ENERGY COMMISSION, GHANA

2014 ENERGY (SUPPLY AND DEMAND) OUTLOOK FOR GHANA

Final

April, 2014

Executive Summary

Energy Commission presents supply and demand forecasts for electricity, crude oil, petroleum products, natural gas and charcoal for the year 2014. Factors that could also influence the demand and supply are also discussed.

Electricity:

In 2013, the total grid electricity generated[1] in the country was 12,874 Gigawatt-hours (GWh)[2] about 6% more than in 2012[3].

For 2014, the total electricity requirement of the country would be in the range of 15,725-16,500 GWh. The low-side represents relatively low supply due to comparatively high cost of electricity as a result of lower than expected flow of gas for power generation and consequently the use of more expensive oil as fuel. The high-side could arise if VALCO operates at two-to-three potlines.

The generally tight economic conditions this year however coupled with the prevailing relatively high electricity costs are likely to limit the total electricity demand to between 14,571-15,351 GWh. The grid electricity available for supply based on the generation capacity would be within 13,011-13,971 GWh.

In 2013, Ghana's peak load[4] on the transmission grid was 1,791 Megawatts (MW); 2.7% more than in 2012 and the total system peak[5] on the transmission system was 1,943 MW; 3.8% more than in 2012.

For 2014, Ghana's peak load would range between 1,900-2,200 MW and the total system peak on the grid transmission system would lie within 2,200-2,300 MW.

[1] i.e. electricity generated by the state utilities and the Independent Power Producers and pumped into the grid. It excludes electricity wheeled from CIE to CEB, exports to CIE and CEB.
[2] Million units of electricity.
[3] 18% short of our forecast for the year, if operating VALCO at more than two potlines was considered, but 6% short of forecast if business-as-usual.
[4] Referred to as Domestic Peak Load by some of the utilities
[5] Referred to as GRIDCo Ghana peak by GRIDCo

The projected electricity demand within the constraints of the limited available supply means that there is bound to be significant supply shortfalls any time a power plant is turned off even for scheduled maintenance.

Unmet demand in 2013 based on our projections was between 1,700-2,480 GWh which translates into 240–330 MW thermal plant equivalent. A total of about **700-800 MW** additional thermal capacity equivalent would therefore be needed to cover the shortfall and a minimum of 20% reserve margin for 2014. Annual capacity shortfall is estimated between **200-250 MW**.

The challenge however is securing adequate supply of gas which is a less expensive fuel to make electricity production cost relatively affordable.

Natural gas

In 2013, a total of 11.6 trillion standard cubic feet (Tscf) of gas was delivered by the West Africa Gas Pipeline (WAGP) for thermal generation. This was 25% less than gas delivered in 2012 and translates into an annual mean of about 31 million standard cubic feet per day (mmscfd) in 2013. The first receipt of gas was on 12th July, 2013 after a section of the pipeline which was raptured a year earlier had been fixed. This was less than a third of the contract volume of about 45 Tscf which translates into 123 mmscfd expected from Nigeria.

For 2014, the total volume of natural gas expected from WAGP is likely to range between 10-20 trillion standard cubic feet which translates into average of 30-50 mmscfd (30,000-50,000 million British thermal units {MMBtu} per day)[6].

Associated gas from the Jubilee field is likely to come on line between August and December 2014 with an average supply of 80-100 mmscfd.

The year 2013 saw the commencement of development of the TEN (Tweneboa-Enyenra-Ntomme) fields which is expected to produce an average supply of 63-70 mmscfd by 2017[7].
It is expected that in 2014, the plan of development (POD) for Sankofa, and Sankofa East fields would be approved. Production from these new fields would make available an average total of

[6] For WAGP gas from Nigeria, 1 mscf=1.0128 MMBtu. However for estimating flows in most cases, assume 1 mmscf=1000 MMBtu.
[7] World Bank report: Energizing Economic Growth in Ghana: Making Power and Petroleum Sectors Rise to the Challenge, June, 2013. Energy Group, African Region.

between 300-500 mmscfd by 2020[8]. However, considering the number and capacities of thermal power plants currently installed and expected to be in operation by 2015, estimated total gas requirement is expected to exceed 800 mmscfd by 2017.
In 2013, the delivered WAGP gas price[9] was $8.27 per MMBtu ($8.42 per mscf) for Foundation customers and $8.38 per MMBtu ($8.54 per mscf) for Standard customers.

For 2014, the delivered WAGP gas price would be $8.40-8.55 per MMBtu ($8.56-8.71 per mscf).

Crude oil and Petroleum products

In 2013, the average purchase price of Brent crude was $109 per barrel, 3.5% lower than in 2012.

For 2014, the average price at which Ghana would source Brent crude is expected to drop slightly to within $107-108 per barrel. Thus the average price is projected to drop further by 1-2% but the Ukrainian crisis could erode the expectation. Global oil consumption for the year has been estimated at 91-93 million barrels per day but the average global commercial stock is almost 3,000 million barrels, besides the expected daily production, and thus apparently making more oil available this year[10].

The average price for other light crudes for refinery operations would fall within $105-106 per barrel. Average delivery price for light crude oil for power generation would range from $108-110 per barrel, if the Ukrainian crisis is resolved by mid-2014.

For 2014, we estimate that the total crude oil and imported products required would increase to about 3.65 million tonnes from about 3.34 million tonnes in 2013, in order to meet optimal refinery operations and refined products for local consumption.

Crude oil required for refinery operations would vary from 1-1.5 million tonnes (7-10 million barrels) during the year, depending upon the availability of the Tema Oil Refinery and its auxiliary units. The shortfall would have to be imported.

[8] Same World Bank \, Energy Group report, June, 2013.
[9] i.e. including duties, taxes, etc
[10] US EIA Short Term Energy Outlook, March, 2014.

For LPG, the total national requirement would be within 300,000-350,000 tonnes due to the growing demand, particularly as transport fuel. However, limited nation-wide storage capacity and the inadequate revenues generated from its sales due to cross-subsidization could constrain supply to less than 300,000 tonnes range in 2014.

The breakdown of the total petroleum products required would be as follows:

Product	National supply requirement in Tonnes
Total Gasoline[11]*	1,150,000 – 1,200,000
Total Diesel	1,760,000 - 1,850,000
Kerosene/ATK	240,000 - 250,000
LPG	300,000 - 350,000
Total	**3,450,000 - 3,650,000**

In 2013, crude oil production from the Jubilee field jumped to 36.9 million barrels from about 24.7 million barrels in 2012. Daily production averaged 91,000 barrels.

For 2014, oil production is likely to increase to an average of 100,000 barrels per day. Production however is expected to ramp up to 120,000 barrels per day during the last quarter of 2014 when the current rate of re-injection is reduced.

Charcoal

The average prices of charcoal in the country rose from GH¢11 per mini bag and GH¢18 per maxi bag in 2012 to about GH¢13 per mini bag and GH¢21 per maxi bag respectively in 2013.

For 2014, we estimate that the average charcoal price would increase by 15-20% in the coastal areas of Greater Accra, Central, Western and Eastern Regions. The average price is likely to increase by 10-15% in the inland regions of Ashanti and Brong Ahafo. The difference would be as a result of transportation cost.

[11] NB: *Total gasoline includes Premix; **Total diesel includes supplies to the mining companies and bunkering, i.e. supply to ships.

Nationwide, we estimate an average increment of 15-20% for 2014 but could increase to 20-25% should there be a significant shortfall in LPG supply across the country during the year.

Recommended Actions

To ameliorate the overall power supply shortage prevailing in the country, emanating out of inadequate fuel supply for power generation, investments in alternative gas supply in the light of limited and unreliable gas from the West Africa Gas Pipeline from Nigeria should be pursued.

In the light of the above:

i. *The power generation utilities supported by the regulators and the sector ministry would continue to look for alternative sources of natural gas for the country's power plants, besides supplies from the West African Gas Pipeline to enhance gas supply and security.*

ii. *In this respect, the sector Ministry in conjunction with the Government should proactively create incentives to encourage investment in LNG regas facility built in the shortest possible time.*

iii. *The Government should do whatever it could to support the entities concerned including the Ghana National Gas Company Ltd to expedite development of the natural gas processing plant to process gas expected from the offshore Jubilee oil fields. Since the thermal plants are now the marginal generators, natural gas, which is largely less expensive than LCO would help supplement oil-based generation and consequently reduce average generation cost.*

iv. *Government should ensure as a matter of urgency, that the required commercial frameworks for the developments of the Sankofa fields are finalized by close of this year – 2014 to enable commercial production in these fields to commence by 2017.*

v. *Government should provide significant attractive fiscal incentives to investors like tax holidays to make the non-associate gas fields economically viable to develop.*

vi. *Renewable Energy technologies can provide at least 5% of the country's electricity requirements at present. Thus, with the passage of the Renewable Energy Act, 2011 (Act 832), the Energy Commission with the mandate to promote renewable energy in the country and with the support of the sector ministry should team up with the*

finance and the environment ministries, other stakeholders such as the Environmental Protection Agency, Ghana Investment Promotion Centre, the international, regional and local financial institutions to find ways of assessing the global carbon finance facilities for grid–connected Renewable energy based power supply in the country.

vii. *The sector Ministry, National Petroleum Authority, BOST, Energy Commission and the Ghana Investment Promotion Centre assemble other key stakeholders to identify the key barriers impeding investment in new oil refineries in the country and to institute the needed incentives, to encourage establishment of new oil refineries to serve both the local and export markets.*

viii. *BOST should develop the Pumpuni LPG Tank Farm and the LPG pipeline to facilitate long term efficient evacuation of LPG from the Gas Processing plant at Atuabo to the Tank Farm without delay. Evacuation of LPG and other Gas-to-Liquids products by road and sea transport modes are applicable but for the short to medium term and tend to be more expensive and risky compared to pipeline transportation.*

ix. *National Petroleum Authority should encourage the Oil Marketing Companies to set up more LPG storage and distribution centres to increase access and consumption.*

Foreword

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

In fulfilment of its mandates, the Energy Commission in 2006, published the Strategic National Energy Plan for Ghana (SNEP) covering the period 2006-2020. Since then, the Commission has been preparing annual energy demand and supply outlook to provide guidelines to the energy sector operators and potential investors as well as the wider business community wishing to operate in the country. The purpose of the 2014 Annual Energy Outlook therefore is to give government, industry and business, indications of the levels/quantities of electricity, liquid and gaseous fuels that would be required to be provided by the energy producers for the next 12 months.

This document covers demand and supply of electricity, crude oil and petroleum products, natural gas as well as charcoal. Even though, no forecast for electricity prices is included, higher thermal generation mix and increasing fuel price would lead to higher generation cost. The rate of cost increase would be lower if more natural gas which is less expensive than oil is made available to replace oil in the generation mix. High crude oil prices would also lead to higher petroleum product prices. Inadequate supply of LPG leads to higher charcoal consumption and consequently more wood for charcoal production. Average price of charcoal is also increasing.

In the document, 'Demand' is used when referring to gross fuel or energy required by a demand sector, e.g. Residential, Commercial, or Industry. 'Supply Requirement' is Supply or Generation/Production plus transmission/transport losses. For further elaboration, please refer to Annex 1 of the document for a schematic overview of Ghana's Energy Demand and Supply System.

This report was prepared by the Strategic Planning and Policy Division of the Energy Commission. General questions about the report should be referred to Mr. Michael Opam, (mopam@energycom.gov.gh, michaelopam@yahoo.com) Director, Planning and Policy. Specific questions about the content may be directed to Dr. Joseph Essandoh-Yeddu (essandohyj@energycom.gov.gh, jeyeddu@hotmail.com), Head of Strategic Planning and Policy Division.

Your comments are most welcome.

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Executive Secretary

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[12] We consider Non-residential tariff as largely the same as Commercial/Services Tariff.

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1.0 Power Subsector

1.1 Overview of grid power supply in 2013

Installed generation capacity available for grid supply as at the end of 2013 was about 2,936 Megawatt (MW) (*see Table 1*).

Table 1. Installed Grid Electricity Generation Capacity as of December 2013.

GENERATION PLANT	FUEL TYPE	INSTALLED CAPACITY MW	Share %
Hydro Power Plants			
Akosombo	Hydro	1,020	
Bui	Hydro	400	
Kpong	Hydro	160	
	Sub-Total	*1,580*	***53.8***
Thermal Power Plants[13]			
Takoradi Power Company (TAPCO)	LCO/NG/diesel	330	
Takoradi International Company (TICO)	LCO/NG/diesel	220	
Sunon–Asogli Power (SAPP)	NG	200	
Tema Thermal Plant1 (TT1P)	LCO/NG/diesel	126	
Tema Thermal Plant2 (TT2P)	NG/diesel	49.5	
CENIT Energy Ltd (CEL)	LCO/NG	126	
Takoradi T3	NG	132	
Mines Reserve Plant	Diesel/NG	40	
Osagyefo Power Barge	NG	125	
	Sub – Total	*1,348.5*	***45.9***
Renewables			
VRA Solar	Solar	2.5	
	Sub – Total	*2.5*	***0.1***
Embedded generation			
Genser Power	LPG	5	
	Sub – Total	*5*	***0.2***
Total		**2,936**	

NG is Natural gas

The total electricity made available for gross transmission in 2013 was 12,927 GWh as against 12,164 GWh in 2012. The 2013 grid electricity transmission comprised 8,233 GWh

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

(63.68%) hydropower[14], 4,635 GWh (35.86%) of thermal power, 15.32 GWh (0.12%) of import and for the first time in the nation's history, solar photovoltaic grid power contributed about 5 GWh (0.04%). The Ghana load at peak on the transmission grid was 1,729 MW and the grid system (maximum) peak was 1,871 MW.

Total power transmission loss in 2013 was 4.5% of gross transmission, 0.2 percentage point higher than in 2012 (*see Table 2*).

Table 2. Transmission losses since 2008.

Year	2008	2009	2010	2011	2012	2013
Transmission losses as % of gross transmission	3.7	3.8	3.7	4.7	4.3	4.4

1.2 2013 forecasts and actuals

Ghana's real Gross Domestic Product (GDP) growth in 2013 has been estimated at 7.1%, a drop from 8.8% in 2012. [15]. The dip in the GDP growth has been attributed to negative growth in Manufacturing subsector and the Services sector largely due to the inadequate grid power supplied culminating into nation-wide load shedding for most part of the year. Also, the expected improvement in Jubilee field commercial oil production did not materialize in 2013.

For 2013, we projected that the total electricity required would be between 13,667-15,794 GWh and that the low-side would be as a result of lower than expected flow of gas for power generation. The high-side would have covered VALCO operating at two-to-three potlines. In addition, we projected that Ghana's peak load and the total system peak on the grid transmission system would be around 1,800 MW and 1,900 MW respectively[16]. The actual Ghana's peak load and the total system peak on the grid transmission system in 2013 were 1,791 MW and 1,943 MW; VALCO did not operate beyond one-potline (*see Tables 3*).

Gross electricity supplied in 2013 was about 12,871 GWh[17], against a forecast of 15,725-16,500 GWh[18] for the year. This implies that supply was 10-15% less than the forecasted demand. This could be explained by the load-shedding that was carried out in the year.

We also projected that oil required for thermal power generation would range from a minimum of 1.15 million tonnes to a maximum of 1.25 million tonnes (about 8-9 million barrels) during the year, depending upon the availability of the thermal plants and the

[14] A drop from 67% in 2012.
[15] Ghana Statistical Service (GSS), April, 2014.
[16] Corresponding figures for VALCO to be operating between 3-4 potlines are 1,980 MW and 2,500 MW.
[17] Excluding exports to CIE and CEB.
[18] Low side includes VALCO operating at one-two potlines and high-side considers VALCO operating at three-four potlines.

volatility of oil prices. Actual oil used was just about 700,000 tonnes, i.e. about 56-60% of the projected requirement (*see Tables 3*).

Global Brent crude price averaged $109 per barrel in 2013 (*see Tables 3*). . Ghana purchased the crude at an average price of about $113 per barrel during the first quarter of 2013 but fell to an average of $103 per barrel during the second quarter. Prices started to move up in the summer to an average of $111 per barrel during the last quarter of the year.

Table 3. Grid Electricity and associated fuels: Forecasts and Actuals for 2013.

