ENERGY COMMISSION, GHANA

2015 ENERGY
(SUPPLY AND DEMAND)
OUTLOOK FOR GHANA

Final

April, 2015

Executive Summary

Energy Commission presents supply and demand forecasts for electricity, crude oil, petroleum products, natural gas and charcoal for the year 2015. Factors that could influence the demand and supply are also discussed.

Electricity:

1. In **2014**, the total electricity made available for gross transmission was 13,071 GWh as against 12,927 GWh in 2013; 144 GWh more than last year. The net grid electricity transmitted[1] to the country was 12,906 GWh as against 12,823 GWh in 2013; less than one percent more but 12-16% less than the projected requirement and equivalent to 400-500 MW shortfall. Peak load for the supply to Ghana on the transmission grid[2] was 1,970 Megawatts (MW); roughly 10% more than in 2013 and the total (maximum) peak on the transmission grid[3] was 2,061 MW; about 6% more than in 2013.

2. For **2015**, the total electricity requirement of the country would range as follows:

   (a) 14,150-14,730 GWh *with VALCO operating at one potline*; to maintain the economic growth at an average of 4.2-4.5%*;* and

   (b) 15,408-16,398 GWh *with VALCO to be operating at more than one potline*; to raise the economic growth from the current 4.2% to 5-6%.

3. The corresponding Ghana's peak demand (including suppressed demand) and total transmission system peak would be between 1,980-2,300 MW**.**

4. The grid electricity available for supply in 2015 based on the planned expansion of generation capacity would be 15,000-15,200 GWh. The higher the penetration of gas in the fuel mix, the easier the high-side of the electricity required is within reach, since gas is far cheaper than oil.

[1] Gross transmission –wheeled –exports.
[2] Referred to as Domestic Peak Load by some of the utilities
[3] Ghana Peak load + Exports

5. Levels (a) however, is achievable provided the planned capacity additions for this year are timely completed and there is finance for adequate fuel; we expect total installed capacity of the country to increase from about 2,830 MW in 2014 to almost 3,250 MW[4] all by thermal additions with average dependable and available capacities of about 2,900 MW and 1,712 MW respectively this year. Last year's average dependable and available capacities were t about 2,552 MW and 1,482 MW respectively.

6. Any further shortfall on the other hand is likely to keep the economy at the low-growth path of 3.5% as projected for Ghana in 2015.

7. **To eliminate the load-shedding in 2015** however, would require a minimum generation of **16,398-17,350 GWh** which translates into additional capacity requirement of **450-550 MW**. Allowing for a minimum of 10-15% of spinning reserve would bring the total capacity shortfall to **800-1,000 MW** translating into an overall national installed capacity requirement of **4000-4,200 MW**. The high-side could arise if VALCO operates more than two potlines.

8. In the light of the foreseen electricity supply shortfall, the Government has gone for international thermal power contracts totalling at least **1,370 MW** of which **800-1,000 MW** is likely to be available during the last quarter of 2015.

9. The challenge however is securing adequate gas which is a less expensive fuel for the thermal plants.

Natural gas

10. In **2014**, a total of about 22.5 trillion standard cubic feet (Tscf) of gas was delivered by the West Africa Gas Pipeline (WAGP) for thermal generation. This was almost twice that of 2013 translating into an annual mean of almost 62 million standard cubic feet per day (mmscfd) but still less than the contract volume of about 45 Tscf which translates into 123 mmscfd expected from Nigeria. Moreover, the supply in 2014 was more erratic compared to 2013.

[4] Excluding "emergency power barges".

11. 2014 also saw the first local associated gas flow from the Atuabo gas processing plant in the Western Region to the thermal plants at Aboadze for power generation, during the last quarter but the flow averaged 35 mmscfd and was largely in the testing phase.

12. For **2015**, we estimate the average WAGP gas flow to be 60 mmscfd, i.e. same as last year, whilst an average of 80 mmscfd (range of 60-100 mmscfd[5]) is expected from the Atuabo gas making a total average of **140 mmscfd** or **50,400 mmscf** for the whole year.

13. **For 2015**, we further estimate that the gas flow required for fuelling the thermal plants would range between **68,620 mmscf (**68 Tcf[6]) **or 188-300 mmscfd[7]** during the first half of the year and **77,103 mmscf** (77 Tcf) or **211-350 mmscfd**, during the second half of the year[8].

14. Additional minimum of **240 mmscfd** would be needed to run the power rentals.

15. Estimated available gas supply of 50,400 mmscf in 2015 means, there would be a minimum gas supply deficit of **18,200 mmscf** which translates into initial oil requirement of **5.5 million barrels** by end of June and ramping up to about **7 million barrels** of oil during the second half of the year.

16. In **2014**, the delivered WAGP gas price[9] was $8.47 per MMBtu ($8.56 per mscf) for foundation customers and $9 per MMBtu ($9.17 per mscf) for the only apparent standard customer which is the Sunon-Asogli Power Plant at Tema.

17. For **2015**, the delivered WAGP gas price would average **9 per MMBtu** ($9.17 per mscf) for both foundation and standard customers. That of the Jubilee gas is estimated as **$8.84 per MMBtu** ($8.99 per mscf).

18. The development of the TEN (Tweneboa-Enyenra-Ntomme) fields commenced in 2013 and is expected to produce an average gas supply of 63-70 mmscfd and between 30,000-

[5] 120 mmscfd high will be reached occasionally but not likely to be in most cases.
[6] Tcf is trillion cubic feet or mmmscf.
[7] Low-side when the plants are operating at averagely higher efficiencies. High consumption when the plants are operating averagely low efficiencies.
[8] A typical 100MW single cycle thermal plant takes on the average 30 mmscfd by volume. A combined cycle of 300MW plant on the averages takes 60mmscfd.
[9] i.e. including duties, taxes, etc

50,000 barrels a day by 2017[10]. However, with oil price averaging $60 per barrel, the schedule of completion of the project could delay since the project economics was based on an oil price of $80 per barrel.

19. The year 2014, saw the approval of the plan of development (POD) for Sankofa, and Sankofa East fields and their consequent commencement. Sankofa, and Sankofa East fields on the other hand are largely gas fields and for that matter more likely to be completed in 2017.

20. Production from these new fields would make available an average total of between 300-500 mmscfd by 2020[11].

Crude oil and Petroleum products

21. In **2014**, the average purchase price of Brent crude was $99 per barrel compared to $109 per barrel in 2013, i.e. about 9% lower than in the previous year. Average price in 2012 was $113 per barrel.

22. For **2015**, the average price at which Ghana would source Brent crude is expected to drop further to within $60-65 per barrel. Thus the average price is projected to drop by 34-39%. The average price for other light crudes for refinery operations would fall within $55-60 per barrel. Average delivery price for light crude oil for power generation would range from $85-90 per barrel.

23. For **2015**, we estimate that the total crude oil and imported products required should increase to about 3.65 million tonnes from about 3.34 million tonnes in 2014, in order to maintain the economic growth at 4.2% and also to meet optimal refinery operations as well as refined products for local consumption.

24. Just as **in 2014**, crude oil required for refinery operations should 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.

[10] World Bank report: Energizing Economic Growth in Ghana: Making Power and Petroleum Sectors Rise to the Challenge, June, 2013. Energy Group, African Region.
[11] Same World Bank \, Energy Group report, June, 2013.

25. In **2015**, For LPG, the total national requirement should be within 300,000-350,000 tonnes due to the growing demand, particularly as transport fuel, just as projected for 2014. However, limited nation-wide storage capacity could constrain supply to the low-side in 2015.

26. The breakdown of the total petroleum products required for 2015 would be as follows:

Product	**National supply requirement in Tonnes**
Total Gasoline[12]*	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**

27. In **2014**, crude oil production from the Jubilee field jumped to 38.7 million barrels from 30.4 million barrels in 2013. Corresponding daily production averaged 105,935 barrels in 2014 and 91,000 barrels in 2013.

28. For **2015**, oil production is likely to increase to an average of 110,000 barrels per day during the first half of the year ramping up to 115,000-120,000 barrels per day during the last quarter of 2015 since now there is no need for re-injection of the gas as the Atuabo processing plant is in operation.

Charcoal

29. In **2014**, the average prices of charcoal in the country rose from GH¢13 per mini bag and GH¢21 per maxi bag in 2013 to about GH¢17 per mini bag and GH¢25 per maxi bag respectively.

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

30. For **2015**, 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.

31. Nationwide, we estimate an average drop from 26% in 2014 to 15-20% for 2014.

Recommended Actions

32. To ameliorate the overall power supply shortage prevailing in the country, emanating out of inadequate fuel supply for power generation, investments in liquefied natural gas (LNG) as an alternative gas supply to augment the limited local and unreliable gas from the West Africa Gas Pipeline from Nigeria should be pursued. In this light, the sector Ministry in conjunction with the Energy Commission are finding ways to help the private sector to build LNG regas facility in the country in the shortest possible time.

Achieving 50% nationwide penetration of LPG

33. National LPG penetration share increased from 6% in 2000 to 18% in 2010. The sector ministry is targeting 50% penetration by 2016 but it is not likely to be achieved due to limited distribution outlets nationwide.

34. This can however be achieved by implementing the measures to support and accelerate the supply and use of LPG outlined in the Energy Sector Strategy and Development Plan, 2010 and the LPG Policy Paper, 2012. These include:

    (a) Deliberate government policy to make the LPG produced available for local consumption as against export;
    (b) Removal of price distortions;
    (c) Re-capitalising Ghana Cylinder Manufacturing Company (GCMC) to expand production capacity with the production of cylinders focused on small sized cylinders that would be portable and affordable to households in rural communities.

(d) Constructing LPG storage and supply infrastructure in all regional and district capitals in the long term, and to develop district capital LPG infrastructure in the medium term.

35. In this light, the Ministry of Petroleum and the National Petroleum Authority should consider looking at investment incentives to encourage the Oil Marketing Companies and other interested investors to set up more LPG storage and distribution centres in-country to increase access and consumption.

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 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 2015 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, petroleum products, natural gas as well as charcoal.

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

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

This report was prepared by the Strategic Planning and Policy Division of the Energy Commission. General questions about the report should be referred to Mr. Michael Opam, (mopam@energycom.gov.gh, michaelopam@yahoo.com) the Acting Executive Secretary. 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.

