GHANA WHOLESALE ELECTRICITY MARKET BULLETIN

MARKET WATCH

Monthly Market Data Analysis

ISSUE NO. 22: 1st October 2017 to 31st October 2017

This Bulletin covers major developments in the Wholesale Electricity Market (WEM) of Ghana from 1st October, 2017 to 31st October, 2017. It analyses the performance of the key WEM indicators against their benchmarks, and examines the likely implications of any discernable trends in the market. This edition of the WEM bulletin continues with the series on the financial sustainability of the financial sector in the third quarter of 2017.

The Energy Commission (EC) would very much appreciate and welcome comments from readers on the Bulletin. Reasonable care has been taken to ensure that the information contained in this Bulletin is accurate at the time of publication, nevertheless, any errors, omissions or inaccuracies therein are regretted.

HIGHLIGHTS OF THE MONTH

Overview of the Month

Electricity supply continues to increase in October 2017 from 36.5 GWh per day supplied in September 2017 to 39.59 GWh per day in October 2017. The 8.2% increase in the daily electricity supply was due to the increase in supply from most of the generation sources. Thermal generation sources witnessed significant increases in electricity supply from 23.97 GWh per day in September 2017 to 26.43 GWh per day in October 2017. This increase in thermal supply was aided by the increase in supply from the TICO and Karpowership which recorded 50% and 52% increase in their daily supply respectively.

The water level for the hydro dams begun to decline in October 2017. The Akosombo dam and Bui dams water levels begun to decline from the 25th October 2017. This meant that the Akosombo dam ended the inflow cycle at a water level of 253.4 ft, which is the maximum water level recorded for the Akosombo dam in 2017 whiles the Bui dam ended at 579.58 ft which was also the highest water level recorded for the Bui dam in 2017. This notwithstanding, supply for Akosombo increased marginally by 0.7%, that of Kpong decreased marginally by 5.8%, whereas supply from Bui increased significantly by 40.4%. In terms of magnitude, Akosombo GS supply increased from 9.38 GWh per day in September 2017 to 9.45 GWh per day in October 2017, whiles Kpong GS decreased from 1.89 GWh per day in September 2017 to 1.87 GWh per day in October 2017. Bui GS supply increased from 0.99 GWh per day in

Table 1 Projected and Actual Outturn of electricity demand and supply in October 2017

	October 2017		September 2017	
	Projected	Actual Outturn	Projected	Actual Outturn
Total Supply (GWh)	1,363.0	1,227.2	1,255.0	1,095.1
Source by Power Plants (GWh)				
AKOSOMBO	288.0	293.0	279.0	281.5
KPONG	57.0	58.0	55.0	56.8
BUI	71.0	43.2	69.0	29.6
Sunon Asogli	144.0	159.8	113.0	146.2
TAPCO	159.0	106.7	136.0	96.9
TICO	182.0	216.7	159.0	139.7
TT1PP	-	14.4	-	52.3
CENIT	-	-	-	-
TT2PP	-	-	-	-
MRP	-	-	-	-
Karpowership	150.0	161.3	145.0	103.3
AMERI	145.0	71.3	140.0	99.2
KTPP	-	7.1	-	-
Trojan Power	-	-	-	-
CENPOWER	-	-	-	-
AKSA	157.0	84.4	149.0	81.7
Total Generation (GWh)	1,353.0	1,215.9	1,245.0	1,087.1
Imports (GWh)	10.0	11.3	10.0	8.0
Total Supply (GWh)	1,363.0	1,227.2	1,255.0	1,095.1
Deficit (GWh)	-	(135.8)	-	(159.9)
Ghana Coincedent Peak Load (MW)	2,077.0	2,126.9	2,098.0	2,021.2
System Coincident Peak Load (MW)	2,250.0	2,130.9	2,271.0	2,021.2

September 2017 to 1.39 GWh per day in October 2019.

Natural gas flow rate from the WAGP decreased to 45.79 MMSCF per day from 54.05 MMSCF per day recorded in September 2017. Likewise, natural gas flow rate from the AGPP decreased to 101.79 MMSCF per day in October 2017 from 97.99 MMSCF per day recorded in September 2017.

There was an increase in the System peak demand in October 2017 compared to that of September 2017 by 109.7 MW to 2,130.9MW from 2,021.2 MW in September 2017. Likewise, the Ghana Peak Demand increased by 105.7 MW to 2,126.9 MW from 2,021.2 MW in September 2017.

Electricity Demand and Supply

Electricity Demand

The System Peak Load increased further in October 2017 to 2130.9 MW from 2,021.2 MW in September 2017 and 1,929.8 MW in August 2017. Similarly, the Ghana Peak Load have increased by about 5.2% (105.7 MW) to 2,126.9 MW in October 2017 from 2,021.2 MW in September 2017. Hydro generation contributed 40.6% of the System Peak Load and Ghana Peak Load whiles thermal generation contributed the rest. This was marginally higher than the 40.2% the hydro power plants contributed in September 2017.

Electricity supply

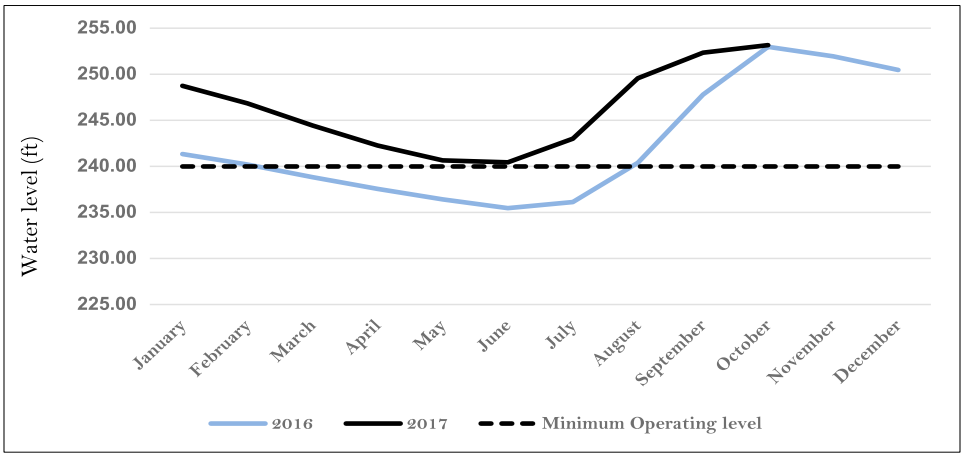
There was an increase in electricity supplied in October 2017. Average daily electricity supplied to meet System requirement increased to 39.51 GWh per day in October 2017 from 36.07 GWh per day recorded in September 2017. The total electricity supplied in October 2017 was 1,227.2 GWh consisting of 1,215.86 GWh from domestic generation and 11.34 GWh of imports from La Cote D'Ivoire. The total supply of electricity in October 2017 was, however, 139.8 GWh lower than the 1,367 GWh projected under the Electricity Supply Plan (ESP) developed for the year 2017. This represents a 10.39% deviation between the outturn and the projection. ection.