	2012	**2013**	
		Forecast	**Actual**
Total Electricity Requirement *(VALCO at 3-4 potlines in brackets)* (GWh)	Not applicable	13,667-15,794 *(16,100-19,500)*	Not applicable
Likely Grid Electricity available (GWh)	12,164	13,459-16,121	12,927
Percentage hydro (%)	67	58-68	63.7
System Peak/Maximum Demand* (MW)*	1,729-1871	1,800-1,900	1,791-1,943
Annual Mean WAGP gas flow (mmscf per day)	65	45-50	31
Oil required/consumed 1000 Tonnes (Million barrels)	704 (~5)	1,158-1,250 (8-9)	700 (4.9)
WAGP Gas transportation tariff ** US$ per mscf *($ per MMBtu)*	4.25 *(4.175)*	4.15-4.27 *(4.08-4.19)*	4.32-4.43 *(4.238-4.346)*
Average price for WAGP Gas*** US$ per mscf *($ per MMBtu)*	2.63-2.50 *(2.587-2.454)*	2.57-2.60 *(2.53-2.55)*	2.51 *(2.469)*
Delivered gas price ** *(other charges included)* US$ per mscf *($ per MMBtu)*	8.34 *(8.188)*	8.15-9.16 *(8-9)*	8.36-8.54 *(8.27-8.38)*
Average price for Brent crude US$ per bbl *($ per MMBtu gas equiv.)*	~ 113 *(Global ~112)*	108-110 *(18-19)*	~109 (Global – ~109) *(18.73)*

**Actuals data obtained from GridCo. Low-side is Ghana/local and high-side is total system peak*
*** Actual data in $/MMBtu courtesy of WAPCo. Low-side for Foundation customers and high-side for Standard customers. Other charges include delivery fee, ELPS transport fees, insurance, etc.*
**** Prices indexed to LCO and negotiated between the buyer and supplier and reviewed every six months. Actual data in $/MMBtu courtesy of WAPCo. Low-side for Foundation customers and high-side for Standard customers.*

The WAGP gas supply which was interrupted in August, 2012 following a rapture of the pipeline in Togolese waters that month, was restored in July, 2013. Total WAGP gas flow from July 2013 to the end of the year was 11,573,011 MMBtu (11,600 mmscf), about 25% lower than in 2012 and less than half the supply in 2011; 30,524,557.83 MMBtu (30,525 mmscf). (*see Tables 4*).

Table 4. Monthly Natural Gas Supply from WAGP in 2013.

Month	**Ghana Total**
	MMBtu
January-June	0
July	1,448,667
August	1,788,735
September	2,012,153
October	1,713,241
November	2,202,386
December	2,407,829
Total	***11,573,011***

Source: Volta River Authority, 2014.

We expected the trend of average annual precipitation for 2013 to be higher than in 2012 as the year coincided with the maximum sunspot cycle (solar maximum) of the sun which is usually associated with higher convection currents and consequently higher rainfalls. Indications from the Ghana Meteorological Agency[19] also optimistically projected mean annual rainfall in 2013 to be higher than in 2012. None of these assertions however materialised, which could also be an indication of the negative impact of climate change which is making weather forecasting more challenging than before. Higher inflows into the hydropower reservoir would have improved the overall power generation in the light of lower than expected gas supply in 2013.

[19] 2013 Meteo forecast, Ghana Meteorological Agency

1.3 Forecast for 2014

Fuel supply challenge and likely impact on generation

WAGP gas flow for power production has however fallen from the average of 84 mmscfd at the end of 2013 to between 30-35 mmscfd by March, 2014 compared to the optimum requirement of 345-400 mmscfd for this year.

Just as in 2013, WAGP gas supply is likely to stay within the average of **40 mmscfd**[20] for most parts of 2014 since barriers to supply improvements in Nigeria remain the same as in 2013. In addition, supplies to Ghana would continue to be very erratic, at times going beyond 50 mmscfd to within 70 mmscfd but for less than 2% of the time or dropping to within 30-35 mmscfd for about 10% of the year. To recall, the Nigerian Commercial Group has so far reneged on their contracted supply volume of about 123 mmscfd.

We also do not expect the total delivered gas price to fall outside **$8.40-8.55 per MMBtu**.

We however expect Ghana's own gas from the Jubilee field operations to be available during the third quarter of 2014, with a range of 80-100 mmscfd, and that would help reduce the use of more expensive oil fuel for power generation.

On account of inadequate natural gas supply to produce adequate and cost-competitive energy to support economic growth, economists are predicting further decrease in real GDP growth from about 7.1% to between 4.8-6.1% for 2014, even though the Government and NDPC have forecast 8% and 8.4% growth respectively for the year. [21].

At such 4.8-6.1% **GDP growth rate**, we projected under SNEP[22] that the total electricity generation[23] required for the country in 2014 would be as follows:

- **15,676-15,932 GWh** with VALCO operating at one potline; and
- **20,200-21,120 GWh** for VALCO to be operating at two to three potlines.

The corresponding Ghana's peak demand (including suppressed demand) and total transmission system peak would be between **1,980-2,300 MW** which translates into about **2,400-2,625 MW** dependable capacity required[24].

[20] Range of 30-50 mmscfd.
[21] Ernst & Young, 2014Rapid Growth Markets Report on Ghana, February, 2014; IMF report on Ghana economy, February, 2014; NDPC, GSGDA II.
[22] Strategic National Energy Plan (2006-2020), Energy Commission, available at www.energycom.gov.gh
[23] Total electricity generation=grid/public generation + private back-up generation.
[24] The generation and transmission utilities have also projected about the same range ;VRA (VRA 2014 Energy Supply Plan) and GridCo (Electricity Supply Plan) have forecast 15,120 GWh (associated system peak of 2,100 MW) and 15,362 GWh (associated system peak of about 2,300 MW) respectively.

However, at the high real GDP growth rate of 8% projected by the Government for 2014, the total electricity generation required for the country in 2014 would have been:

- 20,200-21,120 GWh with VALCO operating at not more than two potlines; and
- 21,120-25,620 GWh for VALCO to be operating at three-five potlines.

Unfortunately, the grid is not likely to provide the said electricity and power requirements for the low economic growth scenario let alone the high economic growth, due to the current limited installed grid power generation capacity of the country (*see Table 5*). The situation has also been worsened by the following:

- TICO is undergoing refurbishment to upgrade it from single cycle to combined cycle operation. It is likely therefore not to be available for a significant part of 2014.
- 132 MW Takoradi T3 thermal plant that malfunctioned in 2013 is still undergoing investigation and probably repairs but legal considerations are not likely to make it available for operations in 2014.
- VRA's 200 MW Kpone Themal plant (KTPP) is scheduled for completion in December, 2014 but test runs and further expansion works would make it un-operational for 2014.
- Relatively high cost of thermal electricity generation due to likely use of more LCO in the light of poor WAGP gas supplies.
- Lack of significant potential power import to supplement shortfall in locally available capacity.

We estimate the total quantity of oil required in 2014 to fire the thermal plants to be about the same as in 2013 (*see Table 10*) but the average delivery cost of the LCO is expected to slightly drop from about $111 per barrels to between **$108-109** barrels during the year.

Global Brent crude oil price is also projected to decline slightly in 2014, falling to **$105-106** per barrel, from $109 per barrel in 2013[25] but the crisis in Ukraine is likely to hold it up at **$107-108** per barrel during the year.

We expected the trend of average annual precipitation for 2013 to be higher than in 2012 as the year coincided with the maximum sunspot cycle (solar maximum) which is usually associated with higher convection currents and consequently higher rainfalls. Even though, it did not materialise in 2013, there is a 50-50 chance that it could occur in 2014. Thus, we still expect the trend of average annual precipitation for 2014 to be higher than in 2013. Higher inflows into the hydropower reservoirs or upstream of the power dams would improve the overall hydropower generation in the light of poor WAGP gas supplies this year.

[25] US EIA Short Term Energy Outlook, March, 2014.

Should it fail to happen, then the said high precipitations expected with the maximum sunspot cycle (solar maximum) might have peaked in 2012. Should this hypothesis prove to be true, then average annual precipitation would continue to drop for the next two to three years, i.e. up to 2017; until the lowest average (trough) is reached and starts to increase again[26].

In of light of the above, the technically dependable capacity and the optimum grid electricity generation available in 2014 is estimated at **2,267 MW** and **13,973 GWh** respectively (*see Table 5*).

Table 5. Grid Power Generation Capacity available for 2014.

GENERATION PLANT	CAPACITY (MW)		Plant Utilisation Factor	Expected Energy (GWh)
	Installed	Dependable		
Hydro Power Plants				
Akosombo	1,020	960	0.90	6,643.20
Kpong	160	140	0.90	1,140.55
Bui	400	380	0.30	998.64
Sub-Total	*1,580*	*1,480*		*8,782.39*
Thermal Power Plants[27]				
TAPCO (CC)	330	300	0.70	1,839.60
TICO (SC)	220	200	0.10	175.20
Sunon – Asogli (gas)	200	180	0.75	1,182.60
Tema Thermal Plant – TT1PP	126	110	0.70	674.52
Tema Thermal Plant – TT2PP	49.5	45	0.70	275.94
Takoradi 3 (T3)	132	120	0.10	105.12
Mines Reserve Plant (MRP)	80	40	0.75	245.28
CENIT Energy Ltd	126	110	0.70	674.52
Sub-Total	*1,263.5*	*1,105*		*5,172.78*
Renewables and Embedded Generation				
Genser Power	5	2	0.70	12.26
*VRA Solar grid-inter-tied	2.5	2	0.30	5.26
Sub – Total	*2*	*2*		*17.52*
Total	**2,851.5**	**2,589**		**≈13,973**

**provisional*

[26] The 11 year sunspot cycle takes a sine shape; four-five years for the first arm of curve, one-three years to plateau or trough, and another four-five years to complete the full curve.

[27] TAPCO is Takoradi Power Company, a combined cycle (CC) thermal plant; TICO is Takoradi International Power Company, a single cycle (SC) thermal plant . VRA is projecting delivery of 5,761 GWh from its total thermal plants , but we are more conservative.

Inadequate WAGP gas would dip the available generation further to about **13,018 GWh** (*see Table 6*), making the supply and demand situation tighter this year than in 2013. Any further delay and dip in the expected supply of Jubilee gas to the thermal plants could therefore worsen the generation situation.

Unmet demand in 2013 was between 1,700-2,480 GWh which translates into 240–330 MW thermal plant equivalent based on gas. A total of about **700-800 MW** additional thermal capacity equivalent would therefore be needed to cover the shortfall and a minimum of 20% reserve margin for 2014. Annual capacity shortfall is estimated between **200-250 MW**.

The challenge however is securing adequate supply of gas which less expensive fuel to make electricity production cost relatively affordable.

Table 6. Grid Power Generation Capacity available for 2014 with less gas supply.

GENERATION PLANT	CAPACITY (MW)		Plant Availability Factor	Expected Energy (GWh)
	Installed	Dependable		
Hydro Power Plants				
Akosombo	1,020	960	0.90	6,643.20
Kpong	160	140	0.90	1,140.55
Bui	400	380	0.30	998.64
Sub-Total	*1,580*	*1,480*		*8,782.39*
Thermal Power Plants[28]				
TAPCO (CC)	330	300	0.66	1,734.48
TICO (SC)	220	200	0.10	175.20
Sunon – Asogli (gas)	200	180	0.60	946.08
Tema Thermal Plant – TT1PP	126	110	0.50	481.80
Tema Thermal Plant – TT2PP	50	45	0.30	118.26
Takoradi 3 (T3)	132	120	0.10	105.12
Mines Reserve Plant (MRP)	80	40	0.50	175.20
CENIT Energy Ltd	126	110	0.50	481.80
Sub-Total	*1,264*	*1,105*		*4,217.94*
Renewables & Embedded Gen				
Genser Power	5	2	0.7	12.26
*VRA Solar grid-inter-tied	2.5	2	0.3	5.26
Sub – Total	*7.5*	*4*		*17.52*
Total	**2,852**	**2,589**		**≈13,018**

provisional

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

The general relatively tight economic conditions this year coupled with the prevailing relatively high commercial and industrial tariffs could also cause total electricity demand to slump from the predicting range of **15,676-15,932 GWh** (*with VALCO operating at one potline*) to between **14,571-15,351 GWh** in 2014.

The closeness of the gap between the electricity requirement by the economy and available supply means, there is bound to be significant shortages with likely accompanying load shedding anytime any of the power plants is shut down for routine maintenance.

1.4 Potential drivers for electricity consumption in 2014

Under contemporary circumstances, we project that the potential drivers for electricity consumption would be as follow:

- Aluminium production should VALCO continue and expand operation;
- Mining, largely influenced by gold prices and production;
- Other industrial growth;
- Electricity pricing;
- On-going national electrification scheme; and
- Petroleum up-stream and mid-stream activities.
- Energy Efficiency and Conservation measures

Aluminium production

The Volta Aluminium Company, VALCO is the country's single largest non-utility electricity customer when in full operation. The smelter has an installed capacity of 200,000 tonnes of primary aluminium production at a maximum power demand of 320 MW with five potlines, consuming about 2,900 GWh per year. The fifth potline however, has not been fully available and hence the plant had in the past operated a maximum of four and a half potlines with maximum production of 180,000 tonnes per annum.

Primary aluminium production in general is energy-intensive. Electricity intensity of production at VALCO averaged 17 MWh per tonne of aluminium in the early 1990s but has improved to the present average of 16.2 MWh per tonne[29]. Aluminium smelting worldwide is very sensitive to electricity pricing and both are highly correlated. At larger production volumes, high electricity tariffs become cost competitive.

Aluminium has become the world's second most used metal after iron and is today the single most important non-ferrous metal. Global demand was about 39 million tonnes in 2010 and

[29] The most efficient smelter produces at about 15 MWh per tonne.

this is projected to exceed 100 million tonnes by 2020 with an estimated annual growth rate ranging between 6.5-10%[30] Global aluminium production in 2011 was almost 46 million tonnes. Production was projected to reach 49 million tonnes by end of 2012 but fell short by about one million tonnes attributed to the slow down in China's economic growth.

Average world market price of the metal however has been dropping since 2011. It dropped from the range of $2,600-$2,800 per tonne in 2011 to $2,060-2,127 per tonne in 2012. The global average price weakened further last year, i.e. 2013, ranging between $1,700-1,800 in 2013 and early 2014 as a result of continuous drop in demand in Europe caused by the economic depression in the region and which has indirectly caused an over-supply.

This is compelling the industry to cut production and could partly explain the weak supply forecast for 2014. Nonetheless, with the seemingly improving European economy, demand has been projected to edge up again reaching about 49 million tonnes by end of 2014, still driven largely by demand in Asia.

Experts project the global price to peak between $1,866-1,885. This is less than the indicative $2,000 per tonne from the highs in 2011. At this price range, it would be challenging for VALCO to operate beyond two potlines at a tariff above 5 cents per kWh[31]. The downside is that there has not even been enough electricity generation capacity to support VALCO's operations beyond one potline in recent times.

Whenever there had been nationwide supply shortage, VALCO had been forced to curtail operations. In 2003-2004, the nation experienced nationwide load shedding and VALCO which then accounted for 26-40% of the total electricity consumption and about 50% of electricity consumed by industry, was called upon to either shut down or reduce production significantly. Consequently, VALCO had been almost out of the electricity consumption share since 2004 except in 2006 when it was allowed to come on line. Since then it had not operated beyond two potlines as a result of inadequate power in the country.

For VALCO to operate between one -two potlines, we estimate electricity requirement of 600 GWh for one more potline in 2014. **In reality however, VALCO is not likely to operate beyond one potline and so poses no additional power requirement in 2014.**

Gold prices and production[32]

Gold surpassed cocoa as the country's number one foreign exchange earner in the 1990s, and had accounted for 43-47% of merchandised export earnings since 2006[33]. Gold which was around $400 per ounce in 2004 rose to an average of $1,572 per ounce in 2011 and hitting a

[30] International Aluminium Institute, https://stats.world-aluminium.org/iai/stats; Alcoa group, www.alcoa.com/ extracted in March, 2013.
[31] Aluminium smelter economics is as such that the high the production levels, the easier to operate on higher tariffs. Refer to SNEP 2006-2020, Annex I of IV, Energy Commission, www.energycom.gov.gh/documents
[32] Gold output data in tonnes have been revised due to wrong computation in the past.
[33] Bank of Ghana Statistical Bulletin, December, 2012.

record average of $1,668 in 2012 as the precious metal provides safe haven as well as alternative to the United States dollar (*which is said to be losing in value*) for investors who were worried by the general global economic uncertainty particularly of the United States and also of the Eurozone [34].