Michael Opam

Ag. Executive Secretary

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Acronyms

GDP	Gross Domestic Product; *measure of wealth of an economy of a nation.*
LPG	Liquefied Petroleum Gas
Solar PV	Solar Photovoltaic; *panel technology for electricity via solar or sunshine*
GWh	Gigawatt-hour, i.e. *million units of electricity*
kWh	Kilowatt-hour, i.e. *one unit of electricity*
MWh	Megawatt-hour, i.e. thousand unit of electricity
NG	Natural Gas
LNG	Liquefied Natural Gas; *natural gas liquefied about 600 times*
mmBTU	Million British Thermal Unit; *an energy unit for gas flow*
mscfd/mcfd	Thousand standard cubic feet per day/ Thousand standard cubic feet per day; *a volumetric unit for gas flow*
mmscfd/mmcfd	Million standard cubic feet per day/ Million standard cubic feet per day; *a volumetric unit for gas flow*
bscfd/bcfd	Billion standard cubic feet per day / Billion standard cubic feet per day; *a volumetric unit for gas flow*
Tcf/tscf	Billion standard cubic feet per day / Billion standard cubic feet per day; *a volumetric unit for gas flow*
IPP	Independent Power Producer
ECG	Electricity Company of Ghana, a public power distributor
TAPCO	Takoradi Thermal Power Company, a public power generator
TICO	Takoradi International Company, a public power generator
VRA	Volta River Authority, a public power generator
VALCO	Volta Aluminium Company, a smelting company
WAGP	West African Gas Pipeline
WAGPCo	West African Gas Pipeline Company

1.0 Power Subsector

1.1 Overview of grid power supply in 2014

Installed generation capacity[13] available for grid power supply as at the end of 2014 was 2,831 Megawatt (MW) and the generation was 12,963 GWh consisting of 64.7% hydro, 34.75% thermal and 0.05% solar power (*see Table 1*).

Table 1. Installed Grid Electricity Generation Capacity as of December 2014.

GENERATION PLANT	FUEL TYPE	CAPACITY (MW)				GENERATION	
		Installed (name plate)	% Share	Average Dependable	Average Available	GWh	% Share
Hydro Power Plants							
Akosombo	Hydro	1,020		900	743	6,509	
Bui	Hydro	400		380	84	730	
Kpong	Hydro	160		140	130	1,148	
	Sub-Total	*1,580*	***55.8***	***1,420***	***956***	***8,387***	***64.70***
Thermal Power Plants[14]							
Takoradi Power Company (TAPCO)	Oil/NG	330		300	102	890	
Takoradi International Company (TICO)	Oil/NG	220		200	82	712	
Sunon–Asogli Power (SAPP)	NG	200		180	144	1,255	
Tema Thermal Plant1 (TT1P)	Oil/NG	110		100	80	697	
Tema Thermal Plant2 (TT2P)	Oil/NG	50		45	26	223	
CENIT Energy Ltd (CEL)	Oil/NG	126		110	58	513	
Takoradi T3	NG	132		125	10	87	
Mines Reserve Plant	Oil/NG	80		70	22	195	
	Sub – Total	*1,248*	***44.1***	***1,130***	***521***	***4,635***	***34.75***
Renewables							
VRA Solar	Solar	2.5		2	1	4	
	Sub – Total	*2.5*	***0.1***				***0.05***
Total		**2,831**		**2,552**	**1,482**	**12,963**	

NG is Natural gas

[13] nameplate

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

The total electricity made available for gross transmission in 2014 was 13,071 GWh as against 12,927 GWh in 2013. The 2014 grid electricity transmission comprised 98.74% of generation and 1.26% of imports. The Ghana load at peak on the transmission grid was 1,970 MW and the grid system (maximum) peak[15] was 2,061 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	2014
Transmission losses as % of gross transmission	3.7	3.8	3.7	4.7	4.3	4.4	4.3

1.2 2014 forecasts and actuals

Ghana's real Gross Domestic Product (GDP) growth in 2014 was 4.2%, a drop from 7.1% in 2013 and 8.8% in 2012. [16]. As in 2013, the dip in the GDP growth has been attributed to negative growth in the Manufacturing subsector and the Industry in general, largely due to the inadequate grid power supplied culminating into the worsening nation-wide load shedding during the year.

For 2014, we projected that all things being equal, the total electricity required would have been between 15,725-16,500 GWh and that but for the generally tight economic conditions, coupled with the prevailing load shedding, we limited the total electricity required to 14,571-15,351 GWh; the low-side being as a result of lower than expected flow of gas for power generation and the high-side would have covered VALCO operating at two potlines. We then forecasted that the grid electricity available for supply based on the generation capacity last year would be within 13,011-13,971 GWh.

In addition, we projected that Ghana's peak load and the total system peak on the grid transmission system would be between 1,900-2,200 MW and 2,200-2,300 MW respectively[17]. The actual Ghana's peak load and the total system peak on the grid transmission system in 2014 were 1,970 MW and 2,061; and just as in last year, VALCO did not operate beyond one-potline (*see Tables 3*).

Gross electricity supplied in 2014 was just 12,906 GWh[18], against the low-case forecast of 14,571-15,351 GWh [19] for the year (*see Table 3*).

[15] Ghana Peak load + Exports
[16] Ghana Statistical Service (GSS), March, 2015.
[17] Corresponding figures for VALCO to be operating between 3-4 potlines are 1,980 MW and 2,500 MW.
[18] Excluding exports to CIE and CEB.

Table 3. Grid Electricity and associated fuels: Forecasts and Actuals for 2014.

	2013	2014	
		Forecast	**Actual**
Total Electricity Requirement *(VALCO at 3-4 potlines in brackets)* (GWh)	Not applicable	14,571-15,351 *(15,725-16,500)*	Not applicable
Grid Electricity available (GWh)	12,927	13,011-13,971	12,906
Percentage hydro (%) *(GWh)*	63.7 *(8,233)*	63-69 *(8,782)*	64.7 *(8,387)*
Ghana System Peak (MW)*	1,791	1,980-2,200	1,970
GRIDCO Transmission System Peak/Maximum Demand MW	1,943	2,200-2,300	2,061
Annual Mean WAGP gas flow (mmscf per day)	31	45-50	61.8
Mean Jubilee gas flow (mmscf per day)	N.A	80-100	35.3
Oil required/consumed 1000 Tonnes (Million barrels)	700 (4.9)	1,158-1,250 (8-9)	931 (6.5)
WAGP Gas transportation tariff * US$ per MMBtu *($ per mscf)*	4.24-4.35 *(4.32-4.43)*	4.23-4.25 *(4.31-4.33)*	4.35 *(4.43)*
Average price for WAGP Gas** US$ per MMBtu *($ per mscf)*	2.469 *(2.51)*	2.58-2.59 *(2.60-2.62)*	2.58 *(2.60)*
Delivered gas price * *(other charges included)* US$ per MMBtu *($ per mscf)*	8.27-8.38 *(8.36-8.54)*	8.40-8.55 *(8.56-8.71)*	8.47-9.00 *(8.63-9.17)*
Average price for Brent crude US$ per bbl *($ per MMBtu gas equiv.)*	~109 *(18.73)*	107-108 *(18.4-18.6)*	99 *(17.01)*
Average price for light crude oil (LCO) *dedicated for power production* $ per bbl *($ per MMBtu)*	100 *(17.18)*	108-110 *(18.6-18.9)*	$110 *(18.9)*
** 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.*			

[19] Low side includes VALCO operating at one-two potlines and high-side considers VALCO operating at three-four potlines.

This implies that supply was 11-16% less than the forecasted requirement last year compared with 10-15% less, for 2013. This could explain the inadequate power situation culminating in the worsened load-shedding situation carried out in the year.

We also projected that oil required for thermal power generation would range from a minimum of 1.16 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 volatility of oil prices. Actual oil used was just about 931,246 tonnes (6.52 million barrels), representing 74-81% of the projected requirement (*see Tables 3*).

Light crude oil (LCO) purchased purposely for power generation averaged $110 per barrel during the year; $117 per barrel during the first quarter, falling to $104 per barrel in the third quarter just after the global price slump in July, and dropping to about $83 per barrel during the last quarter (*see Tables 3*). Ghana however bought Brent crude at a relatively low average price of $103 per barrel during the first half of 2014. The price fell further to an average of $86 per barrel during the second half of the year. Average price of the Brent was $107 per barrel in January reaching a maximum of $112 in June, thereafter, dropping to a minimum of $62 per barrel in December, 2014.

The WAGP gas supply in 2014, improved over that of 2013 by about 50% more than we projected for the year even though, was still far short of about 240 mmscfd required in that year and moreover, was still below the contracted volume of 123 mmscfd. The supply in 2014 was however more erratic compared to 2013. Erratic supply increases operational cost of the power plants due to the gas-oil-gas switching which increases the servicing requirements.

Average WAGP gas flow in 2014 was 61.8 mmscfd, about twice that of 2013 with the minimum and maximum flows occurring in August and September respectively. Total gas flow was 22,541,001 MMBtu, almost twice that of 2013[20]. (*see Table 4*).

The gas price was within our forecast for the year; $8.47 per MMBtu for VRA, the foundation customer and $9 per MMBtu for Sunon-Asogli, a standard customer.

The expected gas from the Jubilee field on the other hand did not materialise as we projected for last year. Gas started to flow from the Atuabo gas processing plant during the last quarter but averaged 35.3 mmscfd and was largely in the testing and commissioning phase.

Average annual precipitation for 2014 in the hydropower dam catchment areas was higher than in 2013 as projected. With prudent management of the hydro-resource, higher inflows into the hydropower reservoir would have meant higher generation from hydro in the light of lower than expected gas supply.

[20] Total WAGP gas flow in 2013 was 11,573,011 MMBtu.

Table 4. Monthly and Daily Natural Gas Supply from WAGP in 2014.

Month	Ghana Total	
	Monthly flow in MMBtu	**Daily flow in mmscf**
January	1,862,621	60.1
February	1,637,288	58.5
March	1,471,483	47.5
April	1,902,184	63.4
May	1,848,987	59.6
June	2,041,079	68.0
July	2,198,767	70.9
August	1,400,610	45.2
September	1,797,959	59.9
October	2,141,149	69.1
November	2,404,278	80.1
December	1,834,598	59.2
Average	1,878,417	***61.8***

Source: Volta River Authority, 2015.

1.3 Forecast for 2015

Electricity Requirement of the Economy

The real GDP growth declined from 7.1% in 2013 to 4.2% in 2014. It is projected to decrease further in **2015 to 3.5%** on the back of the worsening power crisis and fiscal consolidation[21]

But for the power crisis, the economy was expected to expand from 7.1% in 2013 to 7.7% in 2014 and 8% in 2015.

At a high GDP growth of 7.7-8% per annum in 2015, we had projected under SNEP[22] that the total electricity generation[23] required for the country would have been as follows:

- **16,398-20,900 GWh** with VALCO operating at one potline; and
- **20,900-22,074 GWh** for VALCO to be operating at more than two potlines.