Hydro Dam Levels

Akosombo Dam Water Level increased marginally in October 2017

The water level of the Akosombo dam increased at a reducing rate of 0.026 feet per day in October 2017 from 0.093 feet per day recorded in September 2017 as the water level begun to drop at an average of 0.03 ft per day from the 25th October 2017. The water level increased by 0.81 feet in October 2017 to 253.16 feet from 252.35 feet at the beginning of the month. This meant that, the water level for the Akosombo dam was 2.07 ft lower than it was projected in the September edition of the bulletin. The water level at the end of October 2017 was also marginally higher than the level at the same time in October 2016 by about 0.18 feet and 13.16 feet above the minimum operating level of 240 feet. Figure 1 shows comparative end of month trajectory of the level of water in the Akosombo dam from January 2016 to October 2017.

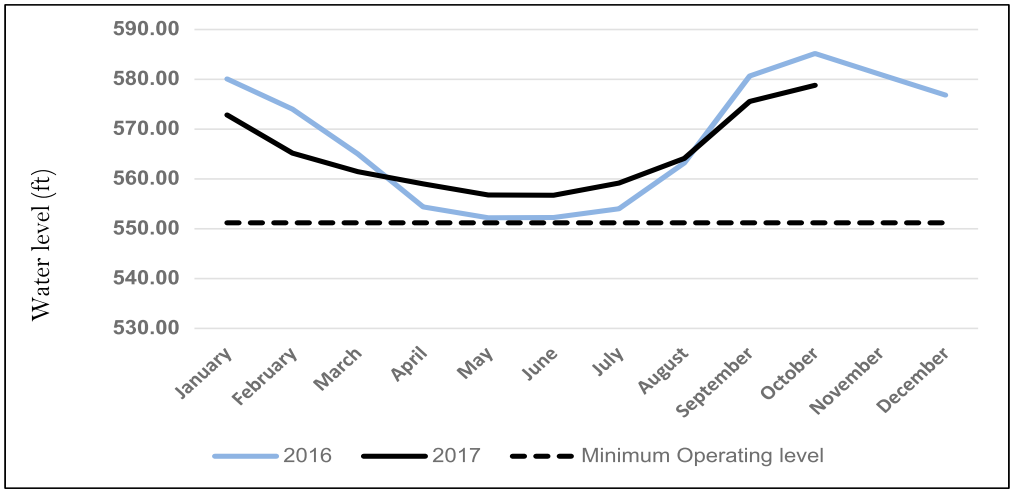
Figure 1: Month-End Water Level for Akosombo Dam from January 2016 to October 2017



Bui Dam Water Level continued to increase in October 2017

The Bui dam net water level continued to increase but at a decreasing rate in October 2017 as the water level begun to drop on the 25th October 2017. The water level increased at an average of 0.108 ft in October 2017 compared to 0.369 ft in September 2017. The water level in October 2017 increased from 575.57 feet level at the beginning of the month to 578.82 feet at the end of the month. The water level at the end of the month for Bui GS (578.82 feet) was lower than the level of the dam at the same period in October 2016 (585.18 feet) by 6.36 feet. Figure 2 shows comparative end of month trajectory of the level of water in the Bui dam from January 2016 to October 2017.

Figure 2: Month-End Water Level for Bui Dam from January 2016 to October 2017



Fuel Supply for Power Generation

Natural gas consumption continued to dominate the fuel supply mix but its share in the total fuel supply mix continued to decrease to 69% in October 2017 from 73% in September 2017 with liquid fuel accounting for the rest. Shares of natural gas supply from the WAGPCo in the total fuel supply decreased in October 2017 to 21% from 26% recorded in September 2017. On the other hand, natural gas supply from the AGPP remained constant at 47% in September 2017. The share of DFO consumption in the total fuel supply mix increased from no supply in September 2017 to 1% in October 2017. Similarly, the share of HFO consumed in October 2017 increased to 31% of the total fuel supply mix from 25% in September 2017.

Figure 3a and Figure 3b shows the shares of sources of fuel and fuel type in the generation fuel mix for electricity generation respectively.

Figure 3a: Shares of sources of fuel in total fuel mix for power generation

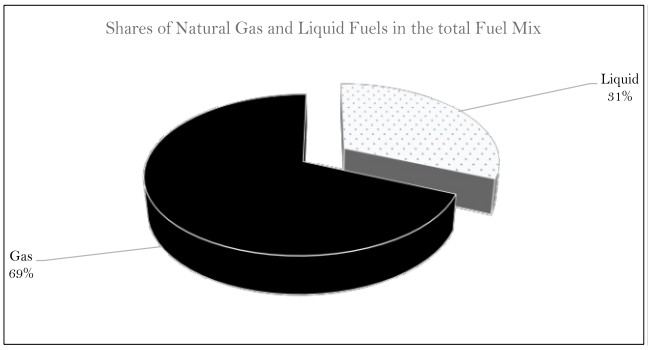
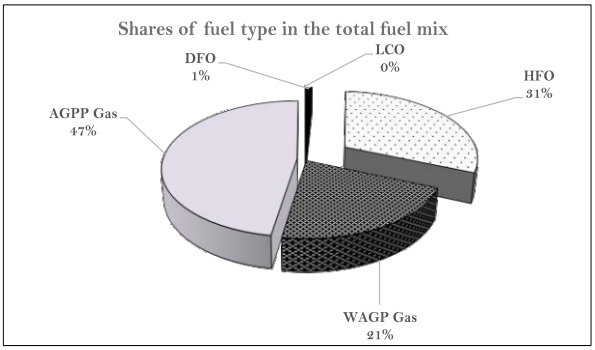


Figure 3b: Shares of fuel type in the generation fuel mix power generation



Natural gas flow rate from WAGPCo decreased in October 2017

Natural gas flow rate from Nigeria through the WAGP to Tema and Kpone decreased significantly to 45.79 MMSCF per day in October 2017 from 54.05 MMSCF per day recorded in September 2017. Total gas consumption from the Tema-Kpone enclave decreased to 1332.48 MMSCF in October 2017 from 1,554.11 MMSCF in September 2017, representing a 14% reduction. The natural gas consumption at the Tema and Kpone accounted for 30% of the total natural gas consumed in October 2017.

Natural gas flow rate from GNGC increased in October 2017

Natural gas flow rate from the AGPP to the Aboadze Power Enclave increased to 101.79 MMSCF per day in October 2017 from 97.99 MMSCF per day recorded in September 2017. Subsequently, total gas consumption at the Aboadze Power Enclave also increased to 2,899.08 MMSCF from, 2,624.88 MMSCF in September 2017, a 10.4% increase in consumption. The increase in the gas flow at the Aboadze Power Enclave led to the increase in generation from the TAPCO and TICO power plants. Natural gas supply from the AGPP accounted for 70% of the total natural gas consumption in October 2017. Of the total natural gas supplied in October from the Aboadze enclave, 21.52% was used by the Ameri Power Plant for electricity generation, 51.08% was used by TICO Power Plant whiles the remaining 27.38% was used by the TAPCO Power plant.

