ENERGY COMMISSION, GHANA

2019 ENERGY
(SUPPLY AND DEMAND)
OUTLOOK FOR GHANA

April, 2019

Executive Summary

The Energy Commission in fulfilment of its mandate under the Energy Commission Act (Act 541, 1997) presents supply and demand forecasts for electricity, crude oil, petroleum products, natural gas and charcoal for the year 2019. Factors that could influence the demand and supply are also discussed.

Electricity

1. As at the end of 2018, the **installed electricity generation capacity** available for grid power supply at the transmission level in the country was about **4,780 Megawatt (MW)**. The installed capacity increases to **4,961.5 MW** if primary embedded generation including the two major solar power plants at the sub-transmission (distribution grid) level are added[1]. This was about 13% expansion over the installed capacity in 2017.

2. Total grid electricity generation in the country including the embedded generation[2] was **16,213.4 Gigawatt-hours (GWh),** comprising 37.1% hydro, 62.7% thermal and about 0.2% solar power. It was about 15.2% more than in 2017.

3. Including imports, the grid electricity at the **transmission**[3] **level**, was around **15,960** GWh comprising about 6,017 GWh (37.7%) from hydro generation, 9,803 GWh (61.4%) from thermal generation and about 140 GWh (0.9%) of import. It was about 11.5% improvement over gross transmission in 2017.

4. **Peak load** on the transmission grid excluding export[4], i.e. the maximum capacity utilised within the country was **2,371 MW**; roughly 14% more than in 2017. The system (maximum including exports) peak i.e. the maximum capacity utilised on the transmission grid was **2,525 MW**, which was about 15% more than in 2017.

5. The total dependable grid capacity 4,380 MW in 2018 was thus in excess of the Peak load by 755 MW.

[1] i.e. Trojan (44 MW), Genser (95 MW), BXC Solar (20 MW), Meinenergy (20 MW) and VRA Solar (2.5 MW).
[2] i.e. Trojan, Genser thermal plants and the grid-tied solar plants
[3] i.e. does not include embedded generation and solar since they are at the distribution grid level.
[4] Referred to as Domestic Peak Load by some of the utilities

6. In 2018, the average electricity end-user tariff was 70.5 Ghp (15.4 US cents) per unit of electricity (kilowatt-hour), a drop from 76.4 Ghp (17.5 US cents) per kilowatt-hour in 2017.

7. End-user tariff since the previous load shedding in 2007 to the beginning of the most recent load shedding in 2012 averaged up to 11 US cents per kilowatt-hour (kWh) whilst the end-user tariff from 2013 to 2018 averaged 17 US cents per kWh.

8. The relatively high end-user tariff is likely to have contributed to the significant surge in the installation of alternative or captive or self-electricity back-up generation largely by the non-residential and industrial customers of the utilities. The said customers apparently found the self back-up generation more cost-competitive compared to the grid as their cumulative electricity consumption units exceeded 300 units per month during the year and thus making it more attractive for the switch at that consumption level. If this trend continues, it could worsen the income and profitability of the existing electricity utility companies.

9. With the Government's projected real **GDP growth of 7.6%**[5] and particularly **6.2%** (***non-oil growth)***, the total electricity required for the expansion of the country's economy in **2019** is expected to be as follows:

   a) **17,238-18,014 GWh** (*with VALCO constrained to operate at most two potlines*). Expected peak capacity demand required would lie within **2,666-2,797 MW**. *Average End-User tariff to make it realized should be within US cents 15-16 per kWh.*

   b) **18,020-18,400 GWh** (*with VALCO constrained to operate at most two potlines*). Expected peak capacity demand required would lie within **2,800-2,900 MW**. *Average End-User tariff to make it realized should be within US cents 14-15 per kWh.*

All the two scenarios are achievable provided the following are accomplished:

i. There is adequate financial resource to procure all the fuel needed to run the thermal power plants even at higher utilisation factors; and

ii. Average end-user-tariff is reduced to within **13-15** US cents per kWh.

[5] The World Bank and the IMF projects 7-7.4% for Ghana for 2019.

Fuel for Power Generation

10. In 2018, total gas flow to the thermal power plants rose to about 55 million mmBTU (53,987 mmscf), almost 27.6% more the supply of 2017; with about 46% coming from Nigeria (27% in 2017) via the WAGP and the remaining 54% (73% in 2017) coming from Ghana Gas, i.e. the Atuabo gas processing plant. The average daily flows were about 67 mmscfd from WAGP and almost 80 mmscfd from Ghana Gas.

11. For **2019**, total gas available for power generation would be almost **80.24 million mmBTU** largely coming from the local fields. VRA power plants are expected to receive about 37.69 million mmBTU (about an average of 100 mmscfd) whilst the IPPs receive the balance of 42.55 million mmBTU (about an average of 110 mmscfd). The expected WAGP gas flow would range between **110-120 mmscfd** throughout the year, whilst an average of **150 mmscfd** could come from Ghana Gas during the first half of the year and then up to about **300 mmscfd** by close of the year due to additional increase in supplies from TEN and the Sankofa-Gye Nyame fields.

12. 1n 2018, the average delivery price of the WAGP gas was $8.71/mmBTU ($8.92/mscf) and that of the Atuabo gas was a uniform $8.53/mmBTU ($9.17mscf) throughout the year.

13. For **2019**, delivery price of WAGP would be $8.41/mmBTU ($8.72/mscf) whilst lean/dry gas or supply from Ghana Gas would sell at $7.29/mmBTU ($7.56/mscf).

14. In 2018, total cost of gas for power generation was almost **$447 million**.

15. For **2019**, the total cost of gas for power generation is estimated to cost almost **$594 million.**

16. In 2018, light crude oil (LCO) consumed by the thermal power plants for grid power production was about 346,440 barrels.

17. For **2019**, even though, no significant requirement for LCO should the anticipated, high volumes of gas from Sankofa, Jubilee and TEN fields are realised and made available timely. Nonetheless, we maintain the same volume for the year against any potential delays in gas supply and in times of unforeseen supply disruptions.

18. In 2018, the average delivery price[6] of LCO for power generation was $80 per barrel.

19. **For 2019**, it is expected that the average delivery price of the light crude would decrease to about **$70** per barrel. The total cost of LCO required would thus be about **$24.2 million**.

20. In 2018, total diesel consumed by the thermal power plants for grid power production as well as for starting and switching off the plants was about 80 thousand barrels.

21. For **2019**, it is estimated that the diesel required largely for the same exercise would remain the same and usage limited largely for starting and switching off the plants due to expected improvement in supply of gas and LCO which are cheaper alternative for power generation.

22. In 2018, the average delivery price of diesel was about $109 per barrel.

23. For **2019**, the average delivery price is expected to increase to **$110** per barrel. The total cost of the required diesel would be around **$8.8 million.**

24. HFO is the fuel being used by the Karpower Barge and the AKSA power plant for power production. In 2018, HFO consumed was about 4.4 million barrels and at an average delivery price of $60 per barrel.

25. For **2019**, it is estimated that the HFO required would be about **5.3 million barrels** (**758,390 tonnes**) at the same average delivery price of **$60** per barrel as in 2018, bringing the total cost of supply to around **$318.5 million**.

26. In all, about **$945.5 million** would thus be needed to procure **fuel** for grid or public electricity generation.

Crude oil and Petroleum products

27. Ghana's oil production in 2018 was about 62 million barrels coming from the three main commercial fields, Jubilee (46%), TEN (38%) and Sankofa-Gye Nyame (16%) compared to about 58.6 million barrels in 2017, representing an increase of about 6% over the previous year. Average daily production for the year was about 186,000 barrels as against

[6] i.e. including transportation and treatment.

175,000 barrels in 2017, but still below the targeted average daily production of about 250,000 barrels.

28. In 2018, crude oil production from the Jubilee field again dropped to about 28.5 million barrels from 33 million barrels in 2017. Corresponding average daily production equally dropped from an average of 91,382 barrels in 2017 to 87,844 barrels in 2018.

29. For **2019**, average crude production from Jubilee is likely to increase to within **90,000-92,000** barrels per day.

30. In 2018, total oil production from the TEN field rose from 20.4 million barrels in 2017 to 23.6 million barrels. The corresponding average daily production increased from about 59,300 barrels in 2017 to about 64,000 barrels.

31. For **2019**, average daily crude production from the TEN field is expected to increase to the range of **70,000-71,000** barrels per day.

32. In 2018, crude oil production from the Sankofa-Gye Nyame field[7] was about 10 million barrels, about double the production in 2017. Corresponding average daily production equally rose to 27,500 barrels from 12,000 barrels in 2017.

33. For **2019**, the Sankofa field average daily crude production is expected to fall within the range of **30,000-33,000** barrels per day.

34. In 2018, the average price of Brent crude on the global market increased to $71.5 per barrel from about $52.4 per barrel in 2017, about 36% rise from the previous year.

35. For **2019**, the average price at which Ghana would source Brent crude is expected to decrease from $71.5 per barrel in 2018 to **$65-67** per barrel. The average price for other light crudes for refinery operations would also decrease from $63 per barrel in 2018 to within **$59-61** per barrel. Average delivery price for light crude oil for power generation would increase from **$70** per barrel to **$69-71** per barrel.

36. In 2018, crude oil from the Jubilee field was sold at $70.6 per barrel ($52.8 per barrel in 2017). Those of the TEN and the Sankofa-Gye Nyame fields in 2018 were sold at an

[7] Also called OCTP (Offshore Cape Three Point) field

average price of $71.6 and $72 per barrel compared with $49.3 and $48 per barrel in 2017 respectively.

37. For **2019**, average oil price from the **Jubilee field** is likely to drop to within **$66-68** per barrel whilst those of TEN and Sankofa fields would also rise but both would range from **$68-70** per barrel.

38. In 2018, total petroleum products pumped into the economy increased to 3.9 million tonnes from 3.5 million tonnes in 2017.

39. For **2019**, total petroleum products required would continue to increase, ranging from **4-4.2 million tonnes**, equivalent to **75,000-80,000** barrels per stream day refinery capacity. It would still largely comprise gasoline about 33-34% and diesel of about 45-47% (*excluding products directly destined for the grid power generating plants*).

40. In 2018, LPG supplied rose to almost 397 tonnes from around 359,000 tonnes, about 15.5 percent higher than in 2017. About 77% was imported and the rest from local production. About 20% of the local supply came from the Atuabo Gas Processing Plant which is producing LPG as by-product from processing the wet associated gas from the local fields into dry gas largely for electricity generation. Production from Tema Oil Refinery was just around 3%.

41. In 2018, about 4,800 tonnes (3% of supply) of LPG was exported, a drop from about 40,000 tonnes exported in 2017; 11% of total supply that year.

42. For **2019**, the Government's 7.6% GDP growth *(6.2% non-oil*) for the year would require **410,000-420,000 tonnes** of LPG of which about 30% is likely to come from the Atuabo gas processing plant. Imports could still dominate since TOR is not likely to operate at full capacity largely due to financial challenges. There is still the growing demand for LPG as cooking fuel in homes and particularly as transport fuel.

Charcoal

43. In 2018, the average prices of charcoal in the country followed the historical increasing trend; for the mini-bag it rose to GH¢27.6 from about GH¢25 per bag in 2017 whilst for the maxi-bag, it increased from about GH¢38 in 2017 to about GH¢41.
44. The overall average percentage change in 2018 for the maxi-bag however remained about the same as in 2017. The average percentage change for the mini-bag on the other hand dropped by about half; from over 20% in 2017 to about 10% in 2018.
45. As usual, the high-price zones were along the coast; Greater Accra, Central and Volta Regions. The low-price areas are still the transitional regions of Brong Ahafo, Northern and Upper West regions followed by the forest regions of Ashanti, Eastern and Western.
46. For **2019**, we expect charcoal consumption to increase due to relatively high prices of LPG. We however do not expect average charcoal prices to increase over more than 5%. At worst it would grow at the same rate as the national inflation for the year.

Recommended Actions

Ameliorating the overall power supply shortage

47. For 2019, Akosombo Generating Station **would be required to operate three to four generating units during the off-peak period and up to five units during the peak period**. This mode of operation is expected to result in operating capacity of up to 750 MW, which would ensure that the reservoir level is kept above the minimum operating level of 240ft (73.15m). This mode of operation would result in a projected minimum elevation of 253ft (77.11m) at the end of the dry season in 2019.
48. Kpong hydroelectric station which is currently undergoing retrofit, **would continue to run three out of the four total installed turbine units.** Consequently, the total average plant output at the Kpong Station would remain at 105 MW.
49. 1n 2019, Bui hydropower plant is expected to operate an average of two turbine units throughout the year. This mode of operation would lead to a projected annual production of 660 GWh and is expected to ensure that its reservoir level would be about 5 metres above its target minimum level of 170 metres-high compared to its 168m-minimum

operating level. It is **estimated that for continuous and sustainable operation of the Bui Power Station for 2018** and for the subsequent years (in the likely event of low inflows), **the reservoir level at the end of the dry season of 2019 should not drop below its 170 m elevation**.

50. **For 2019,** as a result of the operations of the three hydropower plants, the expected total annual electricity generation from hydropower would not exceed **5720 GWh.**

51. Failure to adhere to the plan for hydropower production could significantly compromise reservoir integrity for subsequent years.

52. Crucial requirements for reliable power supply are the availability of the required plant capacities, quantities of fuel and funds to purchase the required fuel in a timely manner.

53. Inadequacy fuel when it is required and gas pricing remain the major risks to reliable electricity supply in Ghana. The present installed capacity is capable of generating over 20,000 GWh, which is enough to meet the country's electricity requirement including supressed demand, should there be adequate and cost-competitive fuel. The key challenge however is competitive grid electricity tariff.

54. The fuel supply challenge also has to do with financing besides technical constraints. It is therefore necessary to arrange to secure the needed funds to purchase the needed quantities of fuel on time.

55. Furthermore, **there is also the need to pay off any indebtedness to fuel suppliers** so that the required volumes would be obtained for thermal generation timely.

Cash Waterfall Mechanism

56. Energy Sector arrears and debt situation was about $4 billion at the 2018, i.e. has doubled since 2017. Most of the debt have been due to short term loan contracted by the power producers culminating in the 'take or pay' and the distribution utilities' inability to collect adequate revenue to cover their operations. The Power subsector debt alone is increasing by about $100 million every quarter.

57. Most of the debt were due to short term loans contracted by the power producers and the distribution utilities' inability to collect adequate revenue to cover their operations. Persistent untimely and insufficient payments for gas delivered also contributes to the huge debt burdens of the gas off-takers, most of them public entities.

58. In order to address the chronic debt challenges and to facilitate equitable distribution of all cash collected in the power sector value chain using the end user tariff as a basis, the Cash Waterfall Mechanism (CWM) concept was instituted in 2016. It was to be implemented through the development of a formula, for adequate distribution of revenue to all stakeholders in the power sector value chain. Ever since, the CWM has still not been operational.

Achieving 50% nationwide penetration of LPG

59. National LPG penetration rate increased from 6% in 2000 to 18% in 2010 and could be around 25% currently. Consumption has however slowed down relative to charcoal consumption for the past two years due its comparatively high prices compared to the charcoal.

60. The sector ministry is targeting 50% LPG penetration by 2020 but it is not likely to be achieved if limited distribution outlets nationwide remain the same and the its price continue to remain high.

61. The LPG consumption growth could surpass charcoal consumption again by implementing deliberate government policy not only to make the LPG produced available for local consumption as against export but **producing LPG adequately to cover both local consumption and for export** taking advantage of the market opportunities within the West Africa sub-region.

62. In addition, constructing LPG storage and supply infrastructure in all regional and district capitals in the long term.

63. In this light, the Ministry of Energy and the National Petroleum **Authority need to consider investment incentives** to encourage the Oil Marketing Companies and other

interested investors to set up more LPG storage and distribution centres in-country to increase access and consumption.

64. There would also be the need to re-capitalising Ghana Cylinder Manufacturing Company (GCMC) to expand production capacity with the production of cylinders focused on small sized cylinders that would be portable and affordable to households in rural communities. Such can be achieved through private sector participation through Public-Private Partnership (PPP).

Expanding Crude Oil Strategic Reserve

65. Fuel supply security and erratic fuel prices have compelled countries to set up strategic stocks both for crude oil and refined products. Crude oil storage however, has the comparative advantage of far longer lifespan and could even be indefinite depending upon the blend and state. Many developed countries have such storage mix and for OECD countries, minimum of six month storage is mandatory.

66. The Commission would continue **to recommend for the inclusion of crude oil** in the country's strategic reserve.

Expanding crude refining operations

67. Equivalent of 75,000-80,000 barrels per stream day refinery capacity would be required to enable the country meet its projected economic growth for 2019. Tema Oil Refinery (TOR)

68. However, low capacity utilisation of TOR which has not made the facility profitable to operate in the past should not be lost in sight in future operations though still dependent on the production configuration. Profit could start emerging as the capacity utilisation increases, in most cases 90% and above.

Preface

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

In fulfilment of its mandates, the Commission has been preparing annual energy demand and supply outlook to provide guidelines to the energy sector operators and potential investors as well as the wider business community wishing to operate in the country. The purpose of the 2019 Annual Energy Outlook therefore is to give government, industry and business, indications of the levels/quantities of electricity, liquid and gaseous fuels that would be required to be provided by the energy producers for this year.

This document covers demand and supply of electricity, crude oil, petroleum products, natural gas as well as charcoal.

In the document, 'Demand' is used when referring to gross fuel or energy required by a demand sector, e.g. Residential, Commercial, or Industry. 'Supply Requirement' is Supply or Generation/Production plus transmission/transport losses.

For further elaboration, please refer to Annex 1 of the document for a schematic overview of Ghana's Energy Demand and Supply System.

This report was prepared by the Strategic Planning and Policy Directorate of the Energy Commission.

General questions about the report should be referred to Dr. A.K. Ofosu-Ahenkorah, (oahenkorah@energycom.gov.gh, ahenkorah@gmail.com) the Executive Secretary. Specific questions about the content may be directed to Dr. Joseph Essandoh-Yeddu (essandohyj@energycom.gov.gh, jeyeddu@gmail.com), Director for Strategic Planning and Policy.

Your comments are most welcome.

A. K. Ofosu-Ahenkorah

Executive Secretary

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Acronyms

GDP	Gross Domestic Product; *measure of wealth of an economy of a nation.*
LPG	Liquefied Petroleum Gas
Solar PV	Solar Photovoltaic; *panel technology for electricity via solar or sunshine*
GWh	Gigawatt-hour, i.e. *million units of electricity*
kWh	Kilowatt-hour, i.e. *one unit of electricity*
MWh	Megawatt-hour, i.e. thousand unit of electricity
NG	Natural Gas
LNG	Liquefied Natural Gas; *natural gas liquefied about 600 times*
mmBTU	Million British Thermal Unit; *an energy unit for gas flow*
mscfd/mcfd	Thousand standard cubic feet per day/ Thousand standard cubic feet per day; *a volumetric unit for gas flow*
mmscfd/mmcfd	Million standard cubic feet per day/ Million standard cubic feet per day; *a volumetric unit for gas flow*
bscfd/bcfd	Billion standard cubic feet per day / Billion standard cubic feet per day; *a volumetric unit for gas flow*
Tcf/tscfd	Trillion standard cubic feet per day / trillion standard cubic feet per day; *a volumetric unit for gas flow*
IPP	Independent Power Producer
BOST	Bulk Oil Storage and Transport company, a state company supposed to manage the country's strategic reserve
ECG	Electricity Company of Ghana, a public power distributor
TAPCO	Takoradi Thermal Power Company, a public power generator
TICO	Takoradi International Company, a public power generator
TOR	Tema Oil Refinery, the only crude oil and public refinery in the country.
VRA	Volta River Authority, a public power generator
VALCO	Volta Aluminium Company, a smelting company
WAGP	West African Gas Pipeline
WAGPCo	West African Gas Pipeline Company

1.0 Power Subsector

1.1 Overview of Grid Power Supply in 2018

Installed generation capacity available for grid power supply at the transmission level as at the end of 2018 was about **4,780 Megawatt** (MW).

It totalled **4,961.5 MW** if primary embedded generation including the listed solar plants[8] at the sub-transmission level are included. This was about 13% expansion over last year's compared to 33% increment from 2016 to 2017. The **dependable capacity** on the other hand was almost 15% more than in 2017 (*see Table 1*).

The 20 MW BXC Solar, 20 MW Meinenergy Solar[9] and 2.5 MW VRA Solar are grid-tied plants connected at the distribution level, just as the Trojan and the Genser power plants.

The **gross grid generation** in the country including the embedded generation[10] in 2018 was **16,213 Gigawatt-hours** (GWh), about 15.2% more than in 2017, comprising 37.1% hydro, 62.7% thermal and about 0.2% solar power. It increased to **16,353 GWh** if imports was added.

Without the primary embedded generation, the country's gross generation in 2018 was **15,820.5 GWh**, about 13.1% more than in 2017, comprising 38.0% hydro, 62.0% thermal power.

Grid electricity made available for **gross transmission**[11], during the year however was around **15,960 GWh** consisting of about 6,017 GWh (37.7%) from hydro generation, 9,803 GWh (61.4%) from thermal generation and about 140 GWh (0.9%) of import. It was almost 11.5% improvement over 2017. Supply in 2017 was about 4.45% more than in 2016.

Power import from la Côte d'Ivoire (CIE) reached a peak of 135 MW whilst export peak was 45 MW during the year. Exports to Togo/Benin (CEB) and Burkina Faso (SONABEL) on the other hand, reached a maximum of 141 MW and 101.38 MW respectively.

A total of about **385 GWh** of electricity was exported to Togo and Benin whilst about **277 GWh** was also exported to Burkina Faso. A net of about **217 GWh** was exchanged between Ghana and Cote d'Ivoire. This was made up of about 140 GWh imports and about 77.5 GWh exports.

Total grid electricity supplied to the economy[12], was about **15,646 GWh** including about 0.9% net imports (140 GWh)[13] and about 0.2% solar (34 GWh). It was about 9% increase over 2017 but 4% less than the minimum projected requirement of 16,300 GWh for the year.

[8] This does not include embedded or captive back-up generation.
[9] The 20 MW Meinenergy was commissioned in 2018.
[10] i.e. Trojan, Genser thermal plants and the grid-tied solar plants
[11] Total generation, less own-use plus total imports. Does not include embedded generation and solar since they are at the distribution grid level.
[12] Total generation + the net imports – transmission losses.
[13] Total imports less wheeled from CIE to CEB.

Table 1: Installed Grid Electricity Generation Capacity operational as of December 2018

GENERATION PLANT		FUEL TYPE	CAPACITY (MW)				TOTAL GENERATION		
			Installed (name plate)	% Share	Average Dependable	Average Available	GWh	% Share (incl.embedd)	% Share (exl.embedd)
Hydro Power Plants	Akosombo	Hydro	1,020		900	505	4,273	*26.4*	*27.0*
	Bui	Hydro	400		360	343	974	*6*	*6.2*
	Kpong	Hydro	160		140	118	771	*4.8*	*4.9*
		Sub-Total	***1,580***	***32® 33#***	***1,400***	***966***	***6,017***	***37.1***	***38.0***
Thermal Power Plants[14]									
Takoradi Power Company (TAPCO)		Oil/NG	330		300	213	730	*4.5*	*4.6*
Takoradi Inter. Company (TICO)		Oil/NG	340		320	310	2,211	*13.6*	*14*
Sunon–Asogli Power (SAPP)		NG	560		520	250	1,970	*12.1*	*12.5*
Kpone Thermal Power Plant(KTPP)		Oil/DFO	220		200	90	317	*2*	*2*
Tema Thermal Plant1 (TT1P)		Oil/NG	110[15]		100	60	314	*2*	*2*
Tema Thermal Plant2 (TT2P)		Oil/NG	80		70	2	3	*0.0*	*0*
CENIT Energy Ltd (CEL)		Oil/NG	110[12]		100	1	2	*0.0*	*0.0*
AMERI		NG	250		230	120	873	*5.4*	*5.5*
Karpower		HFO	470		450	315	2,556	*15.8*	*16.2*
AKSA		HFO	370		350	100	748	*4.6*	*4.7*
Cenpower		Oil/NG	360		340	50	79	*0.5*	*0.5*
		Sub – Total	***3,200***	***67***	**2,980**	**1,511**	**9,803**	*62.7*	*62*
	Trojan*	Diesel/NG	44		40	0	0	*0*	-
	Genser*	Coal/LPG	95 *(22⁺)*		85	45.5	359	*2.2*	-
Sub-total (including embedded generation)			***3,339***	***67***	***3,105***	***1,557***	***10,162***	***62.7***	
Renewables*	VRA Solar	Solar	2.5		1.5	0.8	3.0	0.02	
	BXC Solar	Solar	20		16	10	27	0.17	
	Meinenergy	Solar	20		16	10	4	0.02	
	Safissana	Biogas	0.1		0.1	0.1	0.1	0	
		Sub – Total	***42.5***	***1***	33.6	20.9	***34.1***	***0.2***	
Total *(including embedded generation+ Solar)*			**4,961.5 *(4888.6)***		**4,538.6**	**2,543**	**16,213.5**		
Total *(excluding embedded generation and solar)*			**4,780.5**		**4,380**	**2,477**	**15,820.5**		

*NG is Natural gas. * Sub-transmission (primary embedded) connection. ® Including embedded generation and solar. # Excluding embedded generation and solar. ⁺Genser is 22 MW connected to the grid but total installed capacity is 95MW (Ghana Wholesale Electricity Monthly Market Bulletin, December, 2018, Page 7, www.energycom.gov.gh/emop)*

[14] TAPCO is Takoradi Power Company, a combined cycle (CC) thermal plant; TICO is Takoradi International Power Company, a single cycle (SC) thermal plant.

