availability of 99.75 % for the period, as shown in Table 2.14. The Table also shows average availability for the transmission lines of the various voltage classes.

Table 2.14: the transmission line availability for 1st half of 2020.

| Voltage Class | Availability % |
|---|---|
| 69kV | 99.68% |
| 161kV | 99.70% |
| 225kV | 99.35% |
| 330kV | 99.06% |
| System Average Availability | 99.66% |

### 2.10.3 Transmission System Losses

The average transmission losses recorded during the period was 297.85 GWh which is 4.51% of the total energy transmitted of 6,602.38 GWh. This figure represents a 2.7% increase over the projected transmission loss of 217.13 GWh. This deviation can mainly be attributed to the inability of AKSA and the Cenpower plants in the eastern enclave, which operate on HFO and LCO respectively, to generate at their full capacities of 330 MW and 360 MW respectively during the pigging exercise by WAGPCO. In light of this, dispatch scenarios were changed allowing demand in Accra and its environs, which are the biggest load centres, to be served by generation from the west. This change in energy dispatch resulted in some low voltages which contributed to the increase in transmission losses during the first half of the year. This was forecasted in studies conducted prior to the pigging exercise

Table 2.15 shows the monthly losses recorded for the first half.

Table 2.15 Monthly transmission losses for first half 2020

| Month | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Transmission Losses% | 4.27 | 4.49 | 4.62 | 4.66 | 4.89 | 4.61 |

Table 2.16 also shows system transmission losses for the period 2018 - 2020

Table 2.16: Transmission losses from 2018-2020 for the same period

| Year | 2018 | 2019 | 2020 |
|---|---|---|---|
| Transmission Losses% | 4.22 | 5.12 | 4.60 |

## 2.11 Transformer Capacity

There was no change in transformer capacity during the period. The total transformer capacity as at the end of the first half was 8,959.9 MVA. The total capacity of conventional step down transformers within the NITS is 5,359.9 MVA. The Transformer Utilisation Factor (TUF) of the transmission system is 48.84%, computed based on the peak load of 2,618.0 MVA and system average load factor of 0.88 for the period. This is indicative of a high transformer redundancy within the NITS for adequate and reliable power supply.

Table 2.17 shows transformer loadings in some major substations over the period:

Table 2.17: Key Substation Transformers and their Loading Levels

| Substation | Transformer Code | Rating (MVA) | Loading as @ March 2020 | % Loading |
|---|---|---|---|---|
| Achimota | 5T1 | 66 | 66.92 | 101.39% |
| | 5T2 | 66 | 66.18 | 100.27% |
| | 5T3 | 66 | 66.28 | 100.42% |
| | 5T5 | 66 | 60.23 | 91.26% |
| | 5T6 | 66 | 61.59 | 93.32% |
| Mallam | 37T1 | 66 | 66.96 | 101.45% |
| | 37T1 | 66 | 61.49 | 93.17% |
| | 37T3 | 66 | 70.8 | 107.27% |
| | 37T4 | 66 | 56.34 | 85.36% |
| New Tema | 4T1 | 66 | 43.77 | 66.32% |
| | 4T2 | 33 | 30.84 | 93.45% |
| | 4T3 | 66 | 61.24 | 92.79% |
| | 4T4 | 20 | 0.03 | 29.85% |
| | 4T5 | 66 | 65.85 | 99.27% |
| | 4T6 | 20 | 3.41 | 82.95% |
| Kumasi | 13T1 | 66 | 65.8 | 99.7% |
| | 13T2 | 66 | 61.8 | 93.64% |
| | 13T3 | 66 | 63.1 | 95.61% |
| | 13T4 | 66 | 64.2 | 97.27% |
| Takoradi | 8T1 | 66 | 40.04 | 60.67% |

| | | | | |
|---|---|---|---|---|
| | 8T2 | 33 | 24.4 | 73.94% |
| | 8T3 | 33 | 19.6 | 59.39% |

## 2.12 Distribution Network Performance

Total electricity purchases in the Southern Electricity Distribution Zone for the first quarter of 2020 was 3,207 GWh whilst sales to customers was 2,352 GWh. Electricity distribution losses for the quarter was 26.63%, about 3.43% higher than the regulatory benchmark of 23.2%. Technical loss was about 10% whilst commercial loss was 16.63%. Customer population as at May 2020 was 3.66million. Electricity prices remained the same.

The distribution network was fairly stable and available for most of the periods. Voltages were stable and customers experienced minimal interruptions in power supply.

The outbreak of the novel Corona virus, COVID-19, did not spare the distribution system as it continues to adversely affect electricity distribution operations. The COVID-19 electricity relief announced by the government during the lockdown had two notable effects on customer consumption.

Firstly, consumption by residential as well as industrial consumers that benefitted from the relief increased. However, this increase followed the normal organic growth in consumption. On the other hand, Industrial customers in the LV and HV categories significantly reduced consumption.

Secondly, revenues (payments from consumers) dipped possibly due to the social impact of the outbreak of COVID-19 so that customers' ability to pay for electricity consumed was greatly affected.

The following rehabilitation and network expansion works which commenced between 2017 and 2018 were successfully completed and commissioned within the distribution network:

- Reconstruction of the Inchaban substation in the Western Region;
- Reconstruction of the Daboase and Awaso substations into Indoor Substations;
- Expansion of the Weija, Tokuse and Winneba Outdoor Substations;
- Construction of critical 33kV subtransmission circuit from Diamond Cement to Agona Nkwanta;
- Provision of a dedicated 33kV circuit from the ECG Takoradi Harbour substation to the on-dock container terminal Takoradi Port:
- Reinforcement and upgrade of existing 33kV double circuit tower lines in Accra.

- 2x40MVA double circuit tower from Tokuse substation to the proposed Kasoa 33kv switching station (8.5 km circuit-length);

- Construction of a permanent substation at the existing Kpone industrial area;
- Construction of 2x60MVA double circuit tower lines from GIMPA to Kwabenya and Mobole to Dodowa substations;
- Laying of 6 no. 1x630sq.mm xlpe (33kV) aluminum cables from Accra station 'R' (Ridge) to station 'K' (Switchback Road);
- Laying of 12no. 1x630sq.mm xlpe (33kV) aluminum cables from Accra station 'R' (Ridge) to station 'F' (Kokomlemle);
- Laying of 12no. & 3no. 1 x 630sq.mm xlpe (33kV) aluminum cables from the Graphic Road BSP (A4BSP) to Accra station 'R' (Ridge) and station 'AD' (Praad); and
- 33kV board replacement and expansion works at the Accra Ridge substation and construction of an indoor substation at Agbogba;

The above works are expected to greatly improve the reliability of supply to ECG customers.

### 2.13 Conclusion

In conclusion, electricity demand has not been affected much by the COVID-19 pandemic, however due especially to lower than expected VALCO demand, projected coincident peak load for Ghana for the first half of 2020 was 2,957 MW (recorded on March 19, 2020) slightly lower than the 2020 ESP projection of 3,083 MW.

Overall, the power system performed fairly well according to projections per the 2020 ESP, however hydro generation was higher than projected to make up for lower than projected thermal generation due to faults on TICO unit no. 3 and fuel challenges at AKSA and Cenpower during the period of Pigging.

The hydrology at Akosombo nonetheless remains good to complement thermal generation to serve demand in the second half of the year.

# 3 DEMAND OUTLOOK FOR SECOND HALF OF 2020

## 3.1 **Introduction**

As projected in the 2020 Electricity Supply Plan (2020 ESP), the electricity demand in the first half of 2020 showed significant growth over demand for the same period in 2019. Actual demand trend for the first half year was consistent with the 2020 ESP projections. However, some of the assumptions underpinning the forecast have changed over the first half of 2020. Consequently, demand projections have been adjusted basing on the noted deviation factors to conform with the revised assumptions.

## 3.2 **2020 Peak Demand**

The Projected Coincident Peak demand for Ghana has been reviewed downward to 3,060.72 MW from the initial projection of 3,115.15 MW (2020 ESP). The new demand projection represents a growth of 9.1% and an increase of 257.02 MW over the 2019 system peak of 2,803.7 MW which occurred on December 03, 2019.

## 3.3 **Assumptions for Demand Forecast (review)**

The following are some of the changes in assumptions used for the review of the forecast:

### 3.3.1 **VALCO**

Due to challenges encountered in the first half of the year, VALCO has revised its load plan for the year 2020, reducing the projected demand of the plant from 150 MW to 100 MW.

### 3.3.2 **Mines**

Load survey carried out assured that the COVID-19 pandemic would not impact on mines consumption. This is due to the current high gold price on the international market, which is projected by the IMF to remain so for the rest of the year. Therefore, the projection made for the 2020 ESP is largely maintained. Few adjustments were however made to projections for some mines as follows:

- ✓ **Goldfields Ghana Limited (Tarkwa):** The consumption from the NITS at the mine reduced significantly from the expected 22.75 GWh during the first half-year to 6.02 GWh. This is due to alternative embedded supply procured from Genser. We therefore project a reduction in their grid consumption from 55.00 GWh to 14.47 GWh.
- ✓ **Earl International:** Consumption reviewed downwards to 17.67 GWh from 35.67 GWh.

