



GHANA WHOLESAL ELEC TRICIT Y MARKET BULLETIN

MARKET WATCH

Monthly Market Data Analysis

ISSUE NO. 12: 1st November 2016 to 31st December, 2016

This Bulletin covers major developments in the Wholesale Electricity Market (WEM) of Ghana from 1st November 2016 to 31st December 2016. 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 Bulletin combines the months of November 2016 and December 2016 and discusses the performance of the power sector in 2016 in respect of electricity generation and supply.

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, but nevertheless, regrets any errors, omissions or inaccuracies therein.

HIGHLIGHTS OF THE MONTHS

Electricity supply increases in November 2016 and December 2016

Total electricity supplied to meet Ghana's requirement increased marginally from 1,142.9 GWh in October to 1,184.8 GWh in November 2016, made up of 1,159.8 GWh from domestic sources and 25.0 GWh of imports from La Cote D'Ivoire. The total supply in November 2016 was 16.5% lower than the 1,419 GWh projected under the Electricity Supply Plan (ESP) developed for the year 2016.

A total of 1,239.06 GWh of electricity was supplied in December 2016, made up of 1202.46 GWh from domestic generation and 36.60 GWh of imports from La Cote D'Ivoire. Even though the total supply of electricity increased substantially in December 2016, it was still lower than the 1,471.8 GWh projected under the 2016 ESP by about 15.8%.

The total System Coincident Peak Load (Ghana Peak Generation plus Imports) of 2,077.8 MW recorded in November 2016 increased to 2,105.5 MW in December 2016. The Ghana coincident peak load (Domestic Peak Load including VALCO minus Export) rather decreased marginally from 2,037.80 MW in November 2016 to 2,034.50 MW in December 2016. This was as a result of increased export capacity from an average of 40 MW in November 2016 to an average of 71 MW in December 2016. Both the actual total System and Ghana Peak Loads were lower than the projected System Peak Load (2,477 MW) and Ghana Peak Loads (2,250 MW) respectively for December 2016 under the 2016 ESP. The results represent a total System and Ghana Peak Load deviations of 371.5 MW and 172.2 MW respectively between projected and actual Peak Loads. It is worth noting, however that, the Ghana Peak load has increased by about 421 MW between July 2016 and December 2016. Table 1 shows a comparison of the projected and actual electricity demand and supply for November 2016 and December 2016.

Table 1: Projected and Actual Outturn of electricity supply and demand in November 2016 and December 2016

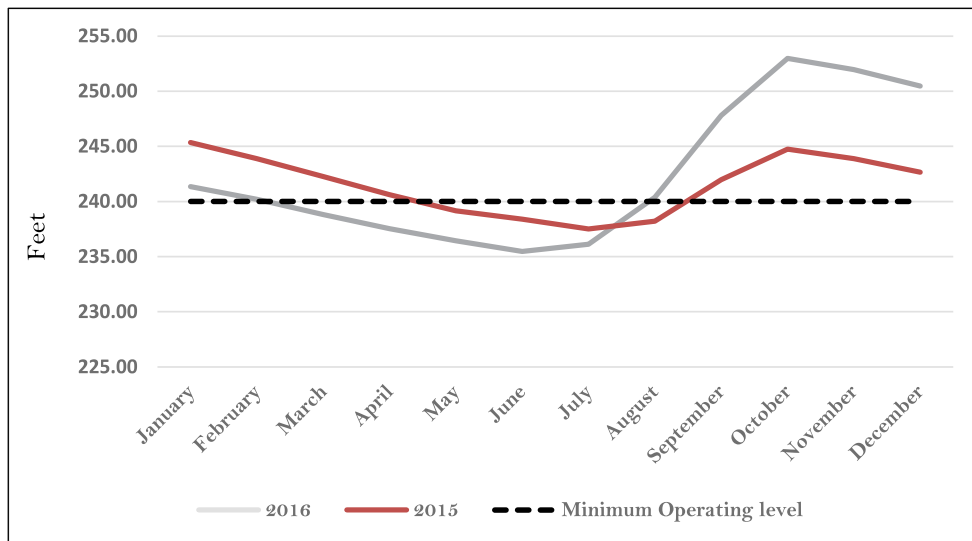
	November 2016		December 2016	
	Projected	Actual	Projected	Actual
Total Demand (GWh)	1,419.0	1,184.8	1,474.0	1,239.1
Source of Supply				
AKOSOMBO	269.0	430.2	278.0	358.0
KPONG	51.0	77.0	53.0	68.1
BUI	83.0	105.9	86.0	79.1
Sunon Asogli - Phase I	111.0	2.5	115.0	62.1
Sunon Asogli - Phase II	110.0	-	114.0	0.0
TAPCO	193.0	80.1	195.0	86.3
TICO	84.0	181.3	193.0	196.6
TT1PP	63.0	24.1	65.0	33.6
CENIT	66.0	11.7	68.0	5.4
TT2PP	-	-	-	0.0
MRP	-	-	-	0.0
Karpowership	146.0	155.6	113.0	164.3
AMERI	149.0	76.8	154.0	134.9
KTPP	91.0	2.2	37.0	2.0
Trojan Power	-	12.4	-	12.1
Total Generation (GWh)	1,416.0	1,159.8	1,471.0	1,202.5
Imports (GWh)	-	25.0	-	36.6
Total Supply (GWh)	1,416.0	1,184.8	1,471.0	1,239.1
Deficit (GWh)	-	(231.2)	-	(231.9)
Reduction in Consumption		16%		16%
Ghana Coincident Peak Load (MW)	2,250.0	2,037.8	2,325.0	2,034.5
System Coincident Peak Load (MW)	2,402.0	2,077.8	2,477.0	2,105.5

HIGHLIGHTS OF THE MONTH

Akosombo dam water level records dips in November 2016 and December 2016 but remains above the minimum design operating level

The level of water in the Akosombo dam dipped for the first time in November 2016 since the dam started its steady recovery in July 2016. It further dipped in December 2016. The dam level dipped by 1.02 feet from its 252.98 feet level in October 2016 to reach 251.96 feet at the end of November 2016 and further dipped by 1.49 feet to end December 2016 at a level of 250.47 feet. This was however well above the minimum design operating level of 240 feet. The dip in the water level points to an increase in drafting of the dam to fill the electricity generation gap left by increased System Peak Load compounded by low availability of thermal power plants. Despite the dip, it is worthy to note that, the water level at the end of December 2016 was higher than the level at the same time in December 2015 by about 7.82 feet. Figure 1 shows comparative end of month trajectory of the level of water in the Akosombo dam for January 2015 to December 2016.