Gold is a rare but precious metal. Global gold output has averaged between 2,500–3,000 tonnes every year since the beginning of the decade. Ghana, ranks as the world's 10^{th} – 12^{th} producer and the second on the continent after South Africa.

Ghana's annual gold production increased from 77 tonnes in 2007 to 79.5 tonnes in 2008. We predicted that it could exceed 80 tonnes in 2010 due to favourable global price and it did, in fact reaching over 89 tonnes (2.97 million ounces) in 2010[35].

Production climbed to a record 134 tonnes (about 4.32 million ounces) in 2012, from about 98 tonnes (almost 3.14 million fine ounces) in 2011 which was unprecedented in modern Ghana's gold mining history. Total revenue in 2011 from the commodity was about $5 billion about 30% more over 2010 earnings[36].

The global average price however fell beyond most predictions from the 2012's average price of $1,668 to around $1,300 per ounce in 2013 as a result of improvement in the U.S economy but also as some European economies started showing signs of improvement, they off-loaded some of their gold reserves unto the world market. Ghana's gold sold between $1,320-1,350 per ounce during the last quarter of 2013.

The dip in the average price culminated in a significant slump in gold output from the record 134 tonnes (4.32 million ounces) in 2012 to 128 tonnes (4.12 million ounces) in 2013. New mining operations which were to add between 300,000-500,000[37] ounces in 2013 did not materialise.

Production for 2014 is expected to fall below 124 tonnes (4 million ounces). Average market price however has been projected to edge up to $1,350-1,400 per ounce for the rest of the year, as the unrest in Ukraine continues, giving rise to the worse standoff between the West and Russia since the end of the Cold War. The Ukraine crisis is the latest sign of global turmoil fuelling the demand for the precious metal as a safe haven.

Four main factors influence gold production technology, particularly, as whether to opt for surface or underground mining. They are the (i) richness or concentration of the ore; (ii) production costs, (iii) world market price of gold and (iv) energy price. For most surface mines in Ghana, the concentration of gold is between 2–3 grammes per tonne of ore, reducing to 1–2 grammes per tonne for workable tailings. For underground mining,

[34] Bloomberg L.P., 2013.
[35] 1 tonne = 32,150.746 Troy ounces.
[36] Bank of Ghana Statistical bulletin October 2013; http://goldprice.org
[37] Newmont's second gold mine at Akyem was expected to start commercial production in 2013 with as much as 450,000 ounces annually. BullionStreet, 2013

concentration could go as high as 8–12 grammes per tonne of ore on the average in Obuasi but drops to a range of 3–5 grammes per tonne of ore for other areas of the country. In general for any given mining area, the ore is richer as one goes deeper underground.

Electricity consumption for underground operations is about three times that for surface mining operations. Electricity intensity of surface gold mining in the country is 8-9 GWh per tonne of gold whilst underground mining requires between 28-29 GWh per tonne of gold [38].

Electricity supply for surface mining is mainly for pumping water and grinding of the ore. For underground mining, besides pumping and grinding, electricity is required for operating the transport-elevators, drilling, air-conditioning and ventilation. The general observation is that the ambient temperature increases by 10 degrees Celsius for every kilometre below the surface of the earth. Most operations thus shift from underground to surface mining, when the cost of electricity per production of ounce of gold exceeds about 10% of the prevailing world market price of gold. The benchmark is for energy cost per production not to exceed 20%. Surface mining is a less expensive technology but has more serious environmental consequences for surrounding communities and the nation as a whole.

At the prevailing global market price of gold, around $1,320-1,350 per ounce, coupled with the PURC's[39] current energy tariff exceeding 18 cents per kWh for the mining sector, cost of electricity has already exceeded the 10% benchmark for underground mining operations. We thus project a drop in deep or underground mining operations this year. Even for the surface mines, average output from the lower grade and marginal fields is expected to slump due to the relatively high cost of energy.

For these reasons, we do not expect any significant additional electricity demand from mining industries, at best demand would be about the same for 2014 as it was in 2013.

Other Industries[40]

The share of grid electricity supplied to the industrial sector (VALCO inclusive) has shown wide variability since 2000 and indeed it was the sector most severely affected during the load shedding in 2003-2004, 2007 and 2013 (*see Table 7*)[41]. The industry (VALCO inclusive) share dropped in 2013 due to the load shedding necessitated by the inadequate supply of electricity caused by the drop in supply of WAGP gas to the generation utilities. It is important to note that supplies to the Residential and Non-residential sectors[42] however increased during the period.

[38] SNEP 2006-2020, Volume 1, Energy Commission, 2006. page 34.
[39] PURC is Public Utilities Regulatory Commission. It is responsible for fiscal regulation of public electricity and water use in the country. www.purc.com.gh
[40] Industry other than VALCO and Gold Mining.
[41] The country underwent a nationwide load shedding from 2002-2004 and 2007 due to low inflows into the Volta reservoir which culminated into reduced generation (about one-third to half capacity less) from the nation's hydropower.
[42] Comprising largely commerce & services.

Table 7. Grid Electricity supply, share and growth to the Demand Sectors since 2000.

YEAR	DEMAND SECTORS										
	Industry			Non Residential			Residential			Total	
	1000 GWh	% Share	% Gr	1000 GWh	% share	% Gr	1000 GWh	% share	% Gr	1000 GWh	% Gr
2000	4.31	68.0	*0*	0.55	8.7	0	1.49	23.5	*0*	**6.34**	***0***
2001	4.33	66.4	*0.5*	0.58	8.7	*5.5*	1.61	24.7	*8.1*	**6.53**	***3.0***
2002	3.90	63.2	*-9.9*	0.60	9.8	*3.4*	1.67	27.1	*3.7*	**6.17**	***-5.5***
2003	2.21	48.6	*-43.3*	0.62	13.6	*3.3*	1,73	38.0	*3.6*	**4.55**	***-26.3***
2004	2.03	448	*-8.1*	0.66	14.6	*6.5*	1.78	39.3	*2.9*	**4.53**	***-0.4***
2005	2.54	49.2	*25.1*	0.70	13.6	*6.1*	1.92	37.2	*7.5*	**5.16**	***13.9***
2006	3.59	55.1	*41.3*	0.79	12.1	*12.9*	2.13	32.7	*10.9*	**6.51**	***26.2***
2007	2.70	48.3	*-25.0*	0. 80	14.3	*1.3*	2.10	37.6	*-1.4*	**5.59**	***-14.1***
2008	2.97	48.2	*10.0*	0.93	15.1	*16.3*	2.27	36.9	*8.1*	**6.16**	***10.2***
2009	2.94	47.2	*-1.0*	0.88	14.1	*-5.4*	2.41	38.7	*6.2*	**6,23**	***1.1***
2010	3.16	46.1	*7.5*	0.97	14.1	*10.2*	2.74	39.9	*13.7*	**6.86**	***10.1***
2011	3.90	48.9	*23.4*	1.31	16.4	*36.1*	2.76	34.6	*0.7*	**7.98**	***16.3***
2012	4.15	51.2	*7.7*	1.15	14.2	*-0.8*	2.80	34.6	*-5.8*	**8.24**	***1.5***
2013	4.22	47.1	*1.7*	1.53	17.0	*32.3*	3.23	36.0	*15.2*	**9.00**	***10.7***
Note: Gr is growth rate											

As VALCO's power consumption share continued to drop over the years, the Mining subsector of Industry *which is dominated by gold mining* and the Other industries[43] have taken over with the latter maintaining the largest share (*see Table 8*).

Table 8. Industrial Sector Grid Electricity supply and shares since 2000.

YEAR	INDUSTRY SECTOR								
	VALCO			MINES			OTHER INDUSTRIES *(i.e. less VALCO less MINES)*		
	1000 GWh	% Share of Industry	% Share of Total Electricity	1000 GWh	% Share of Industry	% Share of Total Electricity	1000 GWh	% Share of Industry	% Share of Total Electricity
2000	2.50	58.0	*39.4*	0.63	14.6	*9.9*	1.17	27.1	*18.5*
2001	2.56	59.1	*39.2*	0.57	13.2	*8.7*	1.20	27.7	*18.4*
2002	2.06	52.8	*33.4*	0.56	14.4	*9.1*	1.28	32.8	*20.7*
2003	0.25	11.3	*5.5*	0.57	25.8	*12.5*	1.38	62.4	*30.3*
2004	0.01	0.5	*0.2*	0.60	29.6	*13.2*	1.42	70.0	*31.3*
2005	0.26	10.2	*5.0*	0.75	29.5	*14.5*	1.53	60.2	*29.7*
2006	1.20	33.4	*18.4*	0.87	24.2	*13.4*	1.52	42.3	*23.3*
2007	0.21	7.8	*3.8*	1.00	37.0	*17.9*	1.48	54.8	*26.5*
2008	0.17	5.7	*2.8*	1.14	38.4	*18.5*	1.65	55.6	*26.8*
2009	0.01	0.8	*0.2*	1.25	42.5	*20.1*	1.66	56.5	*26.6*
2010	0.01	0.3	*0.1*	1.24	39.2	*18.1*	1.91	60.4	*27.8*
2011	0.60	15.4	*7.5*	1.30	33.3	*16.3*	2.00	51.3	*25.1*
2012	0.60	14.3	*7.4*	1.40	33.3	*17.3*	2.20	52.4	*27.2*
2013	0.59	13.9	*6.3*	1.46	34.5	*15.6*	2.18	51.6	*23.3*

[43] i.e. excluding the mines, besides VALCO.

For 2014 however, we do not expect any significant additional power demand by the Non-residential (i.e. Commercial/Services) Sector and the Other Industries subsector due to relatively high electricity tariffs.

Electricity Pricing

Ghana is losing its competitiveness in electricity pricing. With the new tariff announcement in early 2014, average commercial and industrial tariffs in Ghana are now far higher than in South Africa, Nigeria, Ethiopia, Libya, Kenya and Namibia. These are countries that have direct transport and trade links with Ghana and for that matter the trading and travelling citizenry is likely to compare prices with these countries (see figure 1).

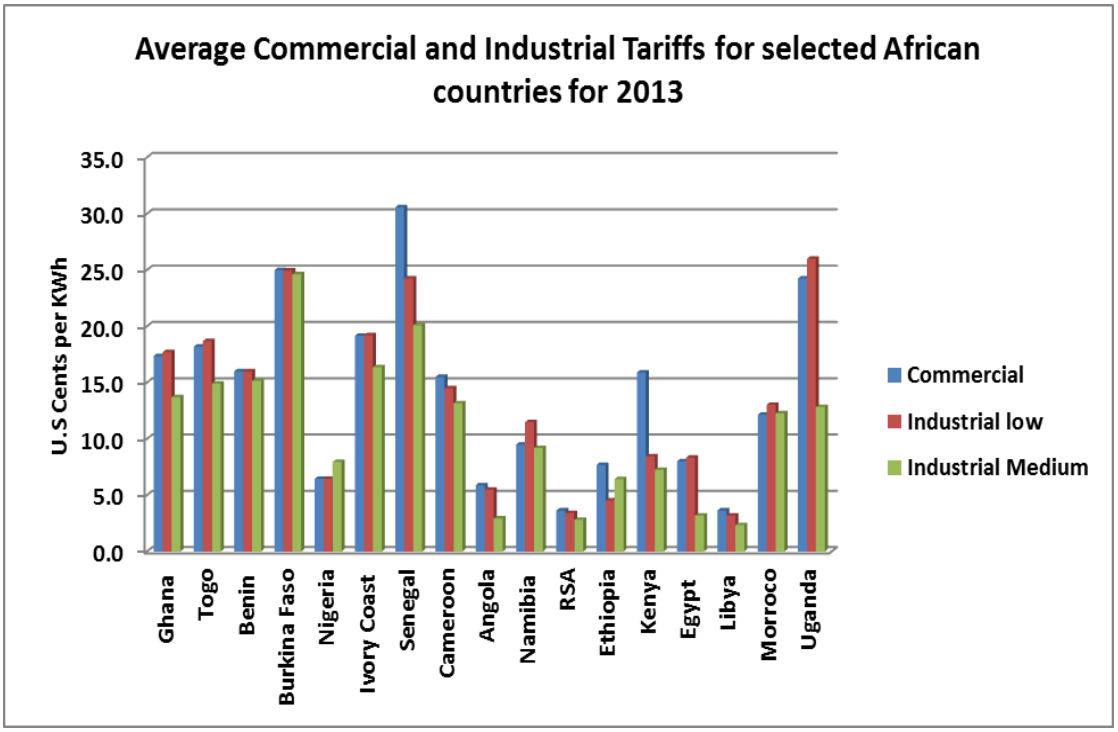

Figure 1. Comparing Commercial and Industrial tariffs of selected African countries - 2013

Most traders travelling to Asia, largely China, India and Republic of Korea pass through Ethiopia. Most trade shipments to Ghana from Africa largely come from Nigeria and South Africa.

Average end-user tariff in Ghana is also higher than in China, India and South Africa where most finished products and light industrial materials are imported from (*see Table 9*).

Table 9. Comparing Average End User Tariffs of Ghana and Selected Middle-Income Developing Countries

Country	Ghana	South Africa	India	China
US cents/kWh	15.6	10	8	8

Source: IEA, 2013[44]; theenergycollective.com

Ghana also has the highest difference between average industrial tariff and the residential tariff for coastal countries within Western Africa including Republic of South Africa (RSA). Furthermore, it is the third highest for tariff difference between Residential and Non-residential (i.e. Commercial/Services) (*see Table 10*).

Table 10. Arithmetical differences for Commercial[45], Average Industrial and Residential (regular)[46] Tariffs for Western African coastal countries including South Africa

	COUNTRY	Ghana	Togo	Benin	Nigeria	Iv. Coast	Senegal	Cameron	Angola	Namibia	RSA
TARIFF DIFFERENCE	Commerce less Residential	10.8	4.2	1.1	21.9	-0.5	11.2	4.0	1.4	-3.0	-1.0
	Average Industrial Less Residential	9.1	2.8	0.6	4.1	-1.9	2.8	2.3	-0.3	-2.2	-1.5

Source: Adapted from IEA, 2013; theenergycollective.com

Thus, all other things being equal, higher average industrial tariff is likely to curtail local production and rather encourage imports of finished consumer products. Higher average Commercial/service sector tariff could also slow down value-added activities in the Agriculture and Commercial/services sectors and on the other hand expand exportation of agricultural produce and other non value-added activities, the very economic path the Government wishes to discourage. The time has therefore come for a critical review of the

[44] Adapted from 2013 World Energy Outlook, International Energy Agency; National Energy Statistics 2014, by Energy Commission.
[45] We consider Non-residential tariff as largely the same as Commercial/Services Tariff.
[46] Regular Residential implies it excludes 'life-line' tariff.

electricity tariff structure in Ghana where the productive sector subsidizes the non-productive residential sector.

Increased Household income levels

We expect electricity consumption of Residential sector to continue to grow. After, Nigeria, Angola and South Africa, Ghana follows with the lowest residential electricity tariff (*see figure 2*).

Besides, household incomes have risen since 1990s. Annual household expenditure rose from about $1,773 equivalent in 1998 to about $2,085 equivalent in 2006. Household per capita income rose from $420 equivalent to $700 equivalent for the same period, an increment of about 70%[47]. Indications are that it is likely to have passed $800 equivalent by 2010. Increasing income means more acquisition of household appliances and a shift from biomass to cleaner fuels such as electricity.