[15] Nameplate as licensed by Energy Commission is 126 MW.

The net grid electricity supplied[16] to the country was about **14,906 GWh**; about 1,461 GWh (about 11%) more than in 2017.

Peak load on the transmission grid excluding export[17] was **2,371 MW**; 294 MW, roughly 14% more than in 2017 and was about 3% above the minimum range of **2,150-2,300 MW** projected for 2018.

The total (maximum) system peak on the transmission grid[18] was however **2,525 MW**, which was about 1.51 MW (0.6%) more than what was projected but 333 MW (about 15%) more than in 2017.

Total power transmission loss in 2018 was 4.4% of gross transmission, 0.3 percentage point higher than in 2017 (*see Table 2*).

Table 2: Grid Power Transmission losses since 2009

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Transmission losses as % of gross transmission	3.8	3.7	4.7	4.3	4.4	4.3	3.8	4.4	4.1	4.4

1.1.1 State of the Generation Sources in 2018

The Hydro generation

Akosombo and Kpong

Akosombo was made to produce about 4,273 GWh against projected supply of 3,600 GWh about 18.7% more than estimated[19].

The Volta Lake started the year 2018 at an elevation of 251.34ft (76.61m), about 16.34ft (5.01m) above the Extreme Minimum Operating level of 235ft (71.6m).

Based on this low reservoir elevation, it was recommended to operate three (3) and five (5) units at off-peak and peak respectively. Following the implementation of the above recommendation, the reservoir elevation dropped to a minimum of 242.96 ft (74.03 m) during the dry season in 2018. This elevation was 0.96 ft (0.03 m) higher than the projected for the year. Figure 1 shows the Akosombo reservoir trajectory recorded for 2018.

[16] Gross grid electricity plus imports, less wheeled, less exports, less transmission loss.
[17] Referred to as Domestic Peak Load by some of the utilities
[18] Ghana Peak load + Exports
[19] Projected for Akosombo was 3,600 GWh and for Kpong was 600 GWh in 2018 Electricity Supply plan, p4.

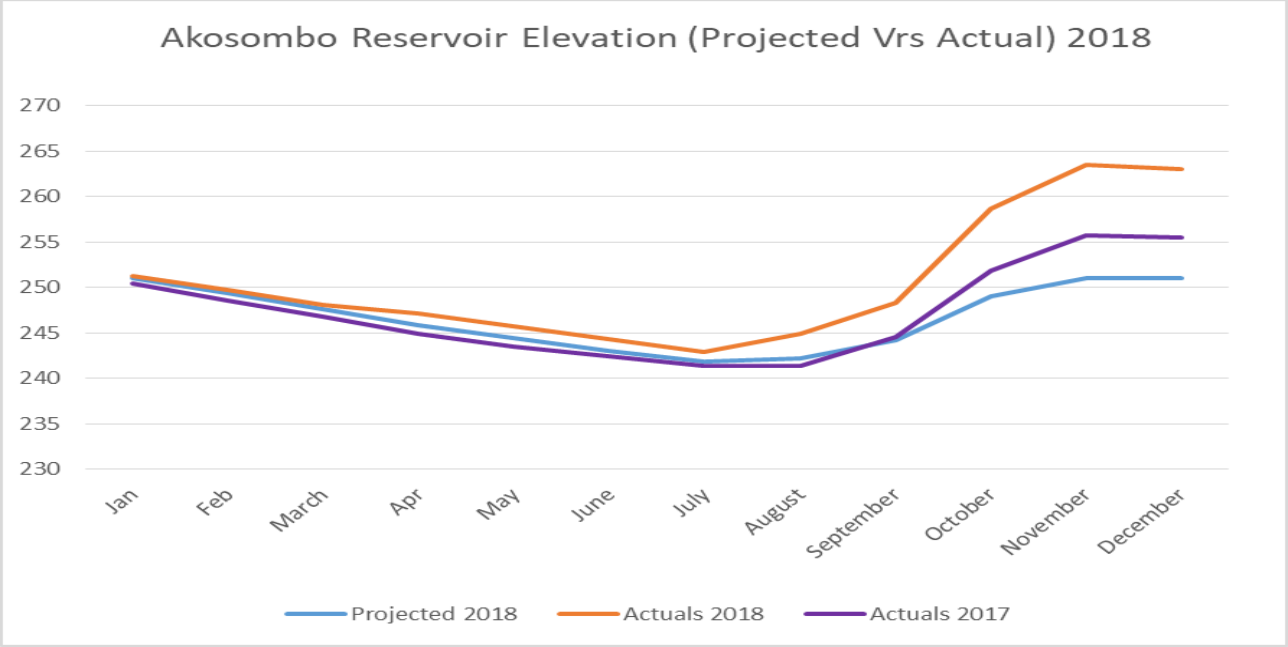

Figure 1: Akosombo Reservoir Trajectory for 2018

The reservoir elevation at the end of 2018 was 261.85 ft, (79.8 m) representing an increase of 10.85 ft (3.3 m) above the projected of 251.0 ft (76.5 m) for the year. The recorded maximum lake elevation at the end of 2018 inflow season was 263.67 ft, (80.3 m) a rise of 23.67 ft (7.2 m) above the regular Minimum Operating Level of 240 ft (73.2 m). The total net inflow recorded in 2018 was 40.01 MAF (million acre feet), which implied that an above average inflow was obtained in 2018[20].

Kpong Hydroelectric Station which is currently undergoing retrofit, as expected ran three (3) out of the four (4) total installed turbine units resulted in an average plant output at Kpong Station at 105 MW.

As a result of the two hydroplants operations, the projected total annual electricity generation from Kpong and Akosombo hydropower Stations was 4,200 GWh but it was exceeded by about 6% more.

Bui Hydro

In 2018, Bui hydropower plant was projected to operate an average of two turbine (2) units throughout the year. This mode of operation of the Bui Hydro was expected to lead to a projected

[20] Long term average inflow into Akosombo is about 30.6 MAF or 37,600 million cubic metres.

annual production of 756 GWh and was expected to ensure that its reservoir level would be about 5 m above its target minimum level of 170 metres-high compared to its 168 m-minimum operating level to guarantee continuous and sustainable operation of the dam for 2018.

Bui reservoir started the year at an elevation of about 175.01 MASL[21] and dropped to 169.10 MASL at the end of the dry season thus about 1.56 MASL below the projected minimum of 170.66 MASL for the year 2018due to over-drafting of the lake in the first quarter to make up for power deficit in the country.. The reservoir attained a maximum level of 181.10 MASL and ended the year with an elevation of 177.01 MASL. Figure 2 shows the Bui reservoir trajectory in 2018.

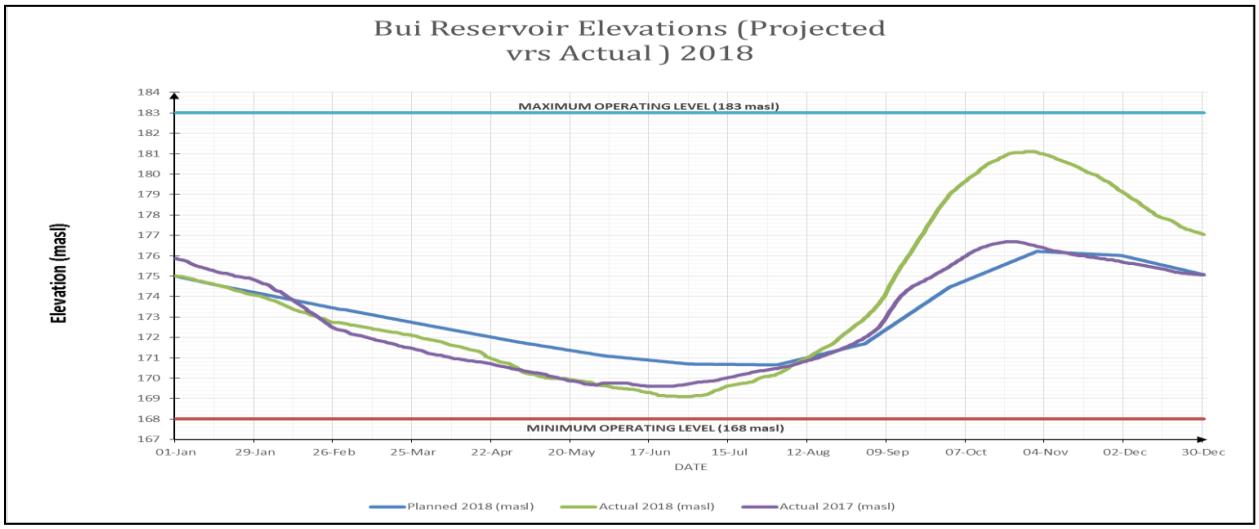

Figure 2: Bui Dam reservoir trajectory in 2018

The total generation was 973.54 GWh compared to the projected of 754 GWh[22]. The higher than projected generation was due to higher than average inflows into the reservoir in the flood season of 2018, forcing a revised strategy to avoid the spillage of the Bui reservoir leading to a much higher than anticipated generation.

Thermal Generation

Total installed thermal generating capacity as at the end of 2018 was about 3,200 MW of which 3,000 MW was the Dependable Capacity; excluding the embedded generation (*see Table 1*).

Total grid electricity generated from the thermal plants excluding the embedded generation was 9,803 GWh which was about 13% less than what projected for 2018 and this was attributed to

[21] masl is metres above sea level.
[22] 2017 Electricity Supply Plan, p4

inadequate gas supply from the WAGP and GNGC[23] (Ghana Gas) coupled with the inability of the thermal entities to purchase adequate liquid fuels to run the thermal plants just as it were in 2017 and 2016 *(see Figure 3).*

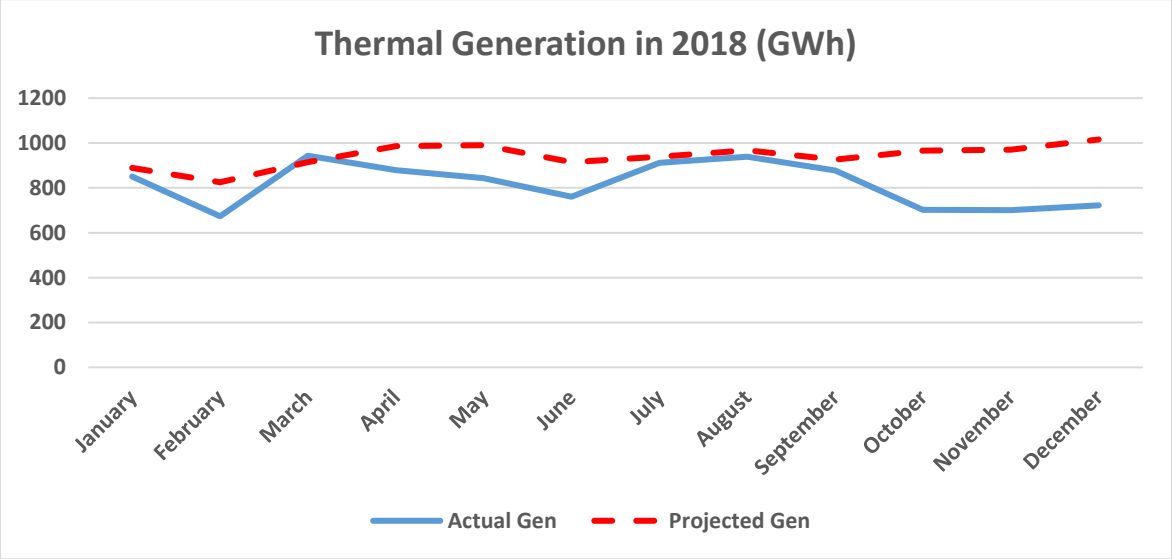

Figure 3: Total Grid Electricity Generation from Thermal Power Plants in 2018

Embedded and Distributed Generation

Grid-tied imbedded generation at the distribution level accounted for 4% (*181.5 MW*) of installed capacity and 2% of generation *(393 GWh*) in 2018.

Electricity from distributed back-up generation in 2017 was estimated at 3,600 GWh comprising 3,072 GWh from diesel, 420 GWh from petrol generation and 108 GWh from solar[24]. This was equivalent to generation from about 500 MW combined cycle thermal power plant.

Renewable Energy Generation

Renewable Energy installations increased from about 43 MWp in 2017 to about 71 MW in 2018. The most significant installation during the year was the 20 MWp grid-tied Solar PV utility system near Winneba in the Central Region bringing the total grid-tied at the distribution level to 42.8 MW.

[23] Ghana National Gas Company
[24] A nationwide survey by Energy Commission and METSS of USAID, Ghana, December, 2017

Electricity Exchanges (Export and Import)

An average of 15 MW of power was exported to la Côte d'Ivoire (CIE) in 2018. The maximum export was 45 MW whilst import from CIE reached a peak of 135 MW during the same period.

In terms of electrical energy, this was made up of 77.48 GWh exports and 139.69 GWh imports. In a nutshell, an aggregate of 217.17 GWh was exchanged between Ghana and Côte d'Ivoire.

Also, a maximum of 141 MW was exported to Togo and Benin (CEB) whilst export to Burkina Faso (SONABEL) totalled 101.38 MW. These translated into a total of 384.95 GWh and 277.07 GWh of exports to Togo/Benin (CEB) and Burkina Faso (SONABEL) respectively.

1.2 2018 Forecast and Actuals

For 2018, three scenarios were projected[25]:

a) **16,300 -17,200 GWh** (*with VALCO constrained to operate at most two potlines*). Expected peak capacity demand required would lie within **2,150-2,300 MW**. *Average End-User tariff to make it realized should be within US cents 14-15 per kWh.*

b) **17,236 -18,400 GWh** (*with VALCO constrained to operate at most two potlines*). Expected peak capacity demand required would lie within **2,200-2,400 MW**. *Average End-User tariff to make it realized should be within US cents 13-14 per kWh.*

c) **18,400-19,500 GWh** (*with VALCO to operate at most, two potlines*). Expected peak capacity demand required would lie within **2,400-2,600 MW**. *Average End-User tariff should be within US cents 11-13 per kWh.*

We indicated that all the three scenarios (a), (b) and (c) were achievable provided the following were accomplished:

i. There was adequate financial resource to procure all the fuel needed to run the thermal power plants even at higher utilisation factors; and

ii. Average end-user-tariff was reduced to within 10-15 US cents per kWh.

The total grid electricity supplied inclusive of embedded generation in 2018 was about 16,213 GWh which fell within scenario (a) projection. The average end-user tariff was 15.4 US cents per kWh which is just about 0.4 US cents outside the scenario (a) projection.

[25] that all things being equal

The economic growth for 2018 was 6.3% (for oil) and 6.5% (non-oil) were also somehow comparable to the Government's projected GDP growth rate of 6.8% (*oil growth)* and maximum of 6% (for non-oil) for the year.

Fuel Supply Issues

In 2018, there was about 5% (*6% in 2017*) drop in electricity supplied against what was projected (*see Table 3*). Even though, the drop in grid electricity demand also led to reduction in fuel demand, inadequate stocks of liquid fuels (LCO and diesel) at the thermal plants compelled the hydro plants to be operated beyond (21%) over the projected (*see Table 3*).

Table 3: Projected and Actual Generation of the Power Plants at Transmission level in 2018

Generation Source	Fuel type	Generation (GWh)			Remarks
		Projected	Actual	Net	
Hydro Power Plants					
Akosombo	Hydro	3600	4,273	673	To make up for inadequate thermal supply
Bui	Hydro	756	974	218	
Kpong	Hydro	600	771	171	
Sub-Total		***4,956***	***6,018***	***1,062***	
Thermal Power Plants[26]					
Takoradi Power Company (TAPCO)	Oil/NG	1,457	730	-727	Maintenance & fuel issues
Takoradi Inter. Company (TICO)	Oil/NG	2,155	2,211	56	Within range
Sunon–Asogli Power (SAPP2)	NG	1,466	1,970	504	
Kpone Thermal Power Plant (KTPP)	Oil/DFO	369	317	-52	Back up
Tema Thermal Plant1 (TT1PP)	Oil/NG	353	314	39	Back up
Tema Thermal Plant2 (TT2PP)	Oil/NG	0	0	0	Fuel issue
CENIT Energy Ltd (CEL)	Oil/NG	381	2	-379	Fuel issue
AMERI	NG	797	873	76	Within range
Karpower	HFO	2,709	2,556	152	Within range
AKSA	HFO	558	748	189	
CenPower	Diesel/NG	1,061	79	982	Test-run mode
Sub – Total		***11,306***	***9,800***	***-1,124***	
Total		***16,652***	***15,818***	***-62***	

[26] TAPCO is Takoradi Power Company, a combined cycle (CC) thermal plant; TICO is Takoradi International Power Company.

The total hydropower reservoir was over-drafted to make up for power deficit arising from the gas supply shortfall from Ghana Gas[27]; an offset which could have been addressed with thermal generation to maintain the integrity of the reservoirs.

The thermal generation on the other hand dropped by 13% just as in 2017, and was largely due to the inability of the generating entities to finance fuel purchases.

Thus about 6.3 million barrels of liquid fuels (about 15.5 cargoes) projected dropped to about 4.8 million barrels (about 12 cargoes), a drop of about 23% (*see Table 4*). About seven and half LCO cargoes projected reduced to less than a cargo[28].

Table 4: Projected and Actual fuel used by the thermal power plants in 2018

THERMAL POWER PLANTS	FUELS							
	GAS		LCO		DFO		HFO	
	1000 mmscf		Bbls					
	Projected	*Actual*	Projected	*Actual*	Projected	*Actual*	Projected	*Actual*
TAPCO	11.996	*7.135*		*7,658*		*390*		
TICO	13.988	*15.952*	596,986	*171,484*		*977*		
AMERI	8.095	*8.654*						
SAPP	13.194	*15.145*		*16,775*				
TT1PP	4.204	*3.422*						
CENIT		*0.026*	885.658					
TT2PP		*0.029*						
MRP								
KARPOWER	10.945						1,977.045	*3,421,590*
TROJAN								
KTPP	4.394	*1.899*				*71,154*		
AKSA							1,203.328	*986,077*
CENPOWER			1,512.221	*150,522*		*7,702*		
Total	**66.816**	***52.261***	**2,994,865**	***346,440***	**100,000**	***80,223***	**3,180,373**	***4,407,676***
Esti. Cargos[29]			*≤ 7*	***<1***	***<1***	***<1***	***~8***	***~11***
Delivery Price US$/bbl			**75**	***80***	**84**	***109***	**58**	***60***

Heavy fuel oil (HFO) was destined for Karpower and AKSA plants just as last year but was above the projected eight cargos by four more. Importing more HFO was apparently more favoured than LCO due to its lower price irrespective. Although, diesel (DFO) is largely used for starting and

[27] A similar instance in 2017
[28] Based on a usual cargo size of 405,000 barrels.
[29] Estimated cargo ships; about 405,000 bbls per cargo.

stopping the thermal plant operations, about 89% went to operate KTPP as a back-up plant and around 10% went to Cenpower for the latter's test-runs during the year.

Total lean gas supplied in 2018 for electricity production was 55,336,941 mmBTU comprising 54% indigenous sources, i.e., supply from Ghana Gas and the remaining 46% import from Nigeria, i.e. WAGP supply (*see Table 5).* This was about 27.6% increase over supply in 2017.

Total gas supply from Ghana Gas was about 34 million mmBTU in 2018, about 3% drop from 2017. Average daily gas flow from Ghana Gas also dropped from about 81 mmscfd to 80 mmscfd, about 2% less. Daily flow during the first quarter averaged 61.5 mmscfd, a drop from about 109 mmscfd in the last quarter of 2017. The average gas flow in the first quarter then ramped up to about 98 mmscfd during the second quarter then dropped again to about 90 mmscfd and continued to drop to about 70 mmscfd in the last quarter. As usual, whilst the Ghana Gas supply (accounting for about 61% of total supply) was to the power plants located at the Takoradi power plants enclave, the WAGP supply (accounting for the remaining 39%) was destined to the Tema enclave.

Table 5: Monthly and Daily Natural Gas Supply for Electricity Production in 2018

Month	Ghana Gas Supply		WAGP Supply		Daily flow in mmscf	
	Monthly flow in mmBTU	Daily flow in mmscf	Monthly flow in mmBTU	Daily flow in mmscf	Takoradi Enclave	Tema Enclave
January	3,325,470.20	104.66	1,095,925	34.49	91.25	33.84
February	36,553.84	1.27	1,146,451	39.95	29.77	4.80
March	2,497,788.81	78.61	2,493,117	78.46	84.83	57.12
April	3,158,980.99	102.73	2,187,821	71.15	91.29	66.87
May	3,337,603.01	105.04	1,718,413	54.08	94.40	52.54
June	2,637,739.22	85.78	1,415,246	46.02	72.16	42.71
July	3,275,283.28	103.08	2,694,889	84.81	87.57	79.67
August	2,583,001.77	81.29	2,840,884	89.41	90.16	83.91
September	2,599,737.71	84.54	2,703,492	87.92	87.32	83.73
October	2,599,737.71	81.82	2891235.93	90.99	66.67	54.46
November	1,730,555.21	56.28	2237811.92	72.77	117.35	55.95
December	2,236,857.45	70.40	1892346.66	59.55	125.88	54.84
Total	***30,019,309***		***25,317,632***			
Average	***2,501,609***	***79.62***	***2,109,803***	***67.47***	***86.55***	***55.87***

Total gas flow from WAGP improved considerably from about 11.7 million mmBTU in 2017 to over 25 million mmBTU in 2018. Average daily flow for the entire year improved from about 30 mmscfd, in 2017 to about 67 mmscfd. The average daily flow during the first quarter of the year was 51 mmscfd, about 25% increase from the last quarter of 2017. It increased marginally to 57 mmscfd in the second quarter, then jumped to 87% by end of the third quarter, but dropped to an average of about 74 mmscfd during the last quarter of the year.

Fuel Cost

In 2018 and unlike 2017, all the prices of the liquid fuels purchased purposely for power generation were above the projected; an increase of about 6.7% for the LCO, about 30% increment for the diesel and for HFO, it was about 3%.

Average WAGP delivery gas price to VRA the foundation customer was $8.71 per mmBTU in 2018; about 1% increase from 2017. It averaged $8.58 per mmBTU during the first quarter, increased to $8.61 per mmBTU in the second quarter, then $8.79 during the third, then reaching $8.81 per mmBTU in the fourth quarter of the year.

The average delivered price of gas from Ghana Gas on the other hand was $7.53 per mmBTU throughout the year, about 13.5% lower than the WAGP gas. The first quarter average was $8.58 per mmBTU same as the WAGP gas, then dropped and remained at $7.29 per mmBTU for the rest of the year.

In all about, $905 million was estimated for fuel procurement; US$ 417.4 million (i.e. 46%) for oil fuels and about $487 million (54%) for gas. However, only about 83% of it amounting to $747.5 million could be secured for the fuel purchases. Thus the gas purchased was 17% less and total liquid fuels were 12% less than the estimated requirement. Based on the original projected fuel prices, only $691.8 million would have been needed, but the relatively high actual prices shot up the actual expenditure on fuel to about $747.5 million, i.e. about $55.7 million more (*see Table 6*).

Table 6: Costs due to Projected and Actual Price of the fuels in 2018

	GAS		**LCO**		**DFO**		**HFO**	
	Projected	**Actual**	**Projected**	**Actual**	**Projected**	**Actual**	**Projected**	**Actual**
Price US$/unit	7.29	8.07	75	80	84	109	58	60
Fuel consumed	55,336,941 mmBTU		346,440 bbl		80,223 bbl		4,407,676	
Cost US$1000	403,406.3	446,569.1	25,983	27,715	6,739	8,744	255,645	264,461
Net gain $1000		**-43,162.8**		**-1,732**		**-2,006**		**-8,815**
Total Savings								***-55,715,941***

US$/unit: mmBTU for gas and bbl for the liquid fuels

Table 7 shows the summary of some of projected and actual indicators in 2018.