Figure 1: Month-End Water Level for Akosombo Dam from January 2015 to December 2016



Generation of electricity from the Akosombo Generation Station (GS) continued to increase from 349.2 GWh in October 2016 to 430.2 GWh in November 2016 and 358.0 GWh in December 2016. The increment in electricity generation from Akosombo GS in November 2016 was 23.2% more than the generation in October 2016. The 430.2 GWh generated by Akosombo GS in November 2016 was also significantly higher than the 269 GWh projected to be generated under the 2016 ESP. The Akosombo GS generated 36.3% of total electricity supplied in November 2016 up from 30.1% of total supply in October 2016. The power plant contributed 702.2 MW (33.8%) to meet total System Peak Load of 2,077.8 MW in November 2016 compared to 480 MW (24.1%) in October 2016 to meet system peak demand of 1,990.2 MW. The Akosombo GS contributed the same elevated amount of 702.2 MW (34.5%) to meet the Ghana Peak Load of 2,037.8 MW in November 2016 compared to 717 MW (30.3%) used to meet the Ghana Peak Load of 1,936.1 MW recorded in October 2016.

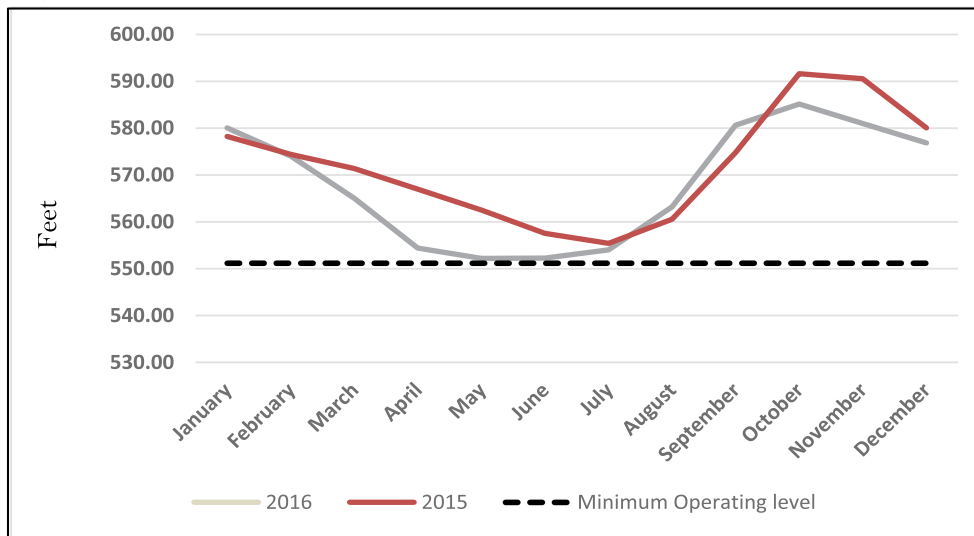
The 358.0 GWh generated by Akosombo GS in December 2016, even though lower than the generation in November 2016, was also significantly higher than the 278 GWh projected under the 2016 ESP. The Akosombo GS generated 28.9% of total electricity supplied in December 2016, down from 36.3% of total supply in November 2016. The power plant contributed 594 MW (28.2%) to meet total system maximum peak load of 2,105.5 MW in December 2016 compared to 702.2 MW (33.8%) in November 2016 to meet System Peak Load of 2,077.8 MW. The Akosombo GS contributed the same elevated amount of 594 MW (29.2%) to meet the Ghana Peak Load of 2,034.5 MW in December 2016 compared to 702.2 MW (34.5%) to meet the Ghana Peak Load of 2,037.8 MW recorded in November 2016.

Electricity generation from Bui Power Plant doubles in November 2016 as water level dips

Electricity production from the Bui Power Plant doubled to 105.9 GWh in November 2016 from 50.52 GWh in October 2016. It then dropped to 79.11 GWh in December 2016. The average electricity generation rate of this peaking plant increased from 1.63 GWh/day in October 2016 to 3.53 GWh/day in November 2016 and 2.55 GWh/day in December 2016. The 105.9 GWh total electricity generated in November 2016 from the Bui Power Plant was significantly higher than the 83 GWh projected to be generated under the 2016 ESP but the generation in December 2016 fell below the 86 GWh projected under the ESP.

HIGHLIGHTS OF THE MONTH

Figure 2: Month-End Water Level for Bui Dam from January 2015 to December 2016



The water level of the Bui dam dipped by 4.2 feet to reach 581 feet at the end of November 2016, which is about 30 feet above the minimum operating level of 551 feet compared to 34.8 feet in October 2016. The water level dipped by a further 4.1 feet to end December 2016 at 576.9 feet, which is about 26 feet above the minimum operating level of the dam. The Bui Power Plant generated 8.9% of total electricity supplied in November 2016 and 6.4% of total electricity supplied in December 2016. The Bui power plant contributed 343.9 MW (16.6%) to meet total System Peak Load in November 2016 and 348 MW (16.5%) to meet total System Peak Load in December 2016.

Sunon Asogli Power Plant resumes generation in November 2016

The Sunon Asogli Power Plant resumed electricity generation on 29th November 2016 for the first time since July 2016 following the resumption of gas supply from Nigeria. It generated a total of 2.5 GWh of electricity for the two days it operated in November 2016 as against 223 GWh projected under the 2016 ESP. The Asogli Plant contributed 94.7MW to meet both total System Peak Load and Ghana Peak Load of 2,077.8 MW and 2,037.8 MW respectively. This represented 4.6% of both System Peak Load and Ghana Peak Load. The average daily generation of Asogli in November 2016 was 1.25 GWh/day and used 11.08 MMSCF of gas per day at an estimated heat rate (fuel efficiency) of 9,393.03 Btu/kWh.

In December 2016, Asogli generated 62.08 GWh of electricity as against a projected 229 GWh under the 2016 ESP and contributed 95.1MW to meet both total System Peak Load and Ghana Peak Load of 2,105.5 MW and 2,034.5 MW respectively. This represented 4.5% and 4.6% of System Peak Load and Ghana Peak Load respectively. The average daily generation of Asogli in December was 2.0 GWh/day using 19.67 MMSCF of gas per day at an estimated heat rate (fuel efficiency) of 10,409.87 Btu/kWh.

CENIT generates slightly in November 2016 and December 2016

CENIT Power Plant which did not operate in October 2016 resumed generation in November 2016 and operated for a total of 7 days in the month, generating a total of 11.7 GWh of electricity and contributing 99 MW to meet both System Peak Load and Ghana Peak Load respectively. The contribution by CENIT to System Peak Load and Ghana Peak Load were respectively 4.8% and 4.9%. Inability to meet demand in November 2016 with other cheaper available plants necessitated the need to bring CENIT online for the 7 days unlike in October 2016 when it did not operate at all even though it was available and had fuel. The 11.7 GWh of electricity generated by CENIT was significantly lower than the projected generation of 66 GWh under the 2016 ESP. The plant consumed 24,819.48 barrels of LCO to generate 11.7 GWh (daily average of 1.67 GWh) of electricity at an average heat rate (fuel efficiency) of 11,233.38 Btu/kWh.

In December 2016, the CENIT Power Plant operated for 4 days generating 5.4 GWh of electricity in the process but did not contribute to both System and Ghana Peak Loads. This is apparently due to the fact that, the System and Ghana Peak loads in the month occurred on days when the plant did not operate. The relatively fewer days of operation by CENIT in December 2016 was once again largely as a result of availability of cheaper sources of generation to meet demand. The plant consumed 11,603 barrels of LCO to generate 5.4 GWh (average of 1.35 GWh/day) of electricity at an average heat rate (fuel efficiency) of 11,389.73 Btu/kWh in December 2016.