However, at the projected low **GDP growth rate of 3.5%** for Ghana for 2015, we expect the total electricity required for the country this year to drop to the following levels:

(1) **11,234 GWh** without VALCO operating; *on-going load shedding would be worsen;*

(2) **14,150-14,730 GWh** with VALCO operating at one potline; *on-going load shedding is reduced if VALCO is entirely shutdown;* and

(3) **15,408-16,398 GWh** for VALCO to be operating at two potlines; *on-going load shedding is reduced significantly if VALCO keeps operating at one potline.*

Level (1) would sink the economic growth from the present 4% to 3.5% in 2015.

Level (2) would maintain the economic growth at 4.2-4.5% in 2015; whilst

Level (3) would help raise the economic growth to 5% and above. It is assumed that energy consumption is directly related to economic growth for developing and middle income developing countries.

Level (2) is achievable provided the planned capacity additions for this year are timely completed and there is adequate financial resource to procure all the fuel needed to run thermal power plants at higher utilisation factors *(see Table 5*).

The corresponding Ghana's peak demand (including suppressed demand) and total transmission system peak for **Level (3)** would average **2,300** and **2,500 MW** respectively[24]. Average dependable capacity would fall within **1,900-2,300 MW**.

[21] Ghana-IMF Three-year Programme report, March, 2015, ,
[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] about the same as projected for 2014. This also corresponds to GRIDCo's projections for 2015.

Impact of the load-shedding on the Economy

The World Bank[25] has indicated that electricity is the second most important constraint to business activities in the country and that Ghana lost about 1.8% of GDP during the 2007 power crisis.

ISSER[26], in its 2014 study[27] also indicates that on the average, the country is losing production worth about US$ 2.1 million per day (or, US$ 55.8 million per month) just being caused by the power crisis alone and that the country lost about US$680 million in 2014 translating into about 2% of GDP due to the power crisis. It further indicated that firms that do not have access to sufficient electricity have lower output/sales, and that not having sufficient electricity lowers firm's annual sales by about 37-48%.

Stable and sufficient electricity supply is thus undoubtedly a key input to firm growth, expansion and development. Ghana's annual electricity consumption per capita since 2010 has been averagely below **400 kWh** compared to the global minimum average of **500 kWh** for lower middle-income developing countries. Even though, the country recorded a marginal increase from 399 to 410 kWh per capita between 2013 and 2014, there is still a significant electricity energy deficit to be cleared.

During periods of outages therefore, many firms that do not have access to a backup system may shut down, downsize or perhaps change business line. ISSER in its report found that only 20% of about 350 medium and small-scale enterprises (SMEs) surveyed had access to backup generators and for a number of micro firms it visited, only 10% had backup generators.

Between December 2014 and end of first quarter 2015, about 1000 workers had been laid off by their employers, the reason attributed to low industrial output as a result of inadequate power[28].

To eliminate the load-shedding in 2015 would however require a minimum generation of **16,398-17,350 GWh** with corresponding dependable capacity of about **3,200 MW** translating into installed capacity of around **3,500 MW**, roughly 24% more of last year's. Such would also raise the country's **consumption per capita** to around **600 kWh** and would be synonymous with the country's status as a **lower middle income** country.

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[25] World Bank, Energizing Economic Growth in Ghana: Making the Power and the Petroleum Sectors Rise to the Challenge, February, 2013

[26] ISSER is Institute of Statistical Social and Economic Research

[27] Electricity Insecurity and its impact on Micro and Small Businesses in Ghana, Charles Ackah, Senior Research fellow, ISSER, University of Ghana, 2015.

[28] http://www.myjoyonline.com/business/2015/March-27th/goldfields-ghana-to-lay-off-200-workers.php; http://www.businessworldghana.com/coca-col-lays-off-98-workers/; http://www.ghana-news.adomonline.com/business/2015/march-26th/dumsor-chocho-industries-to-lay-off-workers.php

Available Grid Electricity Supply

We expect the trend of average annual precipitation for 2015 particularly in the catchment areas of the hydrodams to be lower than in 2014. Rainfall data for the past ten years suggest that the high precipitations associated with maximum sunspot cycle (solar maximum) had peaked in 2012-13. In fact, the sunspot peak in 2013 was the weakest in the last 100 years (*see Annex 2*). Weak sunspot activities imply that geophysical forces need to push rainfall currents such as the inter-tropical boundaries far inland would be weakened, rather, release more precipitations at shorter distances from the equator and the coast.

For this reason, the hydrodam catchment areas which are largely inland are likely to experience lower than expected average annual precipitation for this year and next, i.e. up to 2016[29]. On other hand, the coastal areas are likely to experience some spikes in precipitation such as storms coast to harvest the relatively heavy precipitations. We should however be mindful that climate change could distort all these predictions.

Nevertheless, we project a reservoir elevation gain of **9-10ft** by end of October for Akosombo translating into **225-250 MW** additional capacity to the prevailing available capacity range of **500-550 MW** of the Akosombo hydropower Generating Station by end of the third quarter of 2015. Thus available capacity of the Akosombo hydropower this year is likely to be **100-125 MW** short of its dependable capacity of **900 MW**. This also means there would only be between 175-225 MW extra generation capacity to be managed during the dry spell until the end of the first quarter of 2016.

We also expect additional thermal capacity of about **523-703 MW net** to be available to the grid owing to the expected completion of the following projects:

- 110 MW installed capacity steam unit of the TICO Thermal power plant at Aboadze;
- 200 MW Kpong Thermal Power Plant;
- 160-180 MW Sunon-Asogli gas plant2;
- 25 MW Trojan thermal plant;
- Retrofitting of the (Mines Reserve Plant) MRP from 40MW to 76 MW; and
- 20 MW BXC solar power plant near Mankoadze in the Central Region.
- Rehabilitation of the 132 MW T3 power plant at Aboadze.

There are however some challenges. The 200 MW Kpong Thermal Power Plant is diesel/gas powered. The gas system is yet to be completed and so until it is ready and sufficient gas is available, the plant will be diesel fuelled and would only operate largely as a peaking plant.

[29] 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.

Currently, 100 MW is ready and the remaining unit is expected to come on line most probably during the second half of the year.

Sunon-Asogli plant at Tema is undergoing expansion and it is expected to add about 180 MW comprising 160 MW gas and 20-MW steam turbine by the end of the year. However, due to gas supply challenges, we are not likely to see it commercially operational by the end the year. If anything, very limited not exceeding 20% of dependable capacity.

Of the over 64 provisional licences issued for wholesale power supply from Renewables, 15 of the companies have received siting permits. However, only two have advanced to the construction stage. They are the 20 MW solar photovoltaic grid inter-tied plant being constructed by BXC company at a location near Mankoadze in the Central Region and the 14 MW seawave energy plant near Ada in the Greater Accra Region. The 20MW solar plant is expected to come on line during the third quarter of the year whilst that of the 14 MW wave power is scheduled for early 2016. The other 13 applicants with siting permits are all waiting for Government Support and Consent Agreement (GSCA) before they proceed to the construction stage.

The 132 MW Takoradi T3 thermal power plant that malfunctioned in 2013 is still not operative but planned for rehabilitation this year. The plant suffered a number of operational failures between 2013-2014 but the Canadian supplier has agreed to provide new turbines for the plant. However, search for funding is likely to delay its commercial operations this year. It is more likely to be available in 2016.

From the above analysis, we estimate that the **maximum grid electricity** available in 2015 would not exceed **15,119 GWh** with the corresponding dependable and installed capacity of about **2,922 MW** and **3,250 MW** respectively, provided the planned capacity additions for this year are timely completed and there is adequate financial resource to procure all the fuel needed to run thermal power plants at the projected utilisation factors (*see Table 5*). This means that the existing generation capacity could supply about 15.6% more than last year which is equivalent to an increment of about 231 MW.

However, should fuel supply be less than expected, we project the **low-side supply** to be at least **14,150 GWh** with average dependable capacity around **2,600 MW**.

Table 5. Maximum Grid Power Generation Capacity estimated for 2015.

GENERATION PLANT	CAPACITY (MW)		Plant Utilisation Factor++	Average Available Capacity (MW)	Expected Energy (GWh)
	Installed	Dependable			
Hydro Power Plants					
Akosombo	1,020	900	0.75	675	5,913
Kpong	160	140	0.90	126	981.12
Bui	400	380	0.20	76	665.76
Sub-Total	*1,580*	*1,420*		*877*	*7,682.52*
Thermal Power Plants[30]					
TAPCO (CC)	330	300	0.70	210	1,839.60
TICO (SC)	330	300	0.50	150	1,314
Sunon – Asogli (gas)1	200	180	0.80	144	1,261.44
Sunon-Asogli (gas) 2	180	160	0.20	32	280.32
Tema Thermal Plant – TT1PP	126	110	0.70	77	674.52
Tema Thermal Plant – TT2PP	49.5	45	0.70	31.5	275.94
T3	0	0	0	0	0
Mines Reserve Plant (MRP)	80	76	0.50	38	332.88
CENIT Energy Ltd	126	110	0.70	77	674.52
Kpong Thermal Power Plant	200	180	0.40	72	630.72
Trojan	25	20	0.50	10	122.64
Sub-Total	*1,466.5*	*1,481*		*841.5*	*7,327.74*
Renewables and Embedded Generation					
VRA Solar grid-inter-tied	2.5	2	0.30	0.6	5.26
*BXC Solar grid Power	20	19	0.15	2.85	25
Sub – Total	*22.5*	*21*		*3.45*	*30.16*
Total	**3,249**	**2,922**		**1,712**	**15,119.02**

**provisional.*

++Estimated

Fuel and Cost Implications

Gas required for fuelling the thermal plants would range between **68,620 mmscf (68 Tcf)** [31], **or 188-300**[32] **mmscfd** during the first half of the year and **77,103 mmscf (77 Tcf) or 211-350 mmscfd** during the second half of the year[33].

[30] TAPCO is Takoradi Power Company, a combined cycle (CC) thermal plant; TICO is Takoradi International Power Company, a single cycle (SC) thermal plant.
[31] Tcf is trillion cubic feet or mmmscf.

This year 2015, would see commercial gas coming from two sources, the WAGP and the Atuabo gas processing plant in the Western Region.

We estimate the average WAGP gas flow in 2015 to be **60 mmscfd**, i.e. same as last year, whilst an average of **80 mmscfd** (range of **60-100 mmscfd**[34]) is expected from the Atuabo gas making a total average of **140 mmcf per day supply** or **50,400 mmscf for the whole year**[35]. Assuming an average price of **$9** per MMBtu for the WAGP gas and the Atuabo gas combined, the total cost of gas required is estimated as **$454 million** for 2015.

