# GHANA WHOLESALE ELECTRICITY MARKET BULLETIN

# MARKET WATCH

Monthly Market Data Analysis

**ISSUE NO. 5: 1st May 2016 to 31st May 2016**

This Bulletin covers major developments in the Ghana Wholesale Electricity Market (WEM) from 1st May 2016 to 31st May 2016. It analyses the performance of the key WEM indicators against their benchmarks, and examines the likely implications of any discernable trends for the future of the market. This edition of the monthly WEM Bulletin is also dedicated to developments in solar PV as well as Demand Side Management (DSM) programme.

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, we regrets any errors, omissions or inaccuracies therein.

## HIGHLIGHTS OF THE MONTH

### Electricity demand grows but still lower than projected for May 2016

The Ghana peak load of 2,011 MW recorded in May 2016 was lower than the projected peak load of 2,200 MW and represented a drop of 8 MW compared to the peak load of 2,019 MW recorded in April 2016.

According to the Electricity Supply Plan (ESP) developed for the year 2016 electricity supply projected for May 2016 was 1,430 GWh but the outturn which was 1,099.8 GWh was 23% lower than projected. The total electricity supply of 1,099 GWh in May 2016 was made up of 1,081 GWh produced from domestic sources and 18 GWh from imports from La Cote D'Ivoire. The imports of 18 GWh in May 2016 was significant because the country had not imported any significant amount of electricity since the beginning of the year except for inadvertent transfers on the tie-line. Table 1 shows a comparison of the projected and actual electricity demand and supply for May 2016.

**Table 1 Projected and Actual Outturn of electricity supply and demand in May 2016**

| | May 2016 | |
|---|---|---|
| | Projected | Actual Outturn |
| Total Demand (GWh) | 1,430.0 | 1,099.8 |
| Supply by Power Plant (GWh) | | |
| Akosombo | 276.0 | 368.7 |
| Kpong | 53.0 | 74.5 |
| Bui | 71.0 | 42.7 |
| TAPCO | 150.0 | 102.5 |
| TICO | 202.0 | 116.4 |
| Sunon Asogli - Phase I | 115.0 | 36.3 |
| Sunon Asogli - Phase II | 114.0 | - |
| CENIT | 58.0 | 52.8 |
| TT1PP | 57.0 | - |
| TT2PP | - | 2.2 |
| MRP | - | - |
| KTPP | 37.0 | 36.7 |
| Ameri Energy | 154.0 | 92.2 |
| Karpowership | 143.0 | 156.2 |
| Trojan | - | - |
| Total Electricity Generation | | 1,081.2 |
| Imports | - | 18.6 |
| Total Supply | 1,430.0 | 1,099.8 |
| Deficit/Over supply | | (330.24) |
| % Reduction in Supply | | 23.1% |
| Peak Load (MW) | 2,200.0 | 2,011.1 |

# HIGHLIGHTS OF THE MONTH

### Akosombo dam water level drops further in May 2016

The Akosombo hydro power plant continued to operate below the minimum operating design level of 240 feet reaching 236.46 feet at the end of May 2016. The power plant generated 368.7 Gwh of electricity in May 2016 representing 33.6 % higher than what was projected under the 2016 Electricity Supply Plan (ESP). The 368.7 GWh produced in May 2016 was lower than the 397.7 GWh it generated in April 2016 but higher than electricity generation in January 2016 (258.1 GWh), February 2016 (274.5 GWh), and March 2016 (361 GWh).

### Water level of Bui dam stabilizes in May 2016

The level of the Bui dam remained stable for the second half of May 2016 at 552.06 feet compared to the minimum design operating level of 551 feet. Electricity production from the Bui power plant was also stable during the same period at an average of 0.47 GWh per day representing output from one turbine unit. In the previous month all three (3) units of the Bui hydro power plant were operated at peak to make up for shortages in the power system. The Bui hydro power plant generated 43GWh in May 2016 which was lower than the 71 GWh projected to be generated in the month under the 2016 Electricity Supply Plan (ESP). At the current operational regime of one turbine unit at peak period, the level of the Bui dam could be salvaged from the consistent higher drops experienced since the beginning of the year.

### Ameri Energy Power Plant resumes production in May 2016

The 250MW capacity Ameri Energy Power Plant which was shutdown throughout the month of April 2016, owing to curtailment in natural gas supplies, resumed operation on 5th May 2016. The power plant generated a total of 92.15 Gwh of electricity in May 2016 compared to 154 GWh projected under the ESP. Even though the power plant was technically available, generation was constrained by inadequate natural gas supplies from the Atuabo Gas Processing Plant.

### KTPP enters commercial operations in May 2016

The Volta River Authority (VRA) completed the commissioning of the first unit (110MW) of the Kpone Thermal Power Plant (KTPP) on 20th April 2016 on Distillate Fuel Oil (DFO). In May 2016, the power plant began commercial operation, mainly as a peaking plant, and contributing a total of 36.65 GWh of electricity into the power system. The power plant contributed about 100 MW of capacity to meet daily peak load throughout the month.

### Karpowership increases production of electricity in May 2016 as HFO price also increases

The Karpowership power plant generated 156.2 GWh in May 2016 up from 149.9 GWh recorded in April 2016. The power plant also contributed its full capacity of 220 MW to meet the system peak demand consistently in the month of May 2016. The cost of electricity generated from the power plant however increased as a result of an increase in the cost of Heavy Fuel Oil (HFO) from US$ 174.85 per metric tonne in April 2016 to US$210.31 per metric tonne in May 2016. The increase in the price of HFO resulted in the elevated cost of production from US cents 3.22/kWh in April 2016 to US cents 3.87/kWh in May 2016.