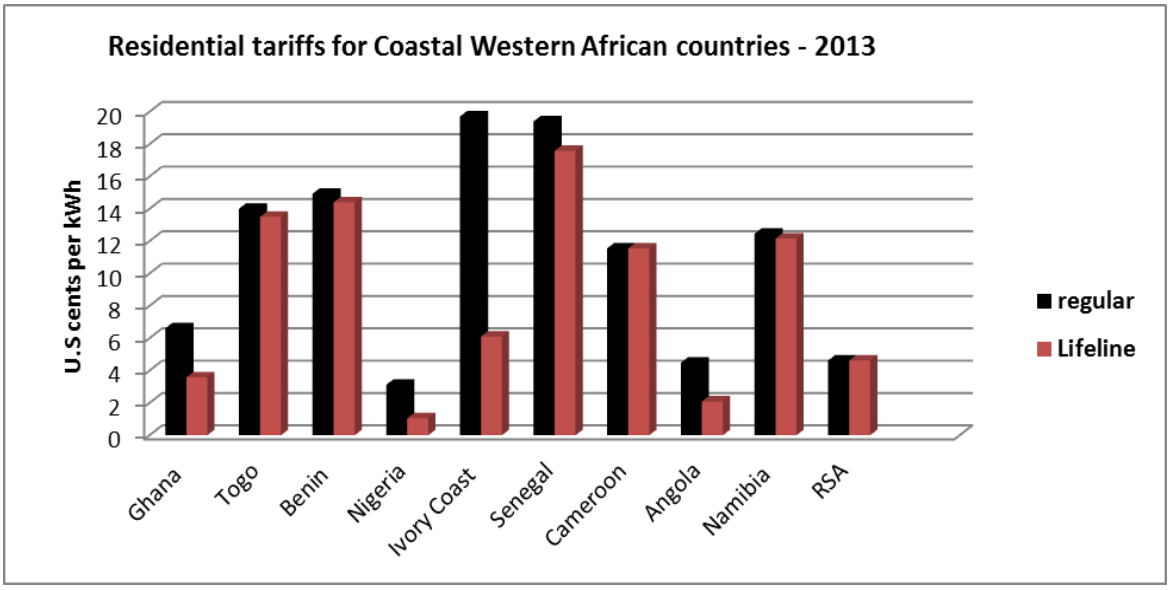

Figure 2. Residential Tariffs of Western African coastal countries including South Africa

This could explain the increasing electricity consumption and shares of the Residential sector. Annual demand (including suppressed demand and commercial losses) is estimated at 8-10% and could reach 5,000 GWh if only more electricity could be made available. In the light of expected supply shortages, we forecast an additional requirement of **500 GWh** for 2014. Affluent homes are likely to meet part of their power deficits using private gensets.

[47] GLSS4 (1999) and GLSS5 (2008) published by Ghana Statistical Service.

Solar, rechargeable and battery powered lamps are fast replacing kerosene lanterns to meeting lighting loads[48].

National Electrification Scheme

The Ministry of Energy in 1989 instituted the National Electrification Scheme (NES) as Government's principal policy to extend electricity to all parts of the country over a 30-year period from 1990-2020.

Almost 1,400 communities were connected to the national grid in 2013, bringing to the total communities connected nationally to 6,857 covering a population of about 19 million. National electrification access was to about 75% as of December 2013[49]. All regional and district capitals have been connected to the national grid.

The remaining communities which are not connected to the grid numbering about 80,000 are largely small settlements with an average population of about 100.

Over 1,000 communities have been earmarked for electrification in 2014. We estimate a net electricity requirement of **100-300 GWh** for 2014, as a result of the National Electrification Scheme.

Petroleum Up-stream and Mid-stream activities

The petroleum upstream covers offshore FPSO[50] vessel operations which involves the production of oil and gas from the Jubilee field. The midstream operations cover the gas evacuation through an undersea pipeline to the processing plant which would receive the associated natural gas from the Jubilee field in the Tano (Western) Basin and process it into lean gas, LPG and other condensates.

The oil production upstream requires between 15-40 MW of power a day for its operations. This is expected to increase to 50-60MW when oil production reaches 120,000 barrels a day. Electricity consumption on the drilling ship is between 300-400 GWh per annum but the fuel supply is gas sourced directly from the oil operations offshore. Construction of the gas processing plant at Atuabo, Western Region ramped up in 2013, even though, it could not be completed as expected. Mechanical completion is therefore expected by the end of the second quarter of 2014 and full operation expected in the third quarter of the year[51]. This would require about **50-100 GWh** in 2014 for its utility operations, but would largely come from the piped wet gas expected from the Jubilee oil field.

[48] 2010 GSS National Population and Housing Census.
[49] Ministry of Energy & Petroleum, Power Sector, National Electrification Scheme, 2014, www.energymin.gov.gh
[50] Floating, Production, Storage and Off-loading vessel.
[51] Personal ccommunication with Director of Operations, Ghana Gas Company. Also from Tullow.

Energy Efficiency and Conservation measures

In order to ameliorate the challenging electricity demand and supply imbalance facing the country, the Energy Commission has already put in place conservation measures and programmes that have resulted in significant reduction of the electricity system load over the years.

Following the successful efficient lighting retrofit in 2007, which saved over 124 MW, the Energy Commission in 2009 installed automatic capacitor banks in six public institutions, leading to a total estimated savings of 1,851kVA by this intervention. The second phase involving 26 selected public institutions across the country could not be implementation in 2012 for technical reasons but would be completed in 2014 with expected savings estimated at 1875kVA or about **15 GWh**.

In the last quarter of 2011, the Energy Commission commenced the Refrigerator Energy Efficiency and Market Transformation project which would run up to end of this year. The project has a rebate and exchange component that seeks, to introduce very efficient refrigerators into the economy whilst at the same time, removing old and inefficient ones from the economy. The long term target is to change the over two million inefficient refrigerators in use in the country, with each consuming, on the average 1,200kWh per year as against 250kWh per year for very efficient ones. Studies have shown that inefficient refrigerators contribute about 50% of household electricity bills. Through the rebate scheme, the share of refrigerating appliance's contribution to electricity cost could be reduced to as low as 15%. In the short term, the project is targeting about 10,000 refrigerators by mid-2014 with estimated savings of about **8 GWh**.

Thus both the capacitor bank and the refrigerator energy efficiency projects could shave off about **23 GWh** of electricity demand this year.

Summary of forecast for the power sector for 2014 is as follows (see *Table 11*):

Table 11. Summary of Power Sector forecast for 2014

Total electricity requirement *(VALCO at 2-3 potlines in brackets)* GWh	15,676-15,932 *(20,200-21,120)*
Likely final electricity required GWh	14,571-15,351
Likely available grid electricity supply * GWh	13,011-13,971
Percentage Hydropower %	63-69[52]
Likely shortfall in capacity MW	250-400
Additional capacity required for reserve margin MW	300-350
Ghana System Peak/Maximum Demand[53] MW	1,980-2,200
GRIDCO Transmission System Peak/Maximum Demand[54] MW	2,200-2,300
Expected Jubilee gas flow rate MMBtu per day *(mmscf per day)*	80,000-100,000
Expected WAGP gas flow rate MMBtu per day *(mmscf per day)*	30,000-50,000 *(30-50)*
WAGP Gas transportation tariff ** $ per MMBtu *($ per mscf)*	4.23-4.25 *(4.31-4.33)*
Average price for WAGP Gas (cif) ** $ per MMBtu *($ per mscf)*	2.58-2.59 *(2.60-2.62)*
Total delivery price of gas $ per MMBtu *($ per mscf)*	8.40-8.55 *(8.56-8.71)*
Optimum crude oil (LCO) requirement Million barrels *(kilotonnes)*	8-9 *(1,158-1,250)*
Average price for light crude oil (LCO) *dedicated for power production* $ per bbl *($ per MMBtu)*	108-110[55] *(18.6-18.9)*
Average price for Brent crude $ per bbl *($ per MMBtu)*	107-108[56] *(18.4-18.6)*
**low-side means relatively high LCO as fuel; high-side for expected or more gas as fuel.* ***Low-side is for foundation customers and high-side for standard customers.*	

[52] Depending upon availability of natural gas which is a less expensive fuel.
[53] Domestic peak
[54] Excludes exports to Togo, Benin and la Cote D'Voire.
[55] LCO price could drop to $107-109 per barrel if the ongoing Ukrainian crisis is resolved by mid-2014.
[56] Brent crude price could drop to $105-106 per barrel if the ongoing Ukrainian crisis is resolved by mid-2014.

Opportunity for Deployment of Solar PV for the Commerce/Services Sector

The prevailing Non-residential tariff *(see Table 12)* means that it would be cost competitive to encourage mass deployment of solar electricity currently having a feed-in tariff of 40.21 pesewas per kWh (15.12 US cents per kWh equivalent[57]) equivalent for commercial applications like lighting in stores, water pumping, or shaving off consumption in the commercial and services sector during peak hours but also as an energy conservation measure.

Table 12. 2014 Non-Residential Electricity Tariff

CONSUMPTION CLASS	RATE	
	Gp per kWh	**US cents per kWh**
0-100	45.2	16.99
101-300	45.2	16.99
301-600	48.1	18.08
600+	75.9	28.53

US cent 1 = 2.66 Ghana pesewas average in March, 2014.

This is achievable through solar grid-connected systems for buildings. During sun hours, the solar unit recharges the storage battery bank and when the latter is fully charged, the excess is pumped into the grid. During no-sunshine hours, the grid takes over and supplies facility. If grid power is not available at any given time, the battery bank takes over. This would avoid the threat of grid collapse associated with utility scale grid inter-tied systems. The impending deployment of the net-metering system required under the operationalization of the Renewable Energy law would facilitate its fair and smooth implementation.

The 600^{+} Consumption Class on the other hand falls into the cost range of operating diesel gensets. Even though, it offers that class the choice of switching to diesel, it increases the operational cost, or simply, the cost of doing business in the Commerce and Services sector. This could also give a backlash where the revenue earned is diverted to cover diesel operational expenses with little or none left to pay grid power bills.

[57] US cent 1 = 2.66 Ghana pesewas average in March, 2014

2.0 Petroleum Subsector: Oil

2.1 Overview of petroleum supply in 2013

Saltpond field

Total oil production from the Saltpond field in 2013 was 105,039 barrels which was about the same as in 2012. Mean daily and monthly productions were 288 and 8,753 barrels respectively. Once again, as in the previous years, the production trend is an indication that either the field has matured or drying up" (*see Figure 3*).

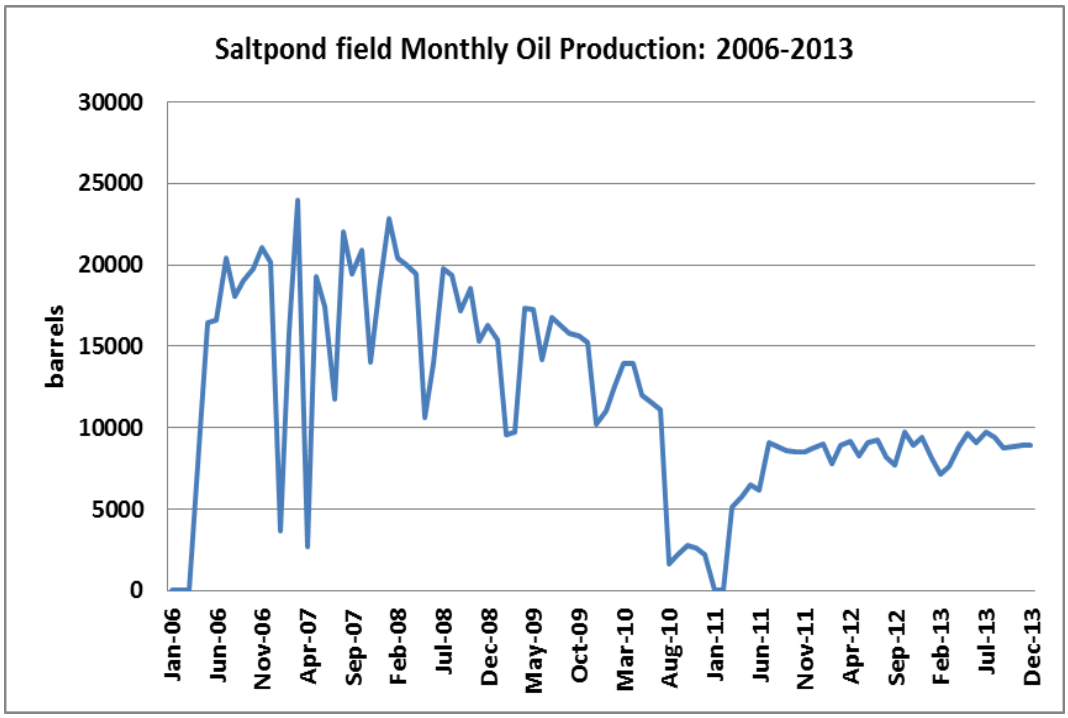

Figure 3. Trend of Saltpond field oil production since 2006

Jubilee field

Total oil production from the Jubilee field in 2013 on the other hand was around 30.4 million barrels compared with 27.4 million barrels in 2012; three million barrels more than the previous year (an increase of about 11%).

Average daily oil production from the Jubilee field increased from about 81,000 barrels in 2012 to around 91,000 barrels in 2013 (i.e. about 12% increase) though, unable to reach the target of 120,000 barrels per day as projected by the industry for 2012 and 2013 (*Figure 4*).

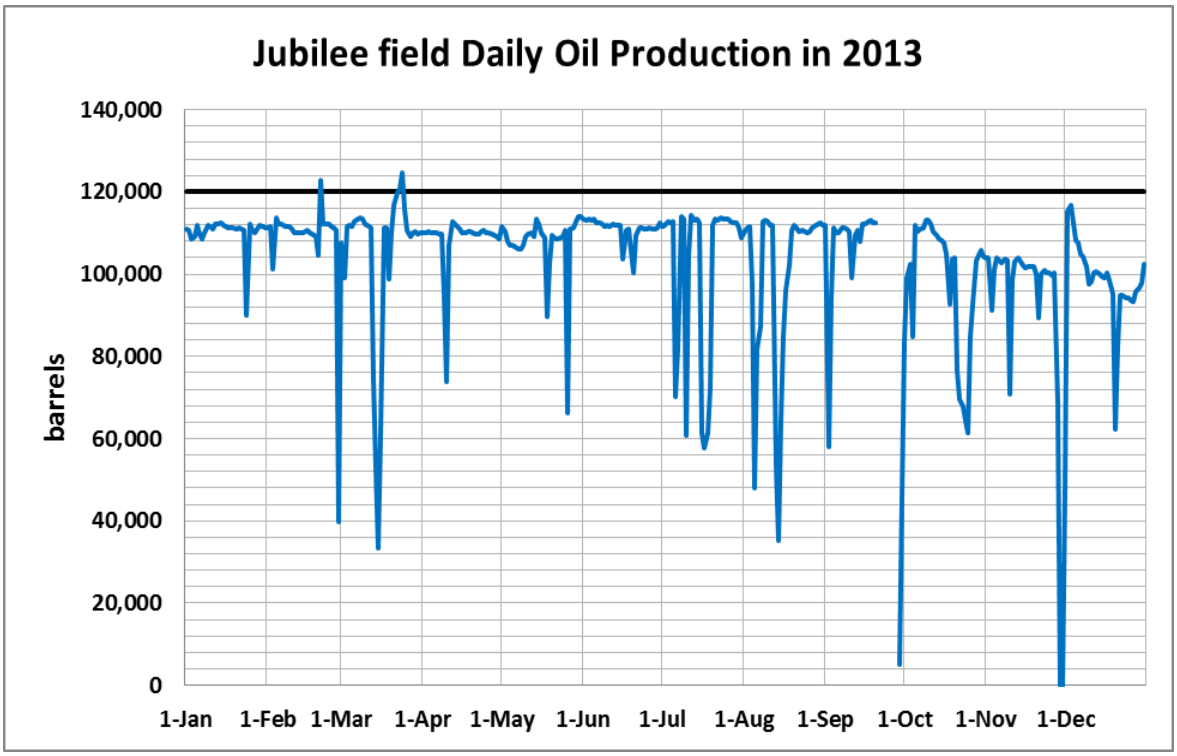

Figure 4. Jubilee field daily oil production in 2013

Production averaged about 110,333 barrels per day in January, 2013 but dropped gradually over the months until August with production falling below 100,000 barrels per day. It averaged about 73,000 barrels a day in September when production was shut down to allow for a planned maiden maintenance work on FPSO[58] Kwame Nkrumah, the floating vessel used for the production and storage of oil from the field[59]. There was therefore virtually no production in October, 2013, because of the suspended field operations for the maintenance work.

Daily production however never recovered to its January- August average levels when production resumed in November, i.e. after the maintenance work.