Estimated available gas supply of **50,400 mmscf** in 2015 means, there would be a minimum gas supply deficit of **18,200 mmscf** which translates into initial oil requirement of **5.5 million** barrels by June and ramping up to about **7 million** barrels of oil during the second half of the year.

LCO dedicated for power generation was bought at an average price of $83 per barrel during the last quarter of 2014. We estimate a peak average price of **$90** per barrel for 2015. At this price, **$504 million** would be needed during the first half of 2015 increasing to almost **$700 million** during the second half of the year to purchase oil for power generation.

Meeting these energy and financial requirements however **do not eliminate the current load shedding but maintain the prevailing schedules.** Annual capacity shortfall has been estimated to be between **200-250 MW** since 2010.

Eliminating the shortfall and consequently the Load-shedding

To **eliminate the on-going load shedding requires** a minimum generation range of **16,398-17,350 GWh**. Deducting the projected grid generation of 15,119 GWh from it leaves a supply deficit of about **1,279-2,231 GWh** which is equivalent to providing approximately **200-300 MW** net capacity. Such would bring the projected total dependable capacity for 2015 to **3,122-3,222 MW**.

However, the grid power system would still experience a noticeable nationwide load shedding whenever a unit of say 200 MW is shut down for servicing/ maintenance adequate spinning/reserve margin is provided. Allowing a minimum of **15% reserve margin** could eliminate such forced load-shedding but would require additional thermal capacity equivalent of 350-440 MW bringing the total net capacity required to about **800-1,000 MW** with corresponding total national installed capacity of **4,000-4,300 MW** for 2015[36].

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[32]Low-side when the plants are operating averagely higher efficiencies. High-side when plants on the average operating at frequencies.

[33] A typical 100MW single cycle thermal plant takes on the average 30 mmscfd by volume. A combined cycle of 300MW plant on the averages takes 60mmscfd.

[34] 120 mmscfd high will be reached occasionally but not likely to be in most cases.

[35] Assumed 140x360 days.

[36] Projected dependable capacity range is 3,900-4,100

Constructing power plants in the range of 800-1,000 MW would range from five to seven years normally associated with greenfield base-load plants such as large hydropower, combined LNG gas-fired and coal power facilities. Any stop-gap measure should thus cover such a period (five – six years). Nuclear power included but that takes longer period; not less than 10 years.

Mobile distributed power rentals usually referred to as 'emergency' or 'temporary' power systems are employed to fill such medium to long-term power supply gaps whilst permanent power plants are being built. IEA estimates that the power rental market would grow by 17.6% between 2015-2019 and largely in developing countries[37].

Power Contracts

In the light of the electricity supply challenges, the Government has ordered the following power contracts through independent power producers (IPPs) to mitigate the situation[38];

- Karpower Ship from Turkey (450MW);
- AKSA Power from Turkey (370 MW)
- APR from UAE (250MW); and
- General Electric (300MW).

This set of 'stop-gap' power contracts are not only needed to fix the current shortfall but provides these co-benefits:

- Providing the necessary cushioning to allow Akosombo and Bui hydrodams to recover to appreciable levels in the light of the less than expected precipitation in their catchment areas this year.
- Enabling the major thermal plants to undergo mandatory maintenance when due without the need for nationwide load-shedding;
- Allowing the necessary long term re-structuring of the existing power sector market to ensure long term sustainability to be implemented.
- Allowing construction of basic infrastructure for greenfield base-load plants such as LNG and or coal plants.

[37] IEA, Global Power Rental Market 2015-2019.

[38] 'Emergency' in the sense that they are immediately needed to offset the huge shortfall in power supply and to mitigate significantly, the on-going nation-wide load-shedding.

Karpower is likely to provide 225 MW this year and the remaining 225 MW coming in 2016. It is contracted to run for 10 years using oil or gas if the latter is available. A site in the Western Region is being prepared to receive the plant.

AKSA Power is providing 200 MW this year and the remaining 170 MW available next year. It is likely to be run on oil and a site to receive it has been prepared.

The APR Power is providing 250 MW. It is going to be located at Aboadze near the existing Takoradi thermal plants and that makes it easier to have access to the gas from the Atuabo processing plant.

GE 300 MW is somehow uncertain due to fuel availability. It is currently considering oil. We estimate that it can provide around 125MW by end of the year.

Thus there is a high certainty of **at least 800 MW** *which is minimum of the estimated demand deficit*, to be available and connected to the grid by end of the year.

In all cases, for the plants running on oil, the delivery price of power would average 19 U.S cents per units (KWh) and an average of 13 U.S cents per units for those to be run on gas.

More efforts therefore should also be geared towards increasing the gas-to-oil ratio in the generation in order to reduce high cost impact of the delivery price on the main off-taker which is the Electricity Company of Ghana and consequently, the public tariff, bearing in mind that the off-taker is currently on the average only able to collect roughly 60% of its expected revenues.

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

The prevailing Non-residential tariff *(see Table 6)* means that it would still be cost competitive to encourage mass deployment of solar electricity currently having feed-in tariff of 58.36 pesewas per kWh (**18.24 US cents per kWh equivalent**) for systems without back-up storage and 64.41 pesewas per kWh (**20.14 US cents per kWh equivalent**) for systems with back-up storage[39]) 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.

On the other hand, customers with consumption more than 600 kWh a month, technically referred to as "the 600^{+} Consumption Class" customers fall 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.

[39] US cent 1 = 3.1986 Ghana pesewas average at September 30, 2014 when the tariff were set.

Table 6. Non-Residential Electricity Tariff for 2014 and 2015

CONSUMPTION CLASS	RATE			
	Gp per kWh		US cents per kWh	
Year	2014	2015	2014	2015
0-100	45.2	60.79	16.99	16.00
101-300	45.2	60.79	16.99	16.00
301-600	48.1	64.69	18.08	17.02
600+	75.9	102.08	28.53	26.86

US cent 1 = 2.66 Ghana pesewas average in March, 2014.
US cent 1 – 3.80 Ghana pesewas average in March, 2015

Rooftop Solar Programme

In the light of the power supply shortfall, the Energy Commission with its mandate to ensure the development and utilisation of the renewable resources has initiated the rooftop solar programme in an effort to contribute to mitigating the current power crisis.

The objective of the programme is to reduce the daily national peak load by 200 MW through self-generation using solar photovoltaic (PV) technology.

The programme is targeted at homes, offices, hospitality industry and small businesses.

Under the programme, a capital subsidy is given to beneficiaries in the form of rebate which would pay for part of the total cost of the solar system, specifically, the solar PV modules while the beneficiaries pay for the balance of system (BOS) components. Beneficiaries would also be given the option to take a special bank loan to offset the payment commitments.

Summary of forecast for the power sector for 2015 is as follows (see *Table 7)*:

Table 7. Summary of Power Sector forecast for 2015

Optimum electricity requirement to eliminate the load-shedding (GWh) *(VALCO at 3-5 potlines in brackets)*	16,398-17,350 *(19,000-21,000)*
Expected dependable capacity (MW) *(Including spinning reserve margin)*	3,200-3,300 *(4,000-4,200)*
Corresponding installed capacity (MW) *(Including spinning/reserve margin)*	3,500 *(4,200-4,500)*
Likely available grid electricity supply GWh	14,300-14,500
Projected dependable capacity (MW) *(projected installed capacity)*	2,900-2,922 *(3,250)*
Likely shortfall in capacity (MW)	450-550
Total capacity required to cover existing shortfall and spinning/reserve margin (MW)	800-1,000
"Emergency" Power contract imported to offset shortfall MW	1,370-1,500
Likely Power contracts expected to be available this year MW [40]	800-1,000
Ghana System Peak/Maximum Demand[41] MW	2,200-2,400
GRIDCO Transmission System Peak/Maximum Demand[42] MW	2,700-2,900
Projected volume of gas required (mmscf)[43]	68,600-77,100
Estimated available gas supply (mmscf)	50,400-50,600
Expected Jubilee gas flow rate MMBtu per day *(mmscf per day)*	60,000-100,000 *(60-100)*
Total delivery Jubilee gas price $ per MMBtu *($ per mscf)*	8.82 *(8.99)*
Expected WAGP gas flow rate* MMBtu per day *(mmscf per day)*	50,000-70,000 *(50-70)*
Total delivery WAGP gas price * $ per MMBtu *($ per mscf)*	8.85-9.00 *(8.99-9.17)*
Optimum crude oil (LCO) requirement** Million barrels *(kilotonnes)*	5-7 *(800-1,000)*
Average price for light crude oil (LCO) *dedicated for power production* $ per bbl *($ per MMBtu)(cif)*	85-90 *(14.6-15.46)*
Average price for Brent crude $ per bbl *($ per MMBtu)(fob)*	60-65 *(10.31-11.17)*
Low-side is for foundation customers and high-side for standard customers.* * Low-side oil implies more gas available and high-side implies less gas available*	

[40] Provided a range to allow for potential additional contracts during the year.
[41] Domestic peak
[42] Excludes exports to Togo, Benin and la Cote D'Voire.
[43] Excluding supply to the "Emergency" power plants.

2.0 Petroleum Subsector: Oil

2.1 Overview of petroleum supply in 2014

Saltpond field

Total oil production from the Saltpond field in 2014 was 97,300 barrels compared with 98,289 barrels in 2013[44]. Mean daily and monthly productions were 290 and 8,108 barrels respectively. Once again, as in the previous years, the production trend is an indication that the field has matured and consequently drying up (*see Figure 1*).