### TAPCO and TICO operates at half capacity in May 2016

Owing to technical challenges, TAPCO and TICO operated below their rated capacities. TAPCO generated 102.5 GWh as against the projected 150 Gwh representing more than half and almost two-thirds of projected production while TICO generated 116.4 GWh which was lower than the projected amount of 202 GWh. TAPCO and TICO contributed 146 MW and 162 MW respectively to meeting the system peak load of 2,011 MW in May 2016.

### TT1PP undergoing mandatory maintenance

The Tema Thermal 1 Power Plant, operated by VRA, continues to be off-line owing to maintenance requirements. The operation of the power plant was stopped as a result of VRA not being able to carry out the requisite mandatory maintenance works on the plant. The maintenance work has now started and is expected to be completed by the end of June 2016, when it will add 110 MW of capacity to the power system.

### Natural Gas supplies improves at Aboadze but supply from WAGPP still low.

Following the resumption of operation of the Floating Production Storage and Off-Loading (FPSO) facility, natural gas supplies from the Atuabo Gas Processing Plant to the Aboadze Power Enclave resumed on 5th May 2016 with 22 mmscf per day, rising to 57 mmscf per day from 11th May 2016 and continuing at the same rate till the end of the month. The gas supply in May 2016 was however lower than the average daily supply of 86 mmscf per day recorded from January 2016 to March 2016 before the curtailment in April 2016.

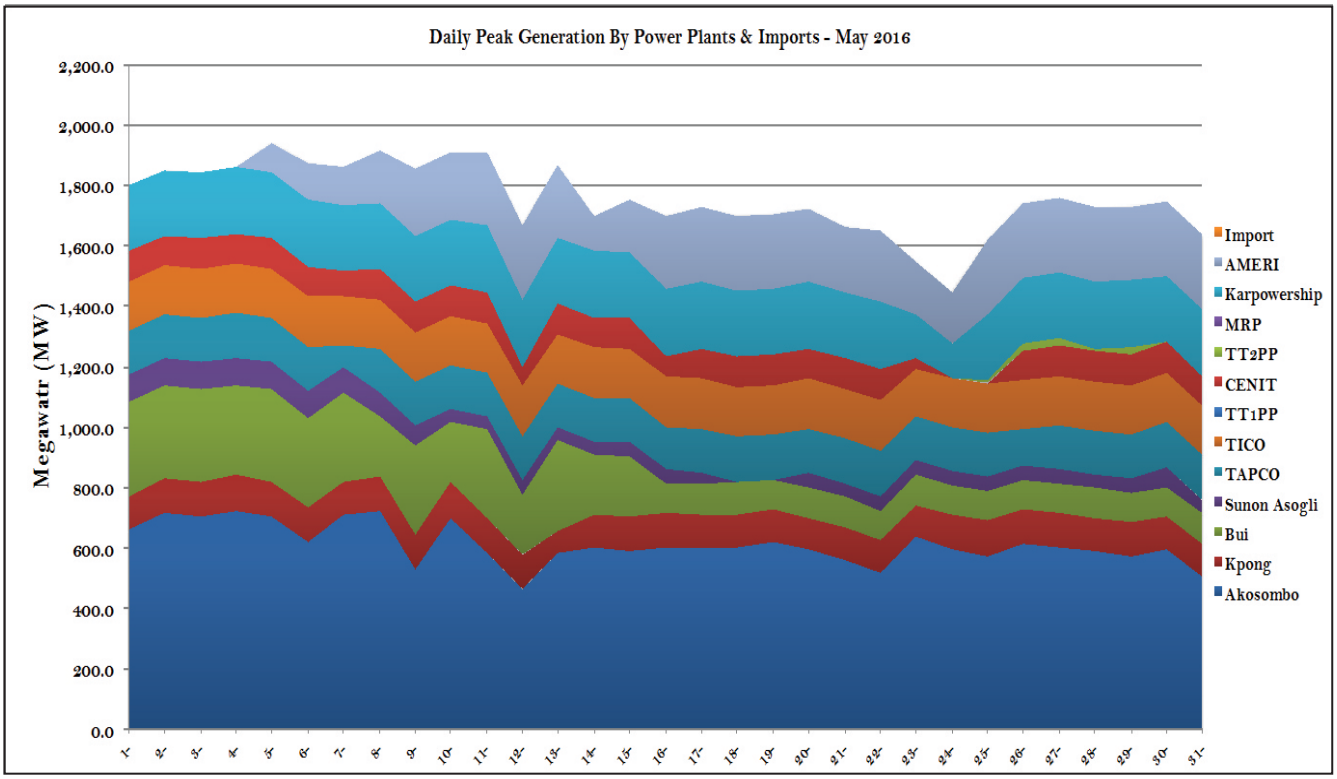
### Spot Market Price of electricity rises in May 2016

By the EC's estimation, the Spot Market Price (SMP) of electricity in the proposed Wholesale Electricity Market (WEM) rose to US cents 15.2/kWh in May 2016 from US cents 12.6/kWh in April 2016. Similarly, the System Marginal Cost increased from US cents 10.4./kWh in April 2016 to US cents 12.15/kWh in May 2016 whilst the System Marginal Capacity Charge increased marginally from US cents 2.88/kWh in April 2016 to US cents 3.06/kWh in May 2016.

On the other hand, all the other Market indicators - Average Market Energy Cost (AMEC), Average Market Capacity Charge (AMCC) and the Total Market Cost (TMC) - recorded marginal reductions in May 2016 compared to values for April 2016 as shown in the Table "Month at a Glance".