- ✓ **Ghana Consolidated diamond:** Operation resumed in January 2020, its forecast was thus reviewed from 0.00 to 0.8 GWh for 2020 based on its first half-year consumption.

#### 3.3.3 Other Bulk Customers

- ✓ **Savanna Cement:** The consumption has been adjusted to 46.26 GWh from 30.06 GWh.

#### 3.3.4 Exports

- ✓ Projected energy export to SONABEL has been reviewed upward to 922.16 GWh from 750 GWh, an increase of 172.16 GWh.

### 3.4 Projected drop in Gross Domestic Product (GDP) due to COVID-19

Due to the COVID–19 pandemic, the economic outlook of the country has been reviewed downwards. According to the World Bank projection released in April 2020, the Ghanaian economy is expected to grow by only 2.5%, down from the initial forecast of 6.8%. The IMF in its latest release (April 2020) likewise reviewed its projected growth of the economy downwards to 1.5% from its December 2019 estimate of 5.8%. The Ministry of Finance also reviewed downward the projected growth of the economy to 0.9% (1.6% non-oil) In the 2020 mid-year budget review (June 2020).

The projected drop is assumed to be driven by lower oil production, weak global aggregate demand, global supply chain disruptions, and a steep decline in international travel, trade, retail and hospitality services. The other key reasons given for the downward adjustment was the containment measures taken to mitigate the spread of the COVID-19 pandemic.

A trend analyses carried out on historical monthly energy consumption over the first half year of 2020 however suggests a minimal impact of the pandemic on electricity consumption in Ghana (refer to Section 2.2). The effect was apparent only during the period a partial lockdown was imposed.

Therefore, in reviewing the demand projection for the second half of 2020, regression analyses using either of the revised GDPs for 2020 did not seem to explain the actual consumption in the first half of 2020. Consequently, a combination of trend analyses of historical demand and regression with a GDP growth of 5.8% as projected by IMF in December 2019 was used.

### 3.5 Details of Revised 2020 Peak Demand Projections

Table 3.1 shows a detailed breakdown of revised 2020 Projected Peak Demand showing the individual Load Entity/Distribution Company.

Table 3.1 Summary of Revised 2020 Projected Peak Demand

| Demand | Customer | | 2020 – Projected Coincident Peak (MW) |
|---|---|---|---|
| Domestic Peak Demand | ECG | | 1,858.86 |
| | NEDCo | | 243.30 |
| | Enclave Power | | 57.04 |
| | Mines | | 246.01 |
| | Other Bulk Customers | Akosombo Textiles<br>Aluworks<br>Ghana Water Company Ltd<br>Enclave Power Company<br>Diamond Cement<br>Volta Hotel<br>Savana Cement (Buipe)<br>VRATownships | 50.14 |
| | Losses +Network Usage | | 175.37 |
| Total Domestic Peak Demand | | | 2,630.72 |
| Exports | CEB | 180 | |
| | CIE | 0 | |
| | SONABEL | 150 | |
| Total Exports | | | 330.00 |
| VALCO | | | 100.00 |
| Coincident Peak Demand MW | | | 3,060.72 |

### 3.6 **Details of Energy Consumption Projections**

The projected 2020 energy consumption has been adjusted slightly upwards to 19,684.73 GWh, *(including transmission losses of 917.8 GWh - ie., 4.66% of total projected energy supply)* from 19,594.44 GWh**.** The increase over the initial projection is due to increased consumption motivated by the electricity relief package announced by the Government of Ghana as part of measures to ease the hardships caused by restrictions imposed to manage the spread of the COVID-19. The package included full absorption of the electricity bills of lifeline customers[2] and 50% reduction in the cost of electricity for all other remaining consumers**.**

The revised projection for 2020 energy consumption represents an increase of 1,797.73 GWh (a growth of approximately 10.05 %) over the 2019 consumption of 17,887 GWh.

The summary of projected 2020 consumption by customer class is shown in Table 3.2.

| Energy | Customer | 2020 – Projected Consumption (GWh) |
|---|---|---|
| Domestic Consumption | ECG | 12,562.62 |
| | NEDCo | 1,537.02 |
| | Enclave Power Company | 258.13 |
| | Mines | 1,533.99 |
| | Other Bulk Customers | 300.16 |
| | Losses + Network Usage | 926.91 |
| Total Domestic | | 17,118.82 |
| Exports | CEB | 836.30 |
| | CIE | 76.52 |
| | SONABEL | 950.76 |
| VALCO | | 702.32 |
| **Total Energy (GWh)** | | **19,684.73** |

Table 3.2: Summary of 2020 consumption by customer class

[2] Distribution Network Customers whose monthly consumption does not exceed 50 kWh

### 3.7 **Projected Monthly Peak and Energy Demand for 2020**

A summary of monthly energy consumption and the corresponding peak demand for the various customer classes is shown in Tables 3.3 and 3.4.

| **Consumers** | **Actual Energy Consumption (GWh)** | | | | | | **Projected Energy Consumption (GWh)** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Months | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Total GWh** |
| ECG | 1048.31 | 1042.56 | 1103.68 | 1016.01 | 1095.36 | 1015.33 | 977.57 | 987.24 | 979.61 | 1061.32 | 1092.47 | 1143.16 | **12562.62** |
| NEDCo | 114.0 | 120.4 | 140.5 | 136.6 | 144.4 | 126.96 | 121.64 | 119.98 | 118.63 | 129.91 | 133.89 | 130.05 | **1537.02** |
| Enclave Power Company | 19.19 | 18.14 | 21.46 | 13.41 | 22.19 | 23.31 | 23.78 | 24.09 | 22.75 | 24.59 | 24.2 | 21.02 | **258.13** |
| MINES | 122.7 | 113.6 | 126.9 | 121.54 | 129.19 | 112.21 | 132.38 | 137.18 | 133.31 | 135.68 | 133.02 | 136.28 | **1533.99** |
| Other Bulk Customers | 22.52 | 22.57 | 23.22 | 21.98 | 24.53 | 33.74 | 25.08 | 25.19 | 24.72 | 25.66 | 24.57 | 26.38 | **300.16** |
| VALCO | 46.77 | 52.49 | 62.58 | 58.52 | 60.32 | 60.77 | 61.13 | 61.13 | 59.16 | 59.16 | 59.16 | 61.13 | **702.32** |
| CEB(Togo/Benin) | 104.33 | 94.7 | 80.45 | 59.84 | 56.13 | 48.80 | 61.82 | 45.46 | 44.01 | 63.57 | 72.19 | 105 | **836.30** |
| SONABEL(Burkina) | 63.21 | 76.72 | 86.77 | 88.63 | 95.5 | 90.59 | 65 | 69 | 68 | 95.5 | 88.63 | 63.21 | **950.76** |
| CIE(Ivory Coast) | 24.93 | 10.02 | 12.45 | 10.56 | 9.69 | 8.87 | 0 | 0 | 0 | 0 | 0 | 0 | **76.52** |
| EDM(Mali) | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | **0.00** |
| Network Usage | 0.79 | 0.78 | 0.85 | 0.8 | 0.84 | 0.77 | 0.76 | 0.76 | 0.75 | 0.82 | 0.84 | 0.87 | **9.63** |
| Losses | 69.92 | 72.92 | 80.28 | 74.73 | 84.27 | 73.51 | 72.91 | 72.95 | 72.01 | 79.21 | 80.84 | 83.73 | **917.28** |
| **Total** | **1,636.72** | **1,624.93** | **1,739.16** | **1,602.64** | **1,722.37** | **1594.86** | **1,542.07** | **1,542.98** | **1,522.95** | **1,675.42** | **1,709.81** | **1,770.83** | **19,684.73** |

Table 3.3: Summary of Projected 2020 Monthly Energy (GWh) Consumption –Base Case Scenario

Table 3.4: Summary of Projected 2020 Monthly Peak (MW) demand – Base Case Scenario

| Coincident Peak Demand (MW) | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECG | 1795.36 | 1795.36 | 1842.07 | 1840.62 | 1820.53 | 1802.94 | 1695.17 | 1705.85 | 1666.62 | 1819.17 | 1819.94 | 1858.86 |
| NEDCo | 216.82 | 227.20 | 227.94 | 247.77 | 231.11 | 228.91 | 219.14 | 221.35 | 223.49 | 235.53 | 243.30 | 243.30 |
| EPC | 53.32 | 57.04 | 57.04 | 57.04 | 57.04 | 54.56 | 54.56 | 54.56 | 54.56 | 57.04 | 57.04 | 57.04 |
| MINES | 234.16 | 236.05 | 237.34 | 237.35 | 237.69 | 238.45 | 238.01 | 243.50 | 244.40 | 246.62 | 246.10 | 246.01 |
| Other Bulk Customers | 50.26 | 48.41 | 52.80 | 51.91 | 51.56 | 50.29 | 50.08 | 48.89 | 47.74 | 51.18 | 50.60 | 50.14 |
| VALCO | 70.00 | 90.00 | 90.00 | 90.00 | 90.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| CEB(Togo/Benin) | 180.00 | 180.00 | 180.00 | 180.00 | 180.00 | 170.00 | 170.00 | 170.00 | 170.00 | 170.00 | 180.00 | 180.00 |
| SONABEL(Burkina) | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 |
| CIE(Ivory Coast) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EDM(Mali) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Network Usage | 1.62 | 1.65 | 1.68 | 1.69 | 1.67 | 1.65 | 1.58 | 1.59 | 1.57 | 1.67 | 1.68 | 1.70 |
| LOSSES | 165.52 | 167.57 | 170.77 | 171.82 | 169.61 | 168.24 | 161.12 | 162.16 | 159.91 | 170.31 | 171.36 | 173.67 |
| **System Peak(Coincident)** | **2,917.06** | **2,953.27** | **3,009.64** | **3,028.20** | **2,989.20** | **2,965.05** | **2,839.66** | **2,857.91** | **2,818.28** | **3,001.52** | **3,020.01** | **3,060.72** |

### 3.8 **Conclusion**

In conclusion, the Coincident Ghana peak demand for 2020 has been reviewed downwards to 3,061 MW from the 2020 ESP projection of 3,115 MW due to reduced VALCO demand. Energy consumption was however reviewed slightly upwards to 19,684.73 GWh, from 19,594.44 GWh due to increased consumption motivated by the electricity tariff relief.