Electricity generation from Ameri Energy Power Plant slumped in November 2016 and recovers in December 2016

Electricity generation from the Ameri Energy Power Plant slumped to 76.77 GWh in November 2016 (average daily generation of 2.56 GWh/day) from 149.5 GWh generated in October 2016 representing a decrease of about 48.6% even though it operated throughout the month. This was attributed to the reduced flow of gas supply from the FPSO Kwame Nkrumah for spread-mooring work to be done. The electricity generated by the plant in November 2016 was also significantly lower than the 149 GWh projected to be produced for the month of November 2016 under the 2016 ESP. The lower electricity generation in November 2016 compared to October 2016 was largely as a result of decreased supply of natural gas from the Atuabo Gas Processing Plant to the Aboadze Power Enclave. Indeed, natural gas supply decreased by 33.4% between October and

HIGHLIGHTS OF THE MONTH

November 2016. The Ameri Energy power plant contributed 73.1 MW to meet both System Peak Load of 2,077.8 MW and Ghana peak load of 2,037.8 MW. The power plant thus contributed 3.5% of total System Peak Load and 3.6 % of Ghana Peak Load in November 2016. The plant consumed a total 23.62 MMSCF per day of gas to generate 76.77 GWh of electricity at an average heat rate (fuel efficiency) of 10,713.25 BTU/kWh.

In December 2016, the Ameri Plant generated 134.91 GWh (average daily generation of 4.35), an increment of 75.7% over its generation in November 2016 and 12.4% less than the projected generation by the Ameri Energy Power Plant in December 2016 under the 2016 ESP. The Ameri Energy Power Plant contributed 239.3 MW to meet both System Peak Load of 2,105.5 MW and Ghana peak load of 2,034.5 MW representing 11.4% and 11.8% of the System and Ghana Peak Load respectively. The Ameri Energy Power Plant consumed 1,177.51 MMSCF of gas (representing 54.79% of total gas delivered to Aboadze Power Enclave) to generate 134.91 GWh of electricity at an average heat rate (fuel efficiency) of 10,132.73 Btu/kWh in December 2016.

Electricity generation from KTPP slumped again in November 2016 and December 2016

Electricity generated from the kpone Thermal Power Plant (KTPP) decreased again in November 2016 to 2.2 GWh from 5.7 GWh in October 2016 as the plant operated only for 4 days in November 2016. The KTPP was projected to be offline in November 2016 in the 2016 ESP. The KTPP was operated virtually as a peaking plant for 4 days in the month of November 2016 but did not contribute to meeting both System Peak Load and Ghana Peak Load in November 2016. The relatively low capacity utilisation by KTPP was as a result of available generation from cheaper sources to meet system demand. The 2.2 GWh of electricity generated in November 2016 by KTPP was achieved with a consumption of 3,896.86 barrels of DFO resulting in average heat rate (fuel efficiency) of 13,525.59 Btu/kWh.

In December 2016, the KTPP operated for only 2 days and generated a total of 2.02 GWh of electricity consuming 4,432.22 barrels of DFO in the process with an estimated average heat rate (fuel efficiency) of 11,790.68 Btu/kWh. Once again, the availability of generation from cheaper sources to meet demand accounted for the relatively low capacity utilization of KTPP in December 2016.

Karpowership maintains average generation in November 2016 and December 2016

The Karpowership Power Plant generated every day in the month of November 2016 and generated 155.63 GWh averaging 5.19 GWh/day in November 2016 compared to 161.7 GWh in October 2016 averaging 5.22 GWh/day. Electricity generation in November 2016 of 155.63 GWh was higher than the projected generation of 146 GWh forecast under the 2016 ESP. The power plant contributed 13.1% of total electricity supplied in November 2016 compared to 14.1% in October 2016. The power plant contributed 205.2 MW to meet both the total System Peak Load of 2,077.8 MW and the Ghana Peak load of 2,037.8 MW. Thus the power plant contributed 9.9% and 10.1% to meet the total System Peak Load and Ghana Peak Load respectively in November 2016. The Karpowership Power Plant consumed 209,284 barrels of Heavy Fuel Oil (HFO) to generate the 155.63 GWh in November 2016 at an average heat rate (fuel efficiency) of 8,252.39 Btu/kWh.

In December 2016, Karpowership operated for the entire 31 days of the month generating a total of 164.32 GWh at an average rate of 5.3 GWh/day. The total electricity generation in December 2016 was 45% higher than what it was projected to generate under the 2016 ESP. Karpowership contributed 209.1 MW to both System and Ghana Peak Loads of 2,105.5 MW and 2,034.5 MW respectively. The Karpowership Power Plant consumed 220,946 barrels of Heavy Fuel Oil (HFO) to generate the 155.63 GWh in December 2016 at an average heat rate (fuel efficiency) of 8,251.49 Btu/kWh.

Electricity generation from TICO was maintained in November 2016 but increased in December 2016

The TICO power plant operated throughout the month of November 2016, generating a total of 181.35 GWh of electricity (average of 6.05 GWh/day) compared to 183.33 GWh (average of 6.11 GWh/day) in October 2016. The total generation of 181.4 GWh in November 2016 was significantly higher than the 84 GWh projected under the 2016 ESP. The TICO Plant operated largely in a combined cycle mode in November 2016, contributing 305.4 MW to meet the total System Peak Load of 2,077.8 MW representing 14.7% of System Peak Load in November 2016. It also contributed the same 305.4 MW to meet the Ghana Peak Load of 2,037.8 MW in November 2016, representing 15% of the Ghana Peak Load. The TICO Power Plant operated solely on light crude oil (LCO) consuming about 275,238 barrels of the fuel to produce 181.4 GWh in November 2016 at an average heat rate (fuel efficiency) of 8,030.15 Btu/kWh.

In December 2016, the TICO Plant operated throughout the month and generated a total of 196.58 GWh of electricity (average of 6.34 GWh/day) as against a total generation of 193 GWh of electricity projected under the 2016 ESP. The TICO Plant contributed 303 MW to meet both System Peak Load of 2,105.5 MW and Ghana Peak Load of 2,034.5 MW, representing 14.4% and 14.9% respectively. The TICO Plant operated solely on LCO in December, 2016 and generated the 196.58 GWh of electricity with 298,644.82 barrels of LCO at an average heat rate of 8,038.05 Btu/kWh.

TAPCO generation increased slightly in November 2016 and December 2016

The TAPCO Plant generated slightly more electricity in November 2016 than in October 2016. The plant operated for 28 days in November, 2016 with one Gas Turbine and half capacity of the Steam Turbine, generating 80.1 GWh of electricity (average of 2.7 GWh/day) compared to the 77.1 GWh it generated in October 2016 (average of 2.5 GWh/day) representing an increase of 3.9%. Electricity generation in November 2016 was significantly lower than the projected amount of 193 GWh under the 2016 ESP for November 2016. The TAPCO Plant contributed 6.5% of total electricity supplied in November 2016 compared to 6.6% of total electricity supplied in October 2016. All of TAPCO's electricity generation in November 2016 was from natural gas, consuming 584.64 MMSCF of gas to generate the 80.1 GWh of electricity in November 2016 at an average heat rate of 8,472.38 Btu/kWh. It contributed 146 MW to meet both the System Peak Load and Ghana Peak Load representing 7% of System Peak Load and 7.2% of the Ghana Peak Load respectively.