# OPERATIONAL FACT SHEET

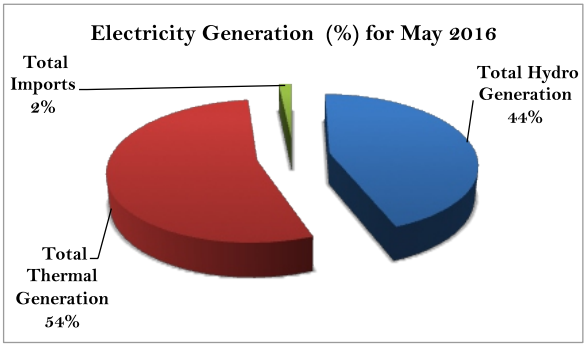
| Peak Generation (MW) - May 2016 | | | | | | |
|---|---|---|---|---|---|---|
| Source of Supply | Week 1 | Week 2 | Week 3 | Week 4 | Maximum Non-Coincident Peak Generation | Generation at System Coincident Peak |
| Akosombo | 724.0 | 720.0 | 620.0 | 636.0 | 724.0 | 702.0 |
| Kpong | 119.0 | 117.0 | 118.0 | 116.0 | 119.0 | 119.0 |
| Bui | 312.0 | 300.0 | 199.0 | 100.0 | 312.0 | 305.0 |
| Sunon Asogli | 91.9 | 82.3 | 46.2 | 63.2 | 91.9 | 89.9 |
| TAPCO | 148.0 | 147.0 | 150.0 | 151.0 | 151.0 | 146.0 |
| TICO | 164.0 | 168.0 | 165.0 | 169.0 | 169.0 | 162.0 |
| TT1PP | - | - | - | - | - | - |
| CENIT | 102.0 | 102.0 | 101.0 | 103.0 | 103.0 | 100.0 |
| KTPP | 100.0 | 102.0 | 102.0 | 102.0 | 102.0 | 70.0 |
| TT2PP | - | - | - | 24.0 | 24.0 | - |
| MRP | - | - | - | - | - | - |
| AMERI Energy | 125.1 | 248.8 | 247.4 | 246.3 | 248.8 | 97.3 |
| Karpowership | 220.0 | 220.0 | 219.9 | 220.1 | 220.1 | 219.9 |
| Import | - | - | - | - | - | - |
| Trojan Power | - | - | - | - | - | - |
| Total Supply including imports | 2,106.0 | 2,207.1 | 1,968.5 | 1,930.6 | 2,264.8 | 2,011.1 |
| Total Generation without imports | 2,106.0 | 2,207.1 | 1,968.5 | 1,930.6 | 2,264.8 | 2,011.1 |

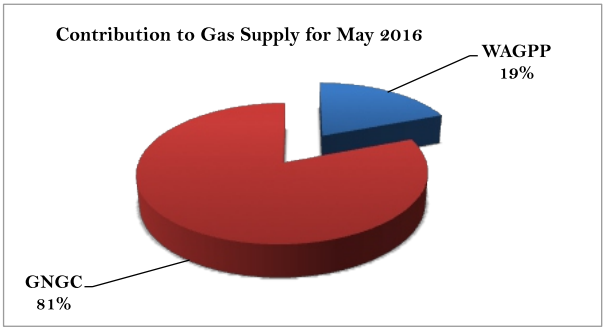



| Ghana Electricity Demand for May 2016 | | |
|---|---|---|
| Maximum Peak Generation | MW | 2,011.10 |
| Minimum Peak Generation | MW | 1,548.50 |
| Average Peak Generation | MW | 1,812.51 |
| Total Energy Generated | GWh | 1,081.17 |
| Load Factor (LF) | % | 72.3% |

# OPERATIONAL FACT SHEET

| Weekly Generation (GWh) - May 2016 | | | | | |
|---|---|---|---|---|---|
| Power Plant | Week 1 | Week 2 | Week 3 | Week 4 | Total |
| Akosombo | 94.63 | 85.07 | 82.61 | 106.41 | 368.72 |
| Kpong | 19.21 | 17.57 | 16.25 | 21.44 | 74.47 |
| Bui | 22.54 | 11.33 | 4.40 | 4.47 | 42.74 |
| Sunon Asogli | 13.59 | 8.17 | 4.33 | 10.20 | 36.29 |
| TAPCO | 23.47 | 23.16 | 23.65 | 32.25 | 102.53 |
| TICO | 26.11 | 26.42 | 26.33 | 37.49 | 116.35 |
| TT1PP | - | - | - | - | - |
| CENIT | 16.17 | 15.23 | 8.53 | 12.91 | 52.84 |
| KTPP | 5.22 | 12.39 | 6.73 | 12.32 | 36.66 |
| TT2PP | - | - | - | 2.23 | 2.23 |
| MRP | - | - | - | - | - |
| AMERI Energy | 6.85 | 34.04 | 38.94 | 12.32 | 92.15 |
| Karpowership | 36.01 | 36.57 | 36.67 | 46.94 | 156.19 |
| Import | 5.31 | 1.84 | 3.45 | 7.99 | 18.59 |
| Trojan Power | - | - | - | - | - |
| Total Supply including imports | 269.11 | 271.79 | 251.89 | 306.97 | 1,099.76 |
| Total Generation without imports | 263.80 | 269.95 | 248.44 | 298.98 | 1,081.17 |