Figure 4a: Contribution of Gas Supply by sources

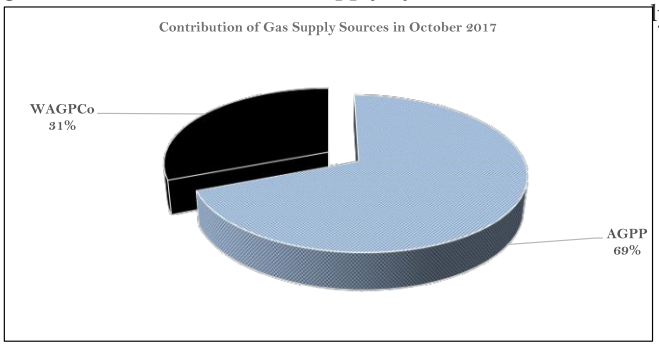
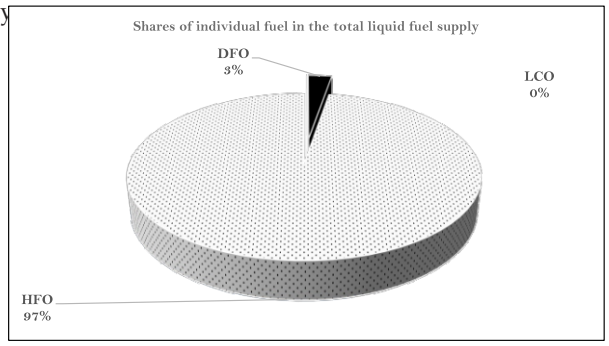


Figure 4b: Contribution of individual fuel in the liquid fuel



Liquid Fuel

Liquid fuel consumption increased further by 27.7% to 345,335 barrels from 271,955 barrels in October 2017. This total comprised of HFO and DFO as LCO were not consumed in October 2017. DFO constituted 3% of the total liquid fuel consumed whiles HFO constituted the rest. DFO was used by the KTPP whiles HFO was used by Karpowership and AKSA power plants. The Karpowership consumed 62.7% of the total liquid fuel consumed and 64.7% of the total HFO consumed whiles the AKSA Power Plant consumed 34.3% of the total liquid fuel consumed and 35.3% of the total HFO consumed.

Plant by Plant Highlights

Electricity Generation at the Akosombo Generation Station (GS) increased marginally in October 2017

The Akosombo GS witnessed a 4.08% increase in the electricity generated in the month of October 2017 to 292.97 GWh from 281.46 GWh recorded in September 2017. Average generation from the Akosombo GS increased marginally to 9.45 GWh per day from 9.38 GWh per day recorded in September 2017. This notwithstanding, the Akosombo GS share of the total electricity supply in October 2017 reduced marginally to 23.87% from 25.7% in September 2017. The Akosombo GS generated 1.7% higher than the 288 GWh projected under the 2017 ESP. The Akosombo GS contributed 527 MW to meet both the System Peak Load and Ghana Peak Load in October 2017 which represented 24.73% of the System Peak Load and 24.78% of the Ghana Peak Load.

Electricity supply by Kpong Generation Station (GS) increased marginally in October 2017

A total of 57.97 GWh was generated in October 2017, 1.18 GWh higher than the 56.79 GWh generated in September 2017. The Kpong GS generated an average of 1.87 GWh per day in October 2017 which was 2.1% higher than the 1.83 GWh generated in September 2017. Generation from the Kpong GS accounted for 4.7% of the total electricity supplied in October 2017, a decline over the share of 5.3% in September 2017. The generation from the Kpong GS was 0.97 GWh higher than the 57 GWh projected for October 2017 under the 2017 ESP. The Kpong GS contributed 111 MW to meet both the System Peak Load and Ghana Peak Load in September 2017 representing 5.2% System Peak Load and Ghana Peak Load in October 2017.

Electricity supply by the Bui Generation Station (GS) increased significantly

Electricity production from the Bui Power Plant increased significantly in October 2017 to 43.18 GWh (1.39GWh per day) from 29.6 GWh (0.95 GWh per day) recorded in September 2017. This represents an increase of 46.3% on September 2017, based on the daily average production of both months. The Bui GS supplied 3.5% of the total electricity supplied in October 2017, higher than the 2.7 % supplied in September 2017. The total electricity generated in October 2017 from the Bui Power Plant was, however, 39% lower than the 71GWh projected to be generated in October under the 2017 Electricity Supply Plan (ESP). The Bui power plant contributed 227 MW to meet both the System Peak Load and Ghana Peak Loads which represents 10.7% of both the System Peak Load and Ghana Peak Load.

Generation by the Sunon Asogli Power Plant (SAPP) continued to increase in October 2017

The continuous supply of natural gas enabled the Sunon Asogli Power Plant (SAPP) to operate for the whole month of October 2017, generating a total of 159.8 GWh (5.15 GWh per day), an increase from the 146.19 GWh of electricity (4.72 GWh per day) generated in September 2017. The Power Plant contributed 13.02% of the total electricity supplied in October 2017, a marginal decrease from the 13.4% recorded in September 2017. The SAPP's generation in October was 10.9% higher than the estimated generation of 144 GWh in the 2017 ESP. The SAPP contributed 221.3 MW to meet both the System Peak Load and Ghana Peak Load which represented 10.4% of the October 2017 System Peak Load and Ghana Peak Load. The SAPP consumed a total of 1,169.59 MMSCF of natural gas at an estimated heat rate of 7,605.49 Btu/kWh, a reduction in fuel efficiency compared to the heat rate of 7,520.76 Btu/kWh, recorded in September 2017.

CENIT Power Plant continued to be offline in October 2017

The CENIT Power Plant was offline for the whole of October 2017 due to unavailability of Light Crude Oil (LCO) stocks to power the plant and system demands. The Power Plant was also correctly projected to be offline in October 2017 under the 2017 ESP.

Ameri Energy Power Plant's generation decreased significantly in October 2017

Electricity generation from the Ameri Energy Power Plant decreased to 2.30 GWh per day in October 2017 from 3.31 GWh per day in September 2017. The total electricity generation in October 2017 of 71.33 GWh was 28% lower than the generation recorded in September 2017 of 99.18 GWh. The Ameri Power Plant generated 50% lower than the 145 GWh projected under the 2017 ESP. The total electricity generated by Ameri Power Plant in October 2017 represented 5.8% of total electricity supplied in the month. The Ameri Power Plant consumed 624.17 MMSCF of natural gas, to generate the 71.33 GWh of electricity at an estimated average heat

rate of 10,159.17 Btu/kWh a marginal decrease in fuel efficiency from the 10,098.06 Btu/kWh recorded in September 2017. The Ameri Power Plant contributed 93.4 MW to meet both the System Peak Load and Ghana Peak Load in October 2017, representing 4.4% of the System and Ghana peak Loads.