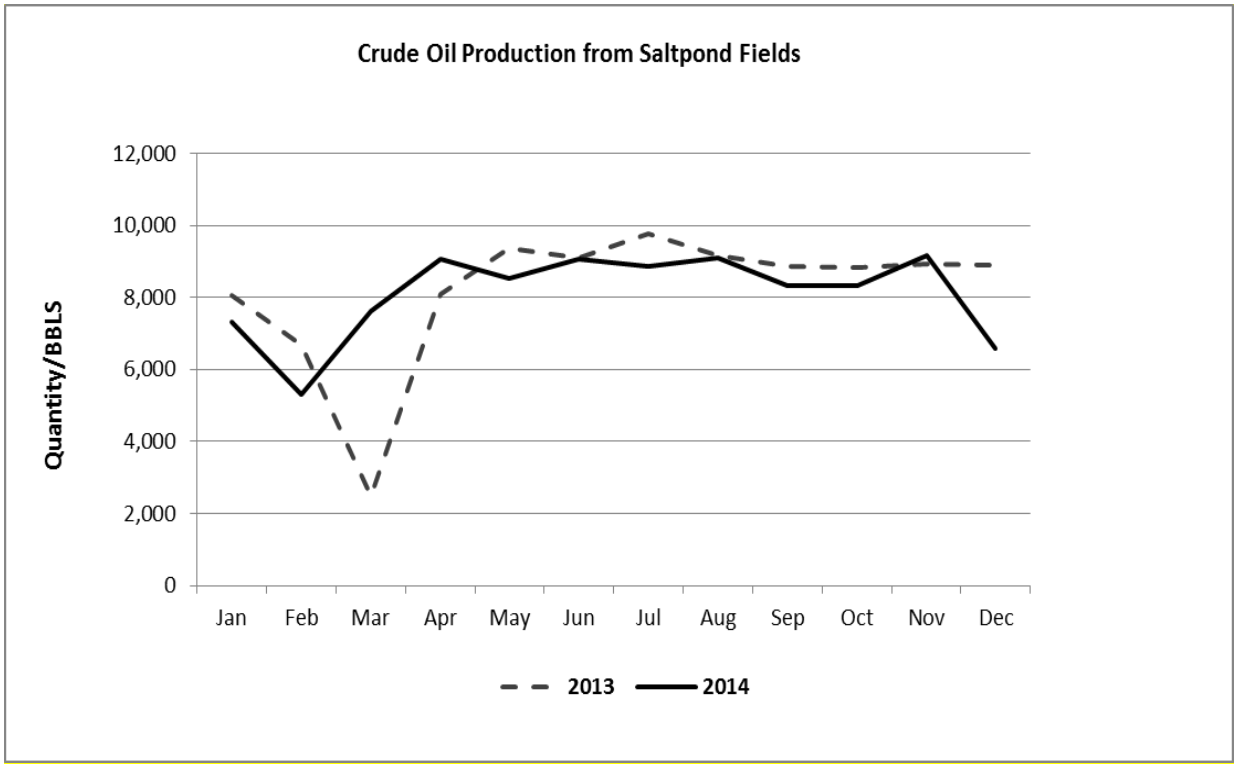

Figure 1. Comparing Saltpond field oil production in 2013 and 2014

Jubilee field

Total oil production from the Jubilee field in 2014 on the other hand was around 38.7 million barrels compared with 30.4 million barrels in 2013; about eight million barrels more than the previous year (an increase of about 27%). Total production in 2012 was 27.4 million, meaning production is on the ascendency.

[44] Data provided by Saltpond Oil Fields Company.

Average daily oil production from the Jubilee field increased from about 91,000 barrels in 2013 to 105,935 barrels in 2014 (i.e. about 16% increase) still though, unable to reach the target of 120,000 barrels per day as projected by the industry since 2012 (*see Figure 2*). Average daily production in 2012 was 81,000 barrels.

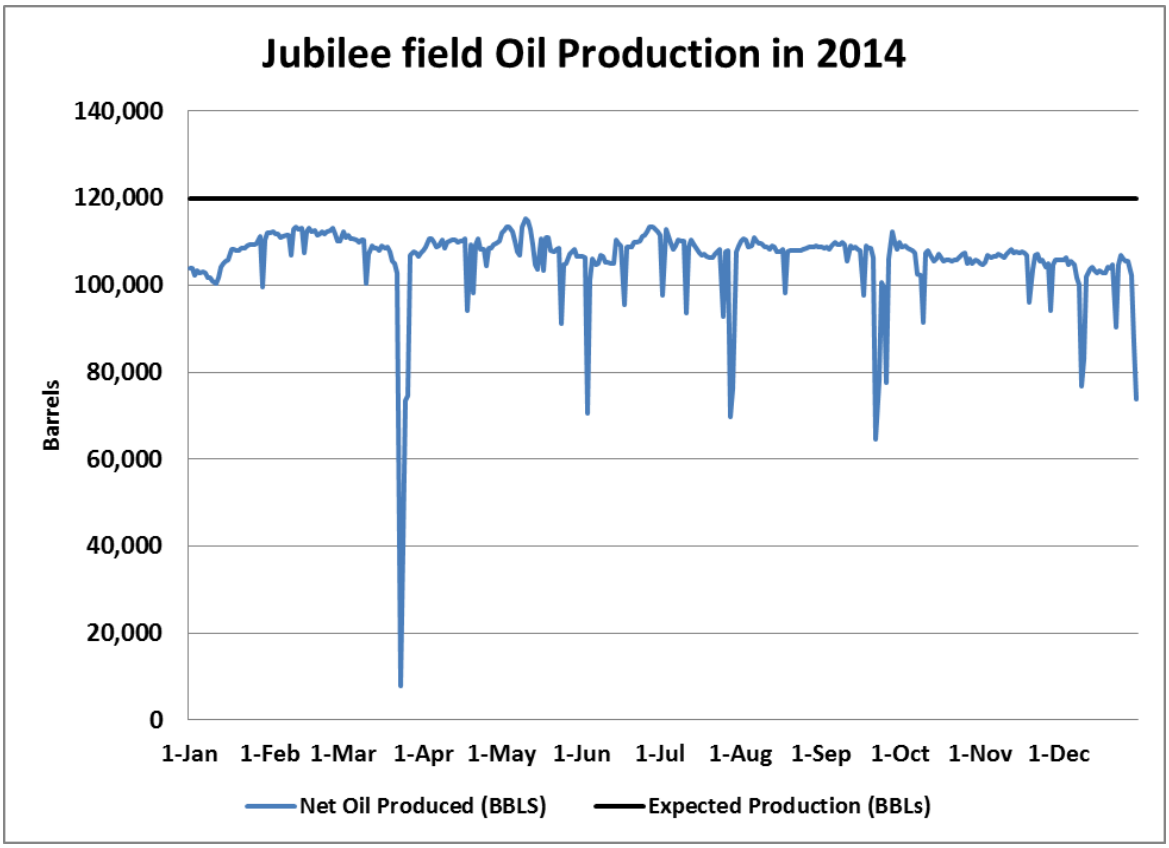

Figure 2. Jubilee field production in 2014

Monthly mean daily production was fairly stable averaging 105,000 barrels throughout the year; the peak average daily production was in February at about 110,000 barrels but dropped to its lowest at 100,186 barrels the following month March.

Crude Prices

In 2014, crude oil from the Jubilee field was sold at an average price of about $96 per barrel compared with about $109 per barrel in 2013[45], about 11% drop. Starting with an average price of $109 per barrel during the first quarter, it rose to $110 per barrels in the second

[45] 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.

quarter, and then dropped to $102 during the third quarter then to its lowest at about $63 per barrel in the last quarter of the year.

Average price of crude oil sourced by Ghana in 2014 was $99 per barrel compared to $109 per barrel in 2013 (*see Table 8*). Average price of the Brent was $107 per barrel in January reaching a maximum of $112 in June, thereafter, dropping to a minimum of $62 per barrel in December, 2014.

Table 8 compares the Ghanaian sourced oil prices and those of West Texas Intermediate (WTI) representing the United States and the London Brent representing Europe.

Table 8. 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
2014	99	93.3	99

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

Global Scan

The global economy has been sluggish since 2013, growing at 3.3% per annum. The global growth is projected to pick up increasing to 3.5% by end of 2015 and increasing to 3.7% by close of 2016. Whilst average growth of advanced economies expanded from 1.3% in 2013 to 1.8% in 2014 and is projected to reach 2.4% by end of 2015, that of emerging market and developing economies dropped from 4.7% in 2013 to 4.4% in 2014 and is projected to decline further to 4.3% in 2015. Growth in Sub-Saharan Africa is projected to drop in 2015 to 4% from 4.5% in 2014 and this is being attributed to the fall in prices of oil and other commodities[46].

From the above discussion and from **Tables 9** and **10**, it is clear that for a developing economy like Ghana, economic growth is directly and strongly related to injection of adequate energy.

46 IMF, World Economic Outlook Update, January, 2015

Table 9. Ghana's Oil Imports, costs and GDP growth compared

Year	Crude oil (million tonnes)		Oil Products imported (1000 tonnes)	Petroleum imported in US$1000 (fob)	Average Crude oil price US$/bbl	Real GDP at 2006 constant prices Million GH Cedis	Average Exchange Rate GHs=$	Real GDP growth Rate
	Imported	Exported						
2010	1.66	0.01	1,590	2,134	80	24,101	1.45	8%
2011	1.53	3.53	2,109	3,159	111	27, 487	1.55	15%
2012	1.21	3.78	2,573	3,279	113	30,040	1.88	8.8%
2013	1.30	5.11	2,946	3,550	109	32,242	1.97	7.3%
2014	0.69	5.39	3,394	3,668	99	33,589	3.20	4.2%*

** Estimated*

Data source: Bank of Ghana, March 2015, Ghana Statistical Services, 2015

Table 10. Ghana Economic Growth and Energy Consumption compared

Year	2010	2011	2012	2013	2014
Real GDP in US$ equivalent	16,621	17,734	15,979	16,366	10,497
GDP Growth %	8	15	8.8	7.3	4.2
Final Energy consumed per GDP (TOE)	0.24	0.23	0.22	0.21	0.2
Primary Energy consumed per capita	0.28	0.30	0.32	0.32	0.34
Middle-income average minimum benchmark	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
Final Energy consumed per capita (TOE)	0.23	0.24	0.25	0.26	0.26
projected	**0.40**	**0.42**	**0.42**	**0.43**	**0.43**
Middle-income average minimum benchmark	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**

However, Ghana's consumption of both primary and final energy are still far below those of average minimum exhibited by countries of lower middle income status as compiled by the International Energy Agency (IEA).

We projected under SNEP 1 that all things being equal[47], the country should had had energy injection of at least 0.40 tonnes of equivalent (TOE) by 2010 increasing to 0.43 TOE by 2015, i.e. achieving the required energy supply and consumption to facilitate comfortable living standard of the populace and befitting a country of lower middle-income status.

[47] i.e. should the recommendations made in SNEP 1 had been followed

Domestic consumption and stocks in 2014

Crude oil imported for domestic consumption was just around 693 thousand tonnes (~4.85 million barrels) in 2014 compared to 1.3 million tonnes (9 million barrels) in 2013; a decrease of almost half the quantity from the previous year. Electricity production accounted for almost 90% of the crude oil consumption whilst primary refinery operations accounted for the remaining 10%. Total products consumed in 2013 amounted to almost 3.3 million tonnes, just about one percent less than in 2012[48]

Except for gasoline and premix fuel which were about the same as last year, almost all the products supplied to the market in 2014, were less than in 2013. 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 11*).