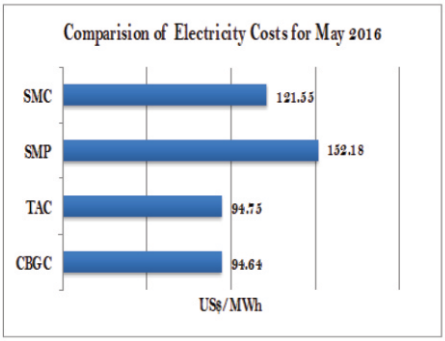

*GNGC= Ghana National Gas Company*
*WAGPP = West African Gas Pipeline Project*

| Average Gas Flow (mmscfd) -May 2016 | | | | | |
|---|---|---|---|---|---|
| Location | Week 1 | Week 2 | Week 3 | Week 4 | Monthly Average |
| Etoki | 16.85 | 10.01 | 10.17 | 15.16 | 12.86 |
| Tema | 17.82 | 11.39 | 6.69 | 11.98 | 11.69 |
| Aboadze | 25.70 | 45.05 | 51.52 | 54.07 | 49.14 |

| Water Level (ft) - May 2016 | | | | | Change in water level |
|---|---|---|---|---|---|
| Hydro Dam | Week 1 | Week 2 | Week 3 | Week 4 | (feet) |
| Akosombo | 237.55 | 237.22 | 236.91 | 236.43 | (1.12) |
| Bui | 554.39 | 552.91 | 552.16 | 552.22 | (2.17) |
| Akosombo Minimum Design Operating Level | 240.00 | 240.00 | 240.00 | 240.00 | |
| Akosombo Maximum Level | 278.00 | 278.00 | 278.00 | 278.00 | |

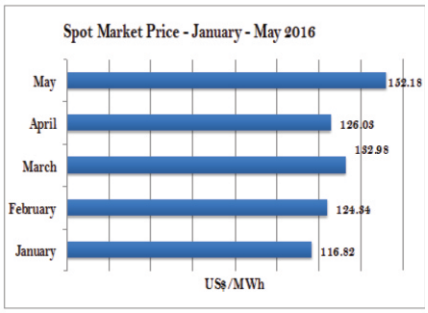
# ECONOMIC FACT SHEET

| Month at a Glance | | | | |
|---|---|---|---|---|
| | Units | Current Month | Previous Month | Change |
| Average Market Energy Cost | US$/MWh | 73.12 | 75.88 | (2.76) |
| Average Market Capacity Charge (AMCC) | US$/MWh | 21.63 | 19.71 | 1.92 |
| Total Average Market Cost (TAC) | US$/MWh | 94.75 | 95.59 | (0.84) |
| | | | | |
| System Marginal Cost (SMC) | US$/MWh | 121.55 | 96.04 | 25.51 |
| System Marginal Capacity Charge (SMCC) | US$/MWh | 30.63 | 28.89 | 1.74 |
| Spot Market Price (SMP) | US$/MWh | 152.18 | 126.03 | 26.15 |
| | | | | |
| Composite Bulk Generation Charge (CBGC) | US$/MWh | 94.64 | 94.64 | (0.00) |
| Deviation of TAC from CBGC | US$/MWh | (0.11) | 1.95 | (2.06) |
| Deviation of SMP from CBGC | US$/MWh | (57.55) | (31.39) | (26.16) |




*CBGC = Composite Bulk Generation Charge; SMC = System Marginal Cost; SMP = Spot Market Price*

| Power Plant | Maximum Non-Coincident Peak Generation (MW) | Plant Utilisation Factor (%) | Electricity Generation (GWh) | Gas Consumption (MMBTU) | LCO Consumption (MMBTU) | HFO Consumption (MMBTU) |
|---|---|---|---|---|---|---|
| Akosombo | 724.00 | 68.45 | 368.72 | - | - | - |
| Kpong | 119.00 | 84.11 | 74.47 | - | - | - |
| Sunon Asogli | 91.90 | 53.08 | 36.29 | 357,842.63 | - | - |
| Bui | 312.00 | 18.41 | 42.74 | - | - | - |
| Trojan Power | - | - | - | - | - | - |
| TAPCO | 151.00 | 91.26 | 102.53 | - | 814,088.20 | - |
| TT1PP | - | - | - | - | - | - |
| TICO | 169.00 | 92.54 | 116.35 | 679,945.92 | 209,482.35 | - |
| MRP | - | - | - | - | - | - |
| CENIT | 103.00 | 68.95 | 52.84 | - | 581,608.29 | - |
| KTPP | 102.00 | 48.31 | 36.66 | - | - | - |
| TT2PP | 24.00 | 12.49 | 2.23 | - | 25,730.99 | - |
| AMERI Energy | 248.80 | 49.78 | 92.15 | 934,794.48 | - | - |
| Imports | - | - | 18.59 | - | - | - |
| Karpowership | 220.10 | 92.00 | 156.19 | - | - | 1,293,620.25 |
| Total | 2,264.80 | | 1,099.76 | 1,972,583.03 | 1,630,909.83 | 1,293,620.25 |