Kpone Thermal Power Plant (KTPP) back online in October 2017

The KTPP was back online and operated for 8 days generating a total of 7.09 GWh, an average of 0.89 GWh per day in October 2017. The Power Plant supplied 0.58% of the total electricity generated in the month. The power plant was projected to be offline in October 2017 as per the 2017 ESP. KTPP made no contribution to either the System Peak Load or Ghana Peak Load. The KTPP in October 2017 consumed 10,141.10 barrels of DFO to generate the 4.80 GWh of electricity at an estimated heat rate of 11,361.24 Btu/kWh

The Karpowership Power Plant generation increased significantly in October 2017

The Karpowership generated 56% higher in October 2017 than in September 2017 based on the average generation of the plants for both months. The Karpowership generated an average of 5.76 GWh per day compared to 3.69 GWh per day generated in September 2017. Total electricity supplied by the Karpowership of 161.26 GWh in October 2017 was also 55% higher than the 103.35 GWh generated in September 2017 and 7.5% higher than the 150 GWh projected under the 2017 ESP. The Power Plant contributed 13.1% of the total electricity supplied in October 2017, which is higher than its contribution of 9.4% in September 2017. The Karpowership also contributed 250.4 MW to meet both the System Peak Load and Ghana Peak Load in October 2017 representing 11.7% of the System Peak Load and Ghana Peak Load. The Karpowership Power Plant consumed 218,006.20 barrels of Heavy Fuel oil (HFO) to generate the 161.26 GWh in October 2017 at an average heat rate of 8,165.42 Btu/kWh which is a marginal decline in fuel efficiency of 8,145.95 Btu/kWh recorded in September 2017.

AKSA Power Plant generation remain relatively constant in October 2017

The AKSA power plant electricity generation remain relatively the same in October 2017 compared to September 2017 of 2.72 GWh. The AKSA Power Plant generated a total of 84.41 GWh in October 2017 which was 4.32 GWh higher than the 81.7 GWh it generated in September 2017 and significantly lower than the 157 GWh projected under the 2017 ESP. The Power Plant supplied 6.9% of the total electricity supplied in October 2017, which was 7.6% lower than it supplied in September 2017. The Power Plant contributed 170.8 MW to meet both the System Peak Load and the Ghana Peak Load in October 2017 representing 8% of the System Peak Load and Ghana Peak Load in October 2017. A total of 119,188.12 barrels of HFO was consumed by the AKSA Power Plant at an average heat rate of 8,528.41 Btu/kWh, a marginal decline in efficiency from the 8,502.52 Btu/kWh recorded in September 2017.

Takoradi International Company (TICO)'s generation in October 2017 increased significantly

The TICO Power plant's electricity supply in October 2017 increased significantly to 216.74 GWh (6.99 GWh per day) from 139.67 GWh (5.41 GWh per day) generated in September 2017 due to technical issues and grid demands from the 2nd to 17th September 2017. The TICO Power Plant's electricity supply of 216.74 GWh constituted 17.7% of the total supply in October 2017, and was marginally higher than the 12.8% recorded in September 2017. TICO's generation of 216.74 was also 19% higher than the 182 GWh projected under the 2017 ESP. The TICO Power Plant in October 2017 contributed 234 MW to meet both the System Peak Load and Ghana Peak Load, representing 15.2% of the System Peak Load and Ghana Peak Load. The Power Plant operated on natural gas consuming about 1,480.97 MMSCF of natural gas to produce the 216.74 GWh of electricity at an estimated average heat rate of 7,337.40 Btu/kWh, an improvement in fuel efficiency over the 7,985.12 Btu/kWh recorded in October 2017.

Takoradi Power Company (TAPCO) Plant's generation increased marginally in October 2017

The TAPCO Power plant's generation increased marginally to 3.68 GWh per day in October 2017 from 3.34 GWh per day in September 2017. TAPCO's total generation increased to 106.71 GWh in October 2017 from 96.87 GWh in September 2017. The power plant contributed 8.7% of the total electricity supplied in October 2017. The power plant generated 38.2% which was lower than the 159 GWh estimated under the 2017 ESP. The TAPCO Power Plant in October 2017 contributed 148 MW to meet both the System Peak Load and Ghana Peak Load, representing a 6.9% of the System Peak Load and Ghana Peak Load. The Power Plant operated on natural gas in October 2017 consuming about 793.94 MMSCF to produce 106.71 GWh of electricity at an estimated average heat rate of 7,989.29 Btu/kWh, an improvement in the fuel efficiency over the 8,020.96 Btu/kWh recorded in September 2017.

Tema Thermal 1 Power Plant (TT1PP)'s generation dropped significantly in October 2017

Low gas pressure limited the operation of TT1PP to 9 days in the month of October 2017. The power plant only generated a total of 14.4 GWh (1.6 GWh per day) which was 37.88 GWh lower than it generated in September 2017. The power plant contributed 1.2% of the total electricity supplied in October 2017, significantly lower than the 4.8% supplied in September 2017. The power plant did not contribute to both the System Peak Load and Ghana Peak Load in October 2017. A total of 163.84 MMSCf of natural gas was used to generate 14.4 GWh of electricity at an average heat rate of 11,832.56 Btu/kWh, a decline in the 11,484.77 Btu/kWh recorded in September 2017.

Trojan Power Plant continued to be offline in October 2017

The Trojan Power Plants in both Tema and Kumasi have been offline since July 2017 and continued to be offline in October 2017 due to fuel supply challenges.

Electricity Exchange – Imports and exports increased whiles Ghana still remained a net importer of electricity

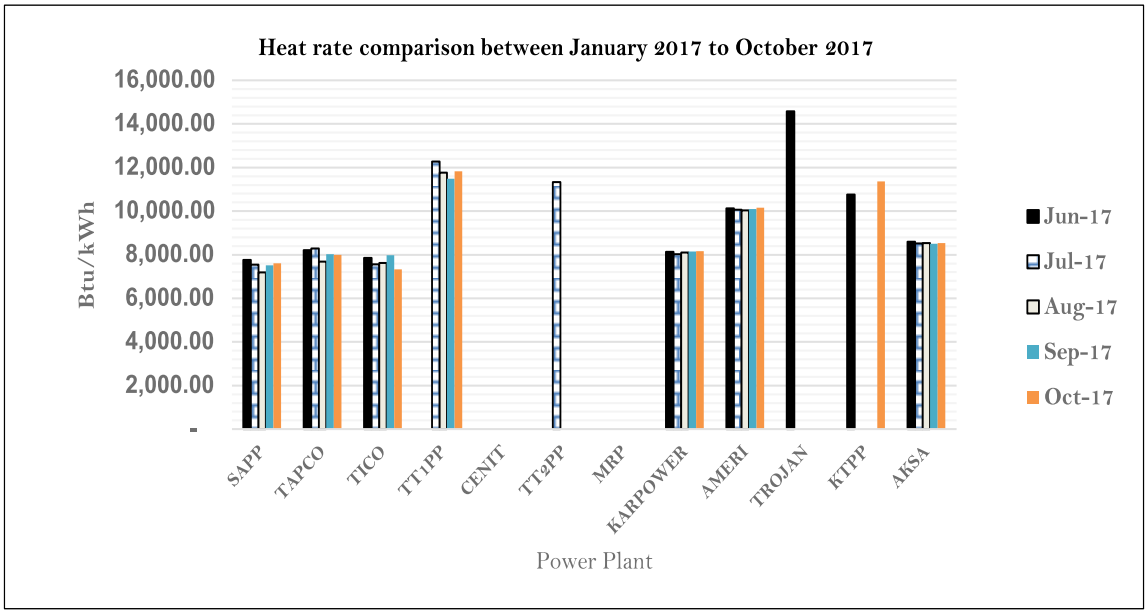
Electricity imports from La Cote D'Ivoire increased to 11.34 GWh in October 2017 from 7.98 GWh in September 2017. Total import in October 2017 was also marginally higher than the 10 GWh projected under the 2017 ESP and contributed 0.93% of the total electricity supplied in October 2017. Daily peak import in October 2017 reached a maximum of 68 MW and contributed 58 MW to both the System Peak Load and Ghana Peak Load.