HIGHLIGHTS OF THE MONTH

In December 2016, the TAPCO Plant again operated for 28 days as it was shut down for minor maintenance works lasting for 3 days. It operated the same number of units as in November 2016 and generated a total of 86.33 GWh of electricity, about 7.8% increment over the November 2016 generation using 651.5 MMSCF of gas at an average heat rate of 8,761.09 Btu/kWh. It contributed 146 MW towards System Peak Load (2,105.5 MW) representing 6.9% and Ghana Peak Load (2,034.5 MW) representing 7.2%. The electricity generated by this plant in December 2016 (86.33 GWh) was just 44.3% of the projected 195 GWh under the 2016 ESP.

Electricity generation from TT1PP increased significantly in November 2016 and December 2016

Electricity generation from the Tema Thermal 1 Power Plant (TT1PP) increased significantly to 24.1 GWh (average of 1.72 GWh/day) in November 2016 from 4.2 GWh in October 2016, representing an increase of over 500%. The power plant operated for 14 days in November 2016 solely on LCO consuming about 48,479 barrels of LCO. The TT1PP produced 2% of total electricity supply in November 2016 as compared to a negligible proportion in October 2016. The average heat rate (fuel efficiency) of TT1PP in November 2016 was 10,634.33 Btu/kWh. The plant did not however contribute to meeting total System Peak Load and Ghana Peak Load in November 2016.

In December 2016, electricity generation from TT1PP increased to 33.61 GWh (average of 1.77 GWh/day) representing an increment of 39.5% over the November 2016 generation as it operated for 19 days in this month. It generated the 33.61 GWh using 71,182 barrels of LCO at an average heat rate of 11,205.53 Btu/kWh. The TT1PP once again did not contribute to both the System and Ghana Peak Loads in December 2016.

Natural gas supplies from WAGPP resumed in November 2016

The West African Gas Pipeline Company (WAGPCo) resumed natural gas supply from Nigeria to Tema on 29th November, 2016 for the first time since July 2016. The gas supply level in November 2016 was only adequate to feed the Sunon Asogli Power Plant which relies solely on natural gas and had been offline following the curtailment of natural gas from Nigeria in July 2016. The resulting average WAGPCo natural gas delivery to Tema in November 2016 was 18.6 MMSCF per day. The inadequacy of the gas supply still compelled the other power plants in Tema to run on LCO when needed at a much higher cost than when they are operated on natural gas.

In December 2016, the average delivery of WAGPCo gas at Tema increased to 18.25 MMSCF per day as supply, even though, inadequate, was consistent in the month. The gas was once again only adequate to feed the Sunon Asogli Power Plant generating at an average Peak Load of 90 MW.

Natural gas supplies from GNGC to the Aboadze Power Enclave decreased substantially in November 2016

Daily average natural gas supply from the Atuabo Gas Processing Plant to the Aboadze Power Enclave decreased from 75.17 MMSCF per day in October 2016 to 50.04 MMSCF per day in November 2016, representing about 33.4% drop. This was due to work on the spread-mooring at the FPSO. Out of the total of 1,293.01 MMSCF of natural gas consumed in November 2016 at the Aboadze Power Enclave, the Ameri Energy Power Plant and the TAPCO power plants consumed 54.79% and 45.21% respectively while the TICO power plant continued to be operated solely on light crude oil (LCO) in November 2016.

Electricity imports dips further in November 2016 and start recovery in December 2016

The downward trend of Electricity imports from La Cote D'Ivoire which started in October 2016, continued in November 2016. Electricity imports dipped further to 25.03 GWh in November 2016 from 90.91 GWh in October 2016 representing a reduction of about 72.5%. Electricity imports in November 2016 was 2.1% of total electricity supplied in the month. Out of the total imports of 25.03 GWh in November 2016, 8.56 GWh, representing 34.2% was exported making Ghana a net importer of electricity in November 2016. Imports in November 2016 did not contribute to meet the total System Peak Load of 2,077.8 MW and Ghana Peak Load of 2,037.8 MW.

Electricity Imports in December 2016 increased by 46.2% in December 2016 to reach 36.60 GWh from 25.03 GWh in November 2016. The electricity import in December 2016 accounted for about 3% of total electricity supplied. The Electricity imports of 36.60 GWh in December 2016 fell short of the 44.34 GWh of electricity exported in the month making Ghana a net exporter of electricity in December 2016. The electricity imports in December 2016 contributed 58.0 MW to meet both System Peak Load (2,105.50 MW) and Ghana Peak Load (2,034.50 MW)

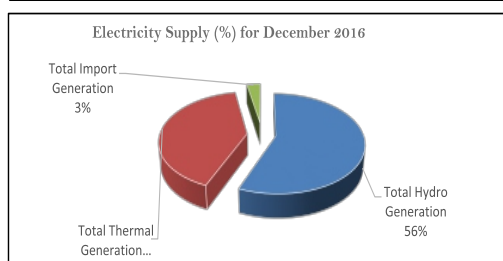
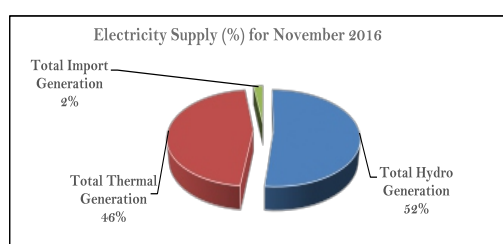
¹ Excludes electricity contracted by CEB from La Cote D'Ivoire and wheeled by GRIDCo to CEB

OPERATIONAL FACT SHEET

Peak Electricity Supply (MW) - November 2016 & December 2016

Source of Supply	Generation at System Coincident Peak Load of November	Generation at Ghana Coincident Peak Load of November	Generation at System Coincident Peak Load of December	Generation at Ghana Coincident Peak Load of December
AKOSOMBO	702.20	702.20	594.00	594.00
KPONG	108.30	108.30	113.00	113.00
BUI	343.90	343.90	348.00	348.00
SAPP	94.70	94.70	95.10	95.10
TAPCO	146.00	146.00	146.00	146.00
TICO	305.40	305.40	303.00	303.00
TT1PP	-	-	-	-
CENIT	99.00	99.00	-	-
TT2PP	-	-	-	-
MRP	-	-	-	-
KARPOWER	205.20	205.20	209.10	209.10
AMERI	73.10	73.10	239.30	239.30
KTPP	-	-	-	-
Trojan Power	-	-	-	-
IMPORT	-	-	58.00	58.00
Export	-	40.00	-	71.00
System Coincident Peak Load	2,077.80		2,105.50	
Ghana Coincident Peak Load		2,037.80		2,034.50