Table 7: Grid Electricity and Associated fuels: Forecast and Actuals in 2018

		2017	2018	
			Forecast	Actual
Ghana's Electricity requirement (GWh)				
VALCO @ 2potlines (EUT @ 14-15US cents/kWh)			*16,300-17,200*	
VALCO @ 2potlines (EUT @ 13-14US cents/kWh)			*17,236-18,400*	
Total Grid Electricity available *(i.e. including imports)* GWh		14,316		16,353
Grid Electricity generation available *(i.e. excluding imports)* GWh		14,069		16,213
Percentage hydropower of generation (%)		39.9 *(5,616 GWh)*	30-31* *(4,956 GWh)*	37-38* *(6,017 GWh)*
Ghana System Peak *(Domestic peak)* MW		*2,077*	2,150-2,300	*2,271*
GRIDCO Transmission System Peak/Maximum Demand MW		2,192	2,523	2,525
Average WAGP gas flow (mmscf per day)		30	60	67
Average GhanaGas gas flow (mmscf per day)		81	150-160	80
Average Delivered WAGP gas price *(VRA receipt +other charges included[#])* US$ per mmBTU *($ per mscf)*		8.6 *(8.92)*	7.29 *(7.56)*	8.71 *(9.54)*
Average Delivered GhanaGas gas price * *(other charges included)* US$ per mmBTU *($ per mscf)*		9.02 *(9.35)*	7.29 *(7.56)*	7.53 *(8.25)*
Oil required (Million barrels)	LCO		3.0	
	Diesel		0.1	
	HFO		3.2	
Oil consumed (Million barrels)	LCO	3.9		0.35
	Diesel	0.4		0.08
	HFO	2.3		4.41
Average delivered light crude oil price *dedicated for power* $ per bbl *($ per mmBTU)*	**LCO**	*63 (10.86)*	75 (12.9)	80 (13.79)
	Diesel	84 *(14.43)*	84 (14.43)	109 (18.73)
	HFO	*55 (8.87)*	58 *(9.35)*	60 *(9.68)*

EUT implies End-User Tariff

** Low-side included imbedded generation; High-side excluded imbedded generation*

1.3 Forecast for 2019

1.3.1 Electricity Requirement of the Economy

The real GDP growth for 2018 was 6.3% (*6.5% non-oil*), a drop from the 8.5% (4.9*% for non-oil*) in 2017. There was however 1.6 percentage points growth in the non-oil GDP which could largely be attributed to the stability and the improvement in the Electricity subsector.
As indicated in the earlier Outlooks, the World Bank[30] has established that electricity is the second most important constraint to business activities in the country. The drop in the Petroleum subsector growth, from about 80% in 2017 to just 3.6% in 2018 contributed significantly to the drop in the overall real GDP growth.

With the continued improvement in the electricity supply and projected increases in oil and gas production and at expected stable or little higher global oil price forecast, Ghana's overall **real GDP growth** is projected to expand from the 6.3% in 2018 to **7.6% this year**, though the non-oil component is expected to drop slightly to **6.2%** from the 6.5% last year[31].

At this Government's projected **GDP growth rate of 7.6%** (7-*7.4% by donor agencies*) and particularly **6.2%** (***non-oil growth)*** for the country in **2019**, we expect the total electricity required for the GDP growth to be as follows:

d) **17,238-18,014 GWh** (*with VALCO constrained to operate at most two potlines*). Expected peak capacity demand required would lie within **2,666-2,797 MW**. *Average End-User tariff to make it realized should be within US cents 15-16 per kWh.*

e) **18,020-18,400 GWh** (*with VALCO constrained to operate at most two potlines*). Expected peak capacity demand required would lie within **2,800-2,900 MW**. *Average End-User tariff to make it realized should be within US cents 14-15 per kWh.*

All the two scenarios are achievable provided there is adequate financial resource to procure all the fuel needed to run the thermal power plants even at higher utilisation factors.

[30] World Bank, Energizing Economic Growth in Ghana: Making the Power and the Petroleum Sectors Rise to the Challenge, February, 2013
[31] 2019 Ghana Government's Budget highlights. The World Bank and the IMF forecasts 7.4% and 7% respectively. https://www.worldbank.org/en/country/ghana/overview

1.3.2 The 2019 Grid Electricity Demand and Supply Outlook[32]

Peak Power Demand

The following spot loads are expected to contribute to peak demand growth in 2019:

a) Full operation of the second potline of VALCO i.e., increasing its peak demand to two potlines (147-150 MW).

b) Increase in export to SONABEL (Burkina Faso) - from 57.5 MW in 2018 to 100 MW by close of 2019.

c) On-going distribution network expansion works intended to extend coverage and improve service quality to consumers nationwide.

d) Expected completion and commissioning of various ongoing rural electrification projects under the National Electrification Programme in 2019.

Summary of Expected Peak Grid Electricity Demand Shares for 2019

Figure 4 describes the percentage share of Peak Demand on the grid of each of the customer class.

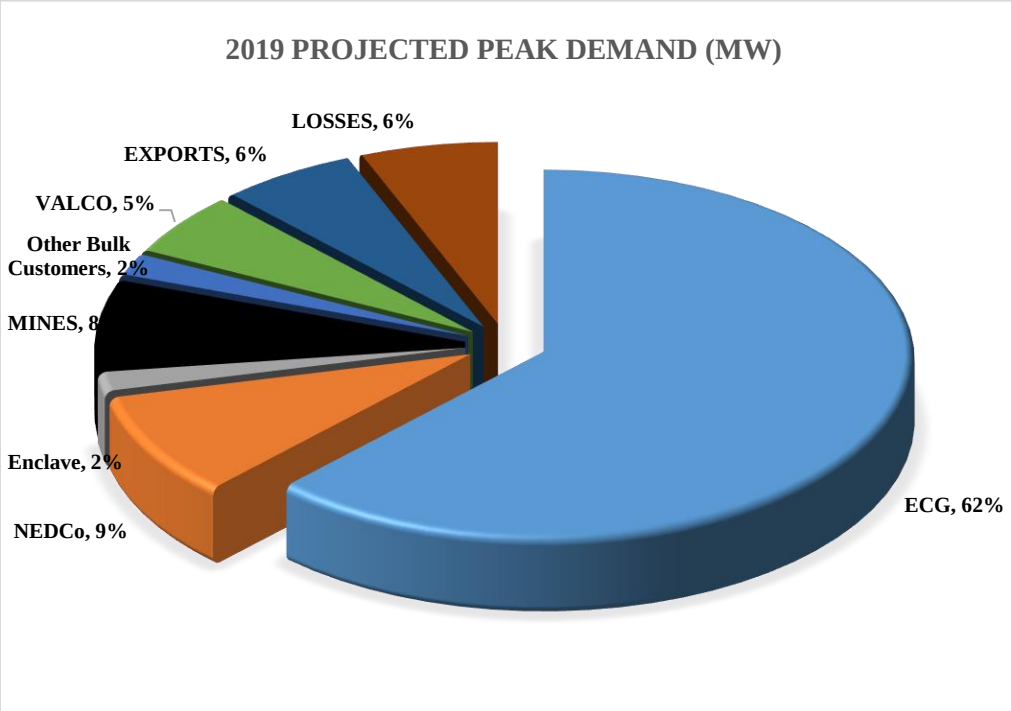

Figure 4: Share of projected peak power demand based on Customer Classes for 2019

[32] This work mostly adapted from the 2019 Electricity Supply report jointly produced by Energy Commission, GRIDCo, VRA, Bui, ECG and NEDCo, January, 2019. Available at www.energycom.gov.gh/planning

From Figure 4, ECG's demand would constitute 62% of the total system peak followed by NEDCo at 9%, then Mines and VALCO at 8% and 5% respectively. Enclave Power operating at the Free Zone and Other Bulk Customers are expected to account for 2% each. Exports to Togo & Benin (CEB) and Burkina Faso (SONABEL) together would account for 6%[33].

Table 8 shows a summary of 2019 peak grid power demand forecast based on the utilities' customer classes.

Table 8: Summary of 2019 Peak Grid Power Demand forecast by Customer Classes

DEMAND SECTOR	CUSTOMER CLASS	COINCIDENT PEAK DEMAND (MW)
Ghana[34]/Domestic Peak Demand	ECG	1657.44
	NEDCo	241.43
	Enclave Power	44.29
	Mines *(largely gold mining)*	201.74
	Other Bulk	50.79
	Losses+Network Usage	162.57
	Total Domestic Peak Demand	**2358.26**
Exports	CEB *(Togo & Benin)*	60
	CIE *(la Cote d'Voire)*	0
	SONABEL *(Burkina Faso)*	100
	Total Exports	**160**
VALCO		**147.42**
Coincident Peak Demand MW		**2,665.68**

Outlook of Grid Electricity Supply

For 2019, the total grid electricity supply including transmission network losses is projected to be between **17,237.79-18,013.96 GWh**. This includes estimated transmission losses and network usage of 898.03 GWh, representing 5.21% *(3.6% in 2018)* of the total projected electricity supply. The projected 2019 grid electricity supply represents a growth of approximately 8% over the 2018 actual consumption (*electricity made available for gross transmission*) of 15,960.36 GWh.

Table 9 presents the summary of 2019 grid electricity supply purchases by customer classes.

[33] ECG is Electricity Company of Ghana, a distribution utility for largely southern Ghana.
NEDCo is Northern Electrification Company of Ghana, a distribution utility for largely northern Ghana.
[34] Excluding VALCO

Table 9: Summary of Projected 2019 Grid Electricity Supply Purchases by Customer Classes

ENERGY	CUSTOMER	PROJECTED REQUIREMENT (GWh)
Ghana[35]/Domestic Consumption	ECG	11,075
	NEDCo	1,443.99
	Enclave Power Company	200
	Mines (largely gold mining)	1,173.47
	Other Bulk Customers	238.58
	Losses + Network Usage	907.15
	Total	15,038.19
Export	CEB (Togo & Benin)	349.72
	CIE (la Cote d'Voire)	0
	SONABEL (Burkina Faso)	566.09
VALCO		1,283.80
	Total Electricity (GWh)	*17,237.79*

Source: 2019 Electricity Supply Plan

Figure 5 shows a representation of the projected electricity consumption of the various customer groupings and their percentage share in 2019. As shown in Figure 5, ECG's uptake of 11,075 GWh for its customers represents about 64% of the total projected grid electricity requirement in 2019. It is followed by VALCO and NEDCo with 8% each, Mines with a projected consumption of 1,173.47 GWh represent 7% of the total consumption.

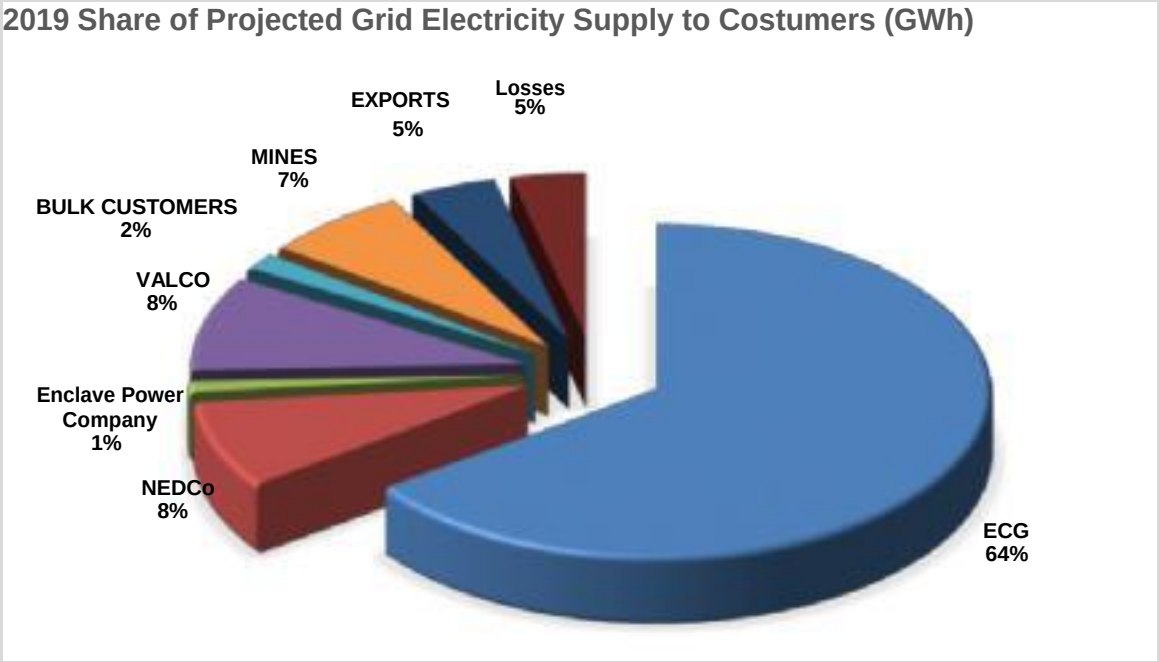

Figure 5: Share of Projected Grid Electricity Supply based on Customer Classes for 2019

[35] Excluding VALCO

1.4 Available Electricity Supply for 2019[36]

1.4.1 Generation Sources

The sources of generation considered are mainly from the existing generation and the committed projects expected to come online in 2019.

Existing Generation Sources – Hydropower

Akosombo and Kpong Hydro

Akosombo Generating Station (GS) is planned to operate three to four generating units during the off-peak period and up to five (5) units during the peak period in the year 2019. This mode of operation is expected to result in operating capacity of up to 750 MW at Akosombo GS in 2019, which would ensure that the reservoir level is kept above the minimum operating level of 240 ft. This mode of operation would result in a projected minimum elevation of 253 feet at the end of the dry season in 2019.

Kpong Generation Station (Kpong GS), which is currently undergoing retrofit, would have three (3) out of the four (4) units available. The total average capacity that would be available at Kpong GS is 105 MW. As a result of the above mode of operation, the projected total annual hydro generation from Kpong and Akosombo generating stations is 5,070 GWh.

Bui Hydro

In 2019, Bui hydropower plant is projected to operate an average of two turbine (2) units throughout the year. This mode of operation would lead to a projected annual production of 660 GWh. Bui Hydro is assumed to provide an average generation capacity of 220 MW to support demand.

It is estimated that, for continuous and sustainable operation of the Bui Power Station for 2019 and for the subsequent years (in the likely event of low inflows), the reservoir level at the end of the dry season of 2018 should not drop below elevation 170 masl[37].

With a year-start elevation of 176.97 masl in 2019 and the total estimated total electricity production of 660 GWh for 2019, the year-end elevation is projected at 175.21 masl.

Assumptions for the projected 2019 generation from the Bui Hydro Plant are as follows:

i. 60% long-term average inflow of 6,167 million cubic metres.

ii. 2019 year start elevation of the Bui reservoir at 176.97 masl.

[36] This work mostly adapted from a 2018 Electricity Supply Plan jointly produced with GRIDCo, VRA, Bui, ECG and NED, January, 2018.

[37] metres above sea level, a description used by the Bui Power Authority to describe the reservoir level at Bui.

iii. Operation of two turbine units in normal mode at 110 MW during the year.

iv. Operation of third unit in Synchronous Condenser Mode (SCM) when required by NITS during the year.

v. Operation of the additional 4 MW 'small' hydropower plant at Bui which has a 3.75 MW turbine throughout the year.

Figure 6 shows the 2018 projected trajectory for Bui hydropower plant.

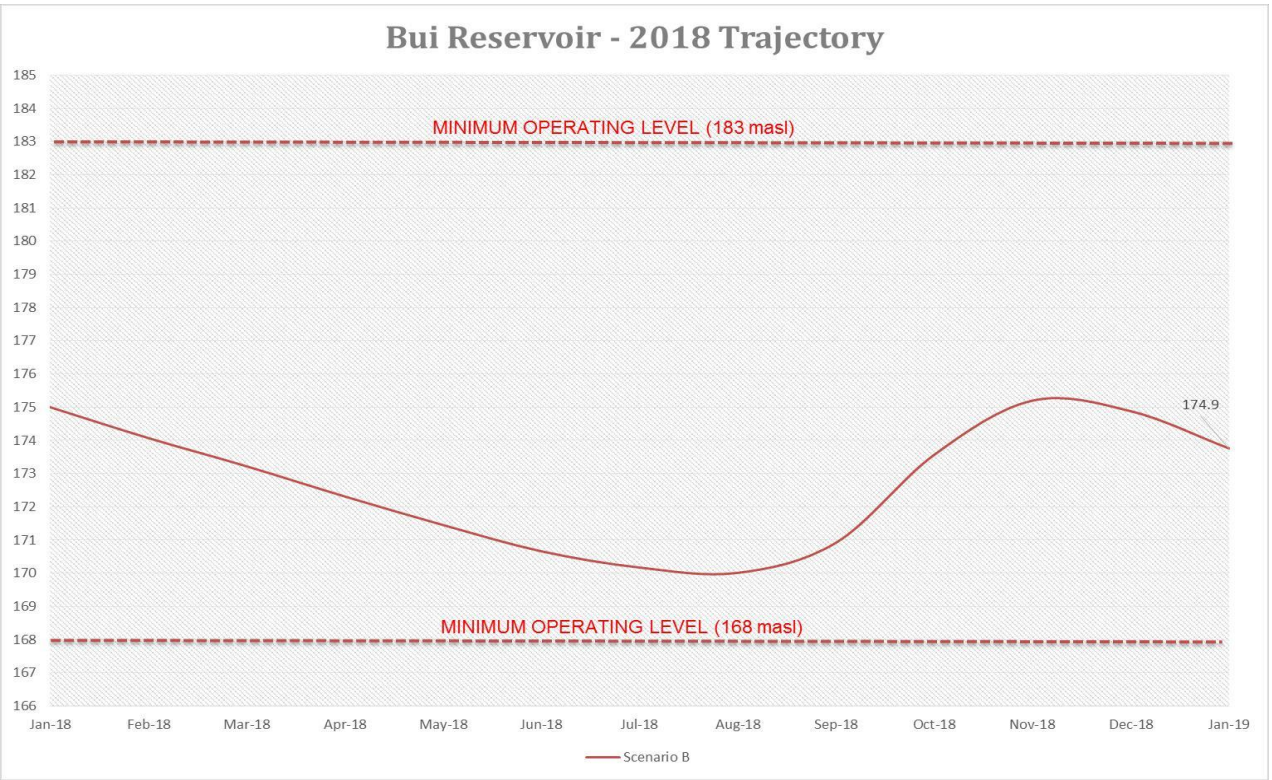

Figure 6: Bui Reservoir Trajectory projected for 2018

Rainfall Pattern

As discussed in 2017, the rising sunspot activity of the sun with its associated high precipitations have started bringing in more rains since 2017 and projected to peak between 2019 and 2020 before starting to subside. Strong sunspot activities imply that geophysical forces needed to push rainfall currents such as the inter-tropical boundaries from the coast far inland would increase and consequently releasing more precipitations at further distances from the equator and the coast.

For this reason, the hydropower dam catchment areas which are largely inland have started experiencing higher than expected average annual rainfall since 2017 and it is expected to peak between this year and 2020. This is evident in the catchment areas of the dam *see Figure 7*).

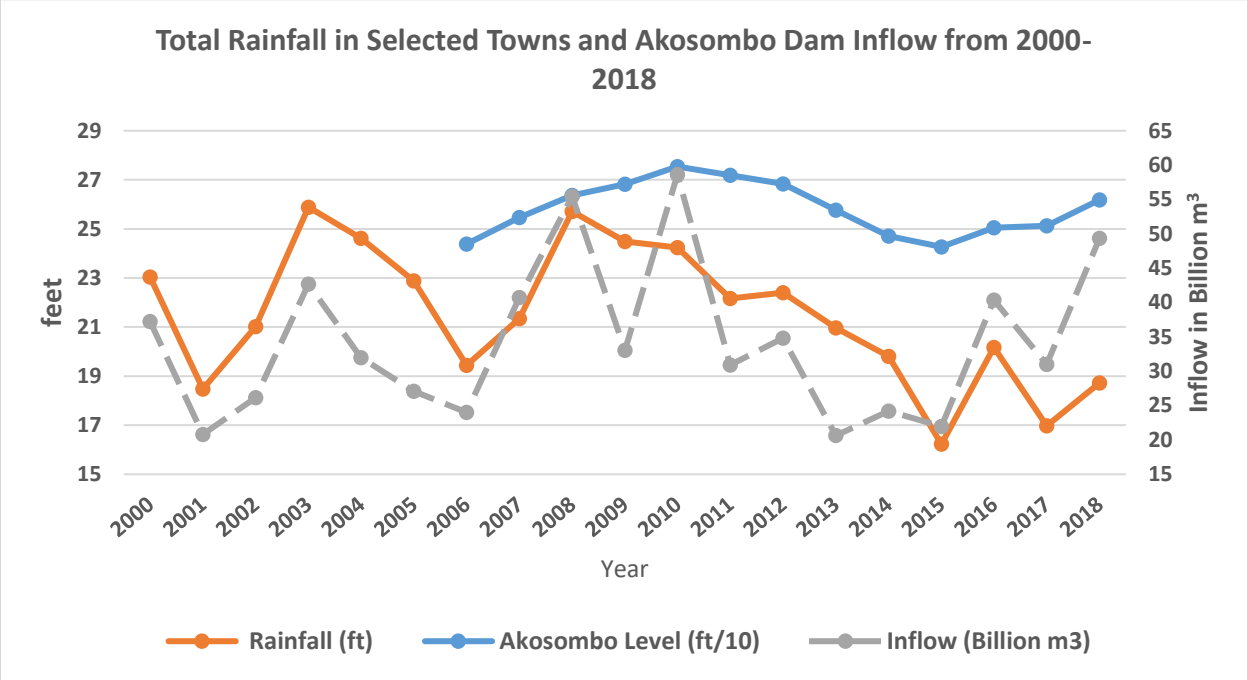

Figure 7: Total Rainfall in key towns in catchment areas and inflows into the Akosombo Reservoir 2000-2018

Thus the precipitations and inflows indicate somehow upward trend from 2015 to 2018 as shown in Figure 8.

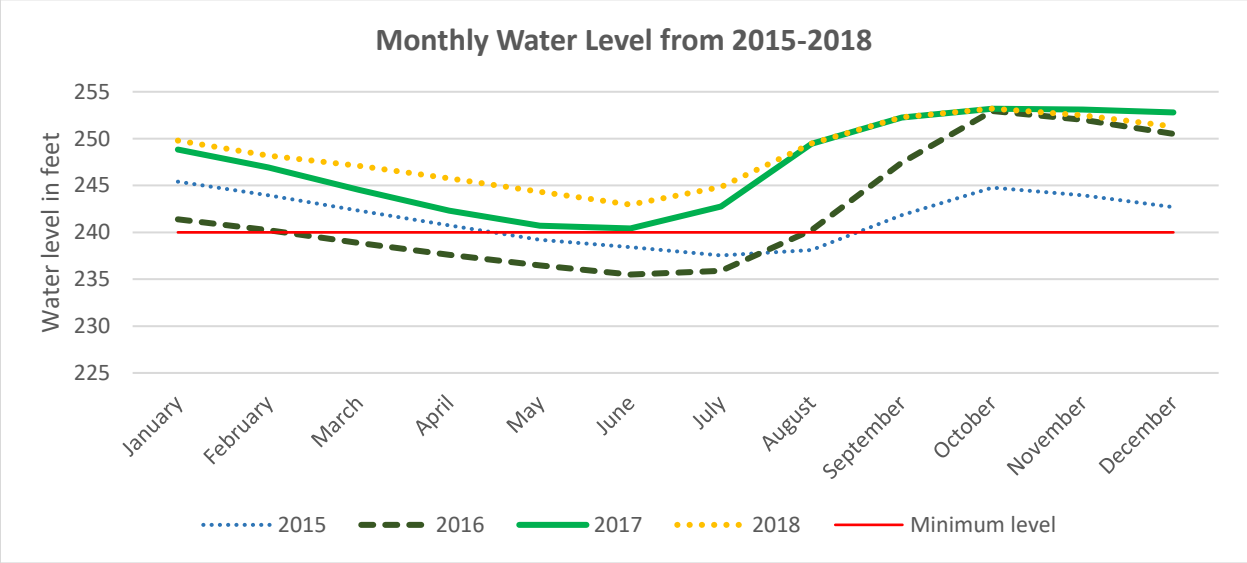

Figure 8: Monthly Water Level at Akosombo Reservoir from 2015-2018

Existing Generation Sources – Thermal Power

Thermal

The total installed grid thermal generating capacity for **2019** is **3,456 MW** of which dependable capacity would be **3,228 MW**[38] (*see Table 10*).