[58] FPSO is Floating Production, Storage and Offloading vessel.

[59] It was the first planned shutdown for maintenance to be undertaken since operations of the FPSO began in late 2010. The maintenance work was supposed to Vessel Inspections and Cleaning, Replacement of Safety Critical Equipment, as well as Pressure Relief Valve Recertification. This was necessary in line with the operating partners' obligations for external Class Certification and adherence to global Maintenance and Integrity standards used throughout the oil & gas industry.

Crude oil from the Jubilee fields was sold at an average price of about $108 per barrel[60], about 4% drop from 2012.

Domestic consumption and stocks in 2013

Crude oil imported for domestic consumption was about 1.3 million tonnes in 2013 compared to 1.2 million tonnes in 2012; an increase of around 7% from the previous year, but about 18% lower than in 2011 Electricity production accounted for about 71% of the crude oil consumption whilst primary refinery operations accounted for the remaining 29%.

Average price of crude oil sourced by Ghana in 2013 was $109 per barrel (*see Table 13*). Monthly prices averaged $112 per barrel in January, reaching its highest of $116 per barrel in February and then falling to its lowest of $103 per barrel during the second quarter which is usually the case. Average monthly price began to rise again reaching $111 per barrel in the second half of the year.

Table 13 compares the Ghanaian sourced oil prices and those of West Texas Intermediate (WTI) representing the United States and the London Brent representing Europe.

Table 13. Average crude oil prices in Ghana, United States (Gulf Coast), and Europe (the North Sea).

Year	Ghana	WTI Gulf Coast/ United States	Brent Crude North Sea/ United Kingdom
	U.S dollars per barrel		
2010	80	79.4	70
2011	111	94.9	111
2012	113	93.3	112
2013	109	97.9	109

Source: Bank of Ghana, LondonGasPrice.com, tradingnrg.com

Total products consumed in 2013 amounted to around 3.3 million tonnes, about 3.2% over supply in 2012[61]

The three major movers in 2013 were RFO, gasoline, and diesel; whilst 2012 had premix gasoline, LPG and gasoline; as the highest movers (*see Table 14*).

[60] Sourced from Bank of Ghana and Ministry of Finance, December 2013; first quarter - ≈$112; second quarter- $102; third quarter-$110; fourth quarter- estimated at $111.

[61] Stocks from the previous year but held by the oil marketing companies might have added up to the supply in the year to make up the total consumption.

Table 14. Petroleum product consumption for 2011-2013

PETROLEUM PRODUCT	2011	2012	2013	*CHANGE*	
				b/n 2011 & 2012	***b/n 2012 & 2013***
	1000 tonnes			***Percentage***	
LPG	214.4	268.5	251.8	*25.2*	*-6.2*
Gasoline	807	992.7	1,080.6	*23.0*	*8.9*
Premix	45.5	58.9	53.4	*29.5*	*-9.3*
Kerosene	62.4	45.6	27.8	*-26.9*	*-39.0*
ATK	135.3	141.3	131.9	*4.4*	*-6.7*
Gas oil/diesel	1,511.5	1,665	1,722.6	*10.2*	*3.5*
RFO	37.5	33.5	39.3	*-10.7*	*17.3*
Total	**2,813.70**	**3,205.50**	**3,307.40**	***13.9***	***3.2***

Source: National Petroleum Authority, 2014.

Petroleum products imported in 2013 were about 3.0 million tonnes, an increase of about 20% over imports in 2012. The products imported were LPG, gasoline, diesel and fuel oil. Growth in gasoline imports increased from 14% in 2012 to 25% in 2013. Diesel oil imports also increased from 9% in 2012 to 25% in 2013, whilst LPG imports dropped from about 36% in 2012 to around 15% in 2013.

Total net oil products supplied[62] to the economy continued to show an upward trend; it was about 2.9 million tonnes in 2013 compared to 2.7 million in 2012 (*see Figure 5*). Products exported were largely marine gas oil (MGO) sold to foreign vessels and heavy gasoline (naphtha). Total product exports in 2013 dropped to almost half of 2012.

[62] Total net oil supply = production + imports – exports

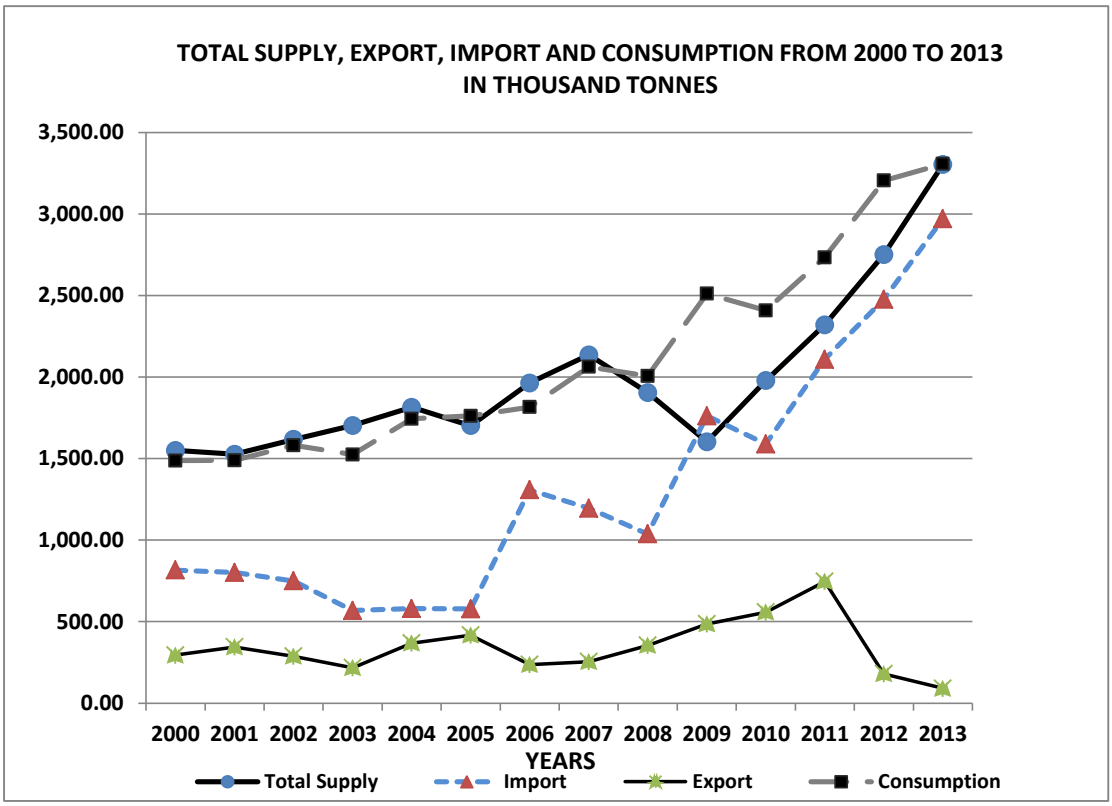

Figure 5. Total oil products supplied from 2000 - 2013

2.2 2013 forecast and actuals

Table 15 presents the forecast and the actuals for 2013.

Table 15. Yearly average crude oil prices for 2013: Forecast and Actuals

	Ghana		WTI Gulf Coast/ United States		Brent Crude North Sea/ United Kingdom
	Brent	**LCOs***	**Brent**	**LCOs***	**Brent**
Forecast	108-110	98-102	106-107	92-97	108-110
Actual	109	109	110	101	109

**Other light crudes / U.S refiner*

Source: Bank of Ghana, www.LondonGasPrice.com, www.tradingnrg.com

Ghana's total crude oil import in 2013 was about 1.3 million tonnes, from 1.21 million tonnes in 2012 and as usual came largely from Nigeria (an OPEC country).

Crude oil for refinery operation has continuously dwindled since 2010. Crude oil refined at Tema Oil Refinery (TOR) slumped again from about 506,000 tonnes in 2012 to just 374,400 in 2013 compared to the refinery capacity of about two (2) million tonnes per annum. In 2011, about 1.3 million tonnes of oil was refined at TOR. Except for ATK and LPG, supply of diesel and gasoline to the economy increased significantly (*see Table 16*).

Table 16. Comparing major petroleum products consumption in Ghana in 2012 and 2013[63]

PRODUCTS	2012 CONSUMPTION			2013 CONSUMPTION		
	1000 Tonnes			1000 Tonnes		
	Forecast	Actual	Net /shortfall	Forecast	Actual	Net /shortfall
Gasoline	850 – 870	992.7	122-143	850-970	1,080.6	110.6-230.6
Diesel	1,600 - 1,700	1,361.3	239-339	1,600-1,700	1,722	22-122
Kerosene /ATK	200 – 230	214	14-16	200-230	159.7	40.3-70.3
LPG	250 – 300	268.5	18.5-31.5	250-300	251.8	1.8-48.2
Total	***2,900 3,100***	***2,836.5***	***63,5-263.5***	***3000-3,200***	***3,214.1***	***14.1***

NB: Total diesel consumption includes sales to the mining companies and bunkering.
Total gasoline consumption includes premix and other premium formulations.
Petroleum supply shortfall in brackets- red

ATK supply shortfall in the country compelled a number of foreign airlines to make alternative refuelling arrangement with neighbouring countries before landing or taking off in the country[64]. The shortage also affected the local aviation industry such that some airlines were forced to reduce their operations[65].

There was also a shortfall in LPG supply which was somehow more challenging than in 2012. Demand for LPG would continue to grow considering the seemingly large number of vehicles that have switched from gasoline to LPG (*see Figures 6 and 7*).

Significant reduction in subsidies on retail prices of LPG might have once again helped in retarding its vehicular consumption.

[63] In this analysis, products supplied to the economy were assumed to be consumed.
[64] Upon an advice by the Ghana Airport Company.
[65] Sourced from Ghana Airports Company, Tema Oil Refinery, March, 2014.

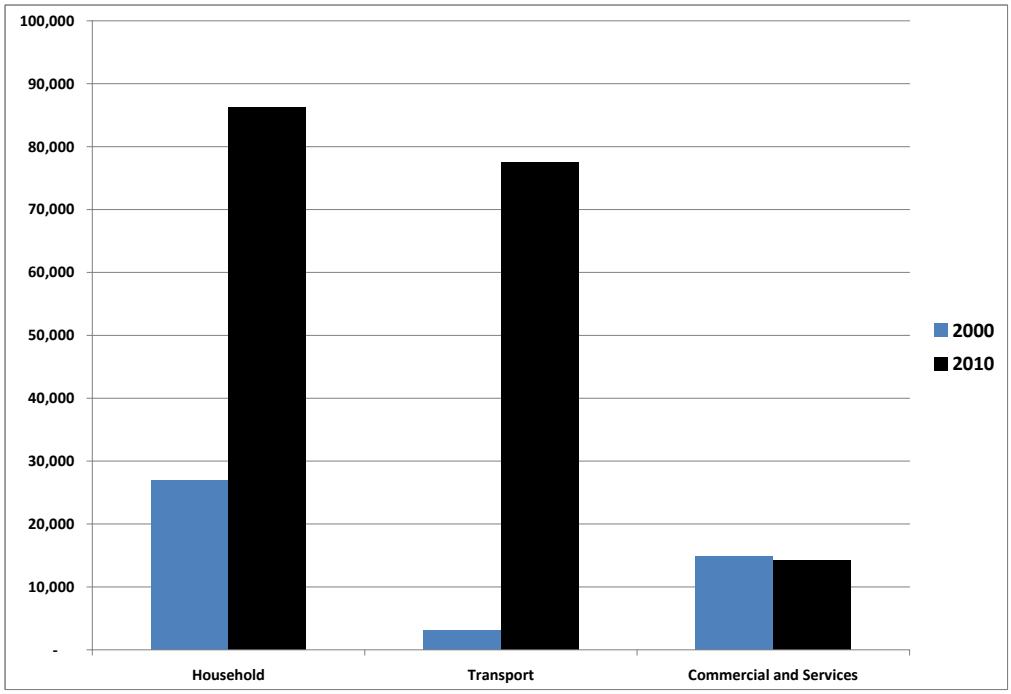

Figure 6. LPG consumption in tonnes for 2000 and 2010

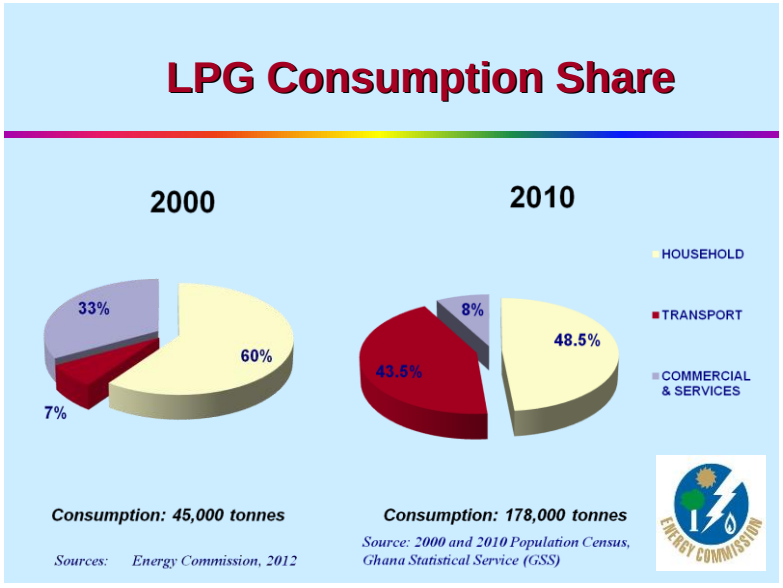

Figure 7. LPG consumption shares for 2000 and 2010

Household fuel use

The improvement in household incomes over the past decade[66] is apparently manifesting in the shift from woodfuels and kerosene to LPG for home cooking. (*see Table 17*).

Table 17. Energy for Household Cooking in 2000 and 2010.

Energy source	2000			2010		
	National	Urban	Rural	National	Urban	Rural
Percentage Penetration						
LPG	**6.2**	*11.8*	*1.1*	**18.2**	*41.5*	*4.8*
Charcoal	**30.0**	*54.3*	*8.2*	**33.7**	*74.6*	*15.9*
Firewood	**55.8**	*22.9*	*85.2*	**40.2**	*26.7.*	*73.4*
Kerosene	**2.0**	*2.6*	*1.4*	**0.5**	*1.1*	*0.3*
Electricity	1.1	*2.0*	*0.4*	0.5	*1.1*	*0.3*

Source: 2000 and 2010 National population census, Ghana Statistical Services

From **Table 17** again, cooking with electricity even though already marginal had also dropped by half by 2010, most probably due to its relatively high cost.

It is clear from **Table 18**, that for a developing economy like Ghana, economic growth is directly and strongly related to injection of adequate energy. The fall in GDP growth in 2012 had been attributed to the fall in oil production and subsequently revenues from it compared to 2011.

Table 18. Ghana's Oil Imports, costs and GDP growth compared

Year	Crude oil (million tonnes)		Products imported (1000 tonnes)	Petroleum imported in US$1000 (cif)	Average Crude oil price US$/bbl	Real GDP at 2006 constant prices Million GH Cedis	Real GDP growth Rate
	Import	Export					
2006	1.71	0.02	906	1,686	66	18,705	6.4%
2007	2.05	0.03	1,200	2,145	73	19,913	5.7%
2008	1.98	0.03	1,096	2,413	98	21,592	7.3%
2009	0.98	0.02	1,890	1,472	62	22,454	6.3%
2010	1.66	0.01	1,450	2,134	80	24,252	8%
2011	1.53	3.53	2,075	3,159	111	27, 891	15%
2012	1.21	3.78	2,478	3,279	113	30,343	8.8%
2013	1.30	5.11	2,970	>3,500	109	32,507	7.1%*

** Estimated*

Data source: Bank of Ghana, December 2013, Ghana Statistical Services, 2014

[66] GLSS4 (1999) and GLSS5 (2008) published by Ghana Statistical Service.

Inadequate natural gas for power generation would trigger increase demand in oil fuel as the most viable option. Oil is however about two-three times more expensive than gas. Thus without adequate revenues to purchase the required oil supply for public/grid electricity generation, private generation largely via gensets would expand with corresponding increase in diesel requirement.