# 4 SUPPLY OUTLOOK FOR SECOND HALF OF 2020

## 2.1 Introduction

In this chapter, the electricity supply outlook for the second half of 2020 is reviewed. Sources of generation considered are mainly the existing Hydro, Thermal and Renewable Energy Plants, and committed power plant projects expected to come on-line during the year.

## 2.1 Summary of Generation Sources

Table 4.1 presents a summary of the existing and committed generation sources considered for 2020.

Table 4.1: Existing Generation Sources for 2020

| Plants | Installed Capacity (MW) | Dependable Capacity (MW) | Capacity @ Peak | Fuel Type |
|---|---|---|---|---|
| | **HYDRO SOURCES** | | | |
| Akosombo GS | 1020 | 900 | 900 | Hydro |
| Kpong GS | 160 | 140 | 140 | Hydro |
| Bui GS | 404 | 360 | 360 | Hydro |
| **Total Hydro** | **1584** | **1400** | **1400** | |
| | **THERMAL SOURCES** | | | |
| TAPCO | 330 | 300 | 300 | LCO/Gas |
| TICO | 340 | 320 | 320 | LCO/Gas |
| TT1PP | 110 | 100 | 100 | LCO/Gas |
| TT2PP | 87 | 70 | 70 | Gas |
| KTPP | 220 | 200 | 200 | Gas/ Diesel |
| CENIT | 110 | 100 | 100 | LCO/Gas |
| Sunon Asogli 161 | 200 | 180 | 180 | Gas |
| Sunon Asogli 330 | 360 | 340 | 340 | LCO/Gas |
| Karpower | 470 | 450 | 450 | Gas |
| AKSA | 370 | 350 | 350 | HFO |
| AMERI | 250 | 230 | 230 | Gas |
| Amandi | 190 | 190 | 190 | LCO/Gas |
| CEN Power | 360 | 340 | 340 | LCO/Gas |
| **Total Thermal** | **3397** | **3170** | **3170** | |
| | **EMBEDDED SOURCES** | | | |
| VRA Solar Plant | 2.5 | 1.75 | 0 | Solar |
| BXC Solar | 20 | 14 | 0 | Solar |
| Meinergy Solar | 20 | 14 | 0 | Solar |
| Trojan | 44 | 39.6 | 39.6 | Diesel/Gas |
| Genser | 95 | 18 | 18 | Gas |
| **TOTAL Embedded** | **181.5** | **87.35** | **57.6** | |
| **TOTAL** | **5,082.50** | **4,657.35** | **4,627.6** | |

## 2.1 Key Assumptions Underpinning the Supply Outlook

In reviewing the 2020 Supply Outlook, the following key assumptions were made:

### 4.1.1 Hydro Power Generation for 2020

Generation from Akosombo and Kpong hydro plants for the first half of 2020 was 3,159.6 GWh. Bui GS generation over the same period was 634.5 GWh, making a total hydro generation of 3,794.1 GWh. Taking into consideration the total hydro generation as at the end of June 2020, the total projected hydro generation for 2020 is 7,386.5 GWh. This is made up of 5,142.5 GWh, 857.5 GWh and 1,386.5 GWh from Akosombo, Kpong and Bui hydro generating plants respectively.

#### a. Akosombo & Kpong Hydro

In the first quarter of the year, Akosombo and Kpong hydro plants were dispatched above what had been planned. This was necessary to make up for capacity shortages at TICO, TAPCO and Bui plants due to fault, when Sunon Asogli Plant, TT1PP, CENIT and TT2PP were already inoperable due to curtailment in gas supply at Tema as a result of the Intelligent pigging exercise carried out on the WAGP (Refer to Section 2.2.1).

The projected total annual hydro generation from Akosombo and Kpong generating stations is 6,000.0 GWh. This is expected to be achieved by operating averagely three/four (3/4) Akosombo units during the off-peak period and up to five (5) units during the peak period until the end of the year 2020.

Kpong Generation Station (Kpong GS), which is currently undergoing retrofit, will have three (3) out of the four (4) units available. The total average capacity that would be available at Kpong GS is 105 MW. The retrofit was expected to be completed by April 2020. However, because of the COVID-19 the completion date is expected to extend to the end of the year.

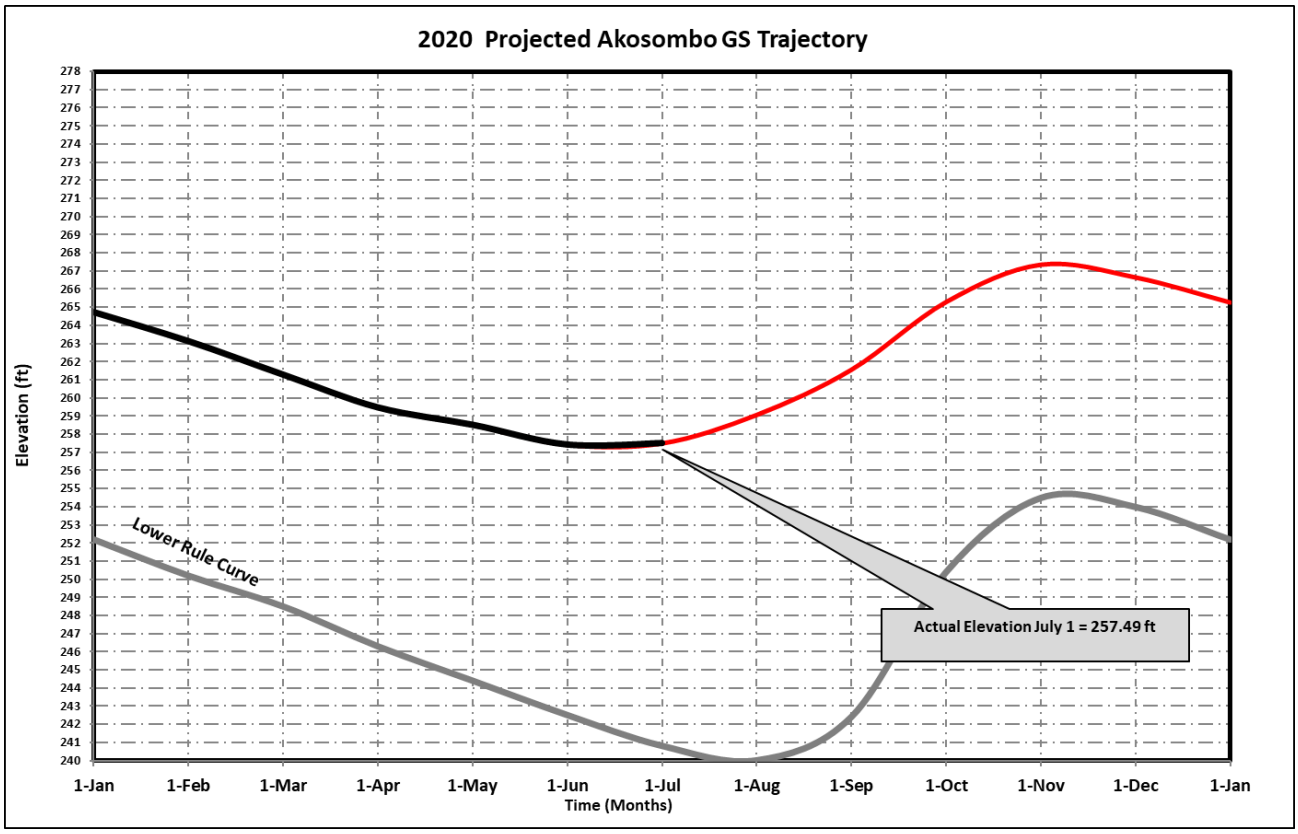


*Figure 4.1:* 2020 Projected Akosombo Reservoir Trajectory

### b. Bui Hydro

Bui Hydro Plant is projected to supply a total of 1,386.5 GWh in 2020 to avoid a need for spillage. This would be achieved by dispatching Bui Hydro at an average of two (2) units throughout the second half of the year. The dam hydrology shall be monitored closely and dispatch regime reviewed accordingly when necessary. The projected Bui reservoir trajectory up to the end of the year is shown in Figure 4.2.