Table 11. Petroleum products supplied to the Economy for 2012-2014

PETROLEUM PRODUCT	2012	2013	2014	*CHANGE*	
				b/n 2012 & 2013	***b/n 2013 & 2014***
	1000 tonnes			***Percentage***	
LPG	268.5	251.8	241.5	*-6.2*	*-4.1*
Gasoline	992.7	1,080.6	1,102.3	*8.9*	*2.0*
Premix	58.9	53.4	56.2	*-9.3*	*5.2*
Kerosene	45.6	27.8	9.3	*-39.0*	*-66.5*
ATK	141.3	131.9	113.9	*-6.7*	*-13.6*
Gas oil/diesel	1,665	1,722.6	1,713	*3.5*	*-0.6*
RFO	33.5	39.3	26.8	*17.3*	*-31.8*
Total	**3,205.5**	**3,307.40**	**3,263.1**	***3.2***	***-1.3***

Source: National Petroleum Authority, 2015.

Total net oil products supplied[49] to the economy continued to show an upward trend; it was about 3.9 million tonnes in 2014 compared to 2.9 million in 2013 (*see Figure 3*) but largely (about 85%) imports, whilst local production from Tema Oil Refinery (TOR) accounted for just around 3%, the remaining 11-12% provided by storage stocks. Production from TOR continued to nose-dive; reaching its lowest in 2014 of about 129 thousand tonnes from its average annual peaks of 1.5 million tonnes in the early to middle of last decade.

[48] 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.
[49] Total net oil supply = production + imports – exports

Petroleum products imported in 2014 were about 3.4 million tonnes, an increase of about 15% over imports in 2013. The products imported were LPG, gasoline, diesel, fuel oil and aviation kerosene.

Diesel had about 51% share of the imports, followed by gasolines with about 37%, then LPG-7%, ATK-3.3% and fuel oil, 1.4%. In terms of percentage points however, ATK was the most imported fuel, an almost three-fold increase in 2014 after a previous dropped by almost half in 2013 from 2012.

Gasoline imports dropped to about 23% in 2014 from 25% in 2013 after increasing from 14% in 2012. Diesel oil imports also dropped from 25% in 2013 to about 6% in 2014 after increasing from 9% in 2012. LPG imports increased marginally to about 16% in 2014 from around 15% in 2013 after a drop from about 36% in 2012. Residual Fuel oil (RFO) import growth was about 9% from 2013 to 2014.

Products exported were largely marine gas oil (MGO) and heavy gasoline (naphtha), the former sold to foreign vessels. Total product exported in 2014 dropped more than four-fold to about 21,000 tonnes. It had declined by almost half in 2013 from about 180,000 tonnes in 2012.

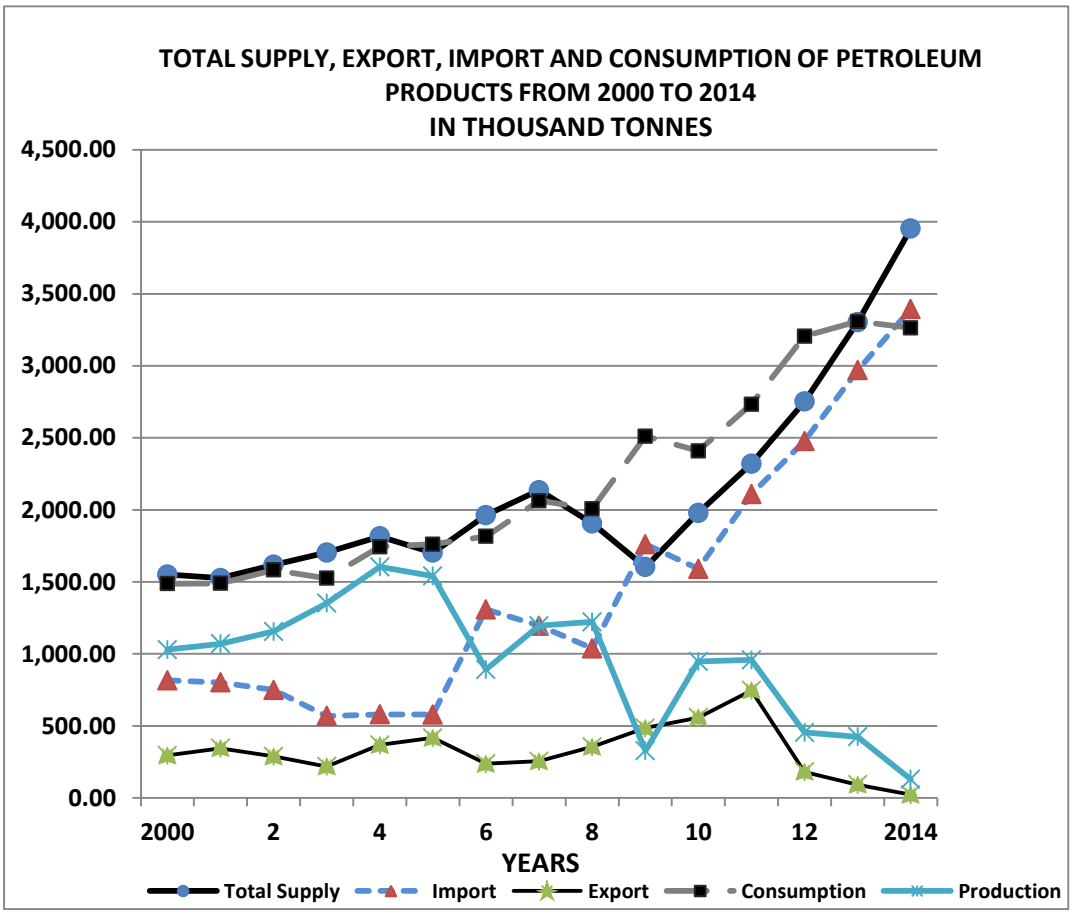

Figure 3. Total oil products supplied from 2000 - 2014

2.2 2014 forecast and actuals

From monthly peaks of $112 per barrel for Brent and $105 per barrel for West Texas Intermediate (WTI) in June, 2014 the global crude oil benchmarks fell to $62 per barrel and $59 per barrel in December, 2014, respectively, thus a drop of almost 50% of their average prices since July, 2014[50]. Ghana did not escape the global price slump (*see Table 12*).

Table 12. Yearly average crude oil prices for 2014: Forecast and Actuals

	Ghana		WTI & NYMEX Gulf Coast/ United States		Brent Crude North Sea/ United Kingdom
	Brent	**LCOs***	**Brent**	**LCOs***	**Brent**
Forecast	107-108	105-106	105-106	96-97	107-108
Actual	99	96	99	93	99

**Other light crudes / U.S refiner*
Source: Bank of Ghana, U.S EIA Short Term Energy Outlook, 2014, 2015

Ghana's total crude oil import in 2014 dropped by about 46% to 693,200 tonnes from 1.3 million tonnes in 2013. Crude oil for refinery operation was also just 10% of the total crude oil imported in 2014 and has continuously dwindled since 2010 reaching its lowest of 70,100 tonnes in 2014 compared to TOR's refinery capacity of about 2 million tonnes per annum *(see Table 13).*

Capacity utilisation at Tema Oil Refinery (TOR) worsened from about 5% in 2013 to just around 3.5% in 2014. Meanwhile, based on international standards, 95% capacity utilization is required for refineries to achieve economic viability.

Table 13. Operating performance of Tema Oil Refinery with and without the RFCC[51]

	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

50 http://www.dailyfx.com/crude-oil

[51] RFCC is Residual Fuel Catalytic Cracker.

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 *(see Table 13).*

The country's annual petroleum requirement has however exceeded the capacity of TOR by more than 50% assuming TOR is operating even at 90% capacity utilisation.

Except for gasoline, almost all the petroleum products supplied were below our projections for 2014. Deficit is estimated at almost 200,000 to 400,000 tonnes (*see Table 14*).

Table 14. Comparing major petroleum products consumption in Ghana in 2013 and 2014[52]

PRODUCTS	2013 CONSUMPTION			2014 CONSUMPTION		
	1000 Tonnes			1000 Tonnes		
	Forecast	Actual	Net /shortfall	Forecast	Actual	Net /shortfall*
Gasoline	850-970	1,080.6	110.6-230.6	1,150 -1,200	1,158.5	8-41.5
Diesel	1,600-1,700	1,722	22-122	1,760 - 1,850	1,713.3	46.7-136.7
Kerosene /ATK	200-230	159.7	40.3-70.3	240 - 250	123.2	116.8-126.8
LPG	250-300	251.8	1.8-48.2	300 - 350	241.5	58.5-108.5
Total	***3000-3,200***	***3,214.1***	***14.1***	***3,450 3,650***	***3,263.5***	***198-405.5***

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
** Low-side implies high efficient fuel consumption.*

There was not much improvement in ATK supply but the industry had gotten accustomed to refuelling abroad due to supply unreliability in the previous year. ATK supply shortfall in the country in 2013 compelled a number of foreign airlines to make alternative refuelling arrangement with neighbouring countries before landing or taking off in the country[53]. The shortage also affected the local aviation industry such that some airlines were forced to reduce their operations[54].

Shortfall in LPG supply continued into 2014, but less challenging than in 2013. Demand for LPG would continue to grow considering the seemingly large number of vehicles that had switched from gasoline to LPG in the earlier years (*see Figures 4 and 5*).