2.3 Forecast for 2014

Most of Ghana's crude oil supplies would continue to come from Nigeria (an OPEC country) and Equatorial Guinea (a non-OPEC country)[67].

Oil production from the Jubilee field has averaged 100,000 barrels per day since the beginning of the year but could slump if the associated gas continues to be re-injected for the rest of the year. We however project oil production to ramp up to 115,000-120,000 barrels per day should significant volumes of the associated gas be allowed to escape[68].

We forecast that average Brent crude oil price that Ghana buys would be $107-108 per barrel [69] and $105-106 per barrel for other light crudes for refinery operations (*see Table 19*). Jubilee field oil was exported at an average price of $108 per barrel. We expect the average price for this year to remain the same as in 2013.

Table 19. Forecast for average light crude oil prices for 2014

FUEL BRAND	Ghana	United States (WTI and NYMEX)	Europe
	US dollars per barrel		
Brent crude	107-108	105-106	107-108
Other light crudes/ U.S refiner	105-106	96-97	102--103

Quantities of imported crude oil refined at TOR and products imported to meet shortfall went up from about 3.08 million tonnes in 2012 to around 3.34 million tonnes in 2013, an increase of about 8.5% which was within our forecast for that year.

With the expected slightly drop in crude oil prices, we estimate that the total crude oil and imported products required for **2014** would range between **3.45-3.65 million tonnes** in order to meet optimal refinery operations and products for local consumption, an increase of

[67] All in West Africa.
[68] Either by flaring or transporting to the gas processing plant at Atuabo.
[69] With characteristics almost or similar to Brent crude.

between 5-7% depending upon the retail prices (*see Table 19*). To avoid product shortages, crude oil required for refinery operations would vary from **1.0-1.5 million tonnes (7-11 million barrels**) during the year, depending upon the availability of the Tema Oil Refinery and its auxiliary units. The remaining **2.45-2.55 million tonnes** balance would be imported products. The shortfall in grid electricity would culminate into significant demand for diesel for back-up power operations.

Table 20 presents estimated the total refined products required for 2014.

Table 20. Petroleum product forecast for 2014.

PRODUCT	**National supply requirement**
	Tonnes
Total Gasoline	1,150,000 -1,200,000
Total Diesel	1,760,000 - 1,850,000
Kerosene/ATK	240,000 - 250,000
LPG	300,000 - 350,000
Total	***3,450,000 3,650,000***

Capacity utilisation at Tema Oil Refinery (TOR) in 2012 was just around 19%. However, based on international standards, 95% capacity utilization is required for refineries to achieve economic viability. TOR is supposed to refine all the crude oil needs of the country, except for consignments meant for power generation. It comprises a Crude Distillation Unit (CDU) of production capacity 45,000 barrels per day (bpd) and a 14,000 bpd Residual Fluid Catalytic Cracker (RFCC) unit to process RFO, a by-product of crude oil processed by the CDU, into more diesel, gasoline and LPG.

The country's annual petroleum requirement has however far exceeded the capacity of TOR by about 50%, assuming TOR is operating at over 90% capacity utilisation.

LPG supply: Half of the total LPG requirement could be met if TOR is operating at over 90% capacity on the average during the year (*see Table 21*). This would also reduce the LPG import requirement to half of the national demand.

However, limited local production means about two-thirds or more of the LPG national requirement would be imported. Cross-subsidization of the ex-depot price of LPG means gasoline and diesel are made to carry most of the tax and levy burden[70]. The shift from

[70] Gasoline carries most of the levies and taxes, whilst LPG is taxed for only excise duty and debt recovery levy.

gasoline to LPG by vehicle users also suggests that the necessary revenues expected are not generated from the gasoline sales to augment or beef up LPG imports[71].

Table 21. Operating performance of Tema Oil Refinery with and without the RFCC[72]

	Without RFCC		With RFCC	
	Tonne per year	**Weight %**	**Tonne per year**	**Weight %**
Technical operational capacity in tonnes	1,995,000	100	1,995,000	100
Products				
LPG	26,136	1.3	114,944	5.8
Gasoline	300,273	15.1	580,615	29.1
Naphtha	38,595	1.9	0	1.9
ATK/kerosene	270,629	13.6	270,629	13.6
Diesel	716,206	35.9	798,034	40.0
Fuel Oil	582,994	29.2	71,575	3.6
Consumption/Losses	60,379	3.0	119,930	6.0

Adapted from Tema Oil Refinery data

Total national LPG storage capacity is also a challenge. In summary, storage limitations and insufficient revenue generation could constrain the supply to less than 300,000 tonnes in 2013. Otherwise, total LPG requirement of the country could exceed 300,000 tonnes up to 350,000 tonnes due to the increasing requirement by the transport sector as fuel, considering that demand growth for LPG as fuel for transport in southern sector had ranged from 11-26% per year since 2006[73].

Additional LPG supplies for the country is expected from processing the wet associated gas from the Jubilee field, when the gas processing facility becomes operational during the second half of this year. For instance, processing 160 mmscfd of the wet gas would yield about 1,000 tonnes of LPG a day, which would be enough to meet the country's short term; 1-2 years demand[74]. Evacuation challenges however from the Gas Processing Plant at Atuabo in Western Region need to be resolved to enable full utilization of the LPG from gas processing.

Priority Issues

We reiterate some of the issues raised in the earlier Outlooks since they were hardly implemented.

[71] LPG price for vehicular fuel is slightly higher than for domestic cylinders but still far lower in energy terms when compared to gasoline.
[72] RFCC is Residual Fuel Catalytic Cracker.
[73] Energy Commission (2011), Liquefied Petroleum Consumption survey, 2003-2007. Energy Survey in Households, Industries, Commercial and Services.
[74] Assuming short term is 1-2 years; 2015-2016 and medium term; 2015-2020.

i. Expand refinery capacity as soon as possible

Crude oil in stock would still have to be refined into usable end products. With the commercial oil production, Ghana stands to gain immensely if immediate steps are taken to expand the refinery capacity of the country. It costs less to import crude oil for refining locally than importing the finished products as shown in **Table 22**.

Table 22. International Price Scale: Ratio of prices of refined product against crude oil

Products	F.O.B	C.I.F*
Crude oil	1.0	-
Gasoline	1.3	1.5 – 1.6
Diesel	1.25	1.3 – 1.4
Kerosene/ATK	1.35	1.4 – 1.5
Fuel oil	0.6 – 0.7	0.8 – 0.9
LPG	1.4	1.5 – 1.7

* *Depending upon distance for delivery*

Ghana announced her intention to expand the Tema Oil Refinery (TOR) as well as build a new refinery in the late 1990s but no construction has since started.

Export opportunities in the West Africa sub-region abounds and an expanded refining capacity would therefore position the country to take advantage of the inadequate refinery capacity in West Africa. Total consumption in non-refinery countries[75] in West Africa has exceeded 80,000 barrels per day (*about 4 million tonnes per annum*). Besides, Nigeria has total refinery capacity of about 800,000 BPD (about 20 million tonnes) but production has been below 50% capacity due largely to operational difficulties. Ghana could quickly expand TOR whilst it makes plans to construct a new refinery to meet local demand as well as targeting the economies within the sub-region, particularly those without refineries and at least, capturing 50% of the market by 2020. Since, building a new refinery of about100,000 barrels per day capacity takes between 3–5 years, such a facility in Ghana could be operational by 2019 if construction starts by 2015.

With the limited refining capacity within the West African sub-region for the short-to-medium term, it is prudent that the right and attractive investment climate is created to encourage investment in new refineries in the country.

It must however be noted that the profitability of refinery operations is very sensitive to the capacity utilisation; 90% capacity utilisation has been accepted as benchmark for economic operations of most refineries. It would therefore be economically wise to locate such say a

[75] Benin, Burkina Faso, The Gambia, Guinea Bissau, Equatorial Guinea, Liberia, Niger, Mali, Mauritania, Togo

100,000 barrel per day refinery plant in the Export Processing Zone (EPZ) with export market as part of its target.

ii. LPG Supply

Increasing refinery capacity and revamping of TOR would increase the production of LPG at TOR. Limited storage capacity however would continue to constrain local distribution and access.

Even though, additional LPG supplies for the country is expected from processing the wet associated gas from the Jubilee field, when the gas processing facility becomes operational during the second half of this year, adequate storage tanks to receive the product should be ready. Unfortunately, the tanks have not been built, at the time of completing this report. This denies the country the maximum benefit from the wet gas value chain.

Evacuation of the LPG could be done by road with LPG tankers and by sea/water with ship, but the most efficient way would be by dedicated pipeline from the processing plant to the storage or tank farms wherever they are located.

Overland pipelines are generally found to have lower cost per unit and higher capacity compared to shipment by rail or road and for that matter the most economical way to transport large quantities of fluids[76] over land. Overland pipeline transportation and distribution have therefore being the dominant mode for terrestrial oil and products transport. It is also said to be safer.[77]

Unfortunately, such an LPG pipeline has also not been built. This mandate falls under BOST. Opportunities for public-private partnership (PPP) financing or incentives to attract private investment for build-operate-transfer (BOT) arrangement should be explored.

[76] Also natural gas and crude oil.
[77] Advances in Natural Gas Technology, INTECH publication, April, 2012, edited by Hamid A. Al-Megren, www.intechopen.com/books.

3.0 Petroleum Subsector: Natural Gas

3.1 Overview of natural gas supply in 2013

Total WAGP gas flow in 2013 was about 14,509,257 MMBtu (15,510 mmscf); about 63% (74% in 2012) destined to the thermal plants in Tema and the rest; 37% (26% in 2012) to Takoradi *(see Figure 8).* The average daily gas flow for the Tema and Takoradi thermal plants were 53,378 and 31,528 MMBtu per day[78].

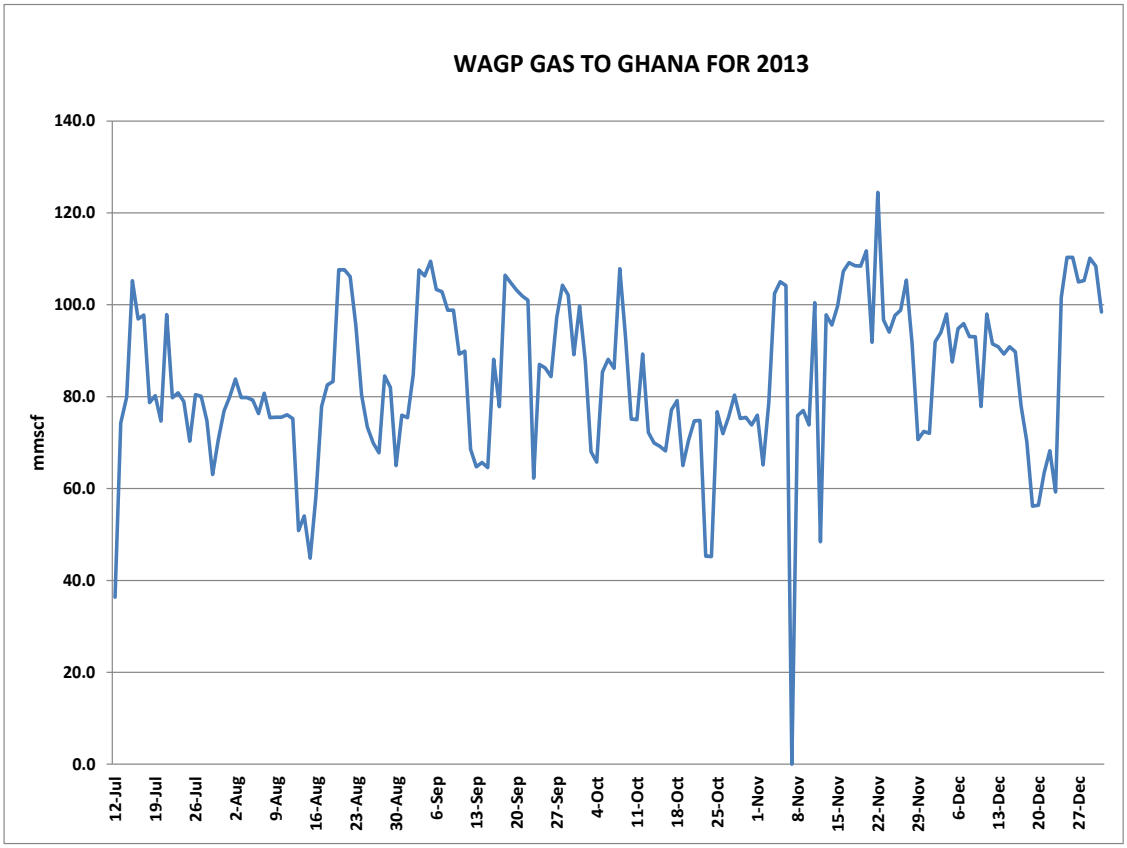

Figure 8. Total WAGP gas supply for Ghana in 2013

[78] Source: data received from WAPCo, 2014.

3.2 2013 forecast and actuals

We projected that despite the encouraging flows in 2011, Ghana was not likely to see the same fortune in 2012-2013 in the light of growing gas demand and political developments in Nigeria.

In 2013, the WAPCo tariff for transporting natural gas via the West African Gas Pipeline (WAGP) was $4.2378 per MMBtu for Foundation customers and $4.346 per MMBtu for Standard customers. Average WAGP gas price in 2013 dropped for Foundation customers, from $2.587 per MMBtu in 2012 to $2.4688 per MMBtu. The total delivery gas price in 2013 was $8.27 per MMBtu for Foundation customers and $8.38 per MMBtu for Standard customers[79] (*see Table 23*).

Table 23. WAGP Delivered Gas Price Components in 2013

Details	Customer Price	
	Foundation	Standard
	$/MMbtu	
Gas Purchase	2.4688	2.4688
ELPS Transport	1.2745	1.2745
WAGP Transport	4.2378	4.3465
WAGP Credit Support Charge	0.2000	0.2000
WAGPA Charge	0.0600	0.0600
Delivery or shipper fee	0.2000	0.2000
Pipeline Protection Zone charge	0.0300	0.0300
Fuel Gas – Commodity	2.4688	2.4688
Fuel Gas - ELPS Transport	1.2745	1.2745
Shipper Fee	0.0000	0.0000
Delivered Gas Price ($/MMbtu)[80]	**8.2711**	**8.38**

Source: Adapted from WAPCo, 2014

3.3 Forecast for 2014 and beyond

For 2014, we do not expect any significant price changes from 2013 since there were not major technical developments on the pipeline after its repairs from the 2012 accident. We however expect slight upward adjustment in the gas purchase price to about $2.60 per MMBtu bringing the total delivery price to within $8.40-$8.55 per MMBtu.

[79] Source: WAPCo, 2013. Communications with the statistical personnel.

[80] Delivered gas price is not an absolute sum of the listed charges. It is usually the total less the repetitive charges. It also does not include the Credit Support Charge component.

Comparatively, average spot (Henry Hub) price in the United States is projected to increase from $3.73 per MMBtu ($3.84 per mscf) to between $4.44-$4.78 per MMBtu ($4.52-$4.88 per mscf) [81] whilst average import delivery price in Europe is expected to drop from $11.70-12 per MMBtu to around $10-11 per MMBtu during the year (*see Table 24*)[82].

Table 24. Average delivery gas prices in Ghana (WAGP), United States (Henry Hub), and Europe (the North Sea); 2011-2014

Year	WAGP/ Ghana	Henry Hub/ United States	Northsea Europe/
	U.S dollars per MMBtu *Average LNG import prices in italic brackets*		
2011	6.56	3.59	8.70 *(11.97)*
2012	8.19	2.75	8.90 *(11.79)*
2013	8.27-8.38	3.73	8.80 *(11.78)*
2014*	**8.40-8.55**	**4.44-4.78** ***(7-8)***	**8.60** ***(10-11)***

**forecast*
Source: Bank of Ghana, LondonGasPrice.com, tradingnrg.com

Securing adequate supply of gas is fundamental to improving availability as well as providing relatively affordable electricity price. Restoring the high supply levels Ghana had in 2011 to August 2012 again, would depend upon demand and political developments in Nigeria due to supply constraints in Nigeria itself.