Table 10: Thermal Grid Electricity Generation Plants for 2019

POWER PLANTS	INSTALLED CAPACITY (MW)	DEPENDABLE CAPACITY (MW)	FUEL TYPE
TAPCO (T1)	330	300 *(200)*	LCO/Gas
TICO (T2)	340	320	LCO/Gas
TT1PP	110 *(126*)*	100	LCO/Gas
TT2PP **KTPP**	80 220	70 200	Gas Gas/ Diesel
CENIT	110 *(126*)*	100	LCO/Gas
AMERI	250	230	Gas
SAPP	200	180	Gas
SAPP 2	360	340	Gas
Karpower	470	450	HFO/Gas
AKSA	370	350	HFO/Gas
CENPOWER	360	340	Gas/LCO
Amandi	190	180	Gas/LCO
Sub-transmission level			
Trojan	44	39.6	Diesel/Gas
Genser	22	18	LPG
TOTAL	**3,456** *(3,488)*	**3,228** *(3,128)*	

***** *Nameplate installed capacities of the TT1PP and CENIT as licensed by Energy Commission is 126 MW.*

In 2019, 360 MW Cenpower Thermal Power Plant located in Tema which was completed and underwent test-runs 2018 is expected to come on line. Another new major plant coming on line is the 190 MW Amandi Thermal Power Plant located within the Aboadze Thermal Enclave in the Western Region.

[38], The steam turbine at TAPCo is out of service for now reducing the total dependable capacity to **4,187.6 MW.**

Existing Generation Sources - Distributed Generation

As indicated earlier, electricity from distributed back-up generation in 2017 was estimated at 3,600 GWh and this was equivalent to generation from about 500 MW combined cycle thermal power plant[39].

With the prevailing relatively high grid electricity tariff, distributed generation would continue to serve as a supplementary source of electricity to help reduce energy cost. For instance, supply from imbedded generation (Genser and Trojan) increased from about 51 GWh in 2017 to 359 GWh in 2018 (*see Table 1*).

Existing Generation Sources - Renewable Energy

Even though, grid-tied Solar PV was almost 43 MW, significant imbedded grid-connected solar power units totalling about 6.5 MW peak and largely owned by commercial customers of ECG are expected to come on line in 2019. There is also a 500 MWp solar irrigation system expected to be completed this year. These are however likely to have an impact on the grid electricity consumption.

1.4.2 Grid Demand-Supply Balance

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

i. Merit order dispatch.
ii. Availability of fuel per plant.
iii. Must-run plants; *take-or-pay* plants.
iv. Variable or intermittent systems like the grid-tied solar plants.
v. System stability requirements.

Instances where there is supply surplus, some plants would not be dispatched under normal operating conditions.

The grid electricity demand - supply balance for 2019 is presented in Table 11.

It is seen from the Table 11 that the total generation from VRA plants would be about **8,867.94 GWh,** representing **51.4%** of the projected total grid electricity generation for **2019**. Generation from Bui Hydro and other Independent Power Producers (IPPs) total about **8,369.86 GWh**, accounting for **48.6%,** out of which total IPP generation is **7,719.85GWh**, representing **44.8%** of projected total generation for **2019**.

[39] A nationwide survey by Energy Commission and METSS of USAID, Ghana, December, 2017

Table 11: 2019 Projected Grid Electricity and Supply Balance in GWh

PROJECTED GRID DEMAND/SUPPLY	DEMAND/SUPPLY (GWh)
DEMAND: Customer Category	
Total Ghana (*so-called Domestic*)	15,038.2
VALCO	1,2835.8
Exports (CEB+SONABEL+CIE)	915.8
Total Projected Electricity Requirement	**17,237.8**
PROJECTED SUPPLY	
Total VRA Hydro (Akosombo & Kpong GS)	5,070
Bui GS	650
Sub-Total: hydro	***5,720***
VRA Existing Thermal & Solar Generation	
TAPCO	1,491.8
TICO	1,933.6
TT1PP	211.4
KTPP	158.2
TT2PP	0
VRA Solar	3
Sub Total	***3,795***
Existing IPP Thermal & Solar Generation	
AMERI Power Plant	1,007.2
Karpower Barge	2,775.1
SAPP1+SAPP2	2,655.8
CENIT	0
AKSA	1,227
CENPOWER	0
Amandi	0
BXC Solar	27
MEINERGY Solar	27
Safisana	0.7
Total VRA Supply	**8,867.9**
Total Non-VRA Supply	**8,369.9**
Total Supply	**17,237.8**

Figure 9 shows a graphical representation of Table 11, giving the percentage share of each generation type. Thermal generation thus would constitute about 66.5% of projected total generation whilst hydro generation and generation from solar PV would constitute 33.2% and 0.3% respectively.

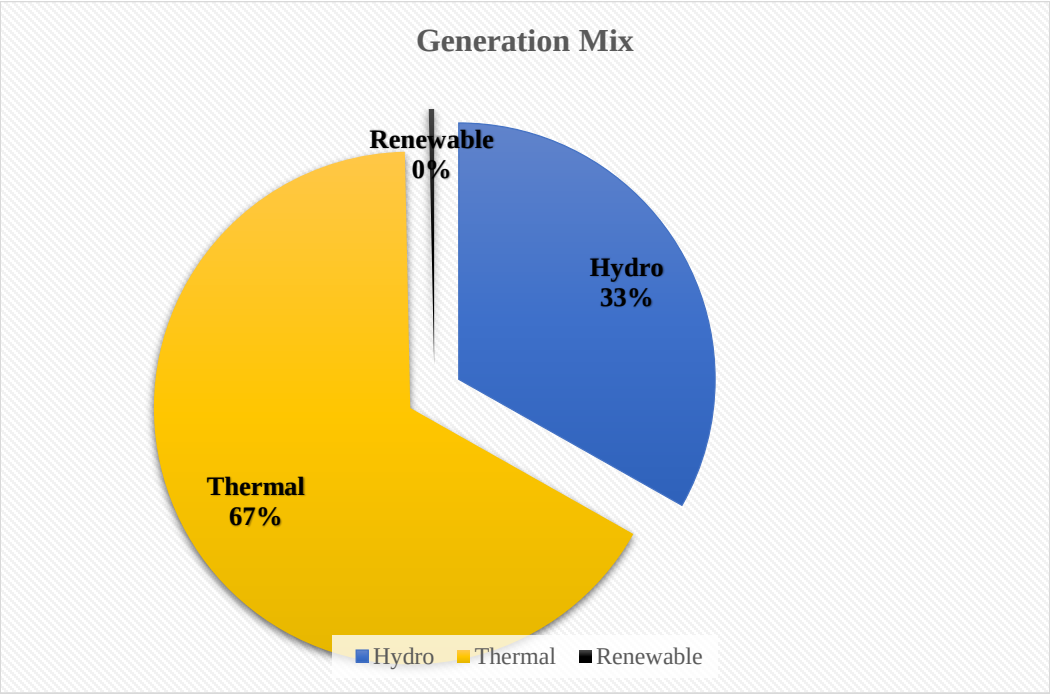

Figure 9: Share of Grid Electricity Supply by Generation Type for 2019

This implies that in 2019 just as in 2018, generation from thermal sources would be more than twice that from hydro sources. This high percentage of thermal generation could have serious implications for the power sector for the following reasons:

i. It will adversely impact the finances of the local power utilities, since local tariffs are cedi denominated and if the cedi becomes relatively unstable during the year.

ii. Any prolong disruptions in gas supply would have dire consequences on the power supply situation in the country in terms of reliability of supply and on generation costs since gas price is on the average cheaper the liquid fuels.

1.4.3 Fuel Requirements and Cost Implications

In 2018, natural gas, Light crude oil (LCO), diesel and Heavy fuel oil (HFO) are the types of fuel that would be required for firing thermal generating plants on the Ghana power system just as in the previous years.

Fuel Allocation and Cost

Fuel type

LCO

The total LCO used in 2018 was about 346,440 barrels. In 2019, even though, no significant requirement for LCO, should the anticipated high volumes of gas from Sankofa, Jubilee and TEN fields realised and made available timely. Nonetheless, we maintain the same volume for the year against potential delays and in times of unforeseen supply disruptions.

HFO

HFO would be used mainly by the Karpowership and AKSA power plant. HFO used in 2018 was about 4.4 million barrels.

In **2019** however, Karpowership would be moving to the Western Power Enclave during the third quarter of the year to receive gas from ENI. The AKSA Plant on the other hand is scheduled to operate on HFO throughout the year. Total requirement for both plants is estimated at **5,308,727 barrels**.

Natural Gas

Natural gas would as usual come from three sources; WAGP carrying gas from Nigeria; and Ghana Gas pipeline carrying indigenous gas from the Jubilee and TEN, then ENI gas from the Sankofa fields.

Average WAGP gas delivered in 2018 was about 67 mmscfd, whilst supply from Ghana Gas was about 80 mmscfd.

For **2019**, total gas consumption is projected to be about **80.24 million mmBTU** which translates to an average daily delivery of about 200-220 mmscfd. VRA power plants would require about 37.69 million mmBTU (about an average of 100 mmscfd) whilst the balance of 42.55 million mmBTU (about an average of 110 mmscfd) would go to the IPPs.

We expect **Ghana Gas** supply to increasing to about **150 mmscfd** and then up to about **300 mmscfd** by close of the year due to additional increasing supplies from TEN and the Sankofa-Gye Nyame fields.

With the increasing outlook from the local gas flow, we also expect the average **WAGP gas** flow to double that of last year, i.e. increased from about **60 mmscfd** to the range of **110-120 mmscfd** based upon previous experience[40].

[40] Increasing local availability of the gas usually induces N-Gas in Nigeria to pump more gas to the WAGP.

The only limitation to the commingled flow would be the intake point at the metering station, i.e. due to infrastructure constraints.

Diesel

As usual, diesel would be used mainly for starting and shutting down the thermal plants. In 2018, just about **80,000 barrels** (about one-fourth of a cargo size of 405,000 barrels) was used. For 2019, we maintain the same quantity needed.

Fuel Prices

Total LCO of about 346,440 barrels estimated for 2019 would cost **$24.2 million** at delivery cost of **$70** per barrel.

Diesel supply requirement for 2019 is projected to cost at about **$8.8 million** at delivery cost of **$110** per barrel.

Total HFO requirement of **5,308,727 barrels** translates to about 13 cargoes, assuming a cargo size of 405,000 barrels at an estimated delivery cost of about **$318.5 million** at **$60** per barrel.

Average delivery price of the WAGP gas in 2018 was $8.71/mmBTU and that of Ghana Gas was $8.53/mmBTU. For **2019**, the delivery gas price would be an weighted average price of $7.29/mmBTU but the delivery cost is estimated at $7.4/mmBTU. Consequently, about **$594 million** would be needed for the gas procurement.

In all, about **$945 .5million** would be needed for **fuel** for the year **2019.** Summary of estimated amount of fuel needed and the cost involved are as presented in Table 12.

Table 12: Expected Average Delivered Fuel Prices for the Thermal Plants for 2019

FUEL TYPE	Average Delivered Cost and equivalent				Total Coast
	US$/mmBTU	US$/mscf	US$/bbl	US$/tonne	(US$) million
Gas	7.4 (7.29)	8.11			593.8
LCO	*12*		70	490	24.2
Diesel	*19*		110	770	8.8
HFO	*9.7*		60	420	318.5
					945.5

The *US$/mmBTU in italics* are approximate equivalent prices of the liquid fuels.

**weighted gas price released by PURC, 2019.*

Fuel Allocation

Since the available gas would still not be enough for all the gas-fuelled thermal plants, fuel supply to the Tema and Takoradi Power Enclaves shall be strategically managed as follows:

Tema Enclave

- 30 mmscf/day allocated to Sunon-Asogli power plants.
- 30 mmscf/day for VRA plants (TT1PP & KTPP) at Tema
- TT2PP/TT2PP-X operate on natural gas (on standby)
- Karpower to operate on HFO from January to September 2019 and then be relocated to Takoradi to run on natural gas from Sankofa Fields in the last quarter of the year
- AKSA to operate on HFO.

Takoradi Enclave

- T1 to operate mainly of Gas
- T2 to operate mainly on Gas
- AMERI to operate mainly on Gas
- Karpower to operate on Gas from Sakofa fields from September to December 2019.

West-to-East Reverse Flow

Ongoing works to facilitate West to East Reverse Flow of gas using the WAPCo Gas Pipeline is expected to be completed by April 2019. This would pave the way for Ghana Gas to supply natural gas to power plants in the Tema Generation Enclave.

1.4.4 Transmission System Performance

State of the NITS[41]

In Ghana, the transmission of electricity is done at three main voltage levels, namely; 69 kV, 161 kV and 330 kV. There is also a 225 kV voltage level transmission that facilitates interconnection with Ghana's western neighbour Cote d'Ivoire and now with northern neighbour Burkina Faso as well. A similar interconnection with Togo is through two 161 kV lines and a 330 kV line.

The National Interconnected Transmission System (NITS) increased from approximately 5,208 circuit kilometres (km) of high voltage transmission lines in 2016 to about 5,284 circuit km at the

[41] See Annex 2

end of 2017 and currently stands at **5,965.83 circuit kilometres**. It connects all the major generation plants to sixty four (64) Bulk Supply Points across the nation.

The transmission lines consist of 364 km of 330 kV line, about 4,637 km of 161 kV and 133 km of 69 kV lines. There is a 225 kV tie-line which interconnects the Ghana grid with that of Cote d'Ivoire and two 161 kV tie-lines that interconnect Ghana grid with that of Togo. In addition, there is a single circuit 225 kV tie-line of about 74 km linking the country's network with that of Cote d'Ivoire.

The network now has **134 transformers** from 127 in 2018, installed at various load centres across the country with a Total Transformer Capacity increased from about 5,610 MVA[42] in 2018 to the present of about **7,191 MVA.**

The National Interconnected Transmission System (NITS) has over 600 MVArs of fixed shunts installed at various Substations including Achimota, Mallam, Smelter, Winneba, Takoradi, Kumasi etc. and a 40 MVArs of Static Synchronous Compensator (STATCOM) installed at the Tamale substation. The fixed shunts and the STATCOM complement the generating units in providing the reactive power requirements of the NITS, in order to maintain good voltages and minimize overall transmission losses.

Ghana Grid Company (GRIDCo) is the operator of the NITS and is responsible for the real time dispatch (monitoring, coordination and control) of power system operations on the Ghana Power System as well as cross-border power exchanges with neighbouring countries.

The System Control Centre (SCC) in Tema is responsible for the real time dispatch (monitoring, coordination and control) of the Ghana Power System as well as cross-border power exchanges with neighbouring countries.

Transmission Line, Feeder and Sub-station Availability

The criteria for transmission Line, Feeder and Substation availability are as presented below;

i. All existing transmission lines are expected to be in service to ensure transmission of electricity from the generation stations to the Bulk Supply Points across the nation and to enable the execution of power exchanges with neighbouring countries.

ii. Maintenance work on transmission lines and substations is not to significantly affect power supply to customers except for single transformer substations and consumers served on radial lines.

In 2019, just as in the previous years, all existing transmission lines are expected to be in service for the transmission of electricity generated at the power plants to bulk supply points across the

[42] MVA is Megavolt-Ampere

nation and as well to enable the execution of power exchange programmes with neighbouring countries.

Maintenance work on transmission lines and substations are not expected to significantly affect power supply to customers except for single transformer substations and consumers served on single radial lines. Most transformers in operation on the NITS are designed with a capability of 100% continuous loading and Transformer Utilization Factor (TUF). Indications from GRIDCo therefore suggests that there is adequate transformer capacity on the NITS for the supply of power under normal operating conditions[43].

Impacts of Transmission on Network Expansion Projects

There are a number of transmission expansion projects on-going which are expected to be commissioned into service in 2019. They are:

i. **Volta–Achimota–Mallam Transmission Line Upgrade Project**

This was supposed to be completed in 2018 but has spilled over to 2019. Upgrading of transmission lines in the Volta – Achimota corridor would increase the evacuation capacity from Tema generation hub to the load centre of Accra. This is necessary to ensure the evacuation of generation from the new thermal power plants in Tema, namely Karpower (225MW), Sunon-Asogli Phase II (360MW) and the Kpone Thermal Power Plant (KTPP-200MW). The project would increase transfer capacity to Accra Central station to facilitate high voltage power transmission close to the central business district of Accra. This would also significantly reduce system losses.

ii. **Aboadze–Prestea-Kumasi 330 kV Transmission Line Project:**

This was also supposed to be completed in 2018 but spilled over to 2019. This would improve high voltage transmission in Kumasi and adjacent substations and consequently reduce overall system losses. The project would also allow for increase in power export capacity to Northern region as well as Burkina Faso.

iii. **Kumasi – Bolgatanga 330 kV transmission line Project**:

This project also could not be completed in 2018 but expected to be completed this year. The project would primarily allow for the export of up to 150 MW of power to Burkina Faso. It would also improve upon the supply capacity and reliability to the northern Ghana.

iv. **Construction of 330 kV Bulk Supply Point substation at Pokuase**

This project is still under construction. When completed, it would increase the reliability of supply to Accra and increase transfer capacity between the generation hub of Aboadze

[43] 2018 Electricity Supply Plan; joint work with GRIDCo, VRA, Bui Authority, ECG and NEDCo.

and Tema to the load Centre at Accra. It would also allow for the reliable evacuation of the 360 MW Sunon Asogli Phase II plant.

v. **Construction of 2x66 MVA Bulk Supply Point at Afienya:**

This project which is still under construction is expected to improve upon supply reliability to Ghana Water Company's pumping station at Dodowa. It would also reduce the loading on the New Tema substation and increase supply reliability to Afienya and its environs.

Fuel Supply and Transmission Challenges

Fuel Supply Challenges

Hydro Risk

Even though, there is high prospects for rainfall this year, it would still be prudent to continue the conservative dispatch of the hydro plants to ensure that the reservoirs are not drawn down below their minimum operating levels to guarantee sustainable operations in the coming years.

Thermal Fuel Risk

There is a planned total shutdown of the Atuabo gas processing plant for two (2) week in April 2019. This is to enable Ghana Gas to interconnect its systems with the West African Gas Pipeline Company (WAPCO) for reverse gas flow to Tema through the WAGP pipeline. This would result in the curtailment of gas supply from Ghana Gas to Aboadze generation enclave.

Reliability of Gas supply from WAGP and Ghana Gas Company remains a major risk to electricity supply reliability in Ghana. Although, there is high installed generating capacity, gas supply sustainability remains one of the major risks to reliable electricity supply in Ghana. Any disruptions in fuel supply, mostly gas, would rendered some thermal plants inoperable and consequently adversely impact on supply reliability.

The Aboadze Power Enclave presently has a dependable total generation capacity of 850 MW and this is expected to increase to 1,490 MW with the relocation of the 450 MW Karpoweship to Sekondi and the commissioning of the 190 MW Amandi Power Plant by the third quarter of 2019. Thus making the Western Enclave the largest generation enclave with over 53% of the overall system peak demand, outstripping both Tema and Akosombo generation enclaves.

This means any incident that affects either the ability of any power plant or the evacuation of power generated in the Western Enclave would have significant consequences on the nation's power system. For instance, there have been incidences of sudden losses of or drop in gas supplies to the power enclaves. On Sunday December 23, 2018 the Ghana power system suffered a system

disturbance as a result of sudden loss of gas supply from Ghana Gas to the generating plants in the Western enclave leading to sudden drop in generation. Should such and similar situations persist, there could result in prolonged load shedding.

Such could be averted by securing alternative fuels and supply for the power plants to make up for any shortfall in the supply of gas within the period of disruptions. Thus, there is the need to make advanced arrangements for adequate LCO storage at both Tema and Takoradi power enclaves.

It is also still imperative that the companies in the Gas Supply chain, namely, Tullow, ENI, GNPC, Ghana Gas, BOST and others collaborate strongly with the power supply entities to ensure effective planning and coordination.

Transmission Challenges

Power Evacuation

There are also transmission capacity constraints in some portions of the network which could lead to transmission line overloads. For instance, insufficient reactive power compensation could lead to poor customer supply voltage in areas such as Kumasi, Accra and some parts of the Western region.

Radial Lines and Single Transformer Stations

Currently, supply reliability to customers served via single circuit radial lines is quite low. This is because an outage on such single circuit radial lines interrupts supply to such customers. Some of the single circuit radial lines on the NITS are the: Tamale–Yendi, Takoradi–Esiama; Dunkwa–Asawinso; Bogoso–Akyempim; Bolga- Zebilla; Zebila–Bawku lines, etc. Supply reliability to customers served on these lines would improve in future when such lines are upgraded through construction of additional line(s) or by looping them into other adjoining substations.

Similar to single circuit radial lines, consumers supplied by single transformer substations also suffer low level of supply reliability. Maintenance and/or upgrade works at these stations are often a challenge due to difficulties in securing outages to carry out planned maintenance works. Such townships supplied via single transformer stations are Yendi, Sogakope, Esiama, Akosombo Township, VRA Township at Akuse, etc.

There are also transmission capacity constraints in some portions of the network which could lead to transmission line overloads. For instance, insufficient reactive power compensation could lead to poor customer supply voltage in areas such as Kumasi, Accra, and some parts of the Western Region.

Impact of High Electricity Tariff on Demand

In March, 2018, new tariff were released by the Government announcing the following reductions; about 17% reduction in Residential; 30% in Commercial and 25% in industrial tariffs. Table 13 compares the 2018 tariffs against the 2016-2017 tariff regime.

Table 13: Comparison of Grid Electricity Tariffs Customer Class from 2017 to 2018

CONSUMPTION CLASS	RESIDENTIAL *(Domestic usage)*			NON-RESIDENTIAL *(Commercial usage less than 100 kVA)*			INDUSTRIAL *(SLT usage)**		
	Ghp/ kWh		*US cents/ kWh*	Ghp/kWh		*US cents/ kWh*	Gp/kWh		*US cents/ kWh*
	2016-17	***2018***		**2016-17**	***2018***		**2016-17**	***2018***	
51-300	67.33	55.54	***12***	96.79	67.75	***15***			
301-600	87.38	72.09	***16***	102.99	72.09	***16***			
601+	97.09	80.09	***17***	162.51	113.76	***25***			
SLT – L V							100.88	75.66	***16***
SLT – MV							78.09	58.57	***13***
SLT – HV							71.76	53.82	***12***
SLT – HV Mines							113.97	102.57	***22***

US cent 1 – 4.59 Ghana pesewas average as at the end of 2018.

US cents/kWh rounded up to the nearest whole number.

*SLT is Special Load Tariff for energy usage for industrial purposes; supply voltages LV–Low Voltage (400V); MV- Medium Voltage (11,000 V) and HV-High Voltage (33,000 V).

The drop in tariff saw an improvement in electricity consumption from about 6% in 2017 to about 8% in 2018, though still below the annual average of 10% growth before the power crisis in 2012.

Even though relatively encouraging, the tariff are still on the high side from the fact that the share of the wealth creation sectors, i.e. industry and commercial (non-residential) of the consumption reduced by about 2-3 percentage points from 2017 to 2018 whilst that of Residential sector increased by almost 7% points during the same period as seen from Table 14.

As indicated in the previous Outlooks, the prevailing high electricity tariff moves Ghana from once among less expensive countries to very expensive grid tariff regimes among middle-income developing countries.

Table 14: Sectoral Share of the Grid Electricity Consumption from 2009 to 2018

	SECTORS						Total	
	Residential		Non-residential		Industrial[44]			
	GWh	% share	GWh	% share	GWh	% share		
2009	2,275	*37.0*	924	*15.0*	2,951	*48.0*	6,150	***Growth***
2010	2,483	*37.5*	966	*14.6*	3,174	*47.9*	6,623	*7.7*
2011	2,527	*33.1*	1,199	*15.7*	3,901	*51.1*	7,627	*15.2*
2012	2,819	*33.1*	1,549	*18.2*	4,153	*48.7*	8,521	*11.7*
2013	3,060	*33.9*	1,532	*17.0*	4,435	*49.1*	9,027	*5.9*
2014	2,772	*30.9*	1,529	*17.0*	4,680	*52.1*	8,981	*-0.5*
2015	2,436	*29.6*	1,531	*18.6*	4,274	*51.9*	8,241	*-8.2*
2016	3,932	*40.8*	1,068	*11.1*	4,626	*48.1*	9,626	*16.8*
2017	3,931	*38.7*	1,356	*13.3*	4,880	*48.0*	10,167	*5.6*
2018	4,824	*44.0*	1,103	*10.1*	5,046	*46.0*	10,973	*7.9*

Such threatens the country's competitiveness as an investment destination since her average grid electricity pricing is about twice higher than in South Africa, China and India where most imports to Ghana originate from (*see Table 15*).