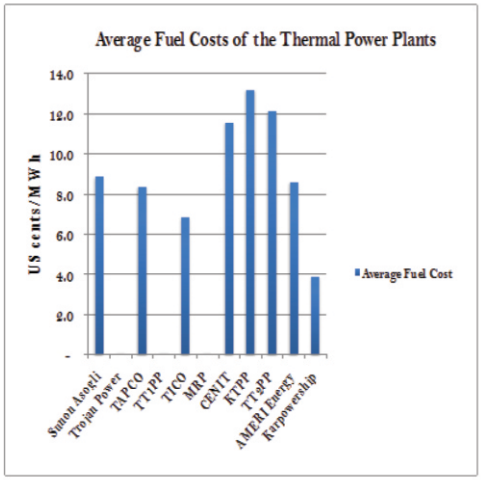

*Spot Market Price = SRMC of Energy + SRMC of Capacity*

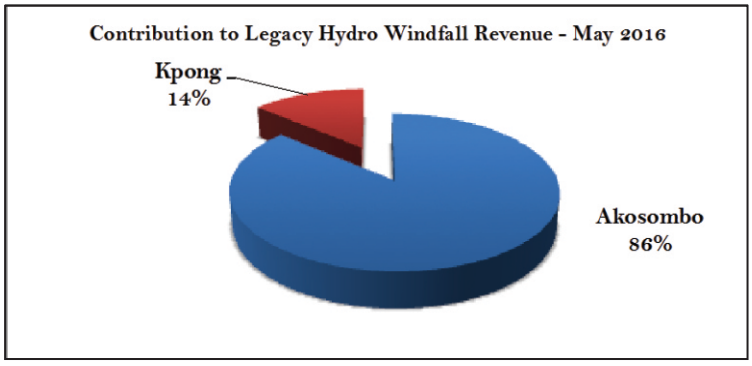
| | | May 2016 | April 2016 | Change |
|---|---|---|---|---|
| Total Thermal Power Plants Fuel Cost | US$ | 44,880,399.77 | 36,998,066.90 | 7,882,332.87 |
| Average Thermal Power Plants Fuel Cost | US$/MWh | 73.12 | 75.93 | (2.81) |

| Legacy Hydro Windfall Revenue for May 2016 | | | | |
|---|---|---|---|---|
| Power Plant | Average Cost (US$/MWh) | Average SMP (US$/MWh) | Difference (US$/MWh) | Windfall Revenue (US$) |
| Akosombo | 33.10 | 152.18 | 119.08 | 43,908,961.64 |
| Kpong | 59.20 | 152.18 | 92.98 | 6,924,580.92 |
| Total | | | | 50,833,542.56 |

*SMP=Spot Market Price*

| Average Fuel Prices | | |
|---|---|---|
| Fuel Type | Unit | Delivered Cost |
| Natural Gas | US$/MMBTU | 8.56 |
| LCO | US$/BBL | 57.08 |
| HFO | US$/Tonne | 210.31 |
| DFO | US$/Tonne | 457.60 |



## 1. Implementation of National Rooftop Solar Programme (NRSP) gathers steam

Globally, renewable energy technologies are gradually changing the energy supply landscape. According to the International Renewable Energy Agency (IRENA), global renewable energy generation capacity increased by 152 GW in 2015. Of this figure, solar PV alone increased by 46.73 GW which is equivalent to about 1,386% of Ghana's total installed capacity. It is also reported that over 60% of all new electricity capacity development in 2015 came from renewable energy sources particularly wind and solar energy.

Ghana is well endowed with solar energy that if properly harnessed, it is capable of meeting all the country's electricity requirements several times over. The promotion of renewable energy in Ghana was given the needed impetus by the passage of the Renewable Energy Act, (Act 832) in 2011. Since then Ghana has seen increased development of grid-connected utility-scale solar PV systems reaching 23.22 MW consisting of a 20 MW project which is currently the largest single solar PV project in West Africa.

Solar PV development in Ghana is gathering further steam with the launch of the National Rooftop Solar Programme (NRSP),born out of the search to secure diversified sources of electricity to ameliorate continuing and persistent electricity shortages in the country. The objective of the NRSP is to deploy about 200,000 solar PV systems on rooftops in Ghana. The programme, will, in the very short-term, reduce Ghana's peak load requirements to assist in mitigating load shedding; and in the medium to long term, increase the mix of renewable energy in the total energy mix of the country.

As part of the preparatory activities, the Energy Commission has implemented some pilot projects to ascertain the technical feasibility and viability of the initiative. A number of rooftop solar systems of different capacities have been installed under different scenarios including the use of Net Meters, in 35 residential homes and commercial facilities, which will enable the beneficiaries to sell electricity generated from solar systems back to the distribution companies who will credit the beneficiary with the supply.

The Energy Commission intends to install 20,000 rooftop solar PV systems in residential homes and micro businesses to kick-start the implementation of the programme in 2016, in the Capital Subsidy Scheme (CSS). Under this scheme, beneficiaries will be assisted in two forms, either:

- cash payment for the solar panel component of the fully installed solar PV system; or
- supply of the requisite solar panels after the beneficiary has purchased and installed the requisite Balance of System (BoS) components such as inverter, batteries, charge controllers, etc.

The maximum capacity of solar panels that will be granted each beneficiary under the programme shall be up to a maximum of 500Watts.

To assist with financial intermediation for the programme, a number of commercial banks have expressed interest in providing loan facilities to interested beneficiaries to enable them acquire BOS components for the solar PV systems of their choice.

The programme is open to everybody living in Ghana particularly residential facilities (Homes); and small or microbusinesses including fashion designers, barbering and hairdressing salons, etc. To qualify for the capital subsidy, prospective beneficiaries will have to satisfy the following conditions:

- Change all lamps in their facility to Light Emitting Diode (LED) lamps;
- Be willing to purchase BoS Components;
- Install only deep cycle batteries designed for solar PV systems;
- Ensure that BoS meet the minimum Standards set by Ghana Standards Authority (GSA); and
- Use only solar PV installers licensed by the Energy Commission for all the installation works.

Interested person can apply to the EC either by picking an application form at its offices or directly from EC's website.

## 2. Energy Commission (EC) to fully implement Net Metering scheme for rooftop solar PV projects

The growth in solar PV solutions in Ghana is being propelled by innovative policy mechanisms to encourage people to take up the technology. One such policy is the deployment of Net Metering mechanism which allows grid-connected consumers who generate electricity within their premises to inject any excess production into the utility grid. The excess electricity injected into the utility grid is then credited to the consumer, either as a roll over credit to be redeemed in kind or, paid for by the utility company at an agreed rate. Net metering is technologically matured and tested in the Ghanaian environment as a popular mechanism for promoting the development of rooftop solar PV and wind systems in homes and businesses. Therefore the Energy Commission (EC) is promoting net metering under the NRSP.