Power Plants	Electricity Supply (GWh)	
	November 2016	December 2016
AKOSOMBO	430.16	357.95
KPONG	76.99	68.06
BUI	105.89	79.11
SAPP	2.50	62.08
TAPCO	80.11	86.33
TICO	181.35	196.58
TT1PP	24.12	33.61
CENIT	11.69	5.39
TT2PP	0.00	0.00
MRP	0.00	0.00
KARPOWER	155.63	164.32
AMERI	76.77	134.91
KTPP	2.17	2.02
Trojan Power	12.40	12.12
IMPORT	25.03	36.60
Total Supply including imports	1,184.80	1,239.08
Total Supply without imports	1,159.77	1,202.48

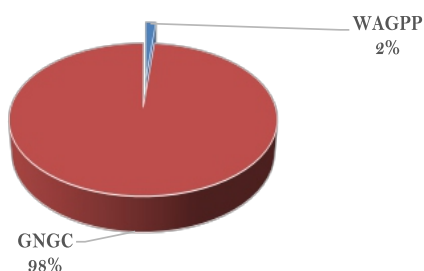


Ghana Electricity Demand

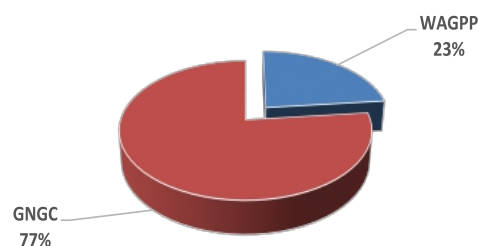
		Nov-16	Dec-16
Maximum Peak Load	MW	2,077.80	2,105.50
Minimum Peak Load	MW	1,795.30	1,800.50
Average Peak Generation	MW	1,961.33	1,972.23
System Base Load	MW	1,202.04	1,037.41
Total Electricity Consumption	GWh	1,184.80	1,239.06
Total Energy Imported	GWh	25.03	36.60
Load Factor (LF)	%	76.70	77.72

OPERATIONAL FACT SHEET

Contribution of Gas Supply Sources in November 2016



Contribution of Gas Supply Sources in December 2016



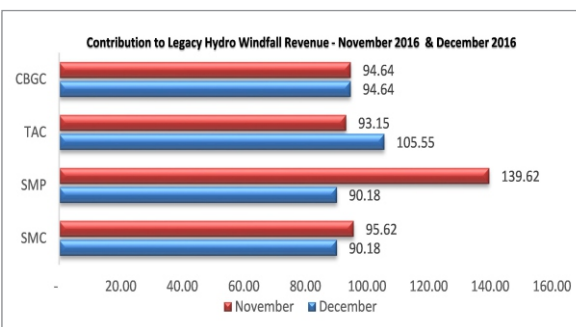
Location	Monthly Average (MMSCFD)	
	November 2016	December 2016
Etoki	1.24	17.12
Tema	1.24	18.25
Aboadze	50.04	68.23

Hydro Dam	November 2016 (ft)			December 2016 (ft)		
	Beginning of the Month	End of the Month	Change in Water level	Beginning of the Month	End of the Month	Change in Water level
Akosombo	252.98	251.96	-1.02	251.96	250.47	-1.49
Bui	585.18	580.99	-4.20	580.99	576.85	-4.14
Akosombo Minimum Design Operating Level	240	240		240	240	
Akosombo Maximum Level	278	278		278	278	

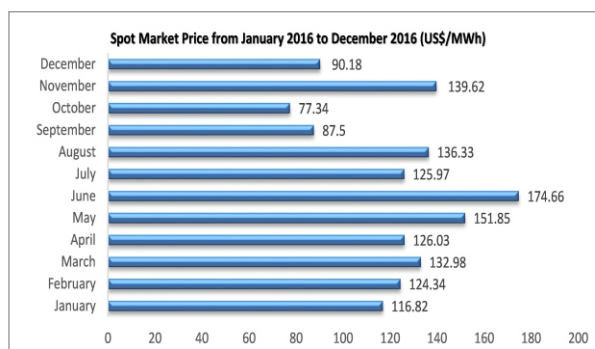
Power Plant Data for November 2016 and December 2016							
	Dependable Capacity (MW)	Plant Utilization (%)	Electricity Generation (GWh)	Gas Consumption (MMBtu)	LCO Consumption (MMBtu)	DFO Consumption (MMBtu)	HFO Consumption (MMBtu)
Akosombo	900.00	59.81	788.11	-	-	-	-
Kpong	140.00	70.77	145.05	-	-	-	-
Bui	340.00	37.17	185.00	-	-	-	-
SAPP	180.00	24.51	64.58	669,727.32	-	-	-
TAPCO	300.00	37.90	166.44	1,435,066.73	-	-	-
TICO	300.00	86.05	377.93	-	3,036,378.34	-	-
TT1PP	110.00	35.85	57.73	-	633,117.72	-	-
CENIT	110.00	10.61	17.08	-	192,708.84	-	-
TT2PP	45.00	-	-	-	-	-	-
MRP	70.00	-	-	-	-	-	-
KARPOWER	225.00	97.13	319.95	-	-	-	2,640,204.49
AMERI	230.00	62.87	211.68	2,189,462.49	-	-	-
TROJAN	-	-	24.52	-	-	268,710.00	-
KTPP	200.00	1.43	4.19	-	-	44,757.28	-
Total	3,150.00		2,362.26	4,294,256.53	3,862,204.90		2,640,204.49

ECONOMIC FACT SHEET

		December	November	Change
Average Market Energy Cost	US\$/MWh	88.27	76.84	11.43
Average Market Capacity Charge (AMCC)	US\$/MWh	17.28	16.31	0.97
Total Average Market Cost (TAC)	US\$/MWh	105.55	93.15	12.40
				-
System Marginal Cost (SMC)	US\$/MWh	90.18	95.62	(5.44)
System Marginal Capacity Charge (SMCC)	US\$/MWh	-	44.00	(44.00)
Spot Market Price (SMP)	US\$/MWh	90.18	139.62	(49.44)
				-
Composite Bulk Generation Charge (CBGC)	US\$/MWh	94.64	94.64	-
Deviation of TAC from CBGC	US\$/MWh	(10.91)	1.49	(12.40)
Deviation of SMP from CBGC	US\$/MWh	4.46	(44.98)	49.44

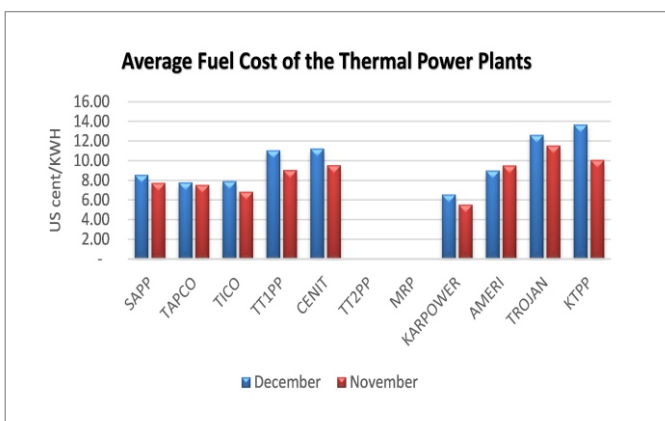
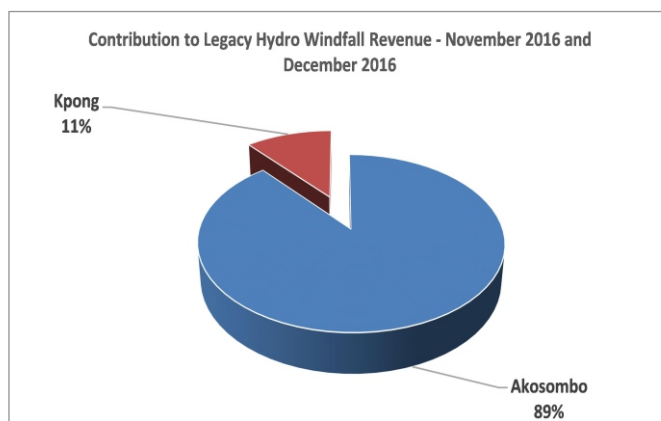