Table 15: Average End User Tariff ranges of Ghana, selected Middle-Income Developing Countries and South-East Asia from 2016-2018

Country/Region	Ghana	South Africa	India	China	South-East Asia
US cents/kWh	14-16	8-10	8-9	7-8	4-7

Source:[45]

Most heavy or base metal industries including the underground gold mines would require on the average tariff less than 6 US cents per kWh to stay competitive with similar products imported. Light industries could go as high as 10 US cents per kWh to survive. Thus the prevailing energy tariff for industries are still on the very high-side and any attempt to increase it could worsen the situation[46].

[44] NB: Industrial are Special load tariff customers of ECG/PDS and NEDCo as well as bulk customers of VRA including VALCO.
[45] Adapted from 2018 World Energy Outlook, International Energy Agency
[46] Low or less expensive tariff: 2-9 US cents/kWh; medium expensive tariff: 10-15 cents/kWh; High or very expensive 18-25 US cents. 26-35 US cents/kWh most expensive.

Excess Grid Capacity

Figure 10 shows the trend in installed grid capacity, dependable capacity and peak demand from 2009 to 2018. The excess grid capacity started to widen from 2014.

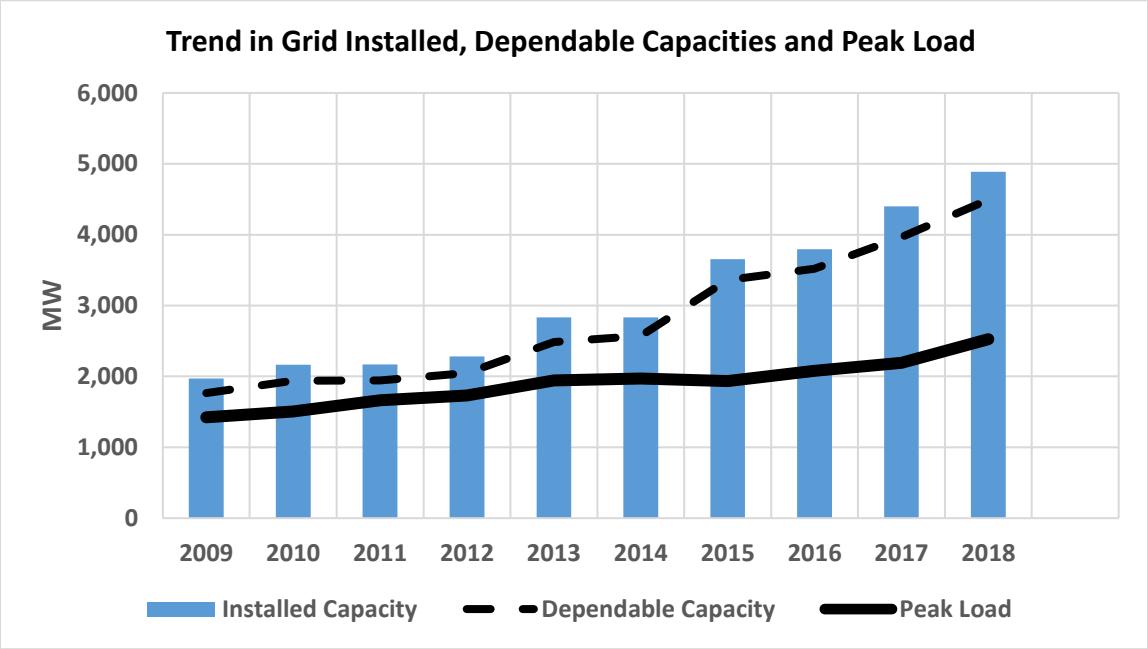

Figure 10: Trend in Installed Grid Capacity, Dependable Capacity and Peak Load; 2009-2018

Local Market

Even though, the share of the grid electricity consumption of the Industrial sector shrank from 48% in 2017 to 46% in 2018, it is still has the highest share of the consumption (*see Table 15*). The 2018 Industrial consumption of about 5,046 GWh equivalent to about 700 MW gross demand accounted for estimated two-thirds of the sector's total electricity requirement, considering that the main consumers including the 320 MW capacity VALCO has been running just two of its five potlines whilst other manufactories are producing on the average at half capacities. This has been attributed to the relatively high grid electricity tariff. Also, at a higher electricity consumption customer class of 600 units, most commercial entities and some industries find it cheaper to rely on imbedded generation instead of the grid given rise to "excess grid capacity". Major consumers and businesses shifting from the grid to alternative sources are also contributing to the "excess grid capacity" besides importing products to maintain their market shares.

As indicated earlier[47], significant imbedded grid-connected solar power units totalling about 6.5 MW peak and largely owned by commercial customers of ECG are expected this year and these

[47] Section 1.4.1 Existing Generation Sources

are likely to have an impact on the grid electricity consumption. Some of the commercial and industrial entities have also adopted survival strategies to cope with the relatively high tariffs including resorting to product importation to maintain their market shares and these measures are contributing to the excess grid capacity.

Export Market

An option for the excess grid capacity is the export market through the West African Power Pool (WAPP). Net exports to Togo and Benin in 2018 almost tripled from around 248 GWh in 2017 to 662 GWh. No net export however to la Cote d'Voire since the latter has lower tariff range (*see Table 16*).

Table 16: Comparison of Electricity Tariff ranges of Ghana and neighbouring Countries in West Africa from 2017-2018

Country	La Cote d'Voire	Ghana	Togo	Benin	Nigeria
US cents/kWh	9-12	14-16	16-18	17-19	6-11

Achieving Upper Middle Income by 2020

With per capita income of US$1,225 ($2,950 ppp[48]) in November 2010 in Ghana attained a lower middle-income status. Her per capita income has been growing since then. However there has been wide gaps in infrastructural indicators. For instance, total energy consumption per capita should average one tonne of oil equivalent (TOE) compared to her current average of 0.25 TOE. The total electricity consumption per capita should range between 1,000 and 1,100 kWh instead of the current average hovering below 500 kWh since 2010.

By the end of the last decade, the then Ministry of Energy put up a policy statement to increase the country's installed capacity from about 2,100 MW in 2010 to achieve 5,000 MW by 2018 at a period where the average end-user tariff was below 10 US cents per kWh with the main objective of achieving upper middle income status by 2020.

Having an total installed capacity of over 5,000 MW could generate about 36,000 GWh by 2020 and corresspondingly increase the average annual electricity consumption per household[49] from about 3,018 kWh in 2010 to around 5,000 kWh by 2020 and consequently grounding the country firmly in the Upper Middle Income Status.

[48] Purchasing Power Parity

[49] Number of households is assumed to expand from 5.5 million to 7.3 million in 2020. Average household size is assumed to range between 4.3-4.4 by 2020.

By close of 2018, the country had achieved an installed grid capacity of about 4,780 (4,961.5[50]) MW capable of generating around 20,000 to 25,000 GWh depending upon the generation mix and which is enough to meet the country's electricity requirement including supressed demand. However, the average end-user tariff now is about double that of the last decade and thus consequently making the prevailing tariff less affordable and consequently creating the excess grid capacity the country is now witnessing since 2016.

Even though there has been a drop in the grid electricity consumption giving rise to the apparent excess grid capacity, electricity consumption in general would continue to grow as depicted by the dash and dotted lines in Figure 11, when estimates from total embedded back-up generation is factored in the computation.

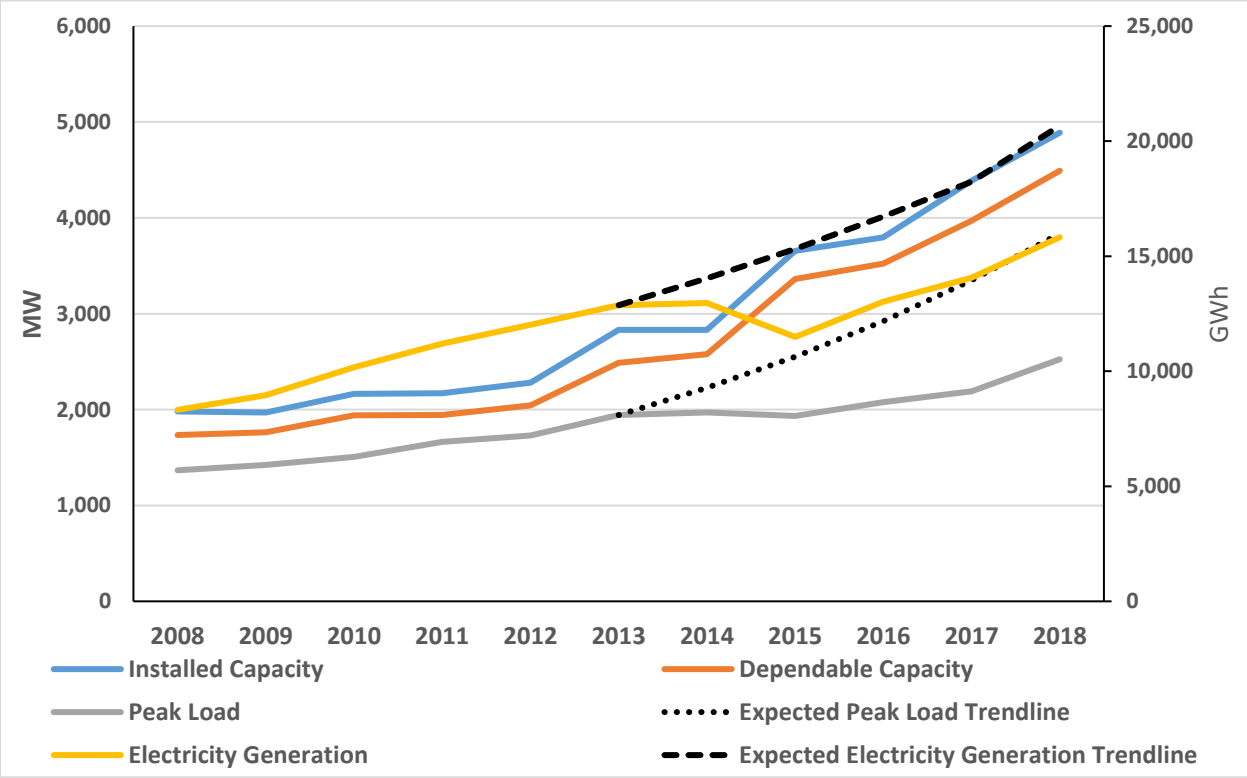

Figure 11: Trends in Installed-, Dependable- Capacities and Peak Load with Generation from 2008 - 2018

The dip in the consumption from 2013-2015 was of course due to the prolonged power crisis. With the load shedding theoretically eliminated by close of 2016, the generation should have picked up significantly but the relatively high tariff regime has been a major barrier.

[50] If imbedded generation is included *(see Table 1).*

2.0 Petroleum Subsector: Oil

2.1 Overview of Petroleum Supply in 2018

Ghana's oil production in 2018 was about 62.1 million barrels coming from the three main commercial fields, Jubilee (46%), TEN (38%) and Sankofa-Gye Nyame (16%) compared to about 58.6 million barrels in 2017, representing an increase of about 6% over the previous year. Average daily production for the year was over 186,000, as against 175,000 barrels in 2017 though still below the targeted production of about 250,000 barrels.

Indigenous Oil Production

Saltpond field

There was no production from the Saltpond field, it has been closed since 2016. It is currently awaiting decommissioning.

Jubilee field

Total oil production from the Jubilee field in 2018 was around 28.5 million barrels compared with 32.7 million barrels in 2017 and 26.9 million barrels in 2016.

Average daily oil production from the Jubilee field continued its downward trend; dropped from about 91,382 barrels in 2017 to 87,844 barrels in 2018, unable to reach the target of 120,000 barrels per day as projected by the industry since 2012 (*see Figure 12*).

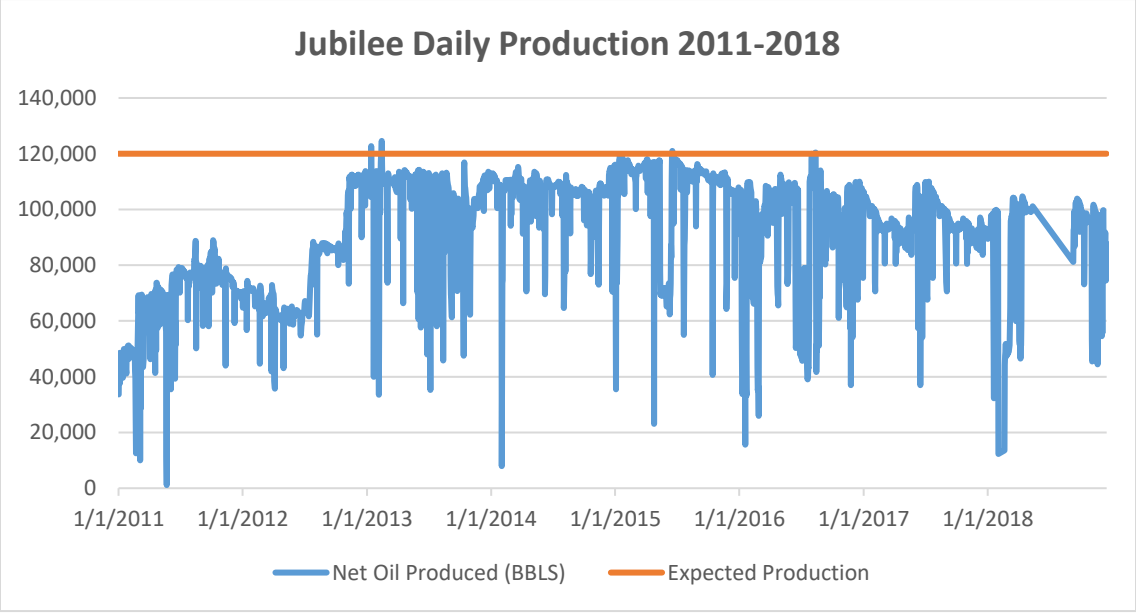

Figure 12: Jubilee field daily oil production trend; 2011-2018

Mean daily production rose from about 70,000 barrels during the first quarter to about 87,000 during of the second half year, then peaking to about 94,000 barrels at the end of the third quarter before dropping to around 85,000 barrels by close of the year.

TEN field

First oil from the TEN field was in August 2016 with production for that year totalling over 5 million barrels. Total production rose to 20.4 million barrels in 2017 and further increased by 15% in 2018 to 23.6 million. Average daily production rose from about 59,300 barrels in 2017 to about 64,000 barrels in 2018, still falling short of the projected average production target of 80,000 barrels for 2017 (*see Figure 13*).

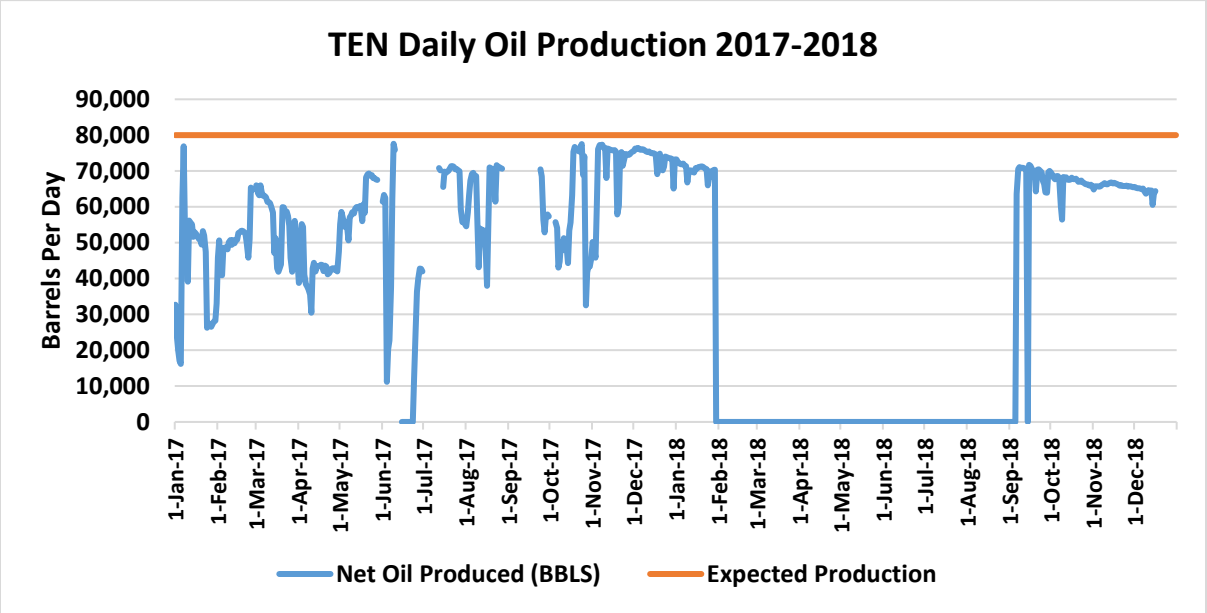

Figure 13: TEN field daily oil production trend, 2016-2018

Sankofa-Gye Nyame field

First oil from the Sankofa-Gye Nyame field[51] occurred in May, 2017. Total production for that year stood at about 5.5 million barrels. The field witnessed its first full year of production in 2018 nearly doubling output to about 10 million barrels. Daily production in the first quarter continued from the average of 36,000 barrels in the previous year starting with average daily production of about 32,000 barrels during the first quarter of 2018. It however decreased to 26,000 barrels in the second quarter and further to about 25,000 barrels in the third quarter where it increased to about 27,000 to round up the year. Although production decreased during the second and third quarters of 2018, they were an improvement over 2017 average quarterly daily production of 12,000 barrels

[51] Also called OCTP (Offshore Cape Three Point) field

and 18,000 barrels respectively, despite still falling short of the average daily production target of 45,000-50,000 barrels per day[52] *(Figure 14)*

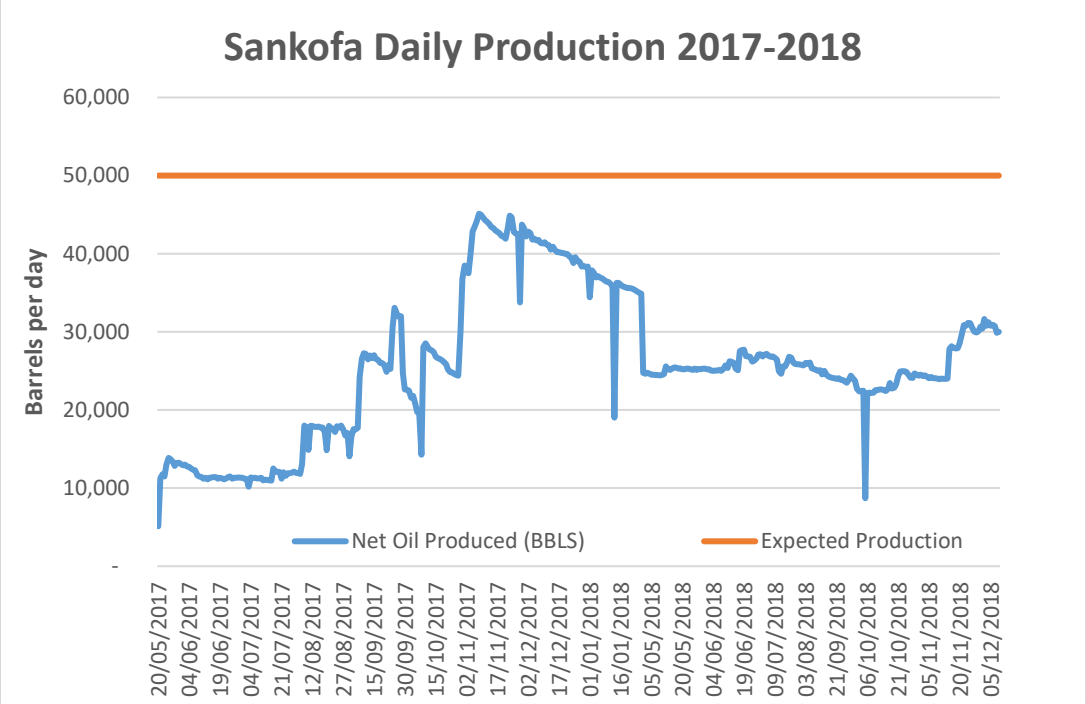

Figure 14: Sankofa-Gye Nyame field daily oil production trend 2017-2018

2.1.1 Crude Oil Prices

In 2018, average price of crude oil for refinery operations was about $71.5 per barrel compared with $54.6 per barrel in 2017. Average price in 2016 was $46.5 per barrel (*see Table 17*).

In 2018, Ghana's crude oil was sold for $68.48 per barrel compared with $54.43 per barrel in 2017.

The average price of Jubilee oil over the period was about $70.6 per barrel compared with $52.8 per barrel in 2017. For the first time TEN oil achieved an average price of about $71.6, which was higher than that of Jubilee. In 2017, TEN oil was sold at $49.3 per barrel. First lifting of Sankofa oil was sold at $63.2 per barrel but ramped up to average $72 per barrel for 2018.

[52] http://www.oilviewafrica.com/exploration/ghana-sankofa-field; https://ghanatalksbusiness.com/first-oil-flow-sankofa/

Table 17 compares the prices of Ghana sourced oil to those of West Texas Intermediate (WTI) representing the United States and the London Brent representing Europe.

Table 17: Average Crude Oil prices in Ghana, United States (Gulf Coast), and Europe (the North Sea) from 2010-2018

Year	Ghana	WTI Gulf Coast/ United States	Brent Crude North Sea/ United Kingdom
	U.S dollars per barrel		
2010	80	79.4	70
2011	111	94.9	111
2012	113	93.3	112
2013	109	97.9	109
2014	99	93.3	99
2015	54.5 (60*)	48.7	52
2016	46.5 (55*)	43.3	43.7
2017	54.6 (63*)	49.7	52.4
2018	71.5 (80*)	64.9	71

**for power generation.*

Source: Bank of Ghana, LondonGasPrice.com, tradingnrg.com; www.statistica.com, www.eia.gov

2.1.2 Domestic Consumption and Stocks in 2018

Crude oil imported for domestic consumption further dropped from 233,200 tonnes (~1.6 million barrels) in 2017 to 197,000 tonnes (~1.4 million barrels) in 2018.

Grid electricity production accounted for about 28% (*compared to 76% in 2017*) of the crude oil consumption whilst primary refinery operations accounted for the remaining 72%.

Crude oil for power generation reduced by 69% due to improvement in gas supply as the preferred and cheaper fuel.

Total petroleum products supplied increased from about 3.5 million tonnes in 2017 to 3.9 million tonnes in 2018. The great product movers as usual, were RFO, LPG, ATK and Premix (*see Table 18*).

The LPG supplied came largely from the Atuabo Gas Processing Plant (~20%) and imports (~77%) since the Tema Oil Refinery was virtually shut down. About 90% of the LPG produced locally came from the Atuabo gas processing plant; is a by-product of processing wet/rich associated gas to dry/lean gas for power production (*see Table 19*).

Table 18: Petroleum products supplied to the Economy from 2015-2018

PETROLEUM PRODUCT	2015	2016	2017	2018	*CHANGE*			
					b/n 2014 & 2015	***b/n 2015 & 2016***	***b/n 2016 & 2017***	***b/n 2017 & 2018***
	1000 tonnes				***Percentage***			
LPG	279	281.5	358.9	396.8	*15.5*	*0.9*	*27.5*	10.6
Gasoline	1,163.20	1,069.20	1,072.60	1,256.50	*5.5*	*-8.1*	*0.3*	17.1
Premix	47.2	56	68.8	55.3	*-16*	*18.6*	*22.9*	-19.6
Kerosene	6.9	8.1	5.6	5	*-25.8*	*17.4*	*-30.9*	-10.7
ATK	112	132.2	166.6	200.3	*-1.7*	*18*	*26*	20.2
Gas oil/diesel	1,902.70	1,765.00	1,661.50	1,836.70	*11.1*	*-7.2*	*-5.9*	10.5
RFO	13.4	12.9	129	139.1	*-50*	*-3.7*	*900*	7.8
Total	**3,524.40**	**3,324.80**	**3,462.90**	**3,889.70**	***8***	***-5.7***	***4.2***	***12.3***

Table 19: Petroleum Products produced Locally, Imported and Exported from 2015-2018

PETROL PRODUCT	2015			2016			2017			2018		
	1000 tonnes											
	Pro	**Imp**	**Exp**	**Pro**	**Imp**	**Exp**	**Pro**	**Imp**	**Exp**	**Pro**	**Imp**	**Exp**
LPG	2	198	0	114	177.9	25.1	114	202.4	40.3	87.9	306.2	4.8
Gasolines	31.8	1182	9.9	244	1,235.7	271.6	6.5	1,304.1	184	101.6	1326	63.2
Kerosene	0.2	0	0	24.5	0	0	2	0	0	33.1	0	0
ATK	18.2	109	102	37.6	112.7	115	0.1	181.4	150	21.5	183.9	184.8
Gas oil	28	2,161	10.3	255	2,161	170.1	6.1	1,780.9	190	113	1753	45.4
RFO	8.9	0	0	64	20.6	69.8	1.3	248.8	53	31.5	111.6	41.5
Total	**89.1**	**3650**	**122.1**	**739**	**3266.7**	**651.6**	**129.9**	**3717.6**	**618**	**388.7**	**3680**	**339.7**

Pro refers to production at the TOR and Atuabo; **Imp** refers to imports while **Exp** refers to exports. NB: *Diesel export is largely sales to international bunkers. ATK export is sales to international aviation bunkers. Gasoline export is largely heavy gasoline.*
*Source: Tema Oil Refinery and National Petroleum Authority***.**

There was also about 4.4 million tonnes of heavy fuel oil (HFO)[53] imported for power production in 2018 but not accounted for in Table 20. This was about 23% increase over the previous year. HFO consumption for power production in 2016 was about 2.3million tonnes.