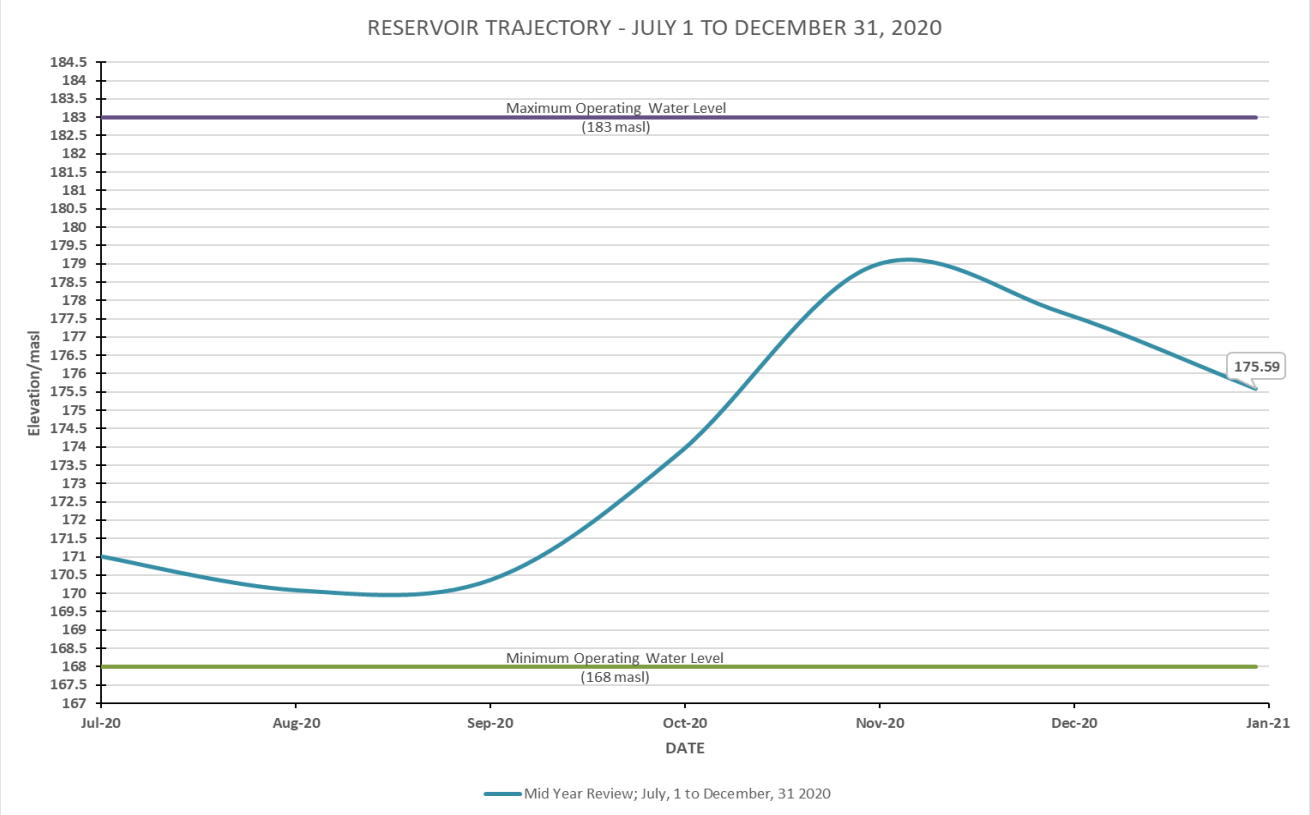


*Figure 4.2: 2020 Projected Bui Reservoir Trajectory*

## Energy Supply Projections for the second half of 2020

*Table 4.2:* Revised Monthly Projected energy for the 2nd half of 2020

| Month | Revised Projected Energy (GWh) |
|---|---|
| July | 86 |
| August | 110 |
| September | 158 |
| October | 158 |
| November | 120 |
| December | 120 |

### 4.1.2 Thermal Power Generation for Second Half of 2020

The projected thermal energy generation for 2020 has been reviewed to 12,264.5 GWh, made up of generation outputs from VRA and IPPs Plants. The corresponding Projected Dependable Thermal Capacity for 2020 is 3,342 MW. This is made up of 3,008 MW from existing units and a total of 334 MW from power plants that are expected to soon declare commercial operation by the third quarter of the year as follows:

- 144 MW Bridge Power Plant: Construction of the power plant is completed and commissioning is expected to be completed by September 2020. The plant can operate on LPG and natural gas. The plant is located in Tema within the Eastern enclave of the power system.

- 190 MW Amandi Power Plant: The plant has been commissioned into service, it is however yet to declare commercial operation. The plant can operate on LCO and natural gas. The plant is located in Aboadze, within the Western enclave of the power system.

### 4.1.3 New Renewable Generation Sources

New renewable generation projects expected to be commissioned into service is as follows:

- ✓ **VRA Kaleo and Lawra Solar Power Plants**: – VRA commenced construction of 17 MWp solar power plant in September 2019. It was initially planned that 4 MWp would be commissioned by June 2020, increasing to 12 MWp in October 2020 and then to 17 MWp in First Quarter of 2021. However, because of the COVID-19 pandemic, a total of 6 MWp will be commissioned by October 2020. The remaining 11 MWp will be commissioned during the first quarter of 2021.

- ✓ **Bui Solar Plant:** The initial 10 MWp, which is part of the first phase of 50MWp Solar Project, is scheduled to be commissioned in September 2020. The remaining 40 MWp is expected to be commissioned by end of December 2020, to complete the first phase of the Bui Solar development.

### 4.1.4 Planned Maintenance

The schedule of key maintenance activities expected to be undertaken from July 2020 on generating units at the various power plants is shown in Table 4.3.

*Table 4.3:* 2020 Planned Maintenance

| Plants | Planned Maintenance |
|---|---|
| Akosombo GS | Unit 2 is scheduled to undergo SCADA Project and annual maintenance from September 28 - November 09, 2020<br>Unit 3 is scheduled to undergo SCADA Project and annual maintenance from June 28 - August 10, 2020<br>Unit 4 is scheduled to undergo SCADA Project and annual maintenance from August 12 – September 24, 2020 |
| Kpong GS | Unit 1: Quarterly maintenance from October 05 - 08, 2020<br>Unit 2: Quarterly maintenance from July 6 - 9 and November 10 – 13, 2020<br>Unit 3: Quarterly maintenance from September 7 – 10, 2020 |
| TAPCO | Unit 1: Hot Gas Path Inspection from August 2 – 25, 2020<br>Unit 2: Offline Compressor Water Wash November 29, 2020 |
| TICO | Unit 1: Offline water wash on November 28, 2020<br>Unit 2: Offline water wash on August 30 and November 29, 2020<br>Unit 3: Major inspection on STG from August 15 – September 18, 2020 |
| KTPP | Unit 2: Type C inspection on October 1 – 31, 2020 |
| TT1PP | 47G1: Offline Compressor Water Wash on September 14 and November 17, 2020 |
| CENIT | 47G2 is scheduled for Offline water wash on December 6, 2020<br>47G2 is scheduled for Combustion Inspection on August 14 – 21, 2020 |

| | |
|---|---|
| TT2PP | Unit 1: Core Engine Swap and main gearbox overhaul July 17 to August 10, 2020<br>Unit 3: Generator Stator Repair Works January 07 to September 30, 2020<br>Unit 3: Core Engine Swap and main gearbox overhaul June 24 to July 18, 2020<br>Unit 5: Type A Maintenance September 03 – 08, 2020<br>Unit 6: Type A Maintenance September 10 – 15, 2020 |
| CENPOWER | Unit 1 is scheduled for Combustion Inspection on July 15 - 23, 2020 |
| Bui GS | Unit 1 is scheduled for Quarterly maintenance on September 14 – 18, and December 14 – 18, 2020 |
| | Unit 2 is scheduled for Quarterly maintenance on August 17 - 21 and November 9 – 13, 2020 |
| | Unit 3 is scheduled for Quarterly maintenance on July 20 – 24, 2020 |
| | Unit 3 is scheduled for Annual maintenance on October 1 – 30, 2020 |
| | Unit 4 is scheduled for Quarterly maintenance on October 12 – 13, 2020 |
| | Unit 4 is scheduled for Level A maintenance July 1 – 31, 2020 |
| ASOGLI | Unit 4 scheduled for July 10 – 23, 2020. (Type C maintenance) |
| | Unit 9 & 10 scheduled for October 20 – November 7, 2020. (Type C maintenance) |
| | Unit 5 scheduled for November 20 – December 24, 2020. (Type B maintenance) |
| | Unit 6 scheduled for December 1 – 14, 2020. (Type C maintenance) |
| AKSA | Unit 5 is scheduled for ABB Generator L4 maintenance and Engine vibration damper maintenance July 7 – 28, 2020 |

### 4.1.5 Natural Gas Quantities and Availabilities

Natural gas is the primary source of fuel for thermal power generation in Ghana. Here we look at assumptions for gas supply.