Dec-16				
	Average Cost	Average SMP	Difference	Windfall Revenue
Power Plant	US\$/MWh	US\$/MWh	US\$/MWh	US\$/MWh
Akosombo	33.1	90.18	57.08	20,432,238.70
Kpong	59.2	90.18	30.98	2,108,584.88
Total	92.3			22,540,823.58



Nov-16				
	Average Cost	Average SMP	Difference	Windfall Revenue
Power Plant	US\$/MWh	US\$/MWh	US\$/MWh	US\$/MWh
Akosombo	33.1	139.62	106.52	45,821,402.24
Kpong	59.2	139.62	80.42	6,191,671.65
Total	92.3			52,013,073.90

		December-16	November-16	Change
Total Thermal Power Plants Fuel Cost	US\$	56,753,549.19	39,533,601.71	17,219,947.48
Average Thermal Power Plants Fuel Cost	US\$/MWh	81.38	72.31	9.08



Average Fuel Prices			
		Dec-16	Nov-16
Fuel Type	Unit	Delivered Cost	Delivered Cost
Natural Gas	US\$/MMBtu	8.57	8.57
LCO	US\$/BBL	52.2	45.03
HFO	US\$/Tonne	310.5	261.77
DFO	US\$/Tonne	464.31	418.38

Other Market News and Trends

1. Review of 2016 annual performance of electricity generation and supply

A review of the annual performance of electricity generation and supply in 2016 reveals significant deviation from the projections made in the 2016 Electricity Supply Plan (ESP). With a total dependable capacity of about 3,000 MW (with Akosombo at 750MW instead of 900MW), and annual peak load of 2,105.5 MW, it was expected that, there would not be any shortfall in electricity supply. However, fuel supply inadequacy coupled with plant breakdown and poor hydrology combined to rob the nation of the needed supply capacity adequacy to meet demand leading to all classes of consumers experiencing the effect of a load curtailment exercise at some point in the year especially at the beginning. A review of the outturn of the year compared to projection reveals the underlying causes. Table 1 shows the actual annual supply of electricity by sources and a comparison with the projections made under the 2016 ESP.

Table 1: Annual Actual Electricity supply by source vrs ESP Projection - 2016

TOTAL GENERATION (GWh)	TOTAL GENERATION (GWh) - 2016			% DEVIATION	CONTRIBUTION TO TOTAL GENERATION (%)
	ACTUAL	PROJECTED	DEVIATION		
AKOSOMBO GS	3,853.31	3,285	568	17.3	28.76
KPONG GS	762.56	625	138	22.0	5.69
BUI	943.70	923	21	2.2	7.04
SEAP	373.19	2,413	-2,040	-84.5	2.79
TAPCO	1,192.16	2,109	-917	-43.5	8.90
T3	0.00	0	0	0.0	0.00
TICO	1,902.61	2,071	-168	-8.1	14.20
TTIPP	178.18	488	-310	-63.5	1.33
CENIT	417.81	692	-274	-39.6	3.12
TT2PP	25.60	44	-18	-41.8	0.19
MRP	3.05	49	-46	-93.8	0.02
KTPP	199.03	1,058	-859	-81.2	1.49
AMERI	1,204.02	1,592	-388	-24.4	8.99
KARPOWER	1,861.95	1,173	689	58.7	13.90
TROJAN	38.90	0	39	100.0	0.29
IMPORT	442.86	77	366	475.1	3.31
TOTAL GENERATION (GWh)	13,399	16,599	-3,200	-19.3	100.00

The total electricity supplied in 2016 was 13,399 GWh, 19.3% short of the 16,599.00 GWh projected under the 2016 ESP. There were generally low plant capacity utilisation factors especially the thermal plants.

1.1 Hydro Generation Sources

In an effort to make up for the deficit in supply or reduce the impact of the load curtailment exercise, generation from the already distressed hydro sources were elevated beyond projections against good industry practice and decades of local experience with hydro power operations. All the hydro plants generated above their projected generation levels. In 2016, Akosombo, Kpong and Bui Generation Stations generated 17.8%, 22.0% and 2.2% respectively above what they were projected to generate under the 2016 ESP. The hydro sources together accounted for 41.6% of total electricity generation compared to the 29.1% projected under the 2016 ESP. The outturn of the draught rate of Akosombo and Kpong was 12.6 GWh/day as compared to the 10.7 GWh/day projected under the 2016 ESP.

The elevated generation from hydro sources had negative impact on the Akosombo Dam. From January 2016, the water level of Akosombo Dam dropped steadily until July 2016 when it reached its lowest level in the year (4.99 ft. below the minimum operating level of 240 ft.). It started rising from the final week of July until November 2016 and started another dip. Between February and August 2016, the water level remained below the minimum operating level of the dam.

From January 2016 to July 2016, the high draught rate caused the dam level to remain below the level for the same period in 2015. The lowest water level of the dam reached in 2016 was 235.01 ft. as compared to 237.09 ft. in 2015. However, better inflow into the dam in 2016 caused the highest level of 253.05 ft. to be attained in November 2016 as compared to the highest level of 244.8 ft. attained in November 2015.

1.2 Thermal Generation Sources

Fuel supply inadequacy and frequent plant breakdown were the major contributors to the low capacity utilisation of Thermal Power Plants. Of the thermal sources, only Karpowership (with a guarantee for fuel) generated (58.7%) above what was projected under the 2016 ESP with the rest of the thermal plants generating below projections. The inadequate gas supply by WAGPCo to Tema was the major cause for Asogli, TT1PP, TT2PP, MRP and indirectly CENIT, generating 84.5%, 63.5%, 41.8%, 93.8%, 39% below what they were

Other Market News and Trends

projected to generate under the 2016 ESP. Breakdown of Unit 1 of TAPCO was the major contributory factor for TAPCO generating 43.5% short of what it was projected to generate under the 2016 ESP.