2.2 2018 Forecast and Actuals

Average Brent crude price for refinery operations was $71.5 per barrel. Average prices in other regions also fell within forecast for the year (*see Table 20)*

Table 20: 2018 Average Crude Oil Prices in Ghana, United States and Europe - Forecast and Actuals

	Ghana		WTI & NYMEX Gulf Coast/ United States	Brent Crude North Sea/ Europe
	Brent	**LCOs***	**LCOs**	**Brent**
Forecast	69-71	63-64	65.58	68-70
Actual	71.5	64.9	65.05	71

** Other light crudes / U.S refiner*
 # power generation requirements
Source: Bank of Ghana, U.S EIA Short Term Energy Outlook, 2018, 2019

Tema Oil Refinery (TOR) was virtually shut down throughout the year, operating just about 20% of its production capacity, even though, thrice that of 2017 operations. This was largely due to management and financial challenges.

Unlike in 2017, the supply of all petroleum products were largely within the 2018 projections. The consumption however was equivalent to operating an 80,000-90,000 barrels per stream day refinery (*see Table 21*).

ATK supply started increasing in 2016. ATK consumption had dropped consistently since 2012 until 2016 which was attributed to its relatively high cost in the country. It would be recalled that ATK supply shortfall in the country in 2013 compelled a number of foreign airlines to make alternative refuelling arrangements with neighbouring countries before landing or taking off in Ghana.

The shortfall in kerosene consumption has largely been due to the shift from its usage as fuel for lighting and cooking to better options such as dry-cell powered and solar lanterns for lighting and LPG for cooking.

[53] HFO is different from RFO (Residual Fuel Oil) by its higher sulphur content. HFO consumption will be incorporated in future releases.

Table 21: Forecast and Actual Petroleum Products Consumption in 2018

PRODUCT	Products Supplied to the Economy	
	Requirement (Forecast)	Consumption (Actual)
	1000 Tonnes	
	For economic growth	Economic growth
Total Gasolines[54]	1,182 -1,300	1,312
Total Diesel	1,832 - 2,000	1,837
Kerosene	4 – 6	5
ATK	184 – 200	200
LPG	396 – 400	397
RFO	N/A	139
Total	***3,598-3,906***	***3,890***
Equivalent refinery capacity	***80-90 per day***	***80-90 per day***

2.3 Forecast for 2019

After a strong economic growth of over 3% in 2017 and early 2018, the global economic is now projected to slow down from 3.6% in 2018 to within 2.6-3.3% in 2019[55]. This is largely being blamed on the trade war between the United States and other major economic blocks, more particularly, China which has the second largest economy.

Growth among emerging market and developing economies is projected to remain at an average of 4% in 2019 just as in 2018.

Africa's economic growth remains uneven with East Africa out-pacing the rest of the continent. On the whole, the continent grew 3.8% in 2018, with sub-Saharan Africa rising somewhat slower. Average growth in Sub-Saharan Africa in 2018 almost remained the same as in 2017; hovering in the range of 3.1-3.2% but dropped to about 2.6% by close of the year. No significant growth is expected in 2019. Most of the growth is expected to come from the continent's two largest economies – South Africa and Nigeria[56]. South Africa is forecast to remain within 1-1.2% growth

[54] Include Premix
[55] The IMF and the World Bank forecasts range, 2019. The World is on the high-side.
[56] Global Economic Prospects: Sub-Saharan Africa, 2019, The World Bank.

in 2019 as in 2018 from about 0.8% in 2017. Nigeria is also anticipated to remain within 2-2.2% in 2019.

The sluggish global economic growth is expected to result in drop in energy requirements. Average prices of crude oil are also projected to decline from the average of $71 per barrel into the $60s per barrel for Brent and from the $60s to $55-57 per barrel for other light crudes[57].

Just as in 2017, the year 2018 equally saw dramatic changes in the global oil and gas market largely due to the crisis in the Middle East which is still 'boiling' with the Syrian crisis; Venezuela and the trade war between the United States and the other economic giants; EU and China. In Europe there is still the frozen conflict between the West and Russia over the crisis in Ukraine and annexation of Crimea.

The U.S EIA projects average world crude oil prices to drop in 2019; from $71 to $65.15 per barrel for Brent and from $65 to $57.8 per barrel for the other light crudes[58].

The IMF and the World Bank forecast an average of $60 and $66 per barrel respectively for 2019.

***Forecast for Ghana**:*

Since Ghana's oil supplies largely come from Nigeria and Equatorial Guinea all in West Africa, we do not expect any significant drop from last year's average global oil prices. This is due to the high maritime risky nature of the Gulf of Guinea, which has surpassed the Strait of Malacca in Asia as the most dangerous maritime route in terms of cases of high-jacking, kidnapping and piracy which are likely to impact significantly in terms of insurance charges on fleet plying the route. The risks thus far outweigh the relatively short-distance advantage and for that matter erases the later.

As usual, we also do not expect Ghana to source her crude oil from the local indigenous fields which are of high premium brands[59]. Rather, it sounds more convenient for the Government to use part of the readily available foreign currency proceeds from sales to support other commitments.

We therefore forecast that the Brent price would fall within the range of **$65-67** per barrel. For other light crudes for refinery operations, it is expected to decrease from the average of **$63** per barrel in 2018 to within **$59-61** per barrel (*see Table 22*). Average delivery price of light crudes for power production is expected fall within **$69-71** per barrel.

[57] The World Bank, IMF forecasts, 2019.
[58] US Energy Information Administration, 2019, https://www.eia.gov › outlooks › steo
[59] With API equal or greater than 37.

Table 22: Forecast for Average Crude Oil Prices for Ghana, United States and Europe for 2019

FUEL BRAND	Ghana	United States EIA (WTI and NYMEX)	Europe[60] (UK & Holland)
	US dollars per barrel		
Brent crude	65-67	65.15	64-66
Other light crudes/ U.S refiner	59-61	57.87	59-61

In 2018, Jubilee field oil was sold at an average price of $70.63 per barrel whilst those of TEN and Sankofa fields were sold at $71.59 and $72 per barrel respectively. Daily production levels however could not exceed the expected minimum for the year despite the favourable oil prices.

With favourable oil price forecast for 2018, Ghana's total production was expected to increase from the average of 175,000 barrels per day in 2017 to between 200,000 – 220,000 barrels per day but it did not happen (*see Table 23*).

For 2019, we expect prices of oil from the three fields to decline due to the global influence; falling within **$66-70** per barrel. Average daily production levels are likely to remain the same or increase marginally (*see Table 23*).

Table 23: Forecast for Ghana's Crude Oil Prices and Production for 2019

SOURCE OF OIL	Fuel Prices US$ per barrel			Average Daily Production Range 1000 barrels		
	2018		Forecast for 2019	2018		Forecast for 2019
	Actual	Forecast		Actual	Forecast	
Jubilee field	70.63	68-70	66-68	80-87	95-105	90-92
TEN field	71.59	63-65	68-69	64-65	70-75	70-71
Sankofa field	72	63-65	68-70	29-30	35-40	30-33
			Total	***173-182***	***200-220***	***190-196***

[60] London and Rotterdam trading forecast for Brent averaged $65-68 for 2019. www.tradingeconomics.com The IMF and World Bank forecast average range of $63-65 per barrel respectively for all crudes for 2019.

To meet the Government economic growth rate target of **7.6%** (7-*7.4% by donor agencies*) and particularly **6.2%** (***non-oil growth)*** for the country in **2019,** the total petroleum products required is expected to increase from 3.9 million tonnes to about 4 million tonnes, with gasoline and diesel as usual having the biggest shares due to the expected growth in the Services and the Agricultural sectors of the economy as the result of the One-District-One Factory, the One-Village-One Dam and Planting for Food & Jobs policies of the government (*see Table 24).*

Table 24: Forecast for Petroleum Products requirements for 2019

PRODUCT	**National supply requirement 1000 Tonnes**
	For economic growth target 6.8% (oil); 5.4% (non-oil)
Total Gasolines	1,350 -1,400
Total Diesel	1,850 - 1,900
Kerosene	4 – 5
ATK	200 – 250
LPG	416 – 455
RFO	140-150
Total	***3,950-4,160***
Equivalent refinery capacity	***75,000-80,000 per day***

The requirement for diesel (gas oil) includes demand by the mining and the petroleum upstream industries. Gasoline demand would continue to increase but marginally.

For LPG, at least about a third of the total LPG requirement is still expected to come from local production.

To achieve a 50% nationwide penetration of LPG, the consumption would require an LPG supply of at least 450,000 tonnes by 2020 based on an estimated population of 30 million by the end of the decade but this is not achievable based upon the present rate of supply. The end year has now been extended to 2030.

3.0 Petroleum Subsector: Natural Gas

3.1 Overview of Natural Gas Supply in 2018

Total gas flow to consuming facilities in Ghana in 2018 was 58,531 mmscf. About 42% was from Nigeria via the WAGP and the remaining 58% coming from indigenous sources through the Atuabo gas processing plant.

About 35% of the gas was supplied to the thermal plants in the Tema power enclave, 54% went to the Takoradi power enclave and the remaining 11% went for non-power activities.

In 2018, a total of 91,459.30 mmscf of raw (wet)[61] gas was produced from the Jubilee, TEN and Sankofa Gye-Nyame (SGN) Fields compared to 77,294.44 mmscf in 2017[62]. The Jubilee Field accounted for 44,841.94 mmscf (49%) and exported 19,330.18 mmscf of it to Ghana Gas, while the TEN and Sankofa Gye-Nyame (SGN) Fields produced 39,472.78 mmscf (about 43%) and 7,144.58 mmscf (about 8%) respectively[63]. Both fields also exported 7,144.58 and 6,109.99 mmscf of their gas to Ghana Gas[64] for processing.

Thus total raw gas receipt at Atuabo gas processing plant (Ghana Gas) was 33,831,15 mmscf; 57% from Jubilee, about 25% from TEN and the remaining 18% from SGN fields. About 87% (i.e. 30,019,309 mmBTU) of the resulting processed (also called dry or lean) gas was shipped for power production whilst the remaining 13% (i.e. 4,657,621 mmBTU) was shipped for non-power activities.

Jubilee field

Total associated gas from the Jubilee field operations in 2018 was almost 44,841.94 mmscf compared to 42,000 mmscf in 2017. There was no gas export from the Jubilee Field to the Atuabo Gas Processing Plant in February due to a 19-day shutdown of the Jubilee FPSO for maintenance. About half of produced gas from the Field was exported to the Atuabo Processing Plant with portions of the remainder re-injected, used or generate power for the FPSOs, or flared.

Average daily production of the raw gas ramped up from 122 mmscfd in 2017 to 137 mmscfd in 2018, about 12% higher than in 2017. Average daily production since 2017 have been within expected yield levels from the field (*see Figure 15*).

[61] Also called rich gas.
[62] Associated gas is produced from the Jubilee and TEN Fields and non-associated gas from Sankofa Gye-Nyame (SGN) Field.
[63] Annual Report on the Management and Use of Petroleum Revenues for the Period 2018, Public Interest Accountability Committee, Publication, 2019.
[64] Ghana National Gas Company (GNGC).

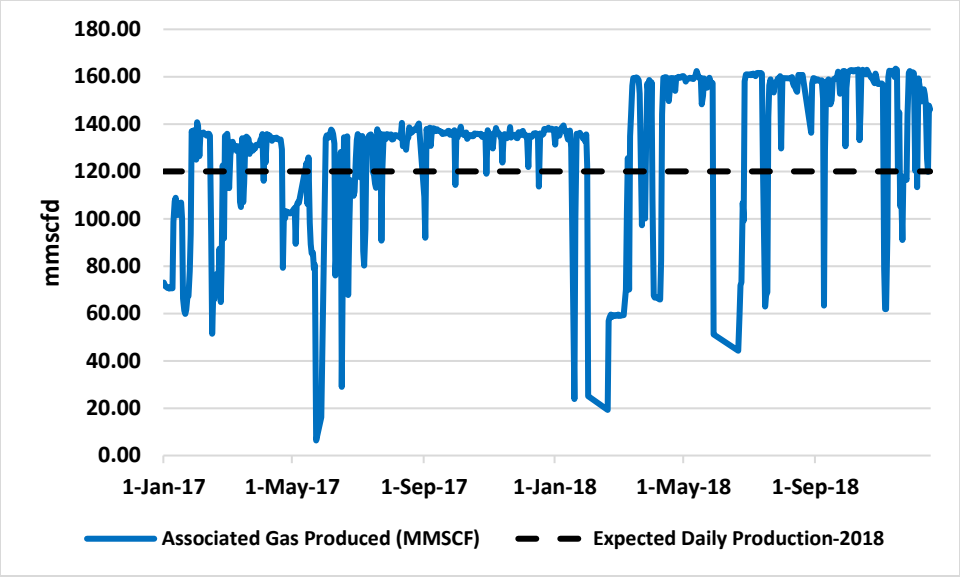

Figure 15: Comparison of Jubilee field daily gas yield; 2017 and 2018

TEN field

In 2018, TEN field produced about 39,473 mmscf wet gas, about 73% more than in 2017 and exported almost 8,391 mmscf to Ghana Gas for processing. Daily production of the raw gas also increased from about 75 mmscfd to 93.7 mmscfd in 2018 (*see Figure 16*).

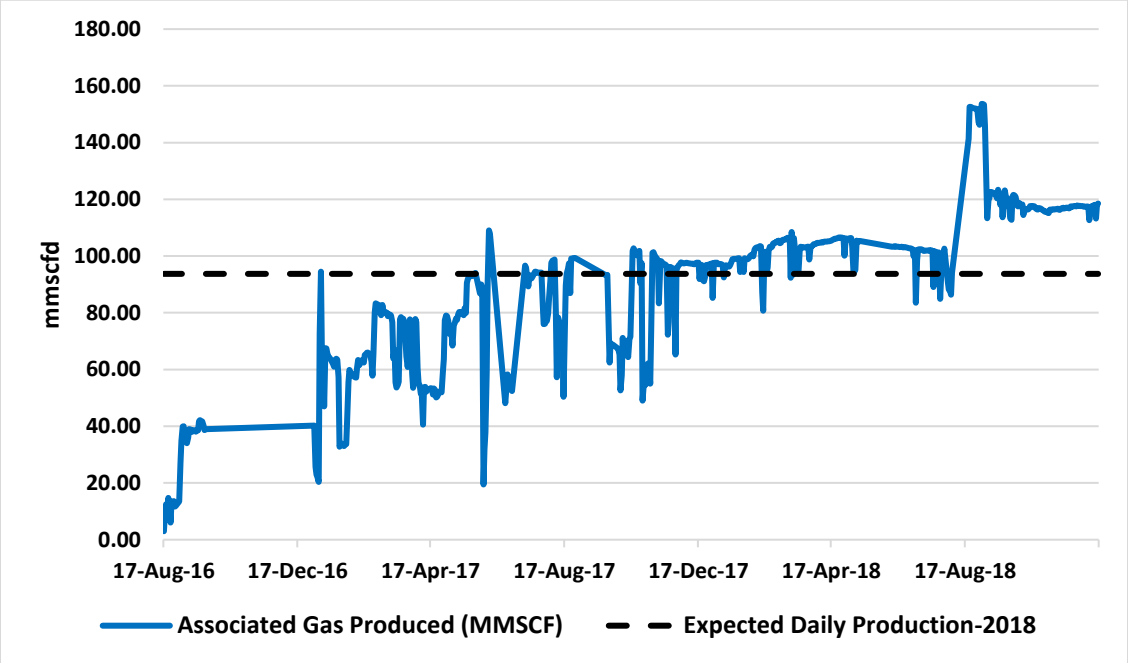

Figure 16: TEN field daily gas yield from 2016-2018

First gas from the TEN field occurred in August 2016 with an average yield of just about 29 mmscfd translating into total production of 1,141 mmscf for that year.

Sankofa-Gye Nyame field

Non-Associated Gas production from the Sankofa-Gye Nyame (SGN) field commenced in June 2018. The June and July productions however were used for re-injection and commissioning of export facilities. Commercial flow from SGN began in August, 2018 after ENI the operator, has commissioned their Offshore Receiving Facility (ORF) in July 2018 and ramping up significantly in November 2018.

Over 85% of the raw gas of 7,144.58 mmscf produced and processed were exported to the Ghana Gas pipeline to comingled with the other indigenous sources.
Daily production increased from about 32 mmscfd in 2017 to over 40 mmscfd in 2018 marking official commencement of its commercial gas operations. The year 2017 witnessed the first gas from the Sankofa-Gye Nyame field[65] in May but at non-commercial levels, i.e. for operator's own production use *(see Figure 17*).

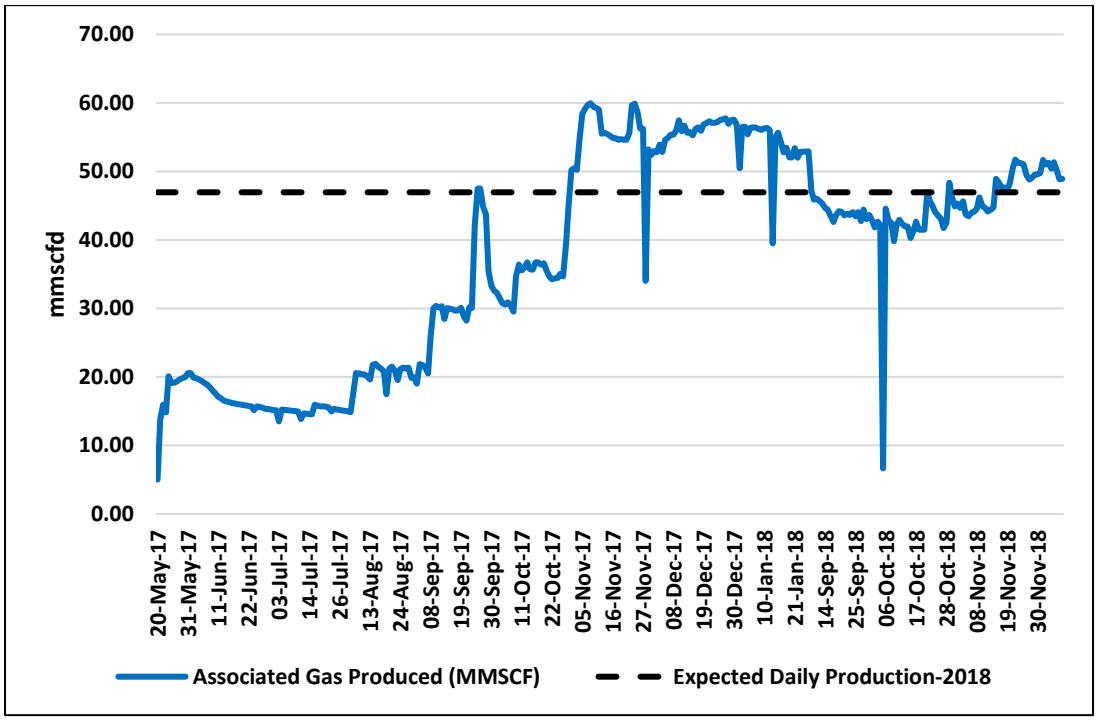

Figure 17: Sankofa-Gye Nyame field daily gas yield in 2018

[65] Also called OCTP (Offshore Cape Three Point) field

3.2 2018 Forecast and Actuals

Average gas flow from the WAGP was 67 mmscfd compared with the 60 mmscfd projected for the year. The average flow from Ghana Gas about 80 mmscfd compared with the projected range of 150-160 mmscfd.

The WAGP delivery gas price averaged $8.71/mmBTU ($9.03/mscf) compared to the expected AWACOG[66] price of $7.29/mmBTU ($7.56/mscf). Average price of delivered processed or dry gas from Ghana Gas for electricity generation on the other hand was $7.53/mmBTU ($7.81/mscf) about $0.24/mmBTU above the AWACOG price. It happened this way because the AWACOG price was implemented after the first quarter of the year.

Delivered wet gas price from Jubilee field to Ghana Gas was $2.90/mmBTU ($3/mscf). Delivered wet gas from TEN was also sold at the same price to Ghana Gas.

Sankofa or SGN gas on the other hand was delivered to the Ghana Gas pipeline system at $7.29/mmBTU ($7.56/mscf) since it was already a dry gas.

Comparatively, average spot (Henry Hub) price in the United States in 2018 increased to $3.16/mmBTU ($3.28/mscf) from $2.99/mmBTU ($3.1/mscf)[67] in 2017; marginally above the projected for the year. Average natural gas import price in the European Union (EU) increased to $7.68/mmBTU ($7.96/mscf) from $5.65/mmBTU ($5.97/mscf) in 2017[68]; about $2/mmBTU more than projected for the year.

3.3 Forecast for 2019 and beyond

On the global scene, the average US spot price for gas is projected to drop from the $3.16/mmBTU ($3.28/mscf) in 2018 to about **$2.36/mmBTU** ($2.45/mscf) in **2019**.[69] . For the EU, the average gas import price would drop from $7.68/mmBTU ($7.96/mscf) in 2018 to within **$4.8-6/mmBTU ($4.98-6.22/mscf)** in **2019.**

For **2019**, average wet gas prices from the Jubilee and TEN are expected to remain about the same as last year, i.e. at **$2.90** being associated gas. For SGN gas, a non-associated gas and feeds into the Ghana Gas pipeline, the average price is expected to remain the same as the comingled gas which is **$7.29/mmBTU**, the AWACOG price *(see Table 25).*

[66] Adjusted Weighted Average Cost of gas
[67] Spot prices usually do not include transportation cost.
[68] https://ycharts.com/indicators/europe_natural_gas_price
[69] US EIA Short Term Energy Outlook, March, 2018.

Table 25: Average Delivery Gas Prices in Ghana (WAGP), United States (Henry Hub), and Europe (North Sea); 2011-2018 and projected prices for 2019

Year	WAGP+local/ Ghana	Henry Hub/ United States	Northsea Europe/
	U.S dollars per mmBTU		
2016	7.9-8.84	2.51	4.56
2017	8.6-9.02	2.99	5.65
2018	7.53-8.71	3.16	7.68
2019*	**7.29-8.41[#]**	**3.36**	**4.8-6**

**forecast ; Low-side for GNGC Gas and high-side for WAGP gas.*
Sources: Bank of Ghana, LondonGasPrice.com, tradingnrg.com, US EIA STEO for 2019

We expect the daily average **Ghana Gas** supply to range from **120-160 mmscfd** and then up to about **300 mmscfd** by close of the year due to additional increasing supplies from TEN and the Sankofa-Gye Nyame fields *(see Table 26).* The only limitation to the comingled flow would be the intake point at the metering station.

Table 26: 2019 Projected Monthly Gas Delivery Profile in mmscfd by GNGC

Gas Source	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jubilee FV	48	13	34	60	73	73	73	73	73	73	73	73
TEN AG	19	-	-	-	-	-	-	24	24	24	24	24
Sankofa NAG	61	117	49	60	90	90	90	90	180	180	180	180
Total Gas Supply	***128***	***130***	***83***	***120***	***163***	***163***	***163***	***187***	***227***	***227***	***227***	***227***

Source: Ghana Gas, 2019.

Table 27 shows forecasts for local gas and WAGP supply.