Electricity export to CEB increased significantly to 10.68 GWh in October 2017 from 5.28 GWh in September 2017 but was significantly lower than the 80 GWh projected under 2017 ESP. Ghana was a net importer of electricity in October 2017.

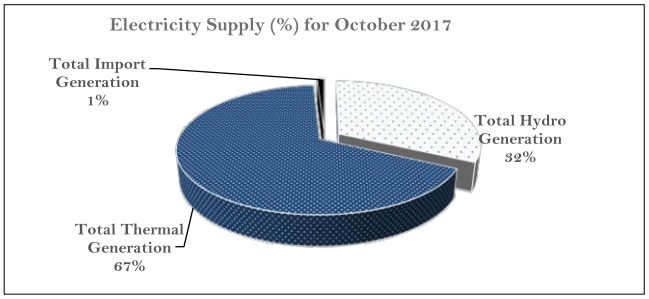
OPERATIONAL FACT SHEET

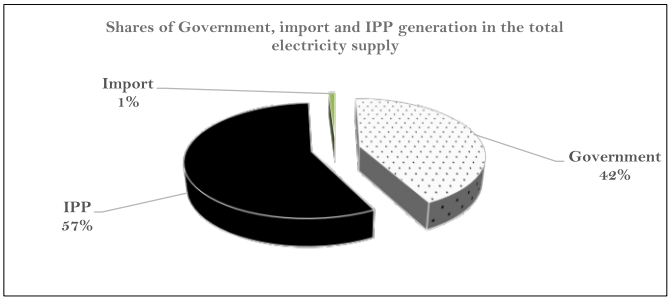
Peak Electricity Supply – October 2017			
Source of Supply	Generation at System Peak Load of October 2017 (MW)	Generation at Ghana Peak Load of October 2017 (MW)	Eleectricity Supply (GWh)
AKOSOMBO	527.00	527.00	292.97
KPONG	111.00	111.00	57.97
BUI	227.00	227.00	43.18
SAPP	221.30	221.30	159.80
TAPCO	148.00	148.00	106.71
TICO	324.00	324.00	216.74
TT1PP	–	–	14.40
CENIT	–	–	–
TT2PP	–	–	–
MRP	–	–	–
KARPOWER	250.40	250.40	161.26
AMERI	93.40	93.40	71.33
KTPP	–	–	7.09
Trojan Power	–	–	–
CENPOWER	–	–	–
AKSA	170.80	170.80	84.41
IMPORT	58.00	58.00	11.34
Export		4.00	10.68
System Coincident Peak Load	2,130.90	–	–
Ghana Coincedent Peak Load	–	2,126.90	–
Total Supply	–	–	1,227.20
Total Supply without export	–	–	1,216.52

Ghana Electricity Demand		
		Oct-17
Maximum System Peak Load	MW	2,130.9
Minimum System Peak Load	MW	1,833.2
Average Peak Generation	MW	1,892.3
System Base Load	MW	1,214.7
Total Electricity	GWh	1,227.2
Load Factor (LF)	%	77.4



OPERATIONAL FACT SHEET





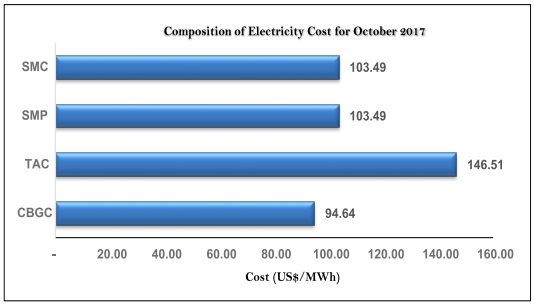
Power Plant Data for October 2017							
	Dependable Capacity (MW)	Plant Capacity Utilization (%)	Electricity Generation (GWh)	Gas Consumption (MMBtu)	LCO Consumption (MMBtu)	DFO Consumption (MMBtu)	HFO Consumption (MMBtu)
Akosombo	900.00	43.75	292.97	-	-	-	-
Kpong	140.00	55.65	57.97	-	-	-	-
Bui	340.00	17.07	43.18	-	-	-	-
SEAP	500.00	42.96	159.80	1,215,330.50	-	-	-
TAPCO	300.00	47.81	106.71	852,553.61	-	-	-
TICO	320.00	91.04	216.74	1,590,311.21	-	-	-
TT1PP	110.00	17.60	14.40	170,388.90	-	-	-
CENIT	110.00	-	-	-	-	-	-
TT2PP	45.00	-	-	-	-	-	-
MRP	70.00	-	-	-	-	-	-
KARPOWER	235.00	92.23	161.26	-	-	-	1,316,757.45
AMERI	230.00	41.68	71.33	724,623.20	-	-	-
TROJAN	56.00	-	-	-	-	-	-
KTPP	200.00	4.77	7.09	28,574.35	-	54,579.40	-
AKSA	230.00	49.33	84.41	-	-	-	719,896.25
Total	**3,786.00**	43.16	**1,215.86**	**4,581,781.76**	**-**		**1,316,757.45**

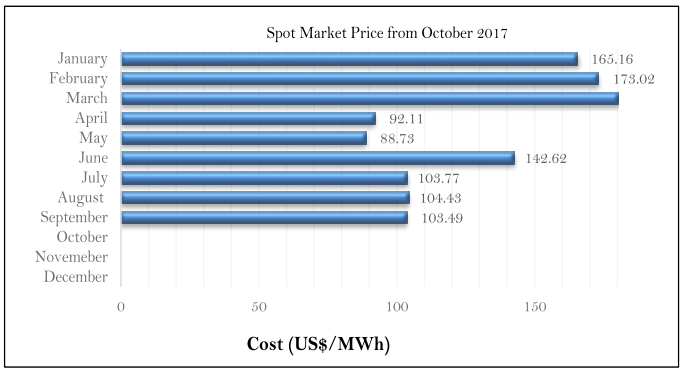
	Average Gas Flow (MMScfd) - October 2017				
Location	Week 1	Week 2	Week 3	Week 4	Monthly Average
Etoki	56.08	53.81	49.39	51.27	**52.51**
Tema	57.16	47.99	38.43	41.45	**45.79**
Aboadze	100.17	103.19	104.12	100.30	**101.79**