#### a. Natural Gas Supply from Ghana Fields

GNPC's Gas Supply Forecast for 2020 (July – December) provides a comprehensive assessment of the domestic gas supply from the three offshore producing fields (Jubilee, TEN and Sankofa) and imported LNG.

Sankofa Gas supply is forecast at **210 MMscfd** for the period. The Jubilee and TEN Fields maintain availability to supply up to **120 MMscfd** and **45 MMscfd** respectively. However, due to capacity limitations at GNGC's Gas Processing P plant, supply is limited to a combined total of **125 MMscfd** from the two (Jubilee & TEN) fields. To further assure gas supply reliability, GNPC has entered into a substitution agreement with the Jubilee and TEN partners to enable seamless substitution of gas supply between the two fields to meet daily requirements. The Tema LNG project is expected to be completed

towards the end of 2020. However, due to commissioning requirements, gas from the terminal has not been considered in the supply outlook for the second half of 2020.

Gas supply is expected to be stable in the second half of the year. A planned shutdown of the OCTP (FPSO John Agyekum Kufuor) for maintenance originally scheduled for Q1 2020 has been rescheduled to later in the year but the dates have not been confirmed. Based on available information, this Supply Plan has assumed that the shutdown will happen in November for ten consecutive days.

The gas supply outlook for the rest of the year is shown below:

Table 4.4: Domestic Gas Supply Outlook

| Month | Jubilee/TEN Forecast (MMscfd) | OCTP/Sankofa Forecast (MMscfd) | Total Forecast (MMscfd) |
|---|---|---|---|
| July | 125 | 210 | 335 |
| August | 125 | 210 | 335 |
| September | 125 | 210 | 335 |
| October | 125 | 210 | 335 |
| November | 125 | 140 | 265 |
| December | 125 | 210 | 335 |
| **Maximum** | **125** | **210** | **335** |

### b. Natural Gas Supply from Nigeria

A total of about 70 MMscfd of natural gas is expected to be supplied from Nigeria till the end of the year 2020. Adding supply from Ghana and Nigeria translates to a maximum supply of about **405 MMscfd** in 2020.

Assuming that each 100 MW generation capacity (simple cycle) will use a total of 30 MMscfd of natural gas, then the 405 MMscfd can be used by a total of about **1,350 MW** of simple cycle generation capacity. If all units using the gas are combined cycle units, then approximately **2,025 MW** of combined cycle generation capacity can be realised from the 405 MMscfd of natural gas.

### c. West to East Reverse Flow

Following the completion of the Takoradi – Tema Interconnection Project (TTIP) to allow flow of gas using the WAPCo Gas Pipeline, a total of 115 MMscfd on firm supply basis of gas can be supplied from the West to East using the WAGP pipeline. This has paved the way for Ghana Gas to supply up to about 90 MMscfd of natural gas to power plants in the Tema Generation Enclave.

The gas infrastructure at Tema has a capacity of 235 MMscfd. Hence the quantity of natural gas that can be transported from the West to the East by GNPC through WAGP depends on how much gas is being supplied from Nigeria. Gas from Nigeria and Ghana will have to fit into the 235 MMscfd. Also,

the quantity of gas that can be transported to the West is limited by the total available generation in operation in the Western enclave of the power system. Volumes of gas available and thermal plant availability in the West could therefore, limit the flows to 30 MMscfd.

### 4.1.6 Gas Usage Plan for Second Half 2020 (Fuel Allocation)

Due to the quantities of natural gas supply in 2020 as projected above, fuel usage at the Tema and Takoradi Power Enclaves shall be strategically managed as follows:

A total of about 70 MMscfd of natural gas is expected to be supplied from Nigeria till the end of the year 2020. Adding supply from Ghana (335 MMscf/day) and Nigeria (70 mmscf/day) translates to a projected maximum supply of about **405 MMscfd** for second half 2020.

Assuming that each 100 MW generation capacity (simple cycle) will use a total of 30 MMscfd of natural gas, then the 405 MMscfd can be used by a total of about 1,350 MW of simple cycle generation capacity.

*Table 4.5: Projected Gas Usage Plan for the 2nd half of 2020*

| | Projected Gas Usage Plan | | | | | |
|---|---|---|---|---|---|---|
| **Customer Category** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Domestic | 2,420.0 | 2,438.0 | 2,398.0 | 2,582.0 | 2,590.0 | 2,631.0 |
| VALCO | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Export (CEB+SONABEL+CIE) | 320.0 | 320.0 | 320.0 | 320.0 | 330.0 | 330.0 |
| **Projected Energy Demand (MW)** | **2,840.0** | **2,858.0** | **2,818.0** | **3,002.0** | **3,020.0** | **3,061.0** |
| **Generation Sources** | | | | | | |
| Akosombo | - | - | - | - | - | - |
| Kpong GS | - | - | - | - | - | - |
| TAPCO | 28.0 | 28.0 | 28.0 | 28.0 | 56.0 | 56.0 |
| TICO | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 |
| TT1PP | 28.0 | 28.0 | | | | |
| KTPP | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 |
| TT2PP | | | | | | |
| VRA Solar (Navrongo) | - | - | - | - | - | - |
| VRA Solar (Kaleo/Lawra) | - | - | - | - | - | - |
| AMERI Power Plant | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 |
| Imports From Cote d'Ivoire | - | - | - | - | - | - |
| Bui GS | - | - | - | - | - | - |
| SAPP | - | - | - | - | - | - |
| CENIT | - | - | - | - | - | - |
| Karpower Barge | 90.0 | 90.0 | 90.0 | 90.0 | 90.0 | 90.0 |
| AKSA | - | - | - | - | - | - |
| CENPOWER | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| AMANDI | - | | 35.0 | 35.0 | 35.0 | 35.0 |
| Early Power | - | - | - | - | - | - |
| BxC Solar | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Meinergy | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Safisana | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total Supply (MMscf/day)** | **345.0** | **345.0** | **352.0** | **352.0** | **380.0** | **380.0** |

### a. Fuel Price

The following assumptions on price of fuel delivered were made:

- ✓ Ghana and Nigeria Gas – US$ 6.08/mmbtu
- ✓ Delivered LCO – US$ 60/barrel
- ✓ Delivered HFO – US$ 84/bbl.

## 2.1 Demand - Supply Analysis

This sub-section analyses the demand-supply balance for the rest of the year 2020. The assumptions underpinning the demand-supply projections for the year are as described above. The analysis begins with the projected monthly energy generation from all the Generating Plants. The analysis of the

monthly energy balance shows supply surplus in 2020. The following criteria were considered to schedule the available generating plants for the second half of 2020:

a) System Stability Requirements

b) Must-run Plants (e.g. Solar)

c) Merit Order Dispatch

d) PURC and EMOP energy allocation for the year

### 4.4.1 System Stability Requirements

To ensure stable operation of the power system, there are some fundamental network requirements. First, a minimum of 3 units of Akosombo are required in operation during off-peak periods and 4 units during peak periods to enable it execute load following and frequency regulation function. It is also required to have at least 300 MW of generation capacity in operation in Takoradi while a minimum of 650 MW of generation is required in operation in Tema.

### 4.4.2 Must-Run Plants (Renewable Energy Plants)

Variable Renewable Energy Plants such as Solar Plants are typically must run plants and hence are dispatched based on expected energy from the plants. A total of about 17.6 GWh is expected from all the solar power plants.

### 4.4.3 Power Imports

No power imports are anticipated for the rest of the year. There could however be some inadvertent energy exchanges.

Based on the above considerations the demand/supply outlook for 2020 is illustrated in Table 4.6. The Table shows the annual energy and supply balance for 2020. It captures both the actual demand/supply for the first half of the year and projects the demand/supply outlook for the rest of the year.