1.3 Fuel Supply Outturn against projection under 2016 ESP

Table 1.3: Comparison of Fuel Supply to Power Plants against Projections under 2016 ESP

Power Plant	ACTUAL	PROJECTED	Deviation	ACTUAL	PROJECTED	Deviation
	DFO (BBLs)	DFO (BBLs)	DFO (BBLs)	HFO (BBLs)	HFO (BBLs)	HFO (BBLs)
TAPCO	655.37	23,944.00	(23,288.63)	-	-	-
TICO	2,351.31	16,072.00	(13,720.69)	-	-	-
TT1PP	2,030.17	10,036.80	(8,006.63)	-	-	-
CENIT	908.97	11,972.00	(11,063.03)	-	-	-
MRP	-	-	-	-	-	-
TT2PP with extension	-	-	-	-	-	-
Sunon Asogli Phase I & II	-	-	-	-	-	-
KTPP	422,473.27	1,297,550.00	(875,076.73)	-	-	-
AMERI	-	-	-	-	-	-
Karpowership	-	-	-	2,496,166.71	2,812,690.00	(316,523.29)
Total Gas	428,419.09	1,359,574.80	(931,155.71)	2,496,166.71	2,812,690.00	(316,523.29)

Power Plant	ACTUAL	PROJECTED	Deviation	ACTUAL	PROJECTED	Deviation
	GAS (MMScf)	GAS (MMScf)	GAS (MMScf)	LCO (BBLs)	LCO (BBLs)	LCO (BBLs)
TAPCO	5,822.92	2,485.56	3,337.37	673,296.77	2,675,188.00	(2,001,891.23)
TICO	3,000.87	11,467.64	(8,466.77)	2,262,616.76	231,900.00	2,030,716.76
TT1PP	10.04	-	10.04	364,514.25	1,096,693.00	(732,178.75)
CENIT	-	-	-	901,529.45	1,612,852.00	(711,322.55)
MRP	36.96	-	41.60	-	-	-
TT2PP with extension	302.68	275.49	70.08	-	-	-
Sunon Asogli Phase I & II	3,272.12	19,342.08	(15,732.73)	-	-	-
KTPP	-	1,583.12	(1,583.12)	-	-	-
AMERI	10,477.73	13,937.79	(3,317.41)	-	-	-
Karpowership	-	-	-	-	-	-
Total Gas	22,923.33	49,091.67	(25,640.94)	4,201,957.23	5,616,633.00	(1,414,675.77)

By converting all fuels into a common unit, British Thermal Unit (Btu) it is observed that, of the total of 109.13 Trillion Btu of fuel required to generate the electricity projected, 65.80 Trillion Btu was supplied thus representing an overall annual shortage in fuel supply of 39.7%.

Natural Gas supply was lower than projected by 51% primarily because of virtually no supply from Nigeria for long periods in the year and lower than projected supply from the Atuabo Gas Processing Plant owing to difficulties with gas production from the FPSO Kwame Nkrumah at the Jubilee Oil and Gas field. Light Crude Oil supplies dipped by 25.2% largely due to financial difficulties emanating from the somber financial position of the distribution utilities. Diesel Fuel Oil (DFO) supplies required to operate mainly the KTPP and some as startup fuel for other thermal plants, also suffered the same fate as DFO, dropping below 68.5% of the projections. The supply of HFO which is used by only the Karpowership reduced by 11.3% over the projections under the 2016 ESP. The shortages in electricity generation are clearly attributable largely to fuel supply difficulties. The inadequate supply of fuel as against what was projected resulted from inadequate financial resources to procure fuel coupled with technical difficulties as well as force majeure situations that affected both supplies from Nigeria and the FPSO.

The nagging issues relating to potential fuel supply difficulties were known right from the beginning of the year. The issues regarding the rationalization of electricity tariffs and other funding mechanisms to resolve the problem of funding fuel supplies were well known and indeed, there were proposals on the table to deal with the issues. The platform for implementing the proposals was not established. Generally, institutional inertia to policy implementation was high in 2016.

²CENIT shares same fuel (LCO) tank with TT1PP which is configured to run on Natural Gas. Availability of gas for TT1PP therefore releases the LCO stock for use by CENIT.

1.4 Capacity Utilisation Factor and Efficiency

Table 1.4: Power Plant Capacity utilization, Average Heat rate and Average Fuel Cost of Generation in 2016

Power Plant	Capacity Utiliation (%)	Average Heatrate (Btu/kWh)	Average Fuel Cost of Generation (US\$/MWh)
AKOSOMBO GS	48.88	-	-
KPONG GS	62.18	-	-
BUI	31.68	-	-
SAPP	12.53	9,294.04	80.46
TAPCO	45.36	8,912.32	83.35
T3	-	-	-
TICO	72.40	7,890.76	81.97
TT1PP	18.49	10,896.07	116.59
CENIT	43.36	11,397.97	122.08
TT2PP	6.49	12,533.04	108.50
MRP	0.50	12,833.32	111.10
KTPP	11.36	10,739.01	107.40
AMERI	59.76	10,102.47	87.46
KARPOWER	94.47	8,232.13	55.64

Karpowership and Takoradi International Company (TICO) had the highest capacity utilization in 2016 of 94.47% and 72.4% respectively. The higher capacity utilization of these power plants were due to the better conditions resulting from good maintenance practice, higher heat rate of the power plants and relatively stable supply of fuel for electricity generation. Fuel supply interruptions especially to power plants in Tema and Kpone limited the capacity utilisation of Sunon Asogli Power Plant to 12.53%, Tema Thermal Power Plant 1 (TT1PP) to 18.49%, Tema Thermal Power Plant 2 (TT2PP) to 6.49%, Kpone Thermal Power Plant (KTPP) to 11.36% and Mine Reserve Plant to 0.5%.

Akosombo GS utilized 48.88% of its capacity in 2016 primarily in order to reduce the draughting of the dam as the dam level dropped below the minimum operating capacity in the first week of March 2017. The Kpong Power Plant on the other hand had one of its units unavailable because it was undergoing retrofitting and had a capacity utilization of 62.18%. Bui GS had a capacity utilization of 31.68%, higher than its design capacity utilization of 25% in order to make up for short fall in generation from the thermal power plants. This capacity utilization of 31.68% also suggests that the power plant served as base load plant for some period in the year.

TICO had the highest thermal efficiency with a heat rate of 7,890.76 Btu/kWh representing 43.2% efficiency in 2016, followed by Karpowership with 8,232.13 Btu/kWh (41.45%), TAPCO with 8,912.32 Btu/kWh (38.28%) and SAPP with 9,294.04 Btu/kWh (36.71%). The least efficient power plants were TT2PP and MRP with 12,533.04 Btu/kWh (27.22%) and 12,833.32 Btu/kWh (26.59%) respectively.

Figure 1.1 shows the ranking of the thermal power plants based on their thermal efficiency levels with their corresponding energy cost of electricity generation. The chart indicates the effect of fuel prices on the cost of generation of the power plants.