Table 27: Forecast for Ghana fields Gas export and WAGP Gas Supply for 2019

SOURCE OF GAS	Average Export Prices US$ per mmBTU		Average Daily Export Range mmscfd	
	2018	**Forecast for 2019**	**2018**	**Forecast for 2019**
Raw/Wet Gas export				
Jubilee field	2.9	2.9	52.5	92-95
TEN field	2.9	2.9	22.5	30-35
lean/Dry Gas export				
Sankofa field	7.29	7.29	40	133-135
WAGP	8.71	8.41	67	110-120
			Total	***365-385****

[*]Wet gas export volumes would reduce marginally though after processing

3.3.1 Gas Supply Challenges

On the average, gas still remains the most sustainable and relatively cost-competitive fuel supply to produce affordable power in the country. The key challenges hampering reliability of gas supply however still remain about the same as in the previous years, though with some significant improvements such as the drop in the gas tariff for 2018, namely:

i. inadequate supply, particularly from Nigeria through the WAGP (*see Annex 4*) ; and
ii. finance - domestic and international payment deficits.

Adequacy of gas supply

About **3,228 MW** dependable capacity of thermal power is expected to be in operation this year - 2019 capable of producing about **17,238 GWh** of electricity, equivalent to **113,111,300-115,000,000 mmBTU** in thermal energy terms. Existing gas supply infrastructure can only provide about **80,240,000 mmBTU** which is equivalent to a daily flow of **200-220 mmscfd**. The remaining of about **33 million mmBTU** equivalent to about **80-100 mmscfd** of gas is to be supplied by oil fuel, largely HFO.

Total lean/dry daily gas supply for **2019** estimated at **365-385 mmscfd** would have been enough to cover the total gas demand of **280-320 mmscfd** but for the technical challenges in the pipeline network. For instance the maximum capacity of the Takoradi Regulatory & Metering (R&M) station is 120 mmscfd and that of Tema is 140 mmscfd. These R&M stations need to be expanded to receive the additional gas.

Besides the fact that the prevailing electricity tariffs are relatively too high, the non-power gas consumption industry is yet to be developed leading to excess stranded gas supply. Should the situation changes with time, more gas would then would be needed in future; most probably via LNG if no significant gas fields are discovered. Price cap for LNG however would be necessary.

As the national gas aggregator, GNPC, also the national oil company (NOC) is mandated to buy all natural gas produced in Ghana and to market it as well. GNPC is made responsible for sourcing natural gas such as LNG from international suppliers to supplement indigenous gas production. The role also mandates GNPC to make specific investments in gas infrastructure to create a viable domestic gas market but this has not been forthcoming as expected.

Progress of Planned LNG projects

Two major LNG projects so far and one is expected in the country by 2020. They are:

- the Tema LNG Terminal Company, and
- a small-scale virtual LNG project.

The **Tema LNG Terminal Company** project is a **Floating Storage and Floating Regasification Unit** with expected capacity of **250 mmscfd** (1.7 mmtpa[70]) expected to be completed in 2020**.** Initial contracted supply amount is about **180 mmscfd.** The company secured a **Construction** Permit from the regulator last year[71]. GNPC has signed a 12-year agreement with Rosneft of Russia for the supply of the LNG.

GNPC earlier in 2017 signed an agreement with a private company, Quantum Power for the latter to construct and operate a 500 mmscfd[72] floating LNG storage, regasification and delivery facility moored offshore Kpone. The US$550 million facility which was supposed to be operational in 2018 apparently fell through and has been replaced with the Rosneft facility.

The **small-scale virtual LNG** is a virtual pipeline project being built by a consortium of small entities along the gas value-chain to supply gas to Sunon-Asogli and Trojan power plants. It is an apparently a stop-gap short-to-medium term measure to meet the fuel requirements of the said power plants. It would comprise seventeen '52-cubic-metre' LNG trucks ferrying LNG from small-scale LNG ships berthed at the Tema port; eight (8) trucks at the loading gantry at a time and additional eight (8) trucks moving every night to deliver the fuel to the 560 MW gas-fired Sunon-Asogli Power Plant thermal plants. Loading is estimated to take an average of an hour. Each LNG truck would take an average of 45 minutes to reach the Sunon-Asogli Power Plant where instant regasification is expected, taking advantage of the relatively high ambient temperatures. Initial contract quantity is said to be 60 mmscfd. This project is currently on hold if not cancelled facing challenges with the supply of the LNG for the project

Unlike the GNPC-Rosneft/Gazprom agreement, the source of LNG for the small-scale project is the **LNG2Africa initiative;** an Equatorial Guinea[73] initiative to sell small-scale LNG for utilisation in Africa. Initial target countries are Togo, Burkina Faso and Ghana.

The LNG aspect of the project was apparently not well negotiated during the contracting process. The major shareholder of the LNG company in Equatorial Guinea, Shell International has blocked the deal ostensibly for not involving them right from the beginning.

Finance – domestic and international payment deficits

Both the Power and the Petroleum subsectors of the Energy Sector are still bedevilled with financial challenges.

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[70] million tonnes per annum

[71] The natural gas transport and use regulator is the Energy Commission.

[72] 3.4 million tonnes of LPG per year.

[73] Equatorial Guinea has been an LNG producer since 2007 with production of 24,000-25,000 cu m per day (151,000 bpd LNG). Proven reserve estimated in 2010 was 4.5 Tcf. Target countries are **Togo** LNG project (MoU, April) 2018; Burkina Faso LNG project (MoU,2017); and **Ghana** LNG project (15-yr MoU) ***150 mmscfd*** equivalent.

Energy Sector arrears and debt situation was about $4 billion at the 2018, about $2 billion more from 2017. Most of the debt have been due to short term loan contracted by the power producers culminating in the 'take or pay' and the distribution utilities' inability to collect adequate revenue to cover their operations. The Power subsector debt alone is increasing by about $100 million every quarter.

Also, persistent untimely and insufficient payments for gas delivered are also contributing to the huge debt burdens of the gas off-takers most of them public entities. For instance, untimely and inadequate payments still contribute to the reasons for the unreliable and interruptions in gas supply from Nigeria through the WAGP. On the domestic side, VRA still owes Ghana Gas Company for gas supplied from Atuabo, and the latter in turn also owes GNPC for the wet gas supplied. Ghana Gas received raw gas worth about US$ 85 million from GNPC during the year, for which payment is outstanding. Total Ghana Gas indebtedness to GNPC stood at about US$315.5 million as at the end of 2018.

Ghana Gas receipt of the sale of lean gas, LPG, and condensates for the period was almost US$225 million of which only about US$85 million was paid. Even then, Ghana Gas made no attempt to defray part of its debt to GNPC, even though the Company received some revenue for the period under review.[74]

Ghana Gas in turn supplied VRA of lean gas worth over US$ 222 million which had not been paid, incurring an interest of almost US$17 million. Total indebtedness to Ghana Gas stood at almost US$751 million as at the end of 2018.

As part of clearing of VRA's debts, the Ministry of Finance had an arrangement with Ghana Gas to apply an amount of over US$233 million being part of its receivables from VRA, to defray part of the latter debt. On the distribution or retail end, the Electricity Company of Ghana (ECG) is still owing the electricity supply utilities.

In order to address the chronic debt challenges and to facilitate equitable distribution of all cash collected in the power sector value chain using the end user tariff as a basis, the Cash Waterfall Mechanism (CWM) concept was instituted in 2016. It was to be implemented through the development of a formula, for adequate distribution of revenue to all stakeholders in the power sector value chain. However, up till now, the CWM has still not been operational.

To resolve the Energy Sector debts due to banks and trade creditors, the Government has set up E.S.L.A. PLC, a Special Purpose Vehicle (SPV) incorporated as a public limited liability company to issue long-term bonds. The securities issued are backed by a component of the Energy Sector Levy Act (ESLA) receivables which has been assigned to the company for the settlement of coupons and principal repayments arising under the securities that are issued.

[74] Annual Report on the Management and Use of Petroleum Revenues for the Period 2018, Public Interest Accountability Committee, Publication, 2019.

4.0 Woodfuel Subsector: Charcoal demand and prices

In 2018, the average prices of charcoal in the country followed the historical increasing trend; for the mini-bag it rose to GH¢27.6 from about GH¢25 per bag in 2017 whilst for the maxi-bag, it increased from about GH¢38 in 2017 to about GH¢41 *(See Annex 5).*

The overall average percentage change in 2018 for the maxi-bag however remained about the same as in 2017. The average percentage change for the mini-bag on the other hand dropped by about half; from over 20% in 2017 to about 10% in 2018 *(see Table 28).*

Table 28: Average Price per bag of Charcoal in the Ten Regions for 2017 and 2018[75].

Region	Mean Price per Mini bag in Ghana Cedi (GH¢)			Mean Price per Maxi bag in Ghana Cedi (GH¢)			*Percentage change in mean prices 2016/2017**	
	2017	2018	*% change*	2017	2018	*% change*	*Mini*	*Maxi*
Ashanti	19.37	20.98	*8.31*	28.59	30.78	*7.66*	*16.27*	*9*
Brong Ahafo	16.80	17.64	*5.00*	26.77	28.75	*7.40*	*38.27*	*19.08*
Central	32.25	35.76	*10.88*	47.33	50.77	*7.27*	*27.47*	*17.04*
Eastern	25.52	27.79	*8.89*	36.83	39.35	*6.84*	*18.64*	*20.56*
Gt. Accra	*31.17*	*33.79*	*8.41*	42.5	46	*8.24*	*15.49*	*9.88*
Volta	35.34	37.3	*5.55*	50	53.45	*6.90*	*30.07*	*13.22*
Western	27.17	29.22	*7.55*	43.13	45.8	*6.19*	*19.43*	*17.62*
Northern	19.46	21.27	*9.30*	32.33	34.77	*7.55*	*76.91*	*11.6*
Upper East	24.67	29.74	*20.55*	38.49	42.03	*9.20*	*-19.98*	*-28.38*
Upper West	19.59	22.91	*16.95*	32.84	37.1	*12.97*	*-17.86*	*-11.24*
National	***25.13***	***27.64***	***10.14***	***37.88***	***40.88***	***8.02***	***20.47***	***7.84***

**revised with latest data available*

As usual, the high-price zones were along the coast; Greater Accra, Central and Volta Regions. Maxi-bag price however dragged Western Region into the high price zone. The low-price areas

[75] The price survey was conducted in the district capitals and computed as average for each region.

were still the transitional regions of Brong Ahafo, Northern and Upper West regions followed by the forest regions of Ashanti, Eastern and Western.

Brong Ahafo, Volta and Western regions experienced the lowest price changes. The Upper East and West regions on the average experienced the highest price change. Official reasons are yet to be known.

After a relative drop in 2014, prices of LPG per kg and per energy i.e. (TOE) have been climbing since 2015, whilst similar prices for charcoal have remained about the same (*see Figures 18 and 19*).

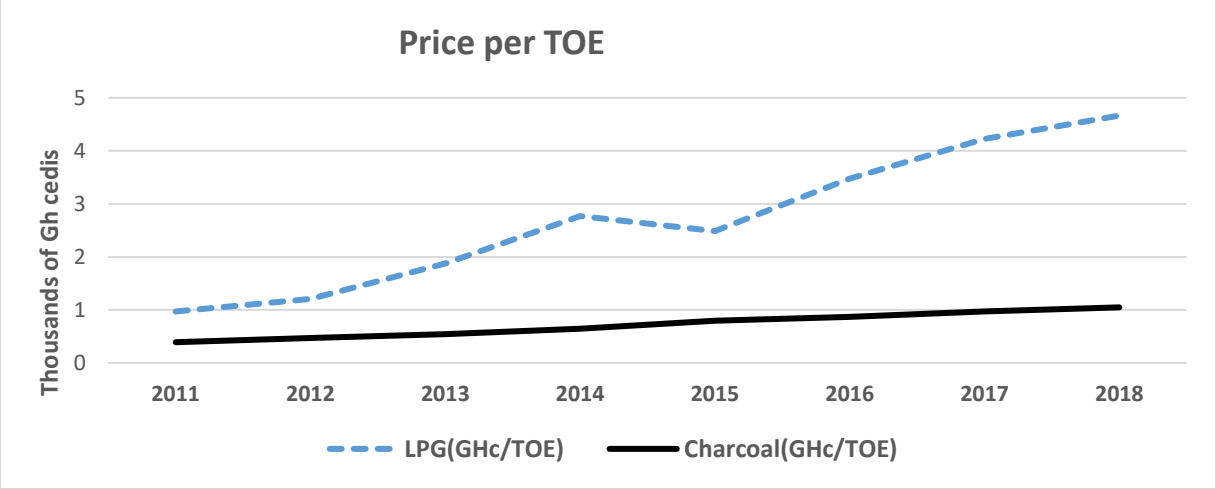


Figure 18: Comparison of prices of Charcoal and LPG per unit energy from 2011-2018

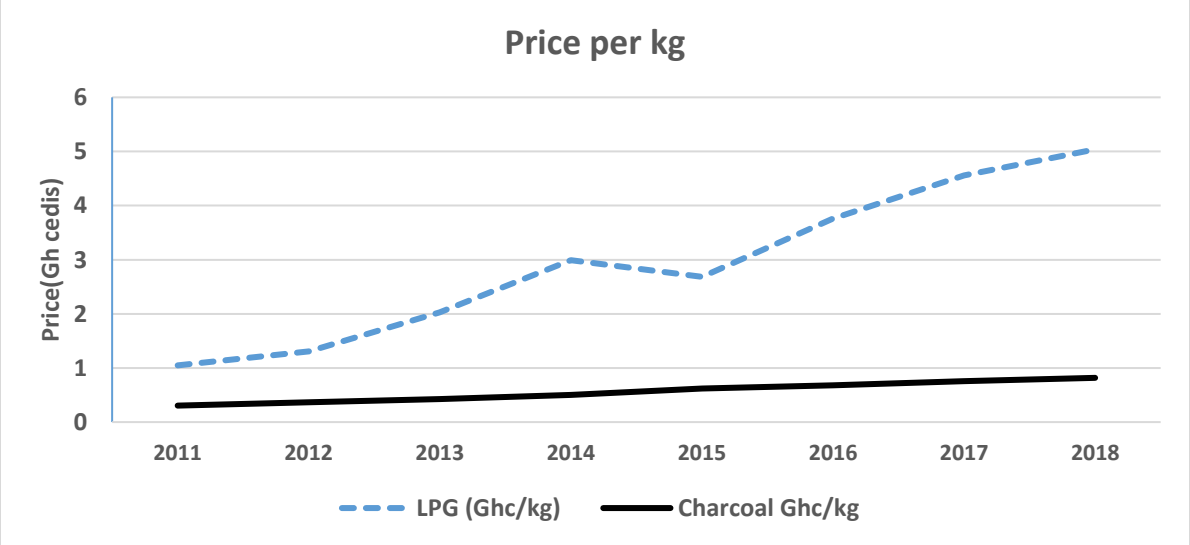


Figure 19: Comparison of unit prices of Charcoal and LPG from 2011-2018

The apparent impact is that consumption of charcoal had levelled up with LPG consumption since 2016 and the former is likely to surpass the latter in the coming years if no favourable policy intervention is implemented (*see Figure 20*).

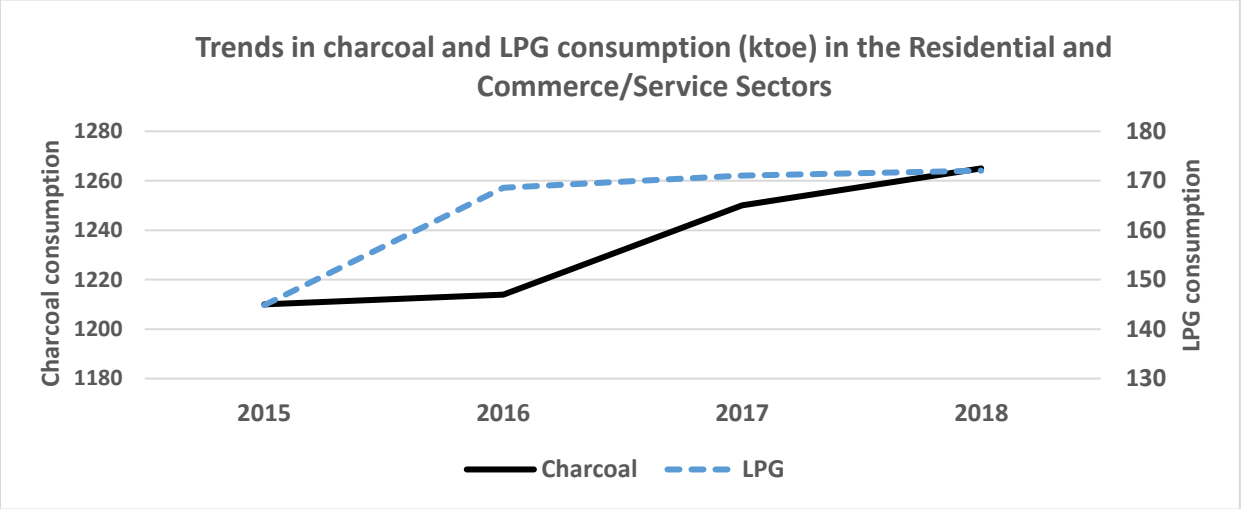


Figure 20: Trends in total charcoal and LPG consumptions in the Residential and Service Sectors

The seriousness of it is that more charcoal consumption means three to four multiples of additional wood since it requires three to four units of wood to produce one unit of charcoal depending upon the wood type.

For **2019**, we expect charcoal consumption to increase due to relatively high prices of LPG. We however do not expect average charcoal prices to increase over more than 5%. At worst it would grow at the same rate as the national inflation for the year.

5.0 The Regulatory Regime

5.1 The Electricity Supply Industry

5.1.1 Licensing and Permitting

The Energy Commission in 2006 established a licensing framework for issuing licences to electricity service providers. The Licensing Manual for service providers in the Electricity Supply Industry was revised and published in 2012, setting the requirements and guidelines for entities desiring to acquire licences to operate in the electricity supply industry.

Under the Licensing framework; permits, provisional licences and full licences have been issued to entities engaged in the various segments of electricity supply. Besides adding generating capacity to the existing capacity and enhancing service delivery to customers, the licensing regime enhances the Commission's authority to hold the licencees to the terms and conditions stipulated in the licence schedule.

Licences and permits issued by the Commission so far are as follows:

i. Number of power generation companies with Operation Licences increased from 13 in 2016 to 17 at the end of 2018. The total capacity had also expanded from 4,001 MW in 2017 to about 4,562 MW as at the end of 2018.
ii. Electricity Embedded Generation licence issued to Genser Power Limited[76], stood at two just as in 2016; 30 MW at Chirano and a 23 MW plant at Damang all in the Western Region. The 5 MW at Tema however has been decommissioned and the license withdrawn.
iii. Construction permits have been issued to the following two power companies with installed capacity totalling 740 MW:
    a. Rotan Power Limited 660 MW Combined Cycle at Aboadze in the Western Region has renewed their construction permit. It was first issued in 2016.
    b. 80 MW Simple Cycle Marinus Energy Power Plant at Anochie near Atuabo in the Western Region.

Sunon-Asogli has been issued with an export licence to export excess power.

Enclave Power Company was issued with distribution and sale licence to distribute and sell electricity to customers in Dawa Power Enclave (under-construction) besides its existing operations at Tema.

Bulk Customers of electricity operating in the deregulated Wholesale Electricity Market increased from 43 in 2017 to 50 as at the end of 2018.

[76] an IPP to distribute electricity to specific consumers in the distribution network,

5.1.2 Codes of Practices and Regulations

The Commission developed and launched the ***National Electricity Grid Code*** in 2012 to govern the operation of the National Interconnected Transmission System (NITS). The Grid Code specifies in detail the technical operational rules, codes and procedures as well as obligations and liabilities of all players in the market. Complementary to the National Electricity Grid Code, the Energy Commission Board approved the ***National Electricity Distribution Code*** that sets in detail, the minimum acceptable technical standards for the development of the electricity distribution networks, provides guidelines and technical requirements for interconnection and evacuation of embedded generation and other relevant issues related to the safe and reliable management and operation of the Electricity Distribution Network in accordance with LI 1816 and LI 1935.

Both the **Grid Code** and the **National Electricity Distribution Code** are currently being updated to cover **Renewable energy and embedded generation**.

The Commission has developed the Electrical Wiring Regulation 2011, L.I. 2008 to regulate electrical wiring in the country.

Pursuant to the above, a certification guideline has been developed. Furthermore, a curriculum for the certification examination was developed in conjunction with the Technical/Vocational Education Directorate of the Ghana Education Service in 2013.

In 2014, The Energy Commission in collaboration with the Technical Examinations Unit, of the Ghana Education Service conducted the first certification examination for potential and practicing electrician for certification as Certified Electrical Wiring Professionals (CEWPs).

Number of examinations conducted increased from nine (9) in 2017 to 12 as the end of last year.

Full implementation of the wiring law came into effect in October, 2017. Under the full implementation, non-certified persons would not be allowed to practice. Also, CEWP persons are expected to invite certified inspectors to inspect their wiring jobs when complete. The certification is being expanded to cover solar infrastructural installations and technicians.

In addition, EWR, 2011 LI 2008 mandates the Energy Commission to register all electrical contractors in the country. The exercise started last year. Also, the LI requires all buildings ten (10) years and older to be inspected to ascertain the integrity of its wiring installations. The Energy Commission also commenced this exercise in 2018 and about twenty (20) buildings have so far been inspected as at the end of the year.

As at end of last year, about 7,673 electricians had been certified as CEWPs and 127 as Certified Electrical Wiring Inspectors. The examinations are conducted twice in a year at 4 centres (Accra, Takoradi, Kumasi and Tamale).

The Commission continues to carry out public sensitization activities to create awareness in the general public on the provisions of the Regulations. In addition, the Commission has conducted training programmes in all the regional capitals for the CEWPs.

As part of its implementation, monitoring exercises are being carried out. CEWPs who are suspected to have violated provisions in the wiring regulations are first giving hearing by a Disciplinary Committee and those found culpable are penalised.

5.1.3 Establishment of Wholesale Electricity Market

The Power Sector Reform embarked on by Ghana in the 1990's adopted a Competitive Wholesale Electricity Market mechanism for Ghana and set out structures and frameworks to remove monopolistic tendencies and market dominance in the Power Sector. The reforms resulted into the unbundling of the Electricity Supply Industry leading to the establishment of an independent Transmission Utility (GRIDCo).

The enactment of the Electricity Transmission (Technical, Operational and Standards of Performance) Rules, 2008, L.1934, defined the National Interconnected Transmission System (NITS)[1] and provided the legal framework for open, fair and non-discriminatory access to electricity transmission network for all industry players. The quest for a competitive power sector was further boosted by the enactment of Electricity Regulations 2008 (L.I.1937) which establishes a Wholesale Electricity Market (WEM) to facilitate the wholesale electricity trading and the provision of ancillary services in the National Interconnected Transmission System (NITS)[77].

The Ghana Wholesale Electricity Market is structured to consist of Bilateral Contracts between wholesale suppliers and other Market Participants for electricity supply; and a Spot Market to provide for additional electricity requirement by Market Participants beyond contracted capacity to make up for shortfalls and balances. The Electricity Regulations 2008 provides that the Electricity Market Rules are the primary guidelines that should govern operations in the Wholesale Electricity Market and is administered by GRIDCo, the Electricity Transmission Utility.

In accordance with Regulation 8(1) of L.I. 1937, no entity shall participate in trading in the Wholesale Electricity Market unless that entity has:

(a) An operating licence or permit issued by Energy Commission;

(b) Registered with the Electricity Transmission Utility; and

(c) Entered into a contractual arrangement with the Electricity Transmission Utility.

[1] The NITS consist of plants and equipment operated at high voltages including the 69kV, 161kV and 330kV infrastructure as well as the 225kV interconnection with La Cote D'Ivoire power system.

[77] The NITS is exclusive of embedded generation assets and infrastructure consisting of plants and equipment within the distribution network which are operated below 69kV and consisting of low voltage 33kV,11kV and 415V lines serving industrial and residential customers.

The operating licenses or permits issued by the Energy Commission are in the following categories:

i. Electricity Wholesale Supply;
ii. Electricity Distribution;
iii. Electricity Brokerage: and
iv. Bulk Customer.

The administration and operation of the Wholesale Electricity Market by GRIDCo as per the Electricity Regulations 2008, is to be supervised by the Electricity Market Oversight Panel (EMOP) which advises the Energy Commission accordingly.