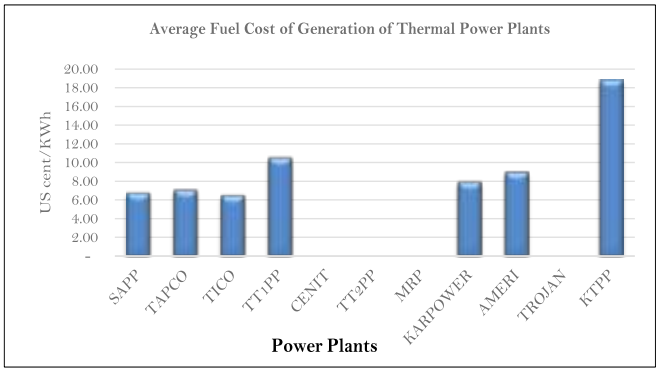
	Water Level (ft) - October 2017				Change in water level
Hydro Dam	Week 1	Week 2	Week 3	Week 4	(feet)
Akosombo	252.35	252.90	253.16	253.16	0.81
Bui	575.57	577.61	578.95	578.82	3.25

ECONOMIC FACT SHEET

		Oct-17	Sep-17	Change
Average Market Energy Cost	US$/MWh	95.04	83.33	11.71
Average Market Capacity Charge (AMCC)	US$/MWh	51.47	32.61	18.86
Total Average Market Cost (TAC)	US$/MWh	146.51	115.94	30.57
System Marginal Cost (SMC)	US$/MWh	103.49	103.49	(0.00)
System Marginal Capacity Charge (SMCC)	US$/MWh	-	-	-
Spot Market Price (SMP)	US$/MWh	103.49	103.49	(0.00)
Composite Bulk Generation Charge (CBGC)	US$/MWh	94.64	94.64	-
Deviation of TAC from CBGC	US$/MWh	(51.87)	(13.78)	(38.09)
Deviation of SMP from CBGC	US$/MWh	(8.85)	(14.32)	5.47

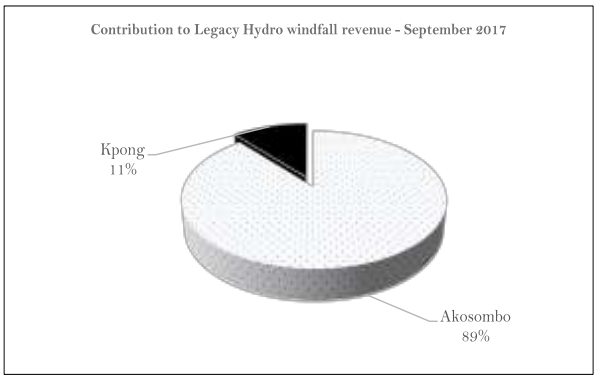






Oct-17				
	Average Cost	Average SMP	Difference	Windfall Revenue
Power Plant	US$/MWh	US$/MWh	US$/MWh	US$/MWh
Akosombo	33.10	103.49	70.39	20,621,267.96
Kpong	59.20	103.49	44.29	2,567,126.56
Total	92.30	-	-	23,188,394.53

Average Fuel Prices		
		Oct-17
Fuel Type	Unit	Delivered Cost
Natural Gas	US$/MMBtu	8.73
LCO	US$/BBL	63.00
HFO (Karpowership)	US$/Tonne	373.73
HFO (Tema)	US$/Tonne	393.73
DFO	US$/Tonne	661.41



1.0 Financial Sustainability of the Power Sector

1.1 Ability to Recover Cost

1.1.1 Electricity generation unit cost

The ability to recover the cost of the electricity generated (fixed cost and variable cost) in the third quarter of 2017 did not deviate much from what was recorded in the first quarter of 2017. The increasing consumption of natural gas reduced the average cost of generation below the gazetted BGT in the United State Dollars (US$) but increasing cost of US$ against the Ghana cedis (GHS) kept the average cost of generation above the gazetted tariff in Ghana cedis. Average cost of generation reduced from GHp 41.52/kWh in July 2017 to GHp 39.54/kWh in August 2017 and increase to GHp 41.07/kWh in September 2017 which were all above the gazette BGT of GHp 35.97/kWh. In United state Dollars (USD), average cost of generation reduced from US cent 9.49/kWh in July 2017 to US cent 8.97/kWh in August 2017 and rose marginally to US cent 9.29/kWh in September 2017 they were all below the gazette BGT of US cent 9.48/kWh.

Table 1.1.1 shows the comparison between the cost of generation of power plants from July 2017 to September 2017 with the approve BGT tariff by the PURC showing the effect of exchange rate variability on the ability to recover cost. Analysis A presents the BGT in terms of GHp which is the predominate currency for payment in the regulated market. Analysis B present the effect of exchange rate of the BGT.

Table 1.1.1 Comparison between cost of generation and PURC approve tariff from July 2017 to September 2017

	Jul-17	Aug-17	Sep-17
Analysis A			
Cost of Generation (GHp/kWh)	41.52	39.54	41.07
PURC CBGT (GHp/kWh)	35.97	35.97	35.97
Difference (GHp/kWh)	-5.55	-3.57	-5.11
Analysis B			
Cost of Generation (USCent/kWh)	9.49	8.97	9.29
PURC CBGT (USCent/kWh)	9.48	9.48	9.48
Difference (USCent/kWh)	-0.01	0.52	0.19
Average Monthly Exchange rate (GHS/US$)	4.37	4.41	4.42

The effect of exchange rate were very significant as average generation cost lower than the gazette tariff in US dollar terms. The ability to recover cost were not clearly meet in the third quarter of 2017.

1.2 Ability to reliability meet demand

1.2.1 Ratio of installed capacity to Demand and Capacity Factor

The ratio of installed capacity to demand measures the extent to which our installed capacity adequately meets demand. This ratio was adequately met in the third quarter of 2017 as the AKSA power plant increased its installed capacity from 160 MW in March 2017 to 250 MW in August 2017. Therefore, Ghana's installed capacity could meet more than twice of Ghana's demand in August and September 2017. An average of 2.04 was recorded in the third quarter of 2017 which compares favorably with the average for the SSA (2.2) and the OECD (2.3) countries.

The capacity factor of a power system measures the extent to which the supply system is being utilized. Capacity factor dropped from an average of 43% in the second quarter of 2017 to an average of 40% in the third quarter of 2017 due to reduced demand in the third quarter compared to the second quarter and increased in the installed capacity from a maximum of 4,074 MW in the second quarter to 4,119 MW in the third quarter (installed capacity do not include capacity for MRP and T3). The average of 40% was lower than the average of 50% for the world average, high income economies and upper and lower middle income economies. The average of 40% compares favorably with the average for the low income economies.