Existing and on-going power projects in Nigeria if all goes well as planned could expand the country's installed capacity to about 13,000 MW by 2016 and 15,000 MW by 2020[83]. The country achieved a generating capacity of 4,350 MW by end of 2012, a feat attributed to more gas being made available last year. According to NERC[84], the country likely to achieve a generation capacity of 7,000 MW in 2014, a target it failed to achieve in 2013. This ambition puts a greater strain on the existing supply situation. Nigeria is struggling to achieve its domestic supply and export plans. Supply requirement totals about 5 billion cubic feet per day (bcfd) for domestic consumption, LNG contractual shipments and WAGP commitments. The country needs to develop new fields and bring them on line to meet the projected demand but experts in the industry do not expect even up to half of the supply to be realised until 2016-2017.

The current policy of the Nigeria government somehow seems to be meeting local gas demand first before considering exports to neighbouring countries. For this reason, there is a policy in place compelling all major gas shippers including N-Gas that ships gas to Ghana through the West African Gas Pipeline to meet local supply quota first before export. As of

[81] Spot prices usually do not include transportation cost.
[82] US EIA Short Term Energy Outlook, March, 2014.
[83] Energy Commission of Nigeria, website news update, 1st Quarter, 2014.
[84] Nigeria Electricity Regulatory Commission, Nigeria Power Report, first quarter 2014.

end of 2013, most shippers are finding it difficult to meet the local quota obligation and should be one of the reasons for the relatively low average supplies this year.

3.4 Alternative natural gas supply sources

3.4.1 Supply from the Jubilee field

Total associated gas produced as a result of the daily oil production in 2013 was about 48,466 mmscf; 61% more than in 2012. About 86% was re-injected, 5% was used as fuel for on-board operations compared to 9.5% in 2012. Associated gas flared however went up from 3% and 5% in 2011 and 2012 respectively to about 8% in 2013 (*see Figure 9*).

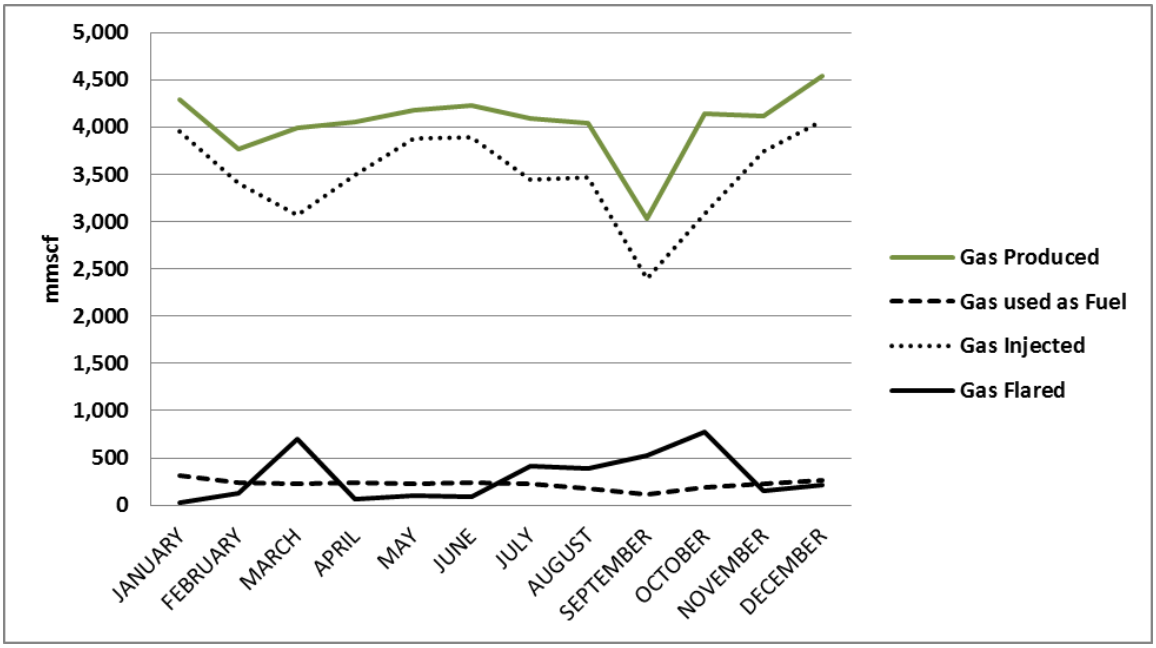

Figure 9. Jubilee field daily gas production in 2013

Recalling that associated gas flared was about 96% at the beginning of commercial production in 2010, this is still encouraging and it is also an indication that the field operators now understand the geology of the formations and so are confident in doing more re-injection of the gas. There is however still some uncertainties as to how long the geological formation would allow re-injection beyond this year if most is not flared by the end of the year. Jubilee

has gas reserves of up to 1.4 Tcf but the delay in production and subsequently transporting it out of the field for productive uses is affecting crude oil production from the field[85].

Pipeline infrastructure to transport the associated gas being produced from the Jubilee fields, from the FPSO[86], onshore for processing is now complete. The construction work on the US$750 million gas processing plant at Atuabo in the Western Region was originally scheduled to be completed in last quarter of 2013, but was not possible due to financial and technical challenges. Mechanical completion of the gas processing plant now is expected by the end of the second quarter and, then commissioning which involves test runs may take up to three months. Commercial operation is therefore expected between August and September, 2014, but Ghana Gas Company is optimistic that commercial operations could start in July[87]. Expected net average gas supply would range between 80-100 mmscfd.

Nonetheless, there is still the fact that the associated gas from the Jubilee field even at 120 mmscfd alone would not be adequate to meet the current gas requirements for medium-to-long term. For this reason, supplementary supply options would have to be looked at.

So far the Energy Commission has issued Provisional wholesale Supply Licence and a Construction Permit to Ghana National Gas Company (GNGC) for the construction of pipelines from the gas processing plant from Atuabo to link the West African Gas Pipeline (WAGP) at Aboadze.

3.4.2 Supply from LNG re-gas facility

There are however opportunities for LNG supply through the following sources:

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

For N-Gas of Nigeria to limit gas supply to WAGP at contract volume of 123 mmscfd instead of the full capacity of 440 mmscfd as originally agreed in the supply contract is of concern but not hopeless[88]. The supply balance of 312 mmscfd reinforces the opportunity for the development of a viable LNG terminal. Furthermore, the un-utilised space in the pipeline can be used as gas storage through a technique known as "line packing" to serve as

[85] Africa Oil and Gas , Vol 17, Issue 9, April 2014.
[86] Floating Production, Storage and Offloading (FPSO) Kwame Nkrumah MV 21
[87] Personal communication with Director of Operations of Ghana Gas Company, February, 2014. Also from Africa Oil and Gas , Vol 17, Issue 9, April 2014
[88] Energy Commission source.

temporary back-up for the potentially alternative gas supply sources but to only to offset very short interruptions in supply.

Under the WAGP sales agreement, **Open access** to the pipeline, i.e. allowing third parties to access the pipeline if convenient is now in place.

About 43 LNG regas plants of 100-200 mmscfd capacity existed globally as at 2010. Eleven new ones have either been approved or under construction and 22 new projects were announced (Annex 2). Larger capacity LNG regas plants are also available.

With significant commercial shale gas discovered in North America demand pressure on global supplies is expected to reduce and natural gas global market average spot price is expected to stay within US$5.5-6.5 per MMBtu for the next five years[89].

Deployment of LNG regas facility

Permanent LNG discharge/re-gasification terminal

Development of permanent LNG re-gasification plant of 100-200 mmscfd capacity however require at least **three-four** years even if a project is approved and money is available today.

Nevertheless, for a permanent LNG regas facility, supplies to Ivory Coast could be included as a medium-to-long term potential market to supplement dwindling indigenous supply in that country. One should also not be surprised, if such a project end up supplying gas to neighbouring Togo and Benin also in the long term provided the WAGP facility allows reverse directional flow.

Energy Bridge Regasification Vessels

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

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

[89] International Energy Agency (IEA), medium to long term forecast, 2013.

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

Floating Re-gasification plants

Average lifetime of most LNG vessels is 25 years. This means LNG vessels built more than 25 years ago have become less competitive for transport services. Such an LNG ship is retired and reconfigured as floating LNG re-gasification facility. Typical LNG ship has capacity of 120,000-125,000 liquid cubic metres (lm^3). The larger the containment the greater the application for floating storage and regasification applications[90]. Some 59 ships built worldwide before 1983 with containment between 122,000-133,000 liquid cubic metres are due for retirement.

Construction of floating regas terminals has rapidly increased since 2005 when the first one was built in Louisiana, USA. Four units were commissioned between February 2007 and August 2008.

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

Cost implications of LNG supply option

LNG supply option however would be relatively expensive compared to local or the WAGP gas. Potential LNG supplies are likely to come from cargos from Nigeria and Angola destined for United States and or the European markets. LNG cargoes from Nigeria to the United States would potentially offer the least cost due to the prevailing low gas prices in the latter. Nigeria accounted for 3% of United States' LNG supply in the past but with the existing gluts in the latter, shippers are looking for alternative markets, of course, the bulk would go to the growing Asian market.

Ownership and financing arrangement would also impact significantly on the cost of the delivered gas. Ownership can be Joint Venture - shared cost between a Ghanaian and foreign partners; Public or State Private Partnership (PPP); or facility wholly owned by a foreigner investor.

PPP through state participation by providing sovereign guarantee is likely to reduce cost further due to potential decrease in risk cost.

Table 25 presents a qualitative analysis of likely cost range for the country if such is built within the next two years.

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

Table 25. Estimated LNG cost range based on cargo shipments from Western Africa to United States and Europe.

LNG Cargo Destination	Ownership/Financing Arrangement in US dollars per MMBtu*			
	PPP	Joint Venture/ Shared Cost	Operator wholly owned	***Add*** Construction of off-loading/regas berth
From Nigeria en-route to USA	6-7	8-9	9-10	1.0-2.0
From Nigeria en-route to Europe	7-8	9-10	11-12	
From Angola en-route to USA	7-8	9-10	10-11	
From Angola en-route to Europe	8-9	11-12	13-14	

**Assuming operating life time of 5-10 years and minimum delivery volume of 200 mmscfd*

3.4.3 Supply from other domestic fields

Besides the gas from the Jubilee field, more associated gas is expected from other neighbouring fields in the medium to long term, the most prominent being TEN (Tweneboa-Enyenra-Ntomme) field where oil production is expected to commence between 2016-2017[91], but this would depend on rate of development of the field. Plan of Development for TEN which is estimated to cost $4.5 billion was approved in the second quarter of 2013 and commenced during the second half of the year. TEN is expected to yield an average of 90 mmscfd for over 20 year operational lifetime.

The Sankofa field, another neighbouring field presents the most significant proven non-associated gas discovery in recent times. Estimated yield is about twice the projected average yield from Jubilee; about 185 mmscfd. Deepwater 'non-associated' however means it would cost more to develop the field. Wellhead price is estimated to be $6-9 per MMBtu compared to wellhead cost of the Jubilee associated gas which is virtually given to Ghana for free[92]. In all cases, generation from gas supply options including the LNG would be less expensive than any oil-fired option.

The initial natural gas demand at Takoradi Thermal Power Plant if the WAGP pipeline were to be operational in 2006 was 36 mmscfd. With the number of thermal power plants currently installed and expected to be in operation by 2015, the current demand is between **350-400 mmscfd** which is about twice the breakeven point for a typical 200-250 mmscfd LNG re-gasification facility. Demand is expected to jump up significantly when gas from the other

[91] Estimated as the commencement year. The operator, Tullow is optimistic that the first oil can flow by mid-2016.

[92] Adapted from the World Bank commissioned report: Natural Gas Pricing Policy for Ghana, Final Report, May 2012, consultant- R. Garcia Consultores S.A

fields discussed are developed and full production starts between 2017 and 2018. Gas demand is projected to exceed **800-mmscfd** by 2017 (*see Table 26*)[93].

Meanwhile, total production from all these local fields is expected to range from a minimum of about **80 mmscfd in 2013** and ramp up to a maximum of about **400 mmscfd** by **2018** if developments of the fields are carried out as planned. Total gas supply is not likely to exceed **500 mmscfd by 2020**.

Thus based on the projected electricity demand and estimated gas required by existing power plants plus those under construction and those planned or issued with licences by the Energy Commission, the country has already been experiencing gas supply shortfalls since 2011 and it is likely to continue. The situation becomes more challenging when industrial demand is included.

In the light of limited supply from Nigeria, the only cost effective gas supply option to quench the shortfall is by LNG import.

In summary, LNG imports would augment domestic gas to make up adequate supplies to meet both power and industry requirement such as for the anticipated production of fertilizers (urea), alcohol (methanol) and other petrochemicals.

In making our forecast for the natural gas up to 2020, we made the following assumptions:

- that industrial use of gas is not likely to be realised until 2015-2016, starting with 5 mmscfd by 2015 to about 50 mmscfd by 2020.
- that a typical urea-fertilizer plant with minimum capacity of 800,000 tonnes per year would require about 50 mmscfd but would not be available until 2017, if construction is even to starts this year-2014.
- that a typical methanol plant with minimum capacity of 800,000 tonnes per year would require about 70 mmscfd but would not be available until 2017, if construction is even to commence this year-2014.

[93] See 2010 Energy Outlook, Energy Commission, 2010.

Table 26. Natural gas forecast for Ghana in mmscfd, 2014-2020

Year	2014	2015	2016	2017	2018	2019	2020
Min *Power only*	**350**	**350**	**400**	**840**	**840**	**870**	**870**
Max *Power only*	**400**	**400**	**446**	**1,128**	**1,128**	**1,140**	**1,140**
Min *Non-power incl.*	**350**	**350**	**380**	**980**	**990**	**1,030**	**1,040**
Max *Non-power incl.*	**400**	**400**	**456**	**1,268**	**1,278**	**1,300**	**1,310**
Current supply	**30-50**						

Source: Energy Commission, 2014

What is urgent at present is for the Government to ensure that the required commercial framework for the development of Sankofa and other new fields are finalized by close of this year–2014 to enable commercial production to commence by 2017. The development of the Sankofa field would require significant fiscal incentives such as tax holidays to investors to make it economically viable since unlike oil which could easily be stored and ferried out of the country's borders to external markets, non-associated gas requires long-term supply commitment before they are developed.

3.5 Recommendation

We thus make following recommendations:

i. *Government proactively creates incentives to encourage investment in LNG regas facility to be built in Ghana at the shortest possible time.*

ii. *Government ensures as a matter of urgency, that the required commercial framework for the development of the Sankofa field are finalized by close of this year – 2014 to enable commercial production in this field also to commence by 2017 as expected with the TEN field.*

iii. *Government provides significant attractive fiscal incentives to investors to make the non-associate gas fields economically viable to develop.*

4.0 Woodfuel Subsector: Charcoal demand and prices

Average prices of charcoal in the country rose from about GH¢11 per mini bag and GH¢18.24 per maxi bag in 2012 to GH¢13.25 per mini bag and GH¢21.16 per maxi bag in 2013; increases of about 20% for mini-bag and 16% for the maxi-bag over the previous year. We projected that average charcoal price in 2013 would increase by 20-25% over 2012 average price nationwide due to the nationwide LPG price increment in early 2013.

The coastal regions were the high-price regions for 2013. Central and Volta Regions experienced the most significant charcoal price increment in 2013 (*see Table 27*).
The low-price regions in 2013 were Ashanti, Brong-Ahafo, Northern and Upper West Regions.

Table 27. Average price per mini and maxi bags of charcoal in the regions for 2012 and 2013[94].

Region	Mean Price per Mini bag in Ghana Cedi			Mean Price per Maxi bag in Ghana Cedi		
	2012	**2013**	***% change***	**2012**	**2013**	***% change***
Ashanti	08.68	09.15	*5.4*	15.07	16.62	*10.3*
Brong Ahafo	06.20	07.11	*14.7*	11.02	12.58	*14.0*
Central	13.95	19.83	*42.2*	22.08	26.49	*20.0*
Eastern	11.69	13.44	*15.0*	16.76	19.03	*13.5*
Gt. Accra	15.01	17.43	*16.1*	21.15	23.66	*11.9*
Volta	13.73	16.66	*21.3*	26.19	32.02	*22.3*
Western	13.60	15.30	*15.5*	23.85	25.79	*8.13*
Northern	07.52	09.10	*21.0*	14.97	18.30	*22.2*
Upper East	11.96	14.80	*23.8*	19.51	24.93	*27.8*
Upper West	08.28	09.42	*13.8*	13.46	15.56	*15.6*

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

In terms of the weights of the charcoal, [95]Volta Region was the highest-price region in 2013 (*see Table 28*).