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

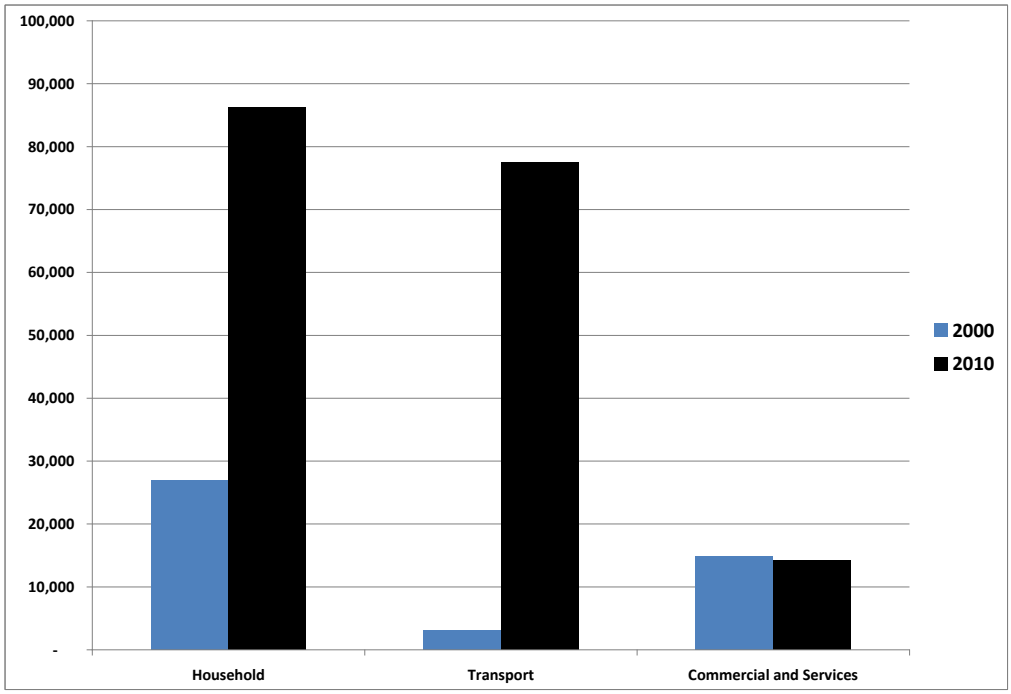

Figure 4. LPG consumption in tonnes for 2000 and 2010

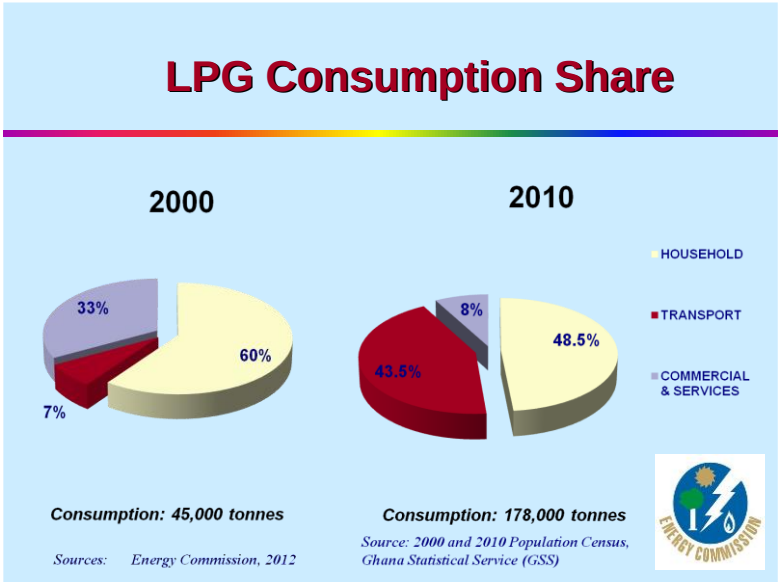

Figure 5. LPG consumption shares for 2000 and 2010

National LPG penetration share increased from 6% in 2000 to 18% in 2010[55]. The sector ministry is targeting 50% penetration by 2016 but it is not likely to be achieved due to limited distribution outlets nationwide.

For instance, to achieve a 50% nationwide penetration of LPG, the consumption would require an LPG supply of at least 450,000 tonnes by 2020 based on an estimated population of 31-32 million by the end of the decade.

This can be achieved by implementing the measures to support and accelerate the supply and use of LPG outlined in the Energy Sector Strategy and Development Plan, 2010 and the LPG Policy Paper, 2012. They include:

- Speeding up the establishment of a Natural Gas Processing Plant to produce LPG from the associated gas to be produced from the Jubilee Oil and Gas Field.
- Deliberate government policy to make the LPG produced available for local consumption as against export;
- Removal of price distortions;
- Re-capitalising Ghana Cylinder Manufacturing Company (GCMC) to expand production capacity with the production of cylinders focused on small sized cylinders that would be portable and affordable to households in rural communities.
- Constructing LPG storage and supply infrastructure in all regional and district capitals in the long term, and to develop district capital LPG infrastructure in the medium term.

[55] 2010 Population Census, Ghana Statistical Services

2.3 Forecast for 2015

Oil production from the Jubilee field has averaged 110,000 barrels per day since the beginning of the year.

For 2015, we project the oil production to ramp up to **115,000-120,000** barrels per day since significant volumes of the associated gas are now being piped out to Atuabo for processing[56].

Further, we forecast that average Brent crude oil that Ghana buys would lie within **$60-65** per barrel [57] and **$55-60** per barrel for other light crudes for refinery operations (*see Table 15*).

Table 15. Forecast for average light crude oil prices for 2015

FUEL BRAND	Ghana	United States[58] (WTI and NYMEX)	Europe[59] (UK & Holland)
	US dollars per barrel		
Brent crude	60-65	60-61	63-65
Other light crudes/ U.S refiner	55-60	54-55	56-58

Jubilee field oil was exported at an average price of $96.18 per barrel in 2014. We expect the average price for 2015 to fall within **$60-65** due to the global price slump.

With the significant drop in crude oil prices, we maintain the same estimates projected for 2014, i.e. the total crude oil and imported products required for **2015** should range between **3.45-3.65 million tonnes** in order to meet optimal refinery operations and products for local consumption, and also if the economy is to be salvaged from the projected slow growth of 3.5% for 2015 to a level well above 4.2% growth for this year.

To further avoid the cyclical product shortages, crude oil required for refinery operations should fall within **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.

[56] Either by flaring or transporting to the gas processing plant at Atuabo.
[57] With characteristics almost or similar to Brent crude.
[58] US EIA quotes forecasts Brent at $60.79 and WTI crude at $54.32 for 2015.
[59] London and Rotterdam trading for Brent averaged $64.75 for 2015. www.tradingeconomics.com

Table 16 presents the estimated total refined products required for 2015.

Table 16. Petroleum product forecast for 2015[60].

PRODUCT	National supply requirement
	Tonnes
Total Gasolines	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***

LPG supply: A third of the total LPG requirement could come from TOR, if operating at over 90% capacity on the average during the year (*see Table 16*).

Additional LPG supplies for the country is expected from processing the wet associated gas from the Jubilee field, now that the Atuabo gas processing facility has become operational. For instance, processing 80 mmscfd of the wet gas would yield about 500 tonnes of LPG a day, which would be enough to meet the country's projected short to medium term demand of **300,000-350,000** tonnes per annum up to 2020[61]. Ability to meeting this supply requirement would translates into achieving the country's target of **50% penetration** within **2015-2020.**

Total national LPG storage capacity coverage is however a challenge, since the distributions are largely found in southern Ghana, from Kumasi, Koforidua and along the coast. In summary, storage limitations could constrain the supply to around 300,000 tonnes in 2015. Otherwise, total LPG requirement of the country could exceed 300,000 tonnes up to 350,000 tonnes due to the expected availability from the Atuabo plant[62].

Priority Issues

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

[60] Same as for 2014
[61] Assuming short term is 1-2 years; 2015-2016 and medium term; 2015-2020.
[62] Energy Commission (2011), Liquefied Petroleum Consumption survey, 2003-2007. Energy Survey in Households, Industries, Commercial and Services.

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 17**.

Table 17. 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[63] in West Africa has exceeded 120,000 barrels per day (*about 6 million tonnes per annum*). Besides, Nigeria has total refinery capacity of over 800,000 BPD (about 20 million tonnes) but production has been below 60% 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 2020 if construction starts by 2016.

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

[63] 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 nationwide however would continue to constrain local distribution and access.

Additional LPG supplies for the country are now available from processing the wet associated gas from the Jubilee field, since the Atuabo gas processing facility is now in commercial operation.

Evacuation of the LPG for now is being done by road since the originally planned LPG pipeline has not been built. 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[64] over land. Overland pipeline transportation and distribution have therefore been the dominant mode for terrestrial oil and products transport. It is also said to be safer.[65]

[64] Also natural gas and crude oil.
[65] 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 2014

Total gas flow in 2014 was 23,633,724 MMBtu (23,634 22,541 mmscf); about 95.4% coming from Nigeria via the WAGP and the remaining 4.6% coming from the Atuabo gas processing plant during its testing phase.

About 51% (63% in 2013) destined to the Sunon-Asogli thermal plant in Tema and the remaining 49% (37% in 2013) to the VRA thermal plant at Takoradi *(see Figure 6).* All the indigenous gas however went to the Takoradi thermal plant.

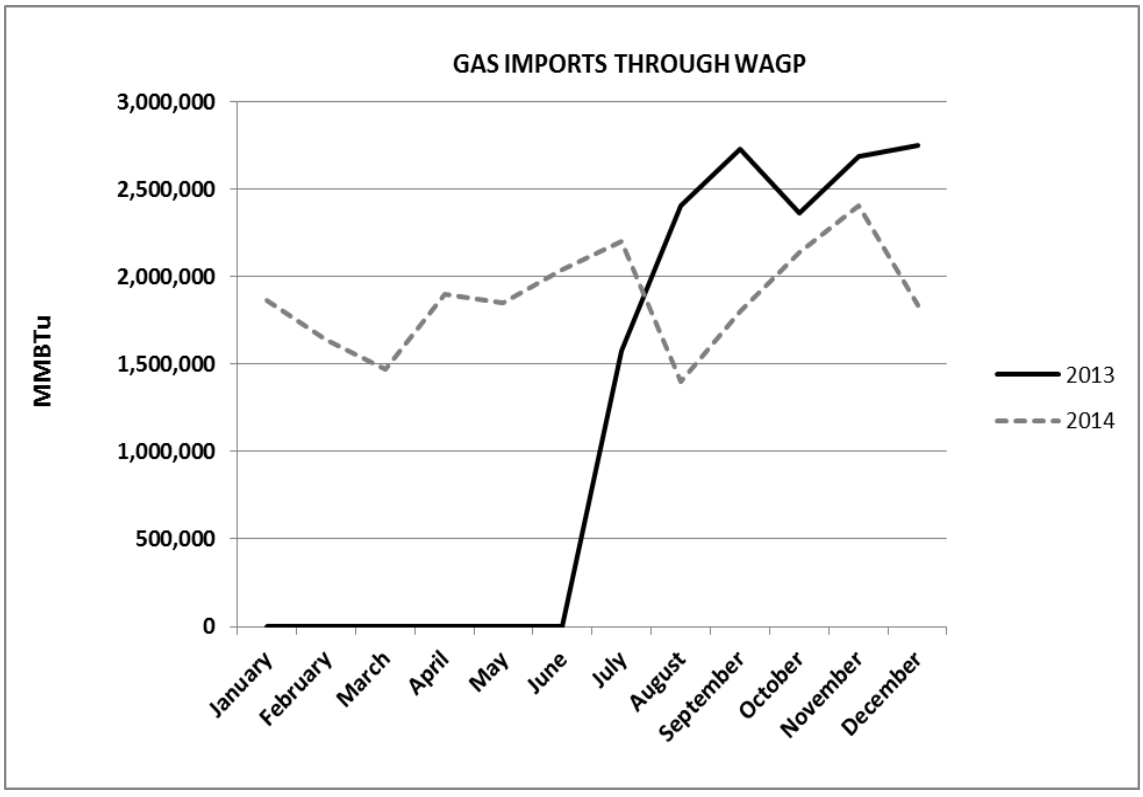

Figure 6. WAGP gas supply for Ghana in 2013 and 2014

3.2 2014 forecast and actuals

Average WAGP gas flow in 2014 was 61.8 mmscfd compared to our forecast of 30-50 mmscfd, albeit, the growing gas demand and increasing nationalism in Nigeria over gas exports.