The EMOP was thus set up in 2015 and members of the panel had been nominated by the appropriate institutions and had since been approved by the Ministry. The EMOP was inaugurated in 2017, has been working and publishing a monthly bulletin which is available on the Commission's website[78]

[78] http://www.energycom.gov.gh/index.php/planning/ghana-wholesale-electricity-market-watch-monthly-bulletin

5.2 The Natural Gas Supply Industry

Natural gas supply from Nigeria through the West African Gas Pipeline (WAGP) has now been improving though still unreliable primarily due to Ghana's indebtedness to WAGP as well N-Gas supply limitations[79] *(see Annex 4).* Gas from the indigenous fields are therefore mitigating the supply situation.

The key natural infrastructure include the Gas Processing Plant, the 20-inch natural gas pipeline from Atuabo through Essiama to Takoradi and also the lateral pipeline from Essiama to Prestea.

In addition to the above, Genser Ghana Limited, is currently operating a 20-inch -158km pipeline from Prestea to Nyinahin in the Western Region. The pipeline is currently evacuating an average of 25 mmscfd to Genser power plants in Tarkwa, Damang and Chirano, all in the Western Region.

ENI Ghana operates the Offshore Receiving Facility (ORF) at Sanzule. The ORF transports the ENI gas to the Atuabo or Ghana Gas pipeline network.

5.2.1 Licensing and Permitting

A Licensing Manual for Natural Gas Supply Industry was developed by the Energy Commission in 2008 to serve as a guide for prospective natural gas service providers with regard to licensing requirements as well as assisting in ensuring compliance with codes and standards governing quality, health and safety in the industry as stipulated in the Energy Commission Act, 1997 (Act 541). The manual was reviewed in 2012 to facilitate the accelerated development of the natural gas industry.

In 2017, BOST ceded the Natural Gas Transmission Utility Licence to operate the Natural Gas Interconnected Transmission System (NGITS) to the Ghana National Gas Company (GNGC) is

The Energy Commission has thus further issued the following licences to players in the Natural Gas industry.

i. Ghana National Gas Company (GNGC) holds a Gas Processing Licence.
ii. Two Natural Gas Bulk Customer Permits were issued in 2016 for downstream offtakers.
iii. Tema LNG Terminal Ghana limited currently holds a Construction Permit for the construction of an LNG facility.
iv. Volta River Authority (VRA) and Ghana National Petroleum Corporation (GNPC) both hold Natural Gas Wholesale Supply licence.
v. Three companies currently hold a Provisional Natural Gas Wholesale Supply Licence.

[79] owners of the commodity

5.2.2 Codes of Practices and Regulations

Since the natural gas industry is still new in Ghana and like any other energy industry, it is important that developers satisfy some basic requirements and comply with established regulation before the construction of facilities takes place. It is in this respect that the Energy Commission has developed the following Legislative Instruments (L.I.) with adopted Ghanaian Standards and which have been approved by Parliament:.

i. Natural Gas Pipeline Safety (Construction, Operation and Maintenance) Regulation (L.I. 2189)
ii. Natural Gas Distribution And Sale(Technical And Operational) Rules, 2007(LI 1911)
iii. Natural Gas Distribution And Sale (Standard of Performance) Regulations, 2007(LI 1912)
iv. Natural Gas Transmission Utility(Technical And Operational) Rules, 2007(LI 1913)
v. Natural Gas Transmission Utility (Standards of Performance) Regulations, 2008(LI 1936)

A ***Natural Gas Transmission Access Code*** to establish conditions for Natural Gas Service Providers to have fair, transparent and safe access to the Natural Gas Transmission Network in Ghana, Access Code has also been developed in accordance with Sections 24, 27 and 28 of the Energy Commission Act, 1997 (Act 541). The Commission however has still not finalise the ***Occupational Health and Safety Regulation*** with adopted Ghanaian Standards.

5.3 Renewable Energy Update

As at the end of March 2019, i.e. just before the release of this report, 130 Provisional Wholesale Electricity Supply Licences had been issued to potential Independent Power Producers (IPPs) who proposed to develop a total of about 7,031 MW of electricity from various renewable energy sources. About 66% increase as at the end of 2017. 63.8% are for solar photovoltaic (PV) generation.

About 40 licencees (compared to 35 at the end of 2017) have moved to the Siting Permit stage of the licensing process of which about 30 are for solar PV. Number of companies issued with Construction Permits increased from eight (8) in 2017 to 13 at the end of 2018 with 11 being issued for the development of solar PV projects.

Four (4) Operational Wholesale Electricity Supply Licences have been granted to the following companies:

i. BXC (Ghana) Company Limited (20MW solar PV plant) located at Gomoa Onyeadze, near Winneba.
ii. Safi Sana Ghana Limited (100kW waste-to-energy plant) located at Ashaiman, near Tema.
iii. Meinergy Technology Company Limited (20MW solar PV plant) located at Gomoa Onyeadze near Winneba.
iv. CrossBoundary Energy Ghana Limited (400kW rooftop solar PV plant at Kasapreko Company Limited) located at Tema.

However, in view of the excess grid generation capacity, the over-subscription of Power Purchase Agreements (PPAs) for solar and wind projects, the Energy Commission has placed a temporary suspension of the issuance of Provisional Licences for utility-scale solar PV and wind energy projects. This directive, however, does not apply to Bulk customers and the off-shore market. The Ministry of Energy has also issued a policy directive that, effective 1st July, 2019, all power (conventional and renewable) to be procured by any Government agency should be done through a competitive tendering process.

The Energy Commission has signed an Agreement with the Agence Francaise de Developpment (AFD) for a €30 million green credit on lending funding support for renewable energy and energy efficiency interventions under the Sustainable Use of Natural Resources and Energy Finance (SUNREF) Programme. The programme also aims to build the capacity of the financial institutions in Ghana in green financing, and expected to take off in 2020.

Annex1 – Schematic Overview of Ghana Energy Demand and Supply System

The integrated energy supply feeds the energy-demand economic sectors comprising Residential, Commercial & Services, Agricultural & Fisheries, Transport and Industries. The Energy Supply Sector of Ghana is thus: **Biomass, Petroleum and Power (Electricity),** whilst the Energy Demand sectors of the economy are the **Residential, Commercial & Services, Agricultural & Fisheries, Transport and Industries** (Figure A).

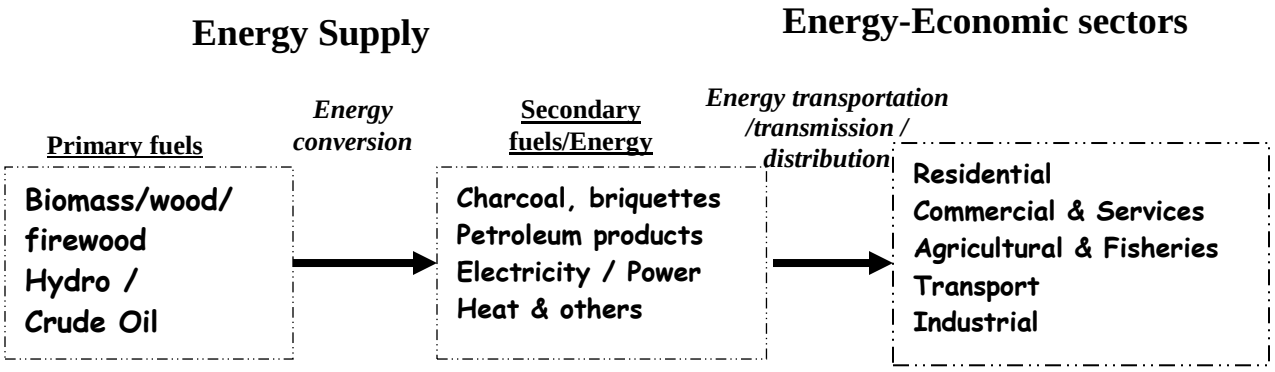


Figure Annex A1. Energy supply continuum

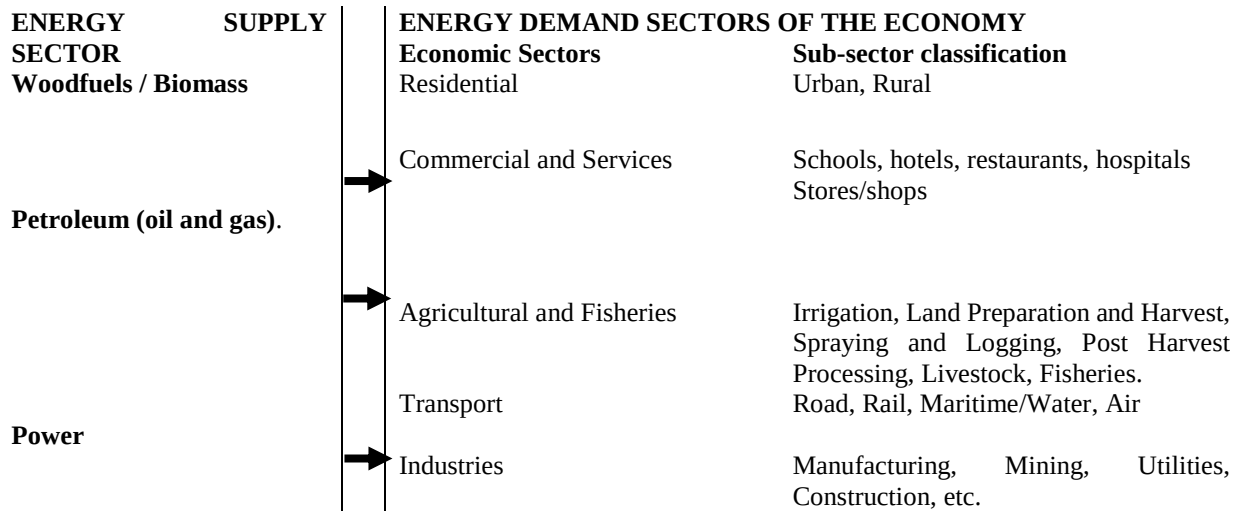
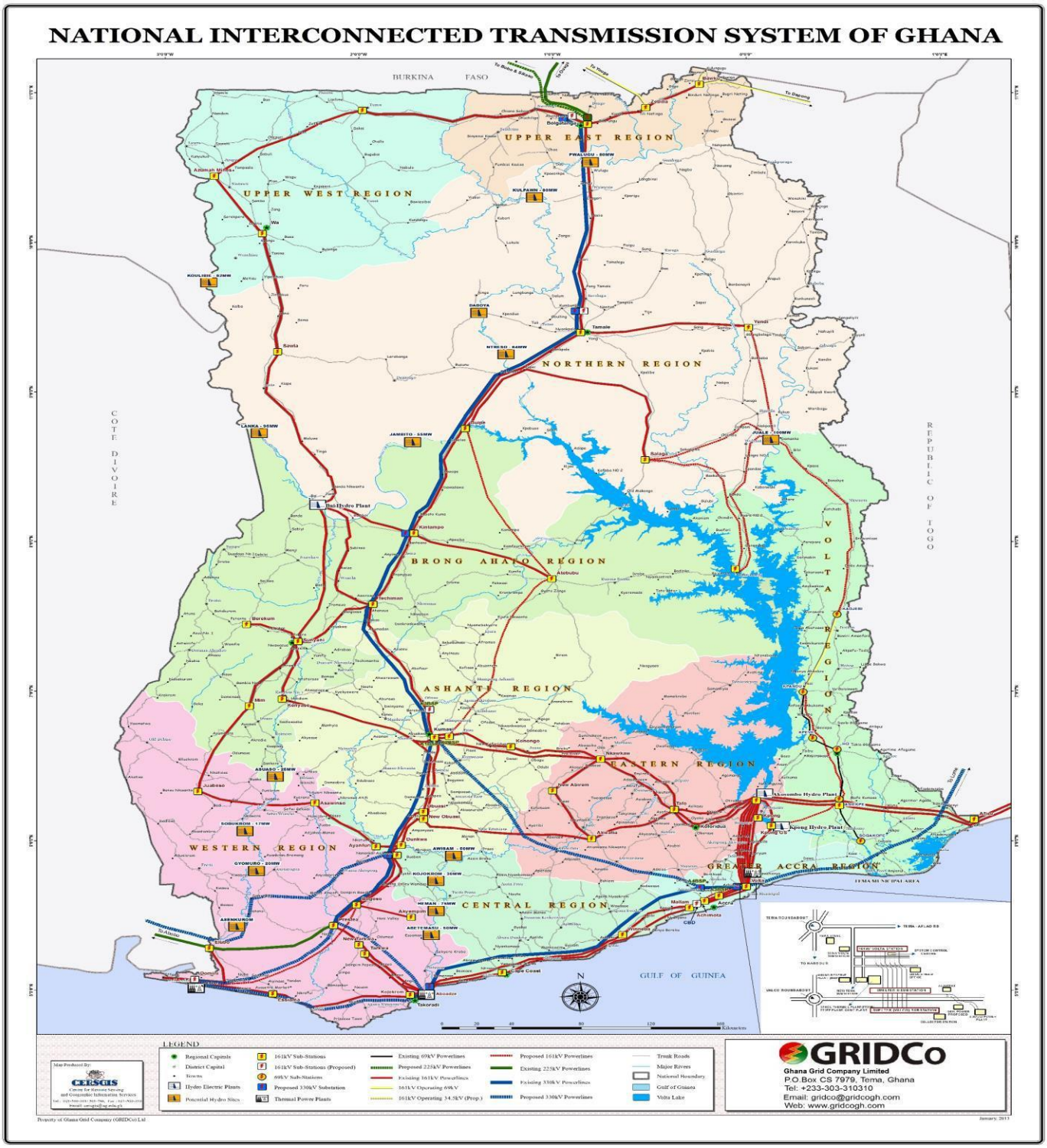


Figure A2. Energy supply continuum

Annex 2 – National Grid Transmission Map



Source: GRIDCo, 2018 Electricity Supply Plan

Annex 3 – Liquefied Natural Gas Regas Terminal Technologies

The normal way to transport natural gas is through pipelines, but pipelines aren't considered economical for transoceanic shipments of natural gas. Liquefied natural gas, or LNG, has been cooled so that it can be shipped more efficiently as a liquid in specially designed cargo ships. Transporting natural gas this way requires specialized facilities at both ends of the voyage.

LNG could be delivered through the following terminal technologies:

- Temporary or stop-gap through "Energy Bridge Re-gasification Vessels" (EBRVs)
- Floating Re-gasification plants using grounded LNG vessels which have retired from services.
- Permanent LNG re-gasification plants.

Energy Bridge Regasification Vessels

Energy Bridge Regasification Vessels, or EBRVs™, are purpose-built floating storage re-gasification units (FSRU) LNG tankers that incorporate on-board equipment for the vapourisation of LNG and delivery of high pressure natural gas. It is the technology that can be delivered in the shortest possible time; i.e. **within a year**. These vessels load in the same manner as standard LNG tankers at traditional liquefaction terminals, and also retain the flexibility to discharge the gas in two distinct ways. These are:

- Through the EBRV's connection with subsea buoy in the hull of the ship; and
- through a high pressure gas manifold located in front of the vessel's LNG loading arms.

The maximum rate of discharge of the natural gas from an EBRV into the deepwater port is determined by a combination of the availability of capacity on downstream pipelines and the regasification capabilities of the facilities located on-board each EBRV.

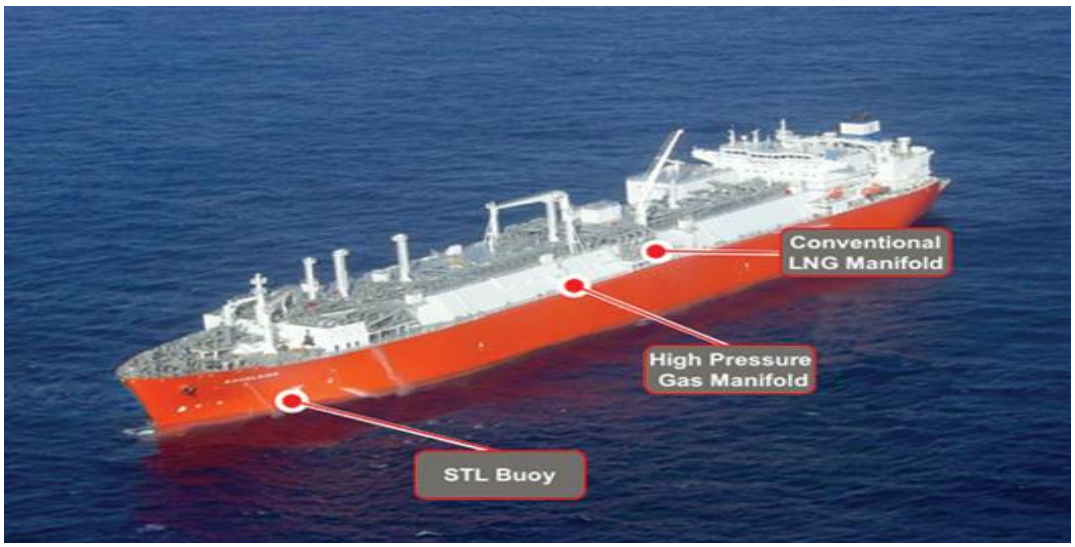


Figure A3. LNG Energy Bridge Regasification Vessel

LNG Floating, Storage and Re-gasification (FSRU) plants

Average lifetime of most LNG vessels is 25 years. This means LNG vessels built more than 25 years ago have become less competitive for transport services. Such an LNG ship is retired and reconfigured as floating storage LNG re-gasification unit or facility (FSRU). Typical LNG ship has capacity of 120,000-125,000 liquid cubic metres (lm^3). The larger the containment the greater the application for floating storage and regasification applications[80]. Construction of floating regas terminals has rapidly increased since 2005 when the first one was built in Louisiana, USA.

Floating Regas facility would take about **one -to-two years** to build if a project is approved and money is readily available today, otherwise **up to two and half years** to allow for initial paper work.

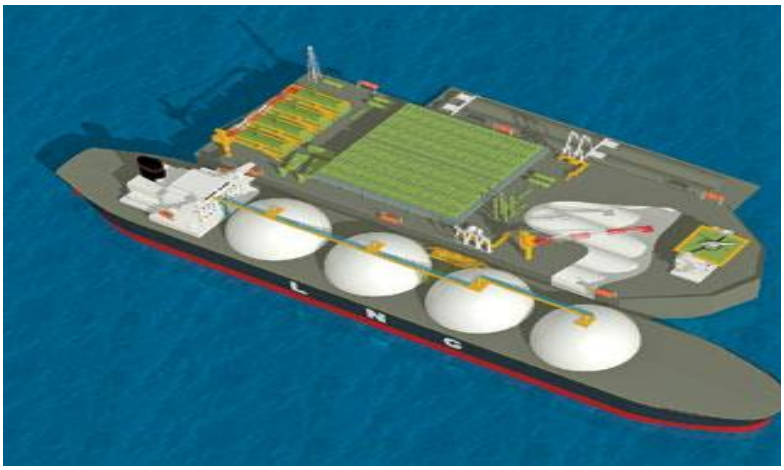


Figure A4. LNG Floating, Storage And Re-Gasification Plant

Permanent LNG discharge/re-gasification terminal

Contrary to FSRU, this is permanently fixed as the name implies and it is usually a specialised or dedicated harbour. Development of permanent LNG re-gasification plant of say 100-200 mmscfd capacity would require at least **3-4** years even if a project is approved and money is available today.

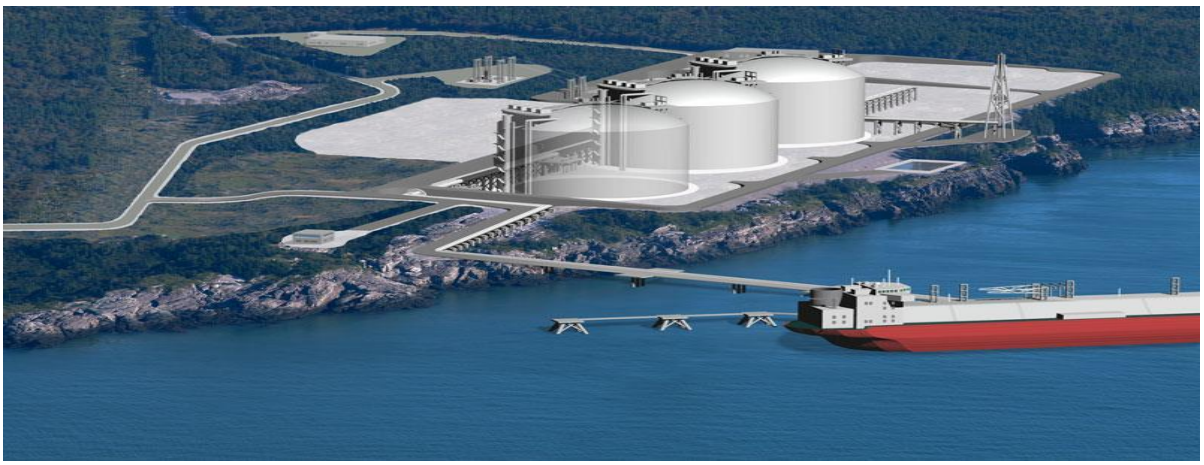


Figure A5: **Permanent LNG Re-Gasification Terminal**

[80] Zeus Liquefied Natural Gas Report, January 28, 2009

Annex 4 – Nigeria Gas Supply Challenges

Ghana has been expecting much of its natural gas to come from Nigeria. However, there are over 25 grid-connected generating plants in operation in the Nigerian Electricity Supply Industry (NESI), with a total installed capacity of about **12,500 MW** and dependable capacity of about **6,800 MW**. Most generation is thermal based of total installed capacity of about 12,000 MW from 9000 MW in early 2018 [81]. Available capacity has however ranged between 3,500-5,000 MW. The target is to hit 15,000 MW by 2020 against an estimated demand of 26,651 MW by the end of the decade[82].

Nigeria estimates that it would require 40,000 MW of additional capacity to address the energy needs.

This ambition puts a greater strain on the existing gas supply situation as the country struggles to achieve its domestic gas supply and export plans. Supply requirement totals about **5 billion cubic feet per day (bcfd)** for domestic consumption, LNG contractual shipments and WAGP commitments. Despite, the country is currently only able to produce about **4 bcfd,** of which about **2.8-3.0 bcfd** is for the production of the **22 million tonnes of LNG** the county exports annually. Existing power plants require at **least 1.5 bcfd,** which translates into very little or no gas for pipeline export to WAGP partner. The supply to the WAGP partner however ramps up only when a local power plant trips or is offline for maintenance. The country thus needs to develop new fields to meet the projected demand but industry experts estimate that to happen within 2017-2018, provided the existing schedule is executed as planned.

The current policy of the Nigerian government somehow seems to be to meet local gas demand first before considering exports to neighbouring countries. For this reason, there is a policy in place compelling all major gas shippers including N-Gas that ship gas to Ghana through the West African Gas Pipeline (WAGP) to meet local supply quota first before export. As at the end of 2013, most shippers were finding it difficult to meet the local quota obligation. Besides, the sabotaging of oil and gas facilities in the Delta region still remains a challenge[83]. These are contributing to the relatively low average supplies to the WAGP, aside untimely payments by off-takers particularly in Ghana for gas supplied.

The country has done well in reducing gas flaring over the years from 2 bcfd in 2015 to about 750 mmscfd, this still equates to burning $700 million annually or wasting fuel that could have been used to generate nearly 3,000MW of electricity.

Thus for N-Gas of Nigeria to limit gas supply to WAGP at the contracted volume of 123 mmscfd instead of the full capacity of 440 mmscfd as originally agreed in the supply contract is of concern but not hopeless[84]. The supply balance of 312 mmscfd reinforces the opportunity for the development of a viable alternative supply option such as an LNG terminal along Ghana's coast.

[81] http://www.nipptransactions.com, 2017
[82] Power Generation: Status and Outlook, a presentation by Presidential Task Force on Power, at Electric Power Investors ' Forum by Bureau of Public Enterprises,
[83] Orient Energy Review, Vol.5 No. 02/03 Feb-March, 2018.
[84] Energy Commission source.

Annex 5 – Woodfuel weights

Firewood/fuelwood	1 Tonne	0.30 - 0.36 TOE
Charcoal	1 Tonne	0.68 - 0.88 TOE
Sawdust/sawmill residues/wood chips	1 Tonne	0.20 - 0.30 TOE

Low side reflecting average dry wood and corresponding Charcoal in the forest zones and the high side reflecting average dry wood and corresponding charcoal in the savannah zones of the country.

Charcoal production is based on the fact that between 4 – 5 mass units of wood have been used to produce one mass unit of charcoal in the country

Charcoal Source	Average Weight (kg) of Charcoal		
	Mini Bag	Maxi Bag	Moisture Content
Sawmill residue	21 – 22	44 - 45	Up to 40%
Savannah wood	30 – 32	55 - 60	Up to 20%
Acacia plant	31 – 32	57 - 63	Up to 20%
All other woods	25 – 27	50 - 55	Up to 25%