*Table 4.6: Projected Monthly Generation in GWh*

| Customer Category | 2020 Proj. Energy (GWh) | Total Actual (Jan -Jun) | Projected | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Jul | Aug | Sep | Oct | Nov | Dec |
| Domestic | 17,118.8 | 8,557.0 | 1,354.1 | 1,367.4 | 1,351.8 | 1,457.2 | 1,489.8 | 1,541.5 |
| VALCO | 702.3 | 341.5 | 61.1 | 61.1 | 59.2 | 59.2 | 59.2 | 61.1 |
| Export (CEB+SONABEL+CIE) | 1,863.6 | 1,022.2 | 126.8 | 114.5 | 112.0 | 159.1 | 160.8 | 168.2 |
| **Projected Energy Consumption** | **19,684.73** | **9,920.7** | **1,542.1** | **1,543.0** | **1,523.0** | **1,675.4** | **1,709.8** | **1,770.8** |
| **Generation Sources** | **2020 Proj. Supply (GWh)** | | | | | | | |
| **Hydro** | | | | | | | | |
| Akosombo | 5,142.5 | 2,735.8 | 405.2 | 405.2 | 393.1 | 405.2 | 393.1 | 405.2 |
| Kpong GS | 857.5 | 424.0 | 73.0 | 73.0 | 70.8 | 73.0 | 70.8 | 73.0 |
| Bui GS | 1,386.5 | 634.5 | 86.0 | 110.0 | 158.0 | 158.0 | 120.0 | 120.0 |
| **Thermal** | | | | | | | | |
| TAPCO | 1,356.2 | 628.3 | 100.4 | 100.4 | 97.2 | 100.4 | 162.0 | 167.4 |
| TICO | 1,637.8 | 732.8 | 139.1 | 91.8 | 73.4 | 202.4 | 195.8 | 202.4 |
| TT1PP | 214.2 | 139.5 | 56.1 | 18.6 | - | - | - | - |
| KTPP | 536.5 | 168.5 | 63.2 | 63.2 | 61.2 | 59.5 | 61.2 | 59.5 |
| TT2PP | 43.4 | 43.4 | - | - | - | - | - | - |
| AMERI Power Plant | 1,280.2 | 738.2 | 151.8 | 151.8 | 41.0 | 27.5 | 77.3 | 92.8 |
| Imports From Cote d'Ivoire | 29.6 | 29.6 | - | - | - | - | - | - |
| SAPP | 1,190.7 | 1,190.7 | - | - | - | - | - | - |
| CENIT | 292.2 | 292.2 | - | - | - | - | - | - |
| Karpower Barge | 3,245.85 | 1,556.7 | 284.6 | 284.6 | 275.4 | 284.6 | 275.4 | 284.6 |
| AKSA | 282.4 | 282.4 | - | - | - | - | - | - |
| CENPOWER | 1,608.5 | 248.4 | 177.7 | 239.6 | 231.8 | 239.6 | 231.8 | 239.6 |
| Amandi | 537.3 | 64.4 | - | - | 116.3 | 120.2 | 116.3 | 120.2 |
| Early Power | 9.6 | 9.6 | - | - | - | - | - | - |
| Bui Solar | 2.3 | | - | - | - | - | 1.1 | 1.1 |
| **Embedded Generation** | | | | | | | | |
| VRA Solar (Navrongo) | 3.1 | **1.5** | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 |
| VRA Solar (Kaleo/Lawra) | 0.9 | 0.0 | | | | 0.3 | 0.3 | 0.3 |
| BxC Solar | 13.6 | 0.0 | 2.3 | 2.3 | 2.2 | 2.3 | 2.2 | 2.3 |
| Meinergy | 13.6 | 0.0 | 2.3 | 2.3 | 2.2 | 2.3 | 2.2 | 2.3 |
| Safisana | 0.4 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Total Supply (GWh)** | **19,684.73** | **9,920.7** | **1,542.1** | **1,543.0** | **1,523.0** | **1,675.4** | **1,709.8** | **1,770.8** |

*Table 4.7: 2020 Projected energy and Supply Balance in GWh*

| Customer Category | 2020 Proj. Consumption (GWh) |
|---|---|
| Domestic | 17,118.82 |
| VALCO | 702.3 |
| Export (CEB+SONABEL+CIE) | 1,863.59 |
| **Projected System Energy Requirement** | **19,684.73** |
| **Generation Sources** | **2020 Projected Supply (GWh)** |
| Akosombo | 5,142.5 |
| Kpong GS | 857.5 |
| Bui GS | 1,386.5 |
| **Total Hydro** | **7,386.5** |
| TAPCO | 1,356.2 |
| TICO | 1,637.8 |
| TT1PP | 214.2 |
| KTPP | 536.5 |
| TT2PP | 43.4 |
| AMERI Power Plant | 1,280.2 |
| Imports From Cote d'Ivoire | 29.6 |
| SAPP | 1,190.7 |
| CENIT | 292.2 |
| Karpower Barge | 3,245.8 |
| AKSA | 282.4 |
| CENPOWER | 1,608.5 |
| Amandi | 537.3 |
| Early Power | 9.6 |
| Bui Solar | 2.3 |
| **Total Thermal Generation** | **12,264.5** |
| VRA Solar (Navrongo) | 3.1 |
| VRA Solar (Kaleo/Lawra) | 0.9 |
| BxC Solar | 13.6 |
| Meinergy | 13.6 |
| Safisana | 0.4 |
| **Total Embedded Generation** | **31.54** |
| **Total Supply (GWh)** | **19,684.73** |

A graphical representation of the above energy supply showing the percentage share of each generation type is shown in Figure 4.3 below. The Chart indicates that, taking into consideration actual generation for the first half of 2020, thermal generation will constitute approximately 62.5% of total projected generation whilst hydro and Solar PV generation would constitute some 37.3% and 0.2% respectively. This indicates the diminishing dominance of hydro in Ghana's overall generation mix.

The increasing proportion of thermal generation in the overall generation mix could have some implications for the sector as follows:

- ✓ As tariffs are cedi-denominated and fuel for thermal generation and other consumables are purchased mostly in United States Dollars (USD), any major depreciation of the Ghana Cedi against the USD would result in losses,
- ✓ Thermal generation in Ghana is predominantly gas-based, therefore any disruption in gas supply would have dire consequences on power supply in the country.

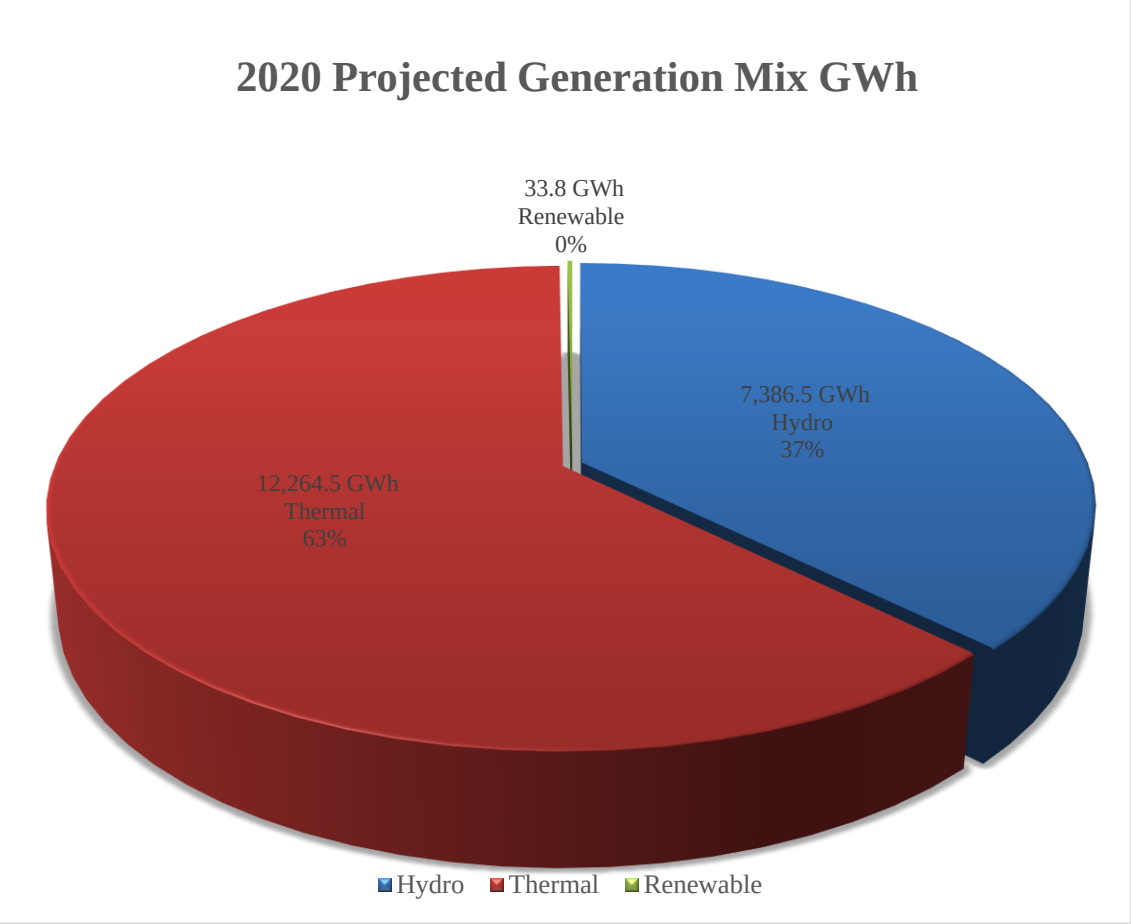


*Figure 4.3:* Contribution of Supply by Generation Types

## 2.1 Projected Capacity Situation

The projected monthly available supply capacity levels, taking planned unit maintenance and Fuel Supply Systems into consideration is shown in Table 4.8.