Table 28. Average price per kilogramme of bag of charcoal in the regions for 2012 and 2013.

Region	2012			2013			*change in mean price*
	Mean Price per kg in Ghana Cedi			Mean Price per kg in Ghana Cedi			
	Mini Bag	Maxi Bag	Mean	Mini Bag	Maxi Bag	Mean	*Percentage*
Ashanti	0.33	0.29	***0.31***	0.35	0.32	***0.34***	*8.1*
Brong Ahafo	0.20	0.19	***0.20***	0.23	0.22	***0.23***	*15.4*
Central	0.44	0.37	***0.41***	0.63	0.44	***0.54***	*32.1*
Eastern	0.45	0.32	***0.39***	0.52	0.36	***0.44***	*14.3*
Gt. Accra	0.35	0.35	***0.35***	0.46	0.39	***0.43***	*21.4*
Volta	0.53	0.50	***0.52***	0.64	0.61	***0.63***	*21.4*
Western	0.52	0.45	***0.49***	0.59	0.49	***0.54***	*11.3*
Northern	0.24	0.26	***0.25***	0.29	0.32	***0.31***	*22.0*
Upper East	0.39	0.34	***0.37***	0.48	0.43	***0.46***	*24.7*
Upper West	0.27	0.23	***0.25***	0.30	0.27	***0.29***	*14.0*

The lowest-price regions were Brong Ahafo, Upper West, Northern and Ashanti.

[95] In terms of the charcoal weight:

- Significant quantities of charcoal production in Ashanti and Eastern Regions come from wood off-cut and sawmill residues. The average mini (fertilizer) bag of charcoal weighs from 21-22 kg and the maxi bags weigh from 44-45 kg.
- For most parts of coastal Central Region and for some parts of Greater Accra, particularly, the Ashaiman suburban, there is significant charcoal production from Acacia plantations. The weight range of mini bag acacia-based charcoal is 31-32 kg and for the maxi bag, the range is 57-63 kg.
- For all other regions, particularly, from the Brong Ahafo upwards to the Upper regions, the average mini bag charcoal weighs around 26 kg and the average maxi bag weighs about 52 kg.

We estimate that the average charcoal price in 2014 would increase by 10-15% in the coastal areas of Greater Accra, Central, Western and Eastern Regions. The average price is likely to increase by 15-20% in the inland regions of Ashanti and Brong Ahafo but could reach 30-35% on the average in the Upper East Region.

Nationwide, we estimate an average increment of 15-20% for 2014 but could increase to 20-25% should there be significant shortfall in LPG supply across the country during the year.

5.0 The Regulatory environment

5.1 The Electricity supply industry

Licensing and Permitting

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

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

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

i. Three new Wholesale Electricity Supply Licences were issued to Independent Power Producers (IPP) to construct and operate thermal plants. Out of this, 200 MW from the Sunon Asogli Plant and 126MW from Tema Osonor Power Plant (now CENIT Energy Limited) have been realized since last quarter of 2010.
ii. Cenpower Generation Company was granted a construction permit to add 300 MW to Ghana's generation capacity.
iii. Volta River Authority (VRA), a Government owned utility, has been issued a Construction Permit to construct a 220 MW Thermal Power Project at Kpone near Tema in the Greater Accra Region.
iv. Two VRA thermal plants namely TAPCO (T1) and Tema Thermal 1 Power Plant (TT1PP) were issued permanent wholesale supply licences.
v. The TICO thermal generation plant in Takoradi, which is jointly owned by VRA and TAQA global, was issued permanent wholesale supply licence.
vi. In 2013 Provisional Licences were issued to the 132 MW Takoradi T3 Power plant.
vii. Twenty Four (24) Provisional Wholesale Electricity Supply licences have been issued to potential Independent Power Producers. This are expected to bring on line about 8900 MW of power when the plants are constructed
viii. In 2012 Construction Permit was issued to TICO for the expansion of the existing 220MW Simple Cycle thermal Power plant to 330MW combined cycle Power plant
ix. One (1) private distribution utility, Enclave Power Company was issued licence to distribute and sell electricity without discrimination to customers in the Tema Free Zone Enclave.

x. Operations of the Electricity Company of Ghana (ECG), a Government owned utility, was also regularized by issuing them with permanent operational distribution and sale licence.

xi. A Distribution and Sales Licence was issued to the Northern Electricity Distribution Company (NEDCo).

xii. Twenty -nine (29) Bulk Customers of electricity have been issued permits to enable them operate in the deregulated Wholesale Electricity Market.

Codes of Practice and Regulations

The Commission developed and launched the ***National Electricity Grid Code*** in 2010 to govern the operation of the National Interconnected Transmission System (NITS). The Grid Code specifies in detail the technical operational rules, codes and procedures as well as obligations and liabilities of all players in the market. Complementary to the National Electricity Grid Code, The Energy Commission is has completed the drafting of the ***National Electricity Distribution Code***, that sets in detail, the minimum acceptable technical standards for the development of the electricity distribution networks, provides guidelines and technical requirements for interconnection and evacuation of embedded generation and other relevant issues related to the safe and reliable management and operation of the Electricity Distribution Network. The draft is currently undergoing stakeholder review and should be launched by the end of the year.

In 2013, the Energy Commission launched a pilot **Toll Free Short Code** service which would allow the general public to report on outages, and poor voltage levels by sending text (SMS) messages. The service currently covers only the Accra East region of the Greater Accra Region and is expected to cover the rest of the year by the end of the year 2014. This initiative would provide the Commission with information from both the customers (who experience the outages) and the utilities (who are responsible for maintaining power supply). This would enable the Commission to cross-check the information provided by the utilities with the reports provided by customers, and thereby obtain a much clearer and validated picture of the outage level within the distribution network.

The Commission has developed the Electrical Wiring Regulation 2011, L. I. 2008 to regulate electrical wiring in the country. This is to ensure the safety of persons, property and livestock from the use of electrical energy.

Pursuant to the above, a certification guideline was developed in August 2012. Further, a curriculum for the certification examination was also developed in conjunction with the Technical/Vocational Education Directorate of the Ghana Education Service. All

stakeholders have also been met to discuss the implementation of the provisions of the Regulations.

In 2013, The Energy Commission in collaboration with the Technical Examinations Unit, of the Ghana Education Service conducted the first certification examination for potential and practicing electrocution for certification as Certified Electrical wiring professionals (CEWPs). The Commission also carried out public sensitization activities to create awareness in the general public on the provisions of the Regulations.

Establishment of Wholesale Electricity Market

The Electricity Regulation 2008 provides for the establishment of a competitive wholesale electricity market to facilitate wholesale electricity trading and the provision of ancillary services in the NITS. The operator of this Wholesale Electricity Market (WEM) in Ghana (the ETU) shall ensure the procurement and dispatch of electricity from any facility of a wholesale supplier to a bulk customer and distribution utility in a fair, transparent and non-discriminatory manner.

The Wholesale Electricity Market would allow for choice and competition in the wholesale supply of electricity and subsequently create an enabling environment to attract Independent Power Producers (IPPs) as well as enhancing Ghana's strive towards increasing its installed capacity from the current of about 2800MW to 5000MW by 2016.

Further incentive for private sector investment in the Wholesale Supply of electricity is Ghana's interconnection with some neighbouring West African countries, thereby opening up the market for electricity in those countries to IPP's in Ghana.

Such a market, in principle, requires to be guided by rules and regulations (backed by legislation) that should essentially reflect government's broad policy objectives regarding the structure and administrative management and operation of the market.

5.2 The Natural Gas supply industry

Electricity supply is heavily dependent on the availability of fuel to power the thermal plants. So far, natural gas supply from Nigeria through the West African Gas Pipeline (WAGP) has proven unreliable. The development of the gas from the Jubilee field is expected to boost the installation and operation of more gas fired plants to increase Ghana's generation capacity.

Licensing and Permitting

A Licensing Manual for Natural Gas Supply Industry was developed by the Energy Commission in 2008 to serve as a guide for prospective natural gas service providers with

regard to licensing requirements as well as assisting in ensuring compliance with codes and standards governing quality, health and safety in the industry as stipulated in the Energy Commission Act, 1997 (Act 541). The manual was reviewed in 2012 to facilitate the accelerated development of the natural gas industry.

i. A Provisional Gas Transmission Utility Licence has been issued to BOST to operate the Natural Gas Transmission Interconnected System (NGTIS).
ii. In 2013 a Provisional Wholesale Supply Licence was also issued to Quantum Power Ghana Gas Limited also for an LNG facility to be sited at Tema in the Greater Accra Region.
iii. Earlier in 2012 a Provisional Wholesale Supply Licence had been issued to Rotan Gas Limited for an LNG facility to be sited at Aboadze in the Western Region

Codes of Practice and Regulations

Since the natural gas industry is still new in Ghana and like any other energy infrastructure, it is important that before any construction of a facility takes place, the developer must be made to satisfy some basic requirements and comply with established regulations.

It is in this respect that the Energy Commission has since developed the ***Natural Gas Pipeline Safety Regulation*** with adopted Ghana Standards and which was approved by Parliament in 2012.

The Commission is also in the process of developing an ***Occupational Health and Safety Regulation*** with adopted Ghanaian Standards. A ***Natural Gas Transmission Access Code*** to establish conditions for Natural Gas Service Providers to have fair, transparent and safe access to the Natural Gas Transmission Network in Ghana has been developed in accordance with Sections 24, 27 and 28 of the Energy Commission Act, 1997 (Act 541).

5.3 Renewable Energy Update

The Energy Commission has so far issued 36 licences for 3,905.31 MW of Renewable Energy electricity. Out of this 29 are for Solar photovoltaic (PV) generation with a total capacity of 2,155 MW.

Also, the number of Provisional licences issued and their capacities for Wave, Biomass, Waste to Energy and Wind are 1000MW, 68MW, 254.31MW and 436MW respectively.

The challenge however is that the grid stability implications of intermittent solar power have not been fully studied in this country. For instance, in 2012 the loss of 860 MW from Akosombo Generating Station led to a total system collapse of the national transmission grid

culminating into a nationwide black-out. The effect of large injections of solar PV electricity on grid stability could have a similar effect. The cost implications of large quantities of solar power on the electricity tariff based on a Feed in Tariff of US$0.201 as approved by the PURC could also be very significant.

The Energy Commission and the PURC[96] are therefore currently working on the Renewable Energy Purchase Obligations (REPO). Until this is completed and all bulk customers and distribution utilities have been issued with their REPO, the Energy Commission has suspended issuing licenses for solar PV power plants. The suspension of wholesale solar PV generation licences would allow more time for Ghana Grid Company (GRIDCo) to complete studies currently going on with the support of GIZ[97], on the implications of Solar PV on the stability of the grid and the cost of electricity.

[96] Public Utility and Regulatory Commission
[97] German International Aid Agency

Annex1 – Schematic Overview of Ghana Energy Demand and Supply System

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

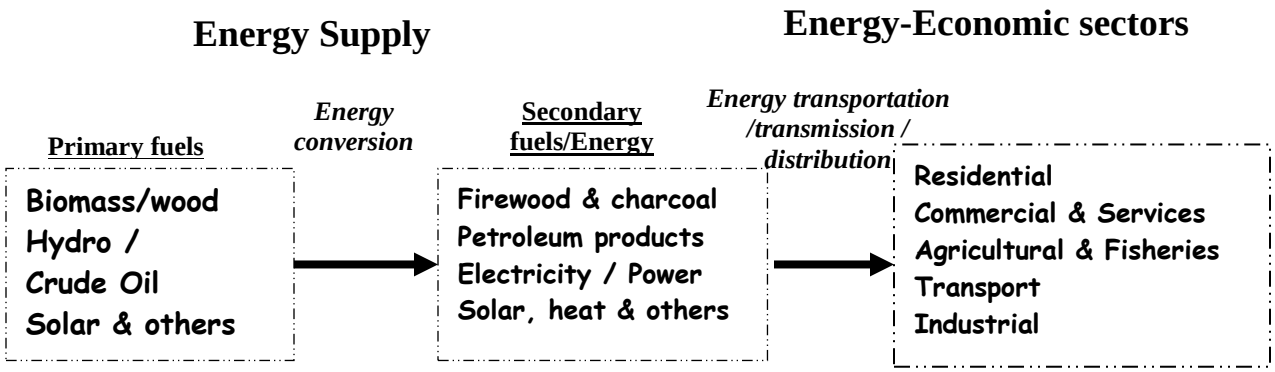

Figure Annex A1. Energy supply continuum

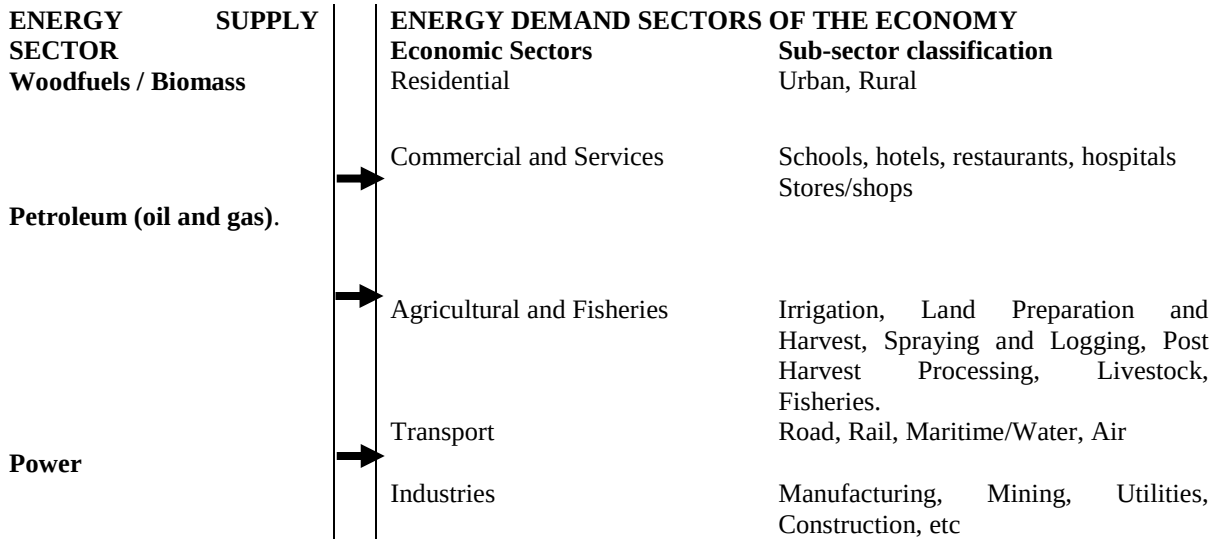

Figure A2. Energy supply continuum

Annex 2 – Existing 100-200 mmscfd LNG plants worldwide

Continent	Country	Capacity Mmscfd	Number Installed	Existing	Status	
					Announced/ Proposed	Approved/ under construct
Asia	China	200	0	0	1	0
	India	200	0	0	1	0
		100	1	1	0	0
	Indonesia	200	0	0	1	0
	Japan	100	3	3	0	1
		200	2	1	2	0
	New Zealand	200	0	0	1	0
	Philippines	200	0	0	2	0
	Sri Lanka	100	0	0	1	0
	South Korea	200	1	1	0	0
	Taiwan	200	1	1	0	0
Europe	Belgium	100	3	3		1
	Cyprus	100	0	0	1	0
	France	100	2	2	1	0
	Greece	200	1	1	0	0
	Italy	200	1	0	2	0
	Lithuania	200	1	0	1	0
	Poland	200	0	0	1	0
	Spain	100	5	5	1	1
		200	7	7	0	0
	Netherlands	100	1	0	1	1
		200	1	0	0	1
	U.K	100	1	1	1	0
		200	5	5	2	2
North America	Dominican Rep	200	0	0	0	1
	El Salvador	100	0	0	0	1
	Puerto Rico	100	1	1	1	0
	United States	200	3	3	0	0
South America	Brazil	200	1	1	0	
	Chile	200	0	0	0	2
		100	2	2	0	0
Africa	South Africa	200	0	0	1	0
Global Total			**43**	**43**	**22**	**11**