A number of net metering systems have already been deployed under a pilot project by the EC in cooperation with ECG, the dominant distribution utility in Ghana. The EC has prepared a Net Metering Sub-Code which defines the conditions under which a consumer can participate in the programme in Ghana.

The Ghana Net Metering Sub-Code provides for excess generation by the consumer to be credited at the end of the month. The credit can only be carried up to the end of the year after which it expires, if not redeemed. The Net Metering Code does not place any limit on how much solar PV capacity per project can qualify for net metering.

To enhance net metering market, it is important to provide adequate financial incentives for excess generation into the grid systems rather than allowing only credit swaps between the customer and the utility. In order to create a competitive power market, it is being proposed that direct payment policy mechanism be put in place which will compel the utility to pay for excess electricity injected into the grid. It is further proposed that the new direct payment policy will come into effect in 2018.

The EC has also developed the RE Net Metering Sub-Codewhich provides the technical conditions under which the Net Metering and other aspects of RE injection can be done. The EC is working with the electricity utility companies, the PURC and other key stakeholders to formally role out the Net Metering Programme as well as the implementation of the RE Distribution Sub-Code.

## 3. Energy Commission discusses partnership with GREDA and Commercial Banks in the implementation of the National Rooftop Solar Programme

The Energy Commission (EC) recognizes that the objectives of the NRSP can be enhanced with the active participation of some key stakeholders including Ghana Real Estates Developers Association (GREDA) and the financial institutions in the implementation of the programme. The Ghana Real Estates Developers Association (GREDA) is a well-organized and active association which is committed to providing affordable housing infrastructure for people residing in Ghana. The banks, on the other hand, could provide financial support to both GREDA and individuals who intend to acquire solar PV systems under the programme.

The EC met with the members of GREDA in Accra on 28th April 2016. About 80 Chief Executive Officers (CEOs) of Real Estate companies participated in the meeting. Staff of the EC did a presentation on the NRSP which covered the purpose, objectives, business model, and the potential role of GREDA in the programme. The EC informed GREDA that the programme would provide free solar panels for new homes which they were going to sell if the estate developer and the new occupant of the home install the requisite balance of systems (BoS) as well as replacing all existing lamps to LED lamps. Members of GREDA expressed their interest to partnerthe EC in the implementation of the programme. The integration of solar PV in real estate development can also take advantage of the net metering programme being promoted by the EC. Under the net metering programme, customers who generate more electricity than their requirement can inject the excess into the distribution grid and be compensated for it by the utility company by netting it out of the customer's bills at the end of the month.

The EC also met with representatives of 11 commercial banks on 18th May 2016 to discuss the concept and progress of the NRSP and the participation of the banks. At the end of the meeting, the banks expressed their interest in participating in the programme.

## 4. Current regulated electricity tariffs boostsprospects for the National Rooftop Solar Project (NRSP)

At the current electricity tariffs, deployment of rooftop solar PV systems can provide cheaper electricity than from the utility grid. The deployment of rooftop solar PV system can also create the opportunity for electricity consumers,

particularly households, small and medium scale businesses including hotels, restaurants and other commercial entities to become not only self-sufficient in providing for their electricity supply needs, but it will also create business and job opportunities for Ghanaians in general. Utility companies need to be aware of the changing energy landscape and make the necessary adjustments to their operations and business processes as well as strategic investment plans if they are to become relevant in the unfolding dispensation. Similarly, regulators must rethink and change their perspectives regarding the regulatory regime particularly on issues of capacity limitations as well as tariffs and the investment climate.

The electricity tariffs announced by the PURC in December 2015 has boosted the prospects of the use of solar PV systems in residential and non-residential facilities. The new rates for most of the tariff bands within the residential and non-residential customer categories are higher than the Levelised Cost of Electricity (LCOE) produced by solar PV rooftop systems. In that regard, using electricity from solar PV systems to reduce electricity consumption in the higher tariff bands will enable the customer to save the difference between the PURC approved rates and the LCOE of the solar PV system.

Table 3.1 shows the various tariff regimes in Ghana currently and also the potential savings per kWh for residential customers who deploy solar PV systems with batteries in their homes with the view to reducing their grid electricity consumption.

**Table 3.1 Potential savings for residential customers with solar PV with batteries**

| Tariff Category | Tariff Band (kWh) | PURC Approved Rates (GHp/kWh) | PURC Approved Rates (US cents/kWh) | Solar PV with batteries (US cents/kWh) | Savings (US cents/kWh) |
|---|---|---|---|---|---|
| 1st Tier | 0-50 | 33.56 | 8.67 | 22.41 | -13.74 |
| 2nd Tier | 51-300 | 67.33 | 17.40 | 22.41 | -5.01 |
| 3rd Tier | 300-600 | 87.38 | 22.58 | 22.41 | 0.17 |
| 4th Tier | 600+ | 97.09 | 25.09 | 22.41 | 2.68 |

Besides the gazetted PURC tariffs for electricity services for end-users, there is also the Feed-in-Tariffs (FITs) for electricity produced from utility-scale solar PV systems.

For residential customers, the four electricity consumption bands, installation of solar PV systems with energy storage will result in negative savings to the customer and would therefore require some level of subsidy. To make it attractive for residential customers to install solar PV systems, some level of subsidy is required in the case of installation of solar PV systems with batteries.

The situation is different in the case of installing solar PV systems without energy storage (Table 3.2) where the savings are positive except for the 1st Tier category. Table 3.2 shows the potential savings in electricity consumption for residential customers who deploy solar PV systems without energy storage in their homes.