*Table 4.8: Projected Monthly Capacity Situation for July - December 2020*

| Customer Category | Proj. 2020 System Peak (MW) | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|
| Domestic | 2630.72 | 2,420 | 2,438 | 2,398 | 2,582 | 2,590 | 2,631 |
| VALCO | 150.00 | 100 | 100 | 100 | 100 | 100 | 100 |
| Export (CEB+SONABEL) | 330.00 | 320 | 320 | 320 | 320 | 330 | 330 |
| **Projected System Demand** | **3060.72** | **2,840** | **2,858** | **2,818** | **3,002** | **3,020** | **3,061** |
| **Generation Sources** | **Dependable Capacity (MW)** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Akosombo | 900 | 750 | 750 | 750 | 750 | 750 | 750 |
| Kpong GS | 140 | 105 | 105 | 105 | 105 | 105 | 105 |
| Bui GS | 345 | 220 | 220 | 220 | 220 | 220 | 220 |
| Bui Min Unit | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| TAPCO | 300 | 150 | 150 | 300 | 150 | 300 | 300 |
| TICO | 320 | 220 | 220 | 220 | 320 | 320 | 320 |
| TT1PP | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| KTPP | 200 | 100 | 0 | 100 | 0 | 100 | 0 |
| TT2PP | 58 | 25 | 25 | 25 | 25 | 25 | 25 |
| AMERI Power Plant | 230 | 200 | 200 | 200 | 200 | 200 | 200 |
| SAPP 161 | 180 | 150 | 180 | 180 | 180 | 180 | 180 |
| SAPP 330 | 350 | 350 | 350 | 350 | 230 | 350 | 350 |
| CENIT | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Karpower Barge | 450 | 400 | 400 | 400 | 400 | 400 | 400 |
| AKSA | 330 | 330 | 330 | 330 | 330 | 330 | 330 |
| Cenpower | 330 | 330 | 330 | 330 | 330 | 330 | 330 |
| Amandi | 192 | 0 | 0 | 190 | 190 | 190 | 190 |
| Early Power | 144 | 0 | 0 | 144 | 144 | 144 | 144 |
| Imports From Cote d'Ivoire | 0 | - | - | - | - | - | - |
| Trojan | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Genser | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Safisana | 0.1 | | | | | | |
| VRA Solar | 2.5 | | | | | | |
| Meinergy | 16 | | | | | | |
| Solar (Central Region) | 16 | | | | | | |
| **Total Available Generation (MW)** | **4,776** | **3,494** | **3,524** | **4,008** | **3,838** | **4,108** | **4,108** |
| **Surplus/deficit (MW)** | **1,715** | **654** | **666** | **1,190** | **836** | **1,088** | **1,047** |
| **Required Reserve (18%)** | **551** | **511** | **514** | **507** | **540** | **544** | **551** |
| **Actual Reserve Margin** | 56% | 23% | 23% | 42% | 28% | 36% | 34% |

The analysis of the above monthly demand and supply situation for July – December 2020 shows monthly positive generation reserve margins of up to 43%. As such, supply deficit challenges are not anticipated barring any unforeseen fuel supply interruptions. With such a considerably high reserve capacity, it is anticipated that some of the Power Plants may not be dispatched whilst others may be forced to operate well below their full capacities.

### 2.1 Fuel Requirement

Currently, the main fuels for power generation include Light Crude Oil (LCO), Natural Gas and Heavy Fuel Oil (HFO) and Liquified Petroleum Gas (LPG). The estimates of quantity and cost of fuel requirement in 2020 is indicated in Table 4.9.

*Table 4.9: Summary of Fuel Requirements for July – December 2020*

| PLANT | LCO (Barrels) | Natural Gas (MMbtu) | HFO (Barrels) |
|---|---|---|---|
| TAPCO | | 6,509,789 | |
| TICO | | 7,151,772 | |
| TT1PP | | 873,968 | |
| KTPP | | 4,334,098 | |
| TT2PP | | | |
| AMERI | | 6,114,117 | |
| Karpower Barge | | 15,374,370 | |
| SAPP | | | |
| CENIT | | | |
| AMANDI | | 3,887,008 | |
| CENPOWER | | 11,180,269 | |
| Bridge Power | | | |
| AKSA | | | |
| **Total Fuel Requirement** | | **55,425,390** | |

The summary of major fuel requirements for 2020 is as presented below:

- ✓ **LCO**: There would be no significant requirement for LCO for the rest of the year 2020. This is due to anticipated high volumes of gas from Sankofa, Jubilee and TEN fields.
- ✓ **Natural Gas**: Based on the assumed gas supply from Nigeria and Ghana, the total natural gas consumption for the period of July to December is projected to be about 55.425 Million MMbtu.
- ✓ **HFO**: The AKSA Plant which operates on HFO is not scheduled to operate for the remainder of the year.

## 2.1 Monthly Fuel Requirement

The breakdown of Monthly fuel requirements and their associated costs are as shown in Table 4.10.

*Table 4.10: Monthly fuel requirements and associated costs*

| | Units | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|
| **Estimated Thermal Fuel Requirement** | **Units** | | | | | | | |
| TAPCO - GAS | mmbtu | 898,235 | 898,235 | 869,260 | 898,235 | 1,448,766 | 1,497,058 | **6,509,789** |
| TICO - GAS | mmbtu | 1,099,529 | 725,495 | 580,396 | 1,599,314 | 1,547,724 | 1,599,314 | **7,151,772** |
| TT1PP - GAS | mmbtu | 656,897 | 217,071 | - | - | - | - | **873,968** |
| KTPP - GAS | mmbtu | 744,967.20 | 744,967.20 | 720,936.00 | 701,145.60 | 720,936.00 | 701,145.60 | **4,334,098** |
| TT2PP - GAS | mmbtu | - | - | - | - | - | - | **-** |
| AMERI Power Plant - GAS | mmbtu | 1,712,006 | 1,712,006 | 462,497 | 309,801 | 871,396 | 1,046,412 | **6,114,117** |
| Karpower Barge - GAS | mmbtu | 2,590,247 | 2,590,247 | 2,506,691 | 2,590,247 | 2,506,691 | 2,590,247 | **15,374,370** |
| SAPP - GAS | mmbtu | - | - | - | - | - | - | **-** |
| CENIT - GAS | mmbtu | - | - | - | - | - | - | **-** |
| AMANDI - GAS | mmbtu | - | - | 955,822 | 987,682 | 955,822 | 987,682 | **3,887,008** |
| CENPOWER - GAS | mmbtu | 1,461,023 | 1,969,265 | 1,905,725 | 1,969,265 | 1,905,725 | 1,969,265 | **11,180,269** |
| BridgePower | mmbtu | - | - | - | - | - | - | **-** |
| AKSA - HFO | barrels | - | - | - | - | - | - | **-** |
| CENPOWER - LCO | barrels | - | - | - | - | - | - | **-** |
| **Total Gas (mmbtu)** | mmbtu | 9,162,904 | 8,857,287 | 8,001,327 | 9,055,690 | 9,957,058 | 10,391,125 | 55,425,390 |
| Total LCO | barrels | - | - | - | - | - | - | **-** |
| Total HFO | barrels | - | - | - | - | - | - | |
| **Estimated Thermal Fuel Cost** | **MUS$** | | | | | | | |
| Total LCO - Cost @ US$ 60/bbl | MUS$ | - | - | - | - | - | - | **-** |
| Total Gas - Cost @ US$ 6.08/mmbtu | MUS$ | 55.71 | 53.85 | 48.65 | 55.06 | 60.54 | 63.18 | **336.99** |
| Total HFO - Cost @ US$ 84/bbl | MUS$ | - | - | - | - | - | - | **-** |
| **Total Fuel Cost** | **MUS$** | **55.71** | **53.85** | **48.65** | **55.06** | **60.54** | **63.18** | **336.99** |

## 2.1 Estimates of Fuel Cost

The breakdown of the estimated cost of fuel for running all the Thermal Plants from July 2020 is shown in Table 4.10. Based on the unit prices assumed, the total estimated fuel cost for the Thermal Plants is US$ 336.99 Million. This translates into an approximate monthly average of US$ 56.17 Million.

# 5 TRANSMISSION SYSTEM UPDATE

## 5.1 General NITS performance

The NITS has continued to provide a backbone for electricity evacuation within Ghana and to international customers within the West African sub-region. This however has not been without constraints.

An operational study carried out at the end of the second quarter confirms low voltages recorded around the Southern part of the country. The existence of low voltage at critical nodes has a direct bearing on power transfer, system losses and the ability of the grid to recover quickly during major system disturbances. The study indicates that the low voltages being experienced on the grid are primarily caused by:

- congestion in some transmission corridors,
- inadequate reactive power compensation and
- poor customer-end power factor

Congestion on the NITS is especially found in the following corridors:

- 161kV Anwomaso-Kumasi corridor
- 161kV Volta – Achimota – Mallam corridor which supplies most of the load in the Capital and suburbs
- 161kV Aboadze – Prestea – Dunkwa and 161kV Dunkwa – Ayanfuri – Asawinso corridors due to growing demand from mining loads.

Overall system losses by the end of the first half of 2020 was at 150.89 MW (5.28% of total power generated) due to the low voltages then characteristic of the NITS. In order to improve this, a simulation of the system incorporating the full complement of some ongoing transmission projects (161 kV Volta – Achimota – Mallam and 330 kV Kumasi – Kintampo) was done. The results showed that the completion of these projects would reduce losses significantly by 37.3% (56.31 MW).