Table 1.2.1 Ratio of installed capacity to demand and capacity factor for the third quarter of 2017

	July 2017 indicator							
	Ghana	World	SSA	OECD	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Ratio Installed capacity to Demand	1.97	2.6	2.2	2.3	2.5	2.4	3.1	2.9
Capacity Factor	0.41	0.5	0.5	0.5	0.5	0.5	0.5	0.4

	August 2017 indicator							
	Ghana	World	SSA	OECD	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Ratio Installed capacity to Demand	2.13	2.6	2.2	2.3	2.5	2.4	3.1	2.9
Capacity Factor	0.39	0.5	0.5	0.5	0.5	0.5	0.5	0.4

	September 2017 indicator							
	Ghana	World	SSA	OECD	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Ratio Installed capacity to Demand	2.04	2.6	2.2	2.3	2.5	2.4	3.1	2.9
Capacity Factor	0.40	0.5	0.5	0.5	0.5	0.5	0.5	0.4

1.2.2 Reserve Margin

The reserve margin of supply system serves as an indicator in measuring the reliability of a power system. The reserve margin, especially the constrained reserve margin throws more light on the utilization of the capacity available. Constrained reserve margin takes into consideration planned maintenance, unplanned maintenance and fuel supply difficulties. That is, power plants that are technically available, has fuel available and could come up online when needed within the period under study.

Table 1.2.2 Average Constrained and unconstrained reserve margin

	Jul-17	Aug-17	Sep-17
Constrained Reserve margin (%)	2.00	15.02	28.34
Uncontrained reserve margin (%)	49.31	53.15	50.93

The constrained reserve margin showed major improvement in the second quarter of 2017 increasing to 15% and 28% in August 2017 and September 2017 respectively due to the increase in natural gas supply within the period and increased capacity of AKSA in August 2017. Within the period, constrained reserve margin increased to a maximum of 40% in August 2017 and 41% in September 2017. The improved reserve margin compares favorably with the 18% to 25% recommended by the International Energy Agency (IEA). There was however an average of 36% capacity unavailable due to technical and fuel supply challenges.

1.3 Ability to make investments

1.3.1 Capacity Annual Growth and Ratio of installed Capacity growth to demand growth

The Capacity Annual Growth indicator measures the annual growth in the installed capacity as a means of our ability to make investment in the power sector. Installed capacity grew by an average of 16.3% between the third quarter of 2016 and third quarter of 2017. Installed capacity grew by 14.56% between between July 2016 and July 2017, 17.12% between August 2016 and August 2017 and 17.12% between September 2016 and September 2017. This growth was significantly higher than the indicators recorded for SSA, High income economies, Upper middle income economies, Lower middle income economies and low income economies as shown in table 1.3.1 below. That is, Ghana has made significant new investment in generation capacity.

Table 1.3.1 Capacity annual growth and Ratio of installed capacity growth to demand growth

	July 2017 indicator					
	Ghana	SSA	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Capacity annaul growth (%)	14.56	3.1	3.1	2.7	3.9	3.4
Ratio of installed capacity growth demand growth	0.85	0.2	0.6	0.7	0.3	0.02

	August 2017 indicator					
	Ghana	SSA	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Capacity annual growth (%)	17.12	3.1	3.1	2.7	3.9	3.4
Ratio of installed capacity growth demand growth	4.33	0.2	0.6	0.7	0.3	0.02

	September 2017 indicator					
	Ghana	SSA	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Capacity annaul growth (%)	17.12	3.1	3.1	2.7	3.9	3.4
Ratio of installed capacity growth demand growth	3.06	0.2	0.6	0.7	0.3	0.02

A high growth in capacity will not be significant if it is not able to meet the required demand. The indicator that measures the ability of the growth in capacity to meet the growth in demand is the ratio of the growth in installed capacity to growth in demand. Ghana's capacity growth to demand growth was once again significantly higher (average of 2.7%) than the average recorded for the SSA, High Income economies, Upper middle income economies, Lower middle income economies and low income economies as seen in table 1.3.3. The capacity additions, that is growth in capacity, were enough to meet our demand growth for the third quarter of 2017.

1.4 Ability to operate according to environmental and social norms

1.4.1 Emission factor and Fossil fuel dependency

Fossil fuel dependency increased from an average of 59.8% in the second quarter of 2017 to an average of 67.2% in the third quarter of 2017. This increase was primarily due to the increase in supply of natural gas to the various power enclaves which increased thermal generation in the third quarter compared to the second quarter.

The emission factor remained constant in the third quarter of 2017 at 0.34 kgCO2/kWh despite the increase in the average fossil fuel dependency from 59.8% in the second quarter of 2017 to 67.2% in the third quarter of 2017 due to the increase in natural gas consumption in the third quarter of 2017 (from 37% of the total fuel consumption in the second quarter to 60.3% in the third quarter). The average emission factor for the third quarter of 2017 of 0.34 kgCO2/kWh still compares favorably with the average for the low income economies. This average is also significantly lower than the world average, average for the high income economies, SSA and Lower middle and upper middle income economies. Table 1.4.1 compares Ghana's emission factor and fossil fuel dependency with indicators from economies and region of the world.

Table 1.4.1 Emission Factor and Fossil fuel dependency

	July 2017 indicator						
	Ghana	World	SSA	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Emission Factor ($KgCO_2/kWh$)	0.35	0.6	0.5	0.9	0.7	0.5	0.3
Fossil fuel dependency (%)	66.05	60.7	45.3	84.4	66.4	59.4	40.6

	August 2017 indicator						
	Ghana	World	SSA	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Emission Factor ($KgCO_2/kWh$)	0.34	0.6	0.5	0.9	0.7	0.5	0.3
Fossil fuel dependency (%)	69.28	60.7	45.3	84.4	66.4	59.4	40.6

	September 2017 indicator						
	Ghana	World	SSA	High Income Non-OECD	Upper Middle Income	Lower Middle Income	Low Income
Emission Factor ($KgCO_2/kWh$)	0.34	0.6	0.5	0.9	0.7	0.5	0.3
Fossil fuel dependency (%)	66.16	60.7	45.3	84.4	66.4	59.4	40.6

1.4 Conclusions

Ghana continue to witness healthy growth in demand capable of meeting the growth in demand in the third quarter of 2017. Capacity grew by a minimum of 14.6% in the third quarter 2017 which was adequate to meet demand with increasing reserve margins. Average Constrained reserve margin reached a maximum of 28.3% due to improvement in fuel supply for the third quarter of 2017. Capacity factor however dropped from an average of 43% in the second quarter of 2017 to 41% in the third quarter due to increase in the installed capacity and drop in demand. Fossil fuel dependency continues to increase in the third quarter of 2017 from 59.8% in the second quarter to 67.2%. Despite the increase in fossil fuel dependency, average emission factor still remained constant at an average of 0.34 kg of CO2 per kWh of electricity produced due to the increased supply of natural gas.