Figure 1.1: Fuel efficiency ranking of thermal power plants with their respective fuel cost of generation

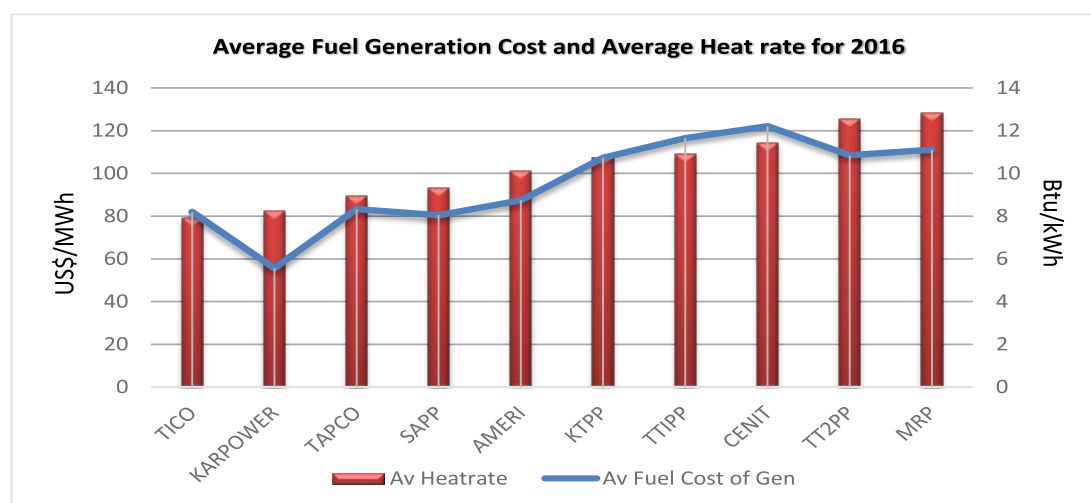


Figure 1.1 show the effect of fuel cost on the average fuel generation cost of thermal power plants in 2016. The most fuel efficient plant in 2016, which was TICO had the third lowest fuel cost of generation of US\$81.97/MWh due to relatively high average cost of LCO (US\$10.71/MMBtu) than natural gas (US\$8.66/MMBtu) and HFO (US\$6.76/MMBtu). Similarly, TT2PP and MRP were the least efficient power plants in 2016 but had a lower fuel cost of generation than TT1PP and CENIT due the relative low cost of natural gas compared with LCO. Karpowership had the least average fuel cost of generation of US\$55/MWh due to lower

average HFO cost (US\$6.76/MMBtu) and relatively high thermal efficiency. The power plant with the highest fuel cost of generation was TT1PP and CENIT with a cost of US\$116.59/MWh and US\$122.08/MWh respectively due to a relatively high fuel price (LCO) and low thermal efficiency even though they were more efficient than TT2PP and MRP.

1.5 Electricity Imports

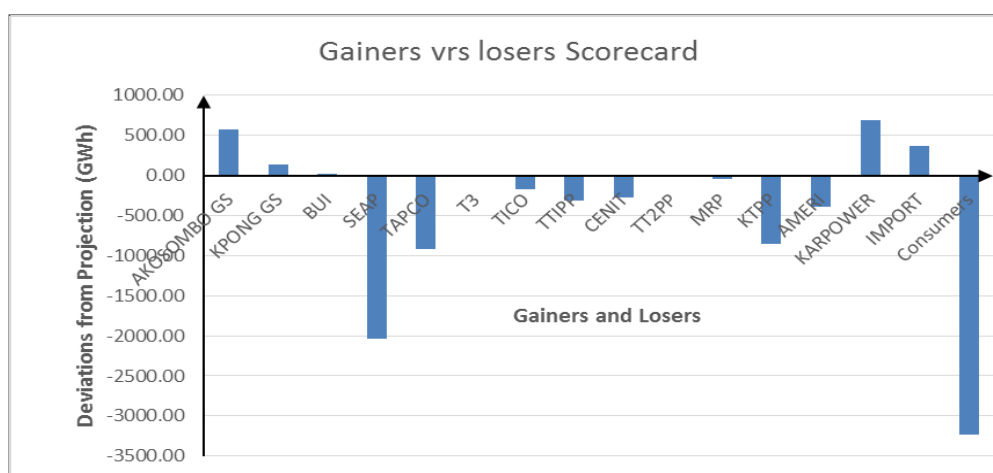
It was projected under the 2016 ESP that, demand for electricity in 2016 will be largely met from domestic electricity generation sources with imports accounting for only 0.6% of the total supply for 2016. It was projected that, import will be required only in January 2016 and February 2016 and that for the rest of the year, no imports will be required.

The 2016 outturn of imports was 442.86 GWh accounting for 3.3% of total supply, higher than the contribution by each of TT1PP (1.3%), Asogli (2.8%), CENIT (3.1%), TT2PP (0.2%) and KTRP (1.5%) as well as MRP which contributed 0.0%.

2 Annual Sector Review – “Gainers” and “Losers” Scorecard

The difficulty to generate adequate electricity to meet projected demand in the year resulted in “gainers” and “losers” among the power producers as well as consumers. When demand and supply are in balance there is stability leading to a “win, win” situation. When demand and supply are not in balance there is market distortion which leads to “gainers” and “losers”. Based on the assumption that, the projections under the 2016 ESP were optimal, any deviations would result in suboptimal states that depart from a “win win” situation into a state of “gainers” and “Losers”. In this submission, “Gainers” represent those power plants that were able to generate more electricity than had been projected under the 2016 ESP while “Losers” were those that were not able to generate the amount of electricity projected. Figure 2.1 shows the “score card” for “gainers” and “losers” in respect of ability to meet projections.

Figure 2: 2016 Gainers and Losers Scorecard



The biggest “losers” were consumers in general who lost about 3,239 GWh of projected electricity which was not supplied. All the hydro power plants emerged as “gainers” with Akosombo being the biggest “gainer” by producing 568.31 GWh over what it was projected to produce in the year. Bui power gained 20.7 GWh and Kpong GS recorded 137.56 GWh above projections.

On the thermal power supply front, Karpowership was the only “gainer” among the thermal power plants with 688.95 GWh above projections. The rest of the thermal power plants were losers with Sunon Asogli Power being the biggest “loser” being unable to generate as much as 2,039.81 GWh of its projected electricity generation for the year.

Acronyms

<i>Btu</i>	= British Thermal Units	<i>CBGC</i>	= Composite Bulk Generation Charge (gazetted by the PURC)
<i>DFO</i>	= Distillate Fuel Oil	<i>EC</i>	= Energy Commission
<i>ECG</i>	= Electricity Company of Ghana	<i>ESP</i>	= Electricity Supply Plan
<i>HFO</i>	= Heavy Fuel Oil	<i>GoG</i>	= Government of Ghana
<i>GHp</i>	= Ghana Peseva	<i>GWh</i>	= Giga-watt Hours
<i>KTRP</i>	= Kpone Thermal Power Plant	<i>kWh</i>	= Kilo-watt hours
<i>LCO</i>	= Light Crude Oil	<i>MMscf</i>	= Million Standard Cubic Feet
<i>MoP</i>	= Ministry of Power	<i>MW</i>	= Megawatt
<i>MWh</i>	= Mega-watt hours	<i>PURC</i>	= Public Utilities Regulatory Commission
<i>SAPP</i>	= Sunon Asogli Power Plant	<i>VRA</i>	= Volta River Authority
<i>WAGPP</i>	= West African Gas Pipeline Project	<i>WEM</i>	= Wholesale Electricity Market

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