The study further showed that when these lines are completed and (70% of capacitor banks) reduce overall system losses on the peak of 150.89 MW (5.28%) to 88.35 MW (3.16%). In absolute terms completing the ongoing transmission projects and restoration of at least 70% of capacitor banks could reduce losses by 62.53 MW at peak.

### 5.2 Status of Compensation Devices

Out of the capacitor bank installed capacity of 944.7 MVAr, only 267.1 MVAr (28%) is currently in service. If the percentage of capacitor banks in service is improved to 70%, there is a savings of 35MW in losses at peak. Similarly, load flow studies indicate that if capacitor banks equivalent to 90% installed capacity) are restored into operation, it will shave off 25% of the losses, about 38.15 MW in absolute terms. Consequently, it can be concluded that the restoration of capacitor banks will improve voltages significantly in the Southern section of the NITS.

The following shows an outlook for the rest of 2020. The grid will be capable of generally supplying power to the major load centres.

### 5.3 161 kV Volta – Achimota (V-H) Corridor Upgrade

The Volta–Achimota–Mallam transmission line corridor is being upgraded to improve transmission capacity for power evacuation to Accra via Tema. This is also expected to reduce transmission losses.

Works on all the tower foundations have been completed and 86 out of 103 towers erected. The overall project is about 53% complete.

The outstanding works are as follows:

- 17 towers to be erected,
- Stringing of the 26 km double circuit lines
- Decommissioning of a 66 MVA transformer at Achimota Substation.

Works are estimated to be completed in a nine-month duration and this will be effective when the ban on international travels is lifted.

To determine optimal network adjustments that will be required to eliminate congestion triggered by the works, contingency analyses have been conducted. The analyses show that in

order to allow for the construction works within the corridor to proceed, some network adjustments are required.

Firstly, upgrade of the line stretch between Volta and Accra East, a generation shift of 220 MW is required from the eastern (Tema) to the western (Takoradi) generational enclaves together with load shedding of 200 MW (50 MW from Accra East and 150 MW from Achimota).

Secondly, upgrade of any of the Volta - Achimota lines requires a generation shift of 220 MW from the eastern to the western enclaves together with load shedding of 100 MW at Achimota.

However, upgrade of the Accra East – Achimota line can be done without any network interventions. No generational shift or load shedding will be required.

### 5.4 161 kV Achimota - Mallam Upgrade

The 13 km Achimota – Mallam lines are to be upgraded. All 33 tower foundations have already been completed.

What is now outstanding is the tower erection and stringing of the conductors. Overall, the project is 31% completed. Upon resumption of work, it is projected to take a duration of six months to complete the outstanding works. Due to high loading levels in the corridor, outage on any circuit in the corridor could lead to load curtailment.

### 5.5 330 kV Anwomaso – Kintampo line

So far the project is approximately 90 percent (90%) completed. As at the end of June, 460 out of 470 towers foundation had been completed. 453 towers had been erected and 37 km out of the total 184 km had been strung.

The challenge is compensation payments to project affected persons which is estimated to be about 25 million cedis. The project is planned to be completed within 12 months.

### 5.6 Accra Fourth Bulk Supply Point (A4BSP)

This project involves the break-in of the 330 kV Aboadze – Volta line at Pokuase. The station will be equipped with 4 x 145 MVA, 330/34.5 kV transformers. All transformers have been delivered,

however installation remains outstanding due to COVID–19 related restrictions. The project is approximately 61 percent completed. The project is expected to be fully completed in June 2021.

### 5.7 Outlook for the third quarter

For the third quarter of the year, demand is expected to be low due to reduced temperatures across the country during the rainy season. There could be incidences of high voltage recorded on substation buses. It is necessary that all reactors in the northern parts of the NITS are operational. Tamale 40MVAr Statcom remains out of service due to a breakdown, so there is no dynamic voltage regulation in the North. GRIDCo loses about 10MVAr at peak in the absence of the SVC. In order to provide a good dynamic support in Tamale, the Statcom in Tamale needs to be restored.

### 5.8 Outlook for the short to medium term

In view of growing system demand, there is a need to continue to upgrade and expand the NITS in order for it to continue to provide the needed evacuation medium for Wholesale Suppliers and Load Entities within Ghana. In the medium term, a number of key projects are required.

Notable amongst them is the upgrade of the 161kV transmission corridors from Aboadze through Dunkwa to Asawinso. Prior to this, there is a need to break into the 330kV Takoradi Thermal – Anwomaso line at Dunkwa and to connect to the 161kV network at Dunkwa. This is critically required to improve voltages and enhance network reliability around Dunkwa, Ayanfuri and Asawinso. Additionally, it will reduce the severity of system instability with the loss of the 330 kV Takoradi Thermal – Anwomaso line.

The construction of the fourth bulk supply substation in Accra is on course. Following the commissioning of the substation, it will be prudent to develop a 161kV link to Mallam to create a transmission ring in the Capital. The link to Mallam will be needful upon the construction of the 161kV Kasoa substation.

# 6 CONCLUSION

The following conclusions are drawn in respect of the mid-year review of the Electricity Supply Plan for 2020:

Despite the significant impact the Covid-19 pandemic has had on social and economic activities in Ghana and across the world, it is not expected to have a significant impact on electricity demand and consumption.

Nonetheless, the Projected Coincident Peak Load for Ghana has been reviewed down to 3,061 MW from the initial projection of 3,115 MW (2020 ESP) due to low VALCO load. The new demand projection represents a growth of 9.1%, an increase of 257.02 MW over the 2019 Ghana Peak Load of 2,803.7 MW. The total projected energy consumption has however been reviewed up to 19,684.73 GWh, from 19,594.44 GWh.

Taking into consideration the total hydro generation as at the end of June 2020, the total projected hydro generation for 2020 is 7,381.1 GWh. This is made up of 5,142.5 GWh, 857.5 GWh and 1,386.5 GWh expected from Akosombo, Kpong and Bui Generating Stations respectively.

Dependable Thermal Capacity for the 2nd half-year is projected at 3,292 MW. The reviewed projected total thermal energy generation for 2020 is 12,264.5 GWh.

The total installed RE generation capacity in Ghana for 2020 is projected at 42.6 MWp. In addition, a 6 MWp (out of 17 MWp VRA Kaleo and Lawra Solar Power Plants) and10 MWp of Bui's 50 MWp project is scheduled to be commissioned in 2nd half of the year.

The reviewed total projected RE generation is 33.8 GWh. All of these utility-scale Solar PV plants are connected on the medium voltage distribution system

Total of 55.425 Million MMbtu of natural gas is projected to be consumed for the 2nd half of the year.

The total estimated fuel cost is US$ 336.99 Million. This translates into an approximate monthly average of US$ 56.17 Million.

The NITS is capable of evacuating all the power that is projected to be generated from all generating enclaves to the major load centres, however congestions can be found within some corridors such as Anwomaso-Kumasi, Volta-Achimota- Mallam, Aboadze-Prestea-Dunkwa and Dunkwa-Ayanfuri-Asawinso 161kV corridors.

In a bid to improve voltages in Nsawam and Aburi, ECG has installed a number of Voltage Regulators to improve on reliability and quality of supply. Furthermore, a number of upgrade projects have either been commissioned into service or under construction. This is to increase distribution capacity and reliability of supply customers.

Electricity distribution losses for the quarter was 26.63%, about 3.43% higher than the regulatory benchmark of 23.2%. Technical loss was about 10% whilst commercial loss was 16.63%.

# 7 RECOMMENDATIONS

Based on the above conclusions, the following recommendations are made:

a) The ongoing transmission expansion projects should be expedited and completed in 2020 to ensure that the peak demand can be supplied. These are:
   - ✓ Volta – Achimota – Mallam Transmission Line Upgrade Project
   - ✓ Kumasi – kintampo 330 kV transmission line Project

b) A well-coordinated maintenance programme should be pursued by both GRIDCo and the Generating Companies (GENCOs).

c) Fuel supply security and adequacy remains the single most important risk to power supply reliability in Ghana. In this vein, it is strongly recommended that all the relevant sector agencies stakeholders work conscientiously together to ensure that fuel supply is adequate and secure at all times.

d) In order to meet the transmission reliability indices, the following are the critical transmissions additions and upgrades are required:
   - ✓ Upgrade of 161kV Aboadze-Takoradi-Tarkwa-Prestea
   - ✓ Construction of a second 330 kV Prestea - Dunkwa – Kumasi line
   - ✓ Upgrade of 161kV Aboadze-Mallam transmission lines
   - ✓ 161 kV Mallam – A4BSP transmission line link
   - ✓ Construction of a second 330 kV Aboadze – A4 BSP circuit
   - ✓ Construction of a double circuit 330 kV line from A4BSP to Kumasi
   - ✓ Construction of a 330 kV substation at Dunkwa with a link to the existing 161 kV substation

# 8 APPENDICES

**Appendix A – Glossary**

**Appendix B – Grid Map**

## APPENDIX A: 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 part 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 pas 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, 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.

## APPENDIX B – GRID MAP