2.0 Performance Indicators of Power Plants

2.1 Capacity Utilization Factor (CUF)

There was a marginal increase in the CUF for the Akosombo GS from 43.4% in September 2017 to 43.8% in October 2017. Likewise, Bui GS also had marginal increase in it CUF from 12.1% in September 2017 to 17.1% in October 2017.Kpong GS however had a marginal reduction in it CUF in October 2017 from 56.3% in September 2017 to 55.7% in October 2017.

Thermal power plant had a general increase in their CUF in October 2017 except TT1PP and AMERI. SAPP and TAPCO had marginal increase it their utilization factors from 40.6% and 44.9% in September 2017 to 43% and 47.8% in October 2017 respectively. Likewise, the TICO and Karpowership had significant increases in their CUF's in October 2017 from 64.7% and 63.8% in September 2017 to 61% and 92.2% respectively in October 2017. On the contrary, the TT1PP and Ameri power plants had decline in their CUF's in October 2017 compared to September 2017 from 66% and 59.9% to 17.6% and 41.7% respectively.

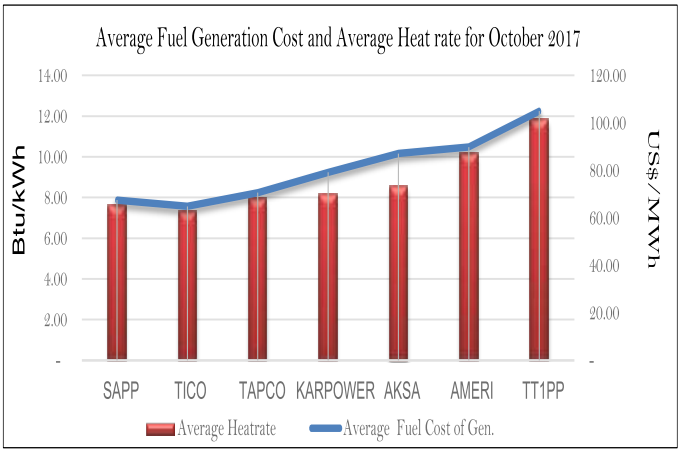
The System Load Factor (LF) increased from 72.8% in September 2017 to 77.3% in October 2017.

The Plant utilisation factors of the various plants is contained in table 2.1.

Table 2.1.1: Power Plant Capacity Utilization, Average heat rate and Average Fuel Cost of Generation

Power Plant	Capacity Utiliation (%)	Average Heatrate (Btu/KWh)	Average Fuel Cost of Generation (US$/MWh)
Akosombo	43.75	-	-
Kpong	55.65	-	-
Bui	17.07	-	-
SAPP	42.96	7,605.49	67.48
TAPCO	47.81	7,989.29	70.63
TICO	91.04	7,337.40	64.86
TT1PP	17.60	11,832.56	104.98
CENIT	-	-	-
TT2PP	-	-	-
MRP	-	-	-
KARPOWER	92.23	8,165.42	79.16
AMERI	41.68	10,159.17	89.81
TROJAN	-	-	-
KTPP	4.77	11,723.02	162.97
AKSA	49.33	8,528.41	87.10

Figure 2.1: Fuel efficiency ranking of thermal power plants with their respective fuel cost of generation.



2.2 Heat Rate (Fuel Efficiency)

Fuel efficiencies of the thermal power plants generally fell in October 2017 compared to September 2017. All the thermal power plants except TAPCO and TICO all declined in October 2017. SAPP which was the most efficient thermal power plant in September 2017 fell in October 2017 from 7,520.76 Btu/kWh to 7,605.49 Btu/kWh with TICO taking its place with its fuel efficiency increasing from 7,985.12 Btu/kWh in September 2017 to 7,337.4 Btu/kWh in October 2017. The TT1PP, Karpowership, Ameri and the AKSA power plants had 3%, 0.2%, 0.6% and 0.3% respectively in October 2017 in their fuel efficiency compared to September 2017.

Figure 2.1 shows the ranking of the thermal power plants based on their efficiency levels with their corresponding fuel cost of electricity generation. The chart indicates the effect of fuel prices on the cost of generation of the thermal power plants.

Figure 2.1: Fuel efficiency ranking of thermal power plants with their respective fuel cost of generation.

2.3 Average Fuel Cost of Electricity Generation

There were general increase in the average fuel cost of generation for thermal power plants in October 2017 compared to September 2017 from an average of US$80.5/MWh to US$94/MWh. The average increase in the fuel cost of generation was due to the coming online of the KTPP which consumes relatively expensive DFO. Average fuel cost of KTPP was US$187.86/MWh in October 2017. The TT1PP and the AKSA power plants also witnessed increased fuel cost of generation from US$101.9/MWh and US$84.69/MWh in September 2017 to US$104.98/MWh and US$87.1/MWh in October 2017 respectively due to the drop in their average fuel efficiencies and a marginal increase in HFO cost in the case of AKSA power plant.

On the contrary, the SAPP, TAPCO and TICO power plants had improvements in their average fuel cost of generation in October 2017 compared to September 2017. Despite the reduction in fuel efficiency of the SAPP it average fuel cost of generation reduced from US$68.92/MWh to US$67.48/MWh due to its operation on natural gas only in October 2017 reducing it average fuel cost from US$9.16/MMBtu to US$8.87/MMBtu. TAPCO and TICO power plants had improvement in their average fuel cost of generation by 0.3% and 8.1% due to improvement in their fuel efficiencies in October 2017 compared to September 2017.

Acronyms

AGPP = Atuabu Gas Processing Plant
Btu = British Thermal Units
CBGC = Composite Bulk Generation Charge
CUF = Capacity Utilization Factor
DFO = Distillate Fuel Oil
EC = Energy Commission
ECG = Electricity Company of Ghana
EMOP = Electricity Market Oversight Panel
ESP – Electricity Supply Plan
FPSO = Floating Production, Storage and Offloading
GHp = Ghana Pesewa
GNGC = Ghana National Gas Company
GWh = Giga-watt Hours
HFO = Heavy Fuel Oil
KTPP = Kpone Thermal Power Plant
kWh = Kilo-watt hours
MRP = Mine Reserve Plant
LEAP = Long-range Energy Alternative Planning
LCO = Light Crude Oil
LI = Legislative Instrument
LTA = Long Term Average
MW = Megawatt
MMscf = Million Standard Cubic Feet
MWh = Mega-watt hours
NITS = National Interconnected Transmission System
PV = Photovoltaic
SAPP = Sunon Asogli Power Plant
SMP = System Marginal Price
SNEP = Strategic National Energy Plan
TEN = Tweneboa, Enyenra, Ntomme
TT1PP = Tema Thermal 2 Power Plant
TT2PP = Tema Thermal 2 Power Plant
VRA = Volta River Authority
WAGPCo – West African Gas Pipeline Company
WAGP = West African Gas Pipeline
WEM = Wholesale Electricity Market

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