**Table 3.2 Potential savings for residential customer tariff categories without batteries**

| Tariff Category | Tariff Band (kWh) | PURC Approved Rates (GHp/kWh) | PURC Approved Rates (US cents/kWh) | Solar PV without batteries (US cents/kWh) | Savings (US cents/kWh) |
|---|---|---|---|---|---|
| 1st Tier | 0-50 | 33.56 | 8.67 | 16.30 | -7.63 |
| 2nd Tier | 51-300 | 67.33 | 17.40 | 16.30 | 1.10 |
| 3rd Tier | 300-600 | 87.38 | 22.58 | 16.30 | 6.28 |
| 4th Tier | 600+ | 97.09 | 25.09 | 16.30 | 8.79 |

In the scenario where batteries are not included in the solar PV system configuration, the savings range from US cents 5.37/kWh for the 2nd Tier category to US cents 13.06/kWh for the 4th Tier category. The prospects for deploying solar PV systems by customers classified as non-residential and who are mainly commercial enterprises are generally better than for residential customers.

Unlike the residential customer tariffs structure, it is observed that the PURC gazette rates for all consumption bands for non-residential customers are higher than the LCOE of the two configurations, with and without energy storage except for the 1st Tier. Table 3.3 shows the potential savings in electricity consumption for non-residential customers who deploy solar PV systems without batteries.

**Table 3.3 Potential savings for non-residential customer tariff categories with batteries**

| Tariff Category | Tariff Band (kWh) | PURC Approved Rates (GHp/kWh) | PURC Approved Rates (US cents/kWh) | Solar PV with batteries (US cents/kWh) | Savings (US cents/kWh) |
|---|---|---|---|---|---|
| 1st Tier | 0-300 | 96.7909 | 25.01 | 22.41 | -0.57 |
| 2nd Tier | 301-600 | 102.9959 | 26.61 | 22.41 | 1.03 |
| 3rd Tier | 600+ | 162.5141 | 41.99 | 22.411 | 16.41 |

Table 3.4 shows the potential savings in electricity consumption for non-residential customers who deploy solar PV systems with batteries.

**Table 3.4 Potential savings for non-residential customer tariff categories without batteries**

| Tariff Category | Tariff Band (kWh) | PURC Approved Rates (GHp/kWh) | PURC Approved Rates (US cents/kWh) | Solar PV without batteries (US cents/kWh) | Savings (US cents/kWh) |
|---|---|---|---|---|---|
| 1st Tier | 0-300 | 96.7909 | 25.01 | 16.300 | 8.71 |
| 2nd Tier | 301-600 | 102.9959 | 26.61 | 16.300 | 10.31 |
| 3rd Tier | 600+ | 162.5141 | 41.99 | 16.300 | 25.69 |

Generally, except for the 1st Tier consumption band in Table 3.3where there is a deficit of US cents 0.57/kWh, the savings are positive for all Tiers of tariff categories for non-residential customers shown in Table 3.3 and Table 3.4. The savings range from US cents1.03/kWh to as much as US cents 25.89/kWh for the 2nd Tier in Table 3.3 and 3rd Tier in Table 3.5 respectively.

In conclusion, under the current electricity tariff structure and rate, the prospects of scaling-up solar PV systems for residential and non-residential (commercial) facilities are good. The analyses above show that, except in the case of residential customers who deploy solar PV systems with energy storage, very little or no subsidy would be required from the point of view of the potential savings for all residential customers and non-residential customers.

## 5. Tendering for 20 MW utility-scale solar PV project progresses

With the commitment of securing cheaper solar PV projects the government of Ghana is proceeding with a tender for the competitive procurement of a 20 MW utility scale solar PV facility. The process has reached the stage of "Request For Proposals (RFP)" after shortlisting of 18 companies out of the 34 companies that expressed interest in developing the project. The shortlisted companies are to submit their proposals by the end of June 2016. When successfully completed, the project for which the tendering is being done will be the second of such large utility scale solar PV project in Ghana. There is an existing wholly privately owned 20 MW utility-scale solar PV power plant already installed and operating at Gomoa Onyeadze near Winneba, in the Central Region and a few kilometers from Accra, the nation's capital city. While the existing solar PV power plant provides valuable lessons for Ghana, it was not procured through competitive bidding but rather through a negotiated Power Purchase Agreement (PPA) between the distribution utility and the private investor to operate as an Independent Power Producer (IPP). It is expected that, with competitive tendering for the procurement of the project, lower prices could be achieved.

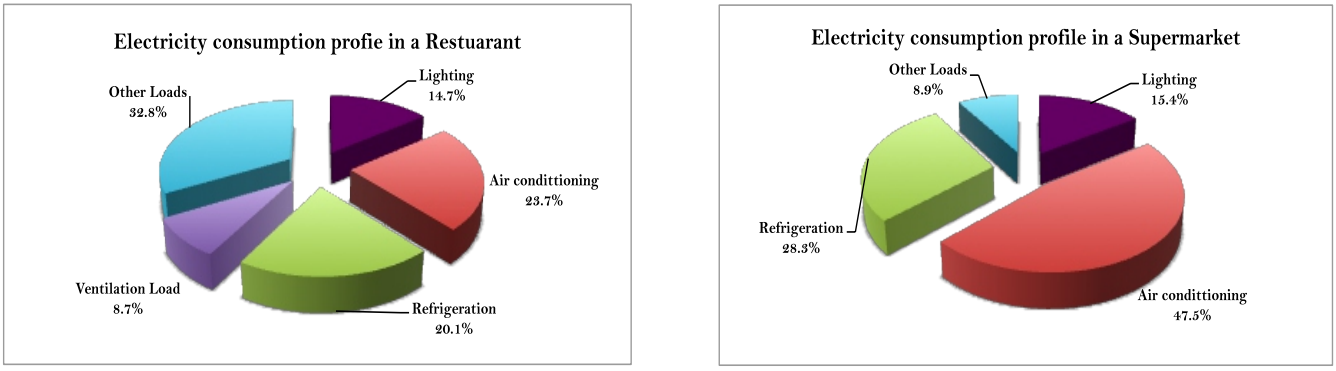
Experiences from similar tendering processes in other countries have shown that, to achieve lower bid prices would require the government granting some concessions such as lands free of charge, waivers on import duty and other taxes including corporate tax as well as provision of adequate government guarantees against virtually all perceived financial and other risks associated with the development and operation of such projects which also enable investors to seek lower return on investment. The level of solar insolation is also results in lower bid prices.

## 6. Energy Audits reveal Commercial Facilities can save substantial amount of electricity

Recent energy audit of some commercial facilities has revealed that the facilities pay electricity tariffs in the range of US 38.45 cents/kWh to about US cents 42.44/kWh on the average while there are opportunities for significant energy saving opportunities through energy efficiency and conservation measures in these facilities. Between February 2016 and April 2016, the Energy Commission conducted energy audits in a number of commercial facilities in Accra to ascertain the veracity of electricity metering and billing by the Electricity Company of Ghana (ECG). The facilities included (i) a restaurant, (ii) a supermarket and (iii) a hotel. The audit for the restaurant and supermarket involved meter accuracy checks as well as appliance inventory and consumption. The audit of the hotel was basically an audit of the tariffsbilled by the utility company while the audits for the restaurant and supermarket were quite comprehensive. The restaurant consisted of dinning facilities, a take-away shop, a bakery and a swimming pool. Besides lighting, air conditioning and ventilation appliances, the restaurant facility contained other loads comprising of ice maker, coffee machine, water pump, flour mixers, dough rollers, microwave ovens which, together, constituted the largest load in the restaurant.

The energy audits revealed that the metering and billing by ECG were accurate and that recent tariff increases and the removal of subsidies had resulted in steep increases in electricity bills. In the restaurant facility, the use of other loads, comprising mainly equipment used in the bakery, take-away shop and swimming pool, consumed the largest amount of electricity followed by air conditioning and then refrigeration. Even though, lighting accounted for 20% of the electricity consumption in the facility, tackling it could result in substantial savings in electricity consumption and reduction in bills. Figure 3.1 shows the profile of electricity consumption by appliances in the restaurant and the supermarket facilities.

**Figure 3.1 Profile of electricity consumption by type of appliance in the restaurant and supermarket**




Air conditioning constituted the highest use of electricity in the supermarket followed by refrigeration. The audit further revealed that there were too many high energy consuming appliances within the restaurant facility which could be replaced with less energy consuming modern appliances. On the other hand some of them could be done away with without compromising the effectiveness of running of the facility.

The consumption of electricity for purposes of air conditioning can be reduced with either solar air conditioning technology that is reported to reduce consumption substantially or by the installation of an Airco Saver gadget on the existing air conditioning system. The Airco Saver is reported to be capable of reducing electricity consumption of air conditioning systems by about 30%. The Energy Commission is currently testing a solar air conditioning system that is reported to be capable of reducing electricity consumption by amounts ranging between 70% and 90%. Some lamps in the restaurant facility, for example, are rated as much as 50Watts. These high electricity-consuming lamps can be replaced with 5-Watts LED lamps that can provide the same level of luminance representing a potential reduction in electricity consumption of about 90%. Besides retrofitting the facilities with modern and more energy efficient technologies including automation, it is observed that simple energy conservation practices by operators of the facilities could also result in substantial reduction in electricity consumption.

## Acronyms

*BOS = Balance of Systems*
*CSP = Concentrated Solar Power*
*DFO – Distillate Fuel Oil*
*ECG= Electricity Company of Ghana*

*ESP – Electricity Supply Plan*
*HFO = Heavy Fuel Oil*
*GREDA – Ghana Real Estate Development Association*
*GHp = Ghana Pesewa*
*KTPP = Kpone Thermal Power Plant*
*LC = Letter of Credit*
*LCOE = Levelised Cost of Electricity*
*LI = Legislative Instrument*
*MW – Megawatt*
*NITS = National Interconnected Transmission System*
*PPA = Power Purchase Agreement*
*PV = Photovoltaic*
*VRA – Volta River Authority*
*WEM = Wholesale Electricity Market*

*CBGC = Composite Bulk Generation Charge (gazetted by the PURC)*
*CSS = Capital Subsidy Scheme*
*EC = Energy Commission*
*EMOP = Electricity Market Oversight Panel*

*FITs = Feed-in-Tariffs*
*GoG = Government of Ghana*
*GWh = Giga-watt Hours*
*IPP – Independent Power Producer*
*kWh = Kilo-watt hours*
*LCO = Light Crude Oil*
*LED = Light Emitting Diode*
*MoP = Ministry of Power*
*MWh = Mega-watt hours*
*NRSP – National Rooftop Solar Project*
*PURC = Public Utilities Regulatory Commission*
*RE = Renewable Energy*
*WAGPP – West African Gas Pipeline Project*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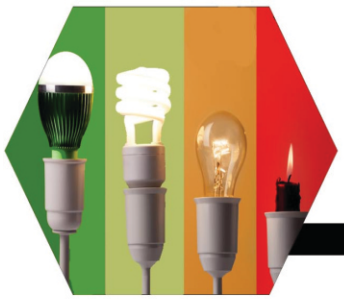

**020 518 1799 / 050 000 4953**

ghanarefair@energycom.gov.gh
ghanarefair@gmail.com

REFairGhana

www.ghanarefair.energycom.gov.gh

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**ORGANISERS**

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For any enquiries please contact the:
EMOP Administrator, EMOP Secretariat, Energy Commission, Accra.
Telephone: +233-302813756/7/9; Or email: marketoversightpanel@energycom.gov.gh