We projected that associated gas from the Jubilee field would come on line between August and December 2014 with an average supply of 80-100 mmscfd. It did come on line as expected beginning November with an average of 16.64 mmscfd increasing to a peak of about 64 mmscfd for a day in December and ending the year with an overall average supply of 35.3 mmscfd.

The WAGP gas price was $8.47-8.49 per MMBtu for VRA, the foundation customer which was within our estimated price of $8.40-8.55 per MMBtu (*see Table 18*). Sunon-Asogli power plant in turn paid $9 per MMBtu for its portion of the gas received from VRA[66].

Table 18. WAGP Delivered Gas Price Components for foundation customers in 2014

Details	Customer Price
	$/MMbtu
Gas Purchase	2.587
ELPS Transport	1.2745
WAGP Transport	4.3465
WAGP Credit Support Charge	0.2000
WAGPA Charge	0.0600
Pipeline Protection Zone charge	0.0300
Shipper Fee	0.0000
Delivered Gas Price ($/MMbtu)[67]	**8.498**

Source: Adapted from WAPCo, 2014

The total delivery gas price in 2013 was $8.27 per MMBtu for Foundation customers and $8.38 per MMBtu for Standard customers[68] Thus a marginal increase of about 2%.

[66] Sunon Asogli does not directly buy the gas from WAGP but VRA buys it from the latter then swaps it since Sunon Asogli has no contractual purchase arrangement with WAGP.

[67] 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.

[68] Source: WAPCo, 2015. Communications with the statistical personnel.

3.3 Forecast for 2015 and beyond

For 2015, indications from the industry players suggest a slight upward adjustment in the WAGP gas transport from about $4 to $5 per MMBtu bringing projected total delivery price to about **$9** per MMBtu.

The price of the Jubilee gas is estimated at **8.84** per MMBtu

Comparatively, average spot (Henry Hub) price in the United States is projected to drop from $4.52 per MMBtu ($4.60 per mscf) to between $3.85-$3.88 per MMBtu ($3.92-$3.95 per mscf) [69] whilst average import delivery price in Europe is expected to drop from $10.05 per MMBtu ($10.24 per mscf) to around $7.80-8.10 per MMBtu ($7.94-8.25 per mscf) during the year. IMF projects long term average gas price for mainland Europe as $9.4 per MMBtu ($9.57 per mscf) and largely coming from Russia (*see Table 19*)[70].

Table 19. Average delivery gas prices in Ghana (WAGP), United States (Henry Hub), and Europe (the North Sea); 2011-2015

Year	WAGP+Jubilee/ Ghana	Henry Hub/ United States	Northsea Europe/
	U.S dollars per MMBtu *Average long term import prices in italic brackets*		
2011	6.56	3.59	8.70
2012	8.19	2.75	8.90
2013	8.27-8.38	3.71	10.63-10.72
2014	8.49	4.52	10.05
2015*	**8.84-9.03**	**3.85-3.88**[71]	**7.80-8.10** ** ***(9.4*[72]*)***

**forecast ; ** spot market price, own 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.

Nigeria gas supply challenges

Ghana has been expecting much of its natural gas to come from Nigeria. However, there are currently 23 grid-connected generating plants in operation in the Nigerian Electricity Supply Industry (NESI), with a total installed capacity of 10,396 MW and available capacity of

[69] Spot prices usually do not include transportation cost.
[70] US EIA Short Term Energy Outlook, March, 2014.
[71] Estimates from US EIA Short Term Energy Outlook, 2015
[72] Long term forecast from IMF, March, 2015

6,056 MW. Most generation is thermal based, with an installed capacity of 8,457.6 MW (81% of the total) and an available capacity of 4,996 MW (83% of the total) as of 2014[73].

Nigeria had projected to expand its installed capacity to about 13,000 MW by 2016 and 15,000 MW by 2020 against an estimated demand of 26,651 MW by end of the decade[74]. However, the nation could only achieve available capacity of 5,500 MW beginning 2015[75].

This ambition puts a greater strain on the existing gas supply situation. Nigeria is struggling to achieve its domestic gas supply and export plans. Supply requirement totals about **5 billion cubic feet per day (bcfd)** for domestic consumption, LNG contractual shipments and WAGP commitments but the country currently is only able to produce about **4 bcfd** of which about **2.8-3.0 bcfd** goes to produce the **22 million tonnes of LNG** its exports annually. Existing power plants requires at **least 1.5 bcfd** which means there is little or none for pipeline export to WAGP partners and that supply to the latter ramps up only when a local power plant trips or is offline for maintenance.

The country needs to develop new fields to meet the projected demand but industry experts estimate that to happen between 2017-2018, provided existing schedule is executed as planned.

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 (WAGP) to meet local supply quota first before export. As of 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 to WAGP.

Such does not augur well for Ghana's short-medium term energy security.

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[76]. The supply balance of 312 mmscfd reinforces the opportunity for the development of a viable alternative supply option such as an LNG terminal.

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.

[73] http://www.nipptransactions.com, 2015
[74] Power Generation: Status and Outlook, a presentation by Presidential Task Force on Power, at Electric Power Investors ' Forum by Bureau of Public Enterprises,
[75] Energy Commission of Nigeria, website news update, 1st Quarter, 2015.
[76] Energy Commission source.

3.4 Alternative natural gas supply sources

3.4.1 Supply from the Jubilee field

In November 2014, local associated gas from the Jubilee field started reaching the thermal plant at Aboadze, averaging 35.3 mmscfd by end of the year.

For 2015, we expect the flow to ramp up to 80-100 mscfd on the average throughout the year.

Total associated gas produced as a result of the daily oil production in 2014 was about 55,779 mmscf; 15% more than in 2013. About 82% was re-injected, 6% was used as fuel for on-board operations, just one percent more than last year compared to 9.5% in 2012. Associated gas flared also went up one percent to 9% from 8% in 2013 (*see Figure 7*).

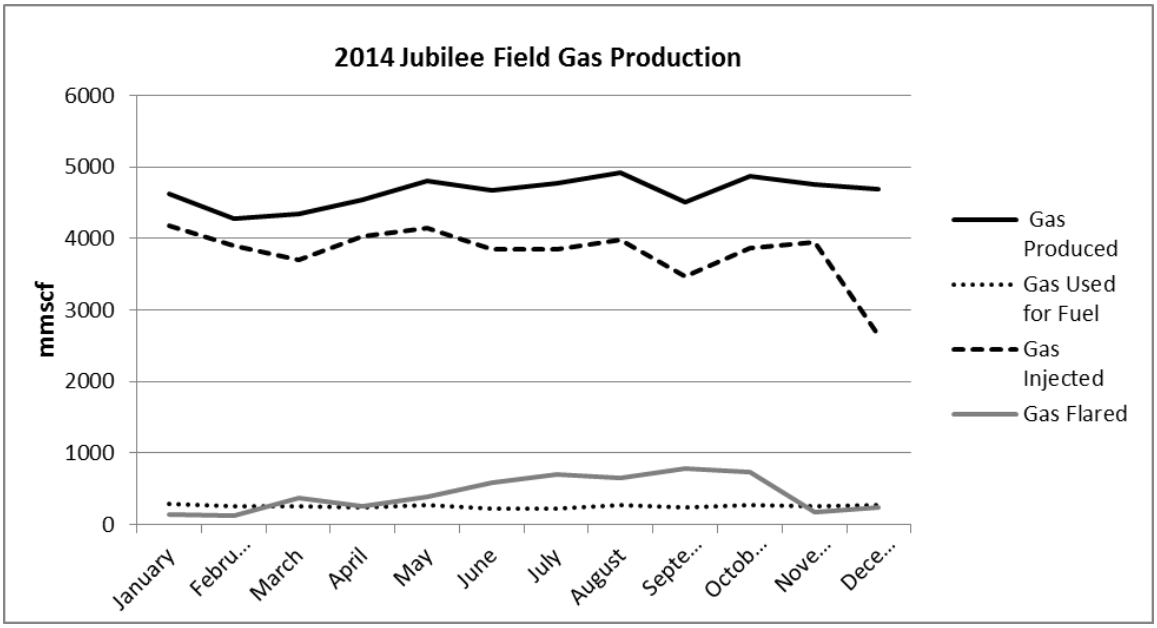

Figure 7. Jubilee field daily gas production in 2014

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, Ghana is looking at supplementary supply options such as other indigenous fields and LNG imports.

3.4.2 Supply from other domestic fields

Besides the associated gas from the Jubilee field, more are expected from other neighbouring fields in the short to medium term, the most prominent being TEN (Tweneboa-Enyenra-Ntomme) field where oil production is expected to commence between 2016-2017[77], but this would depend on the rate of development of the field. 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 [78].

With the number of thermal power plants currently installed and expected to be in operation by 2015, supply requirement by the end of the year including potential demand by the power rentals would be between **350-400 mmscfd**. Gas demand is projected to exceed **800-mmscfd** by 2017 (*see Table 20*)[79].

Meanwhile, total production from all these local fields is expected to 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**.

Even though, most of the gas would be destined for power generation, there would be demand for industrial purposes such as heating and as feedstock.

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

- that industrial use of gas is not likely to be realised until after 2020 and beyond.
- 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 after 2020, if construction is even to starts in 2018.
- 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 after 2020, if construction is even to commence in 2018.

[77] Estimated as the commencement year. The operator, Tullow is optimistic that the first oil can flow by mid-2016.
[78] Natural Gas Pricing Policy for Ghana, Final Report, World Bank, May 2012, consultant- R. Garcia Consultores S.A
[79] See 2010 Energy Outlook, Energy Commission, 2010.

Table 20. Natural gas forecast for Ghana in mmscfd, 2015-2020

Year	2015	2016	2017	2018	2019	2020
Min *Power only*	**350**	**400**	**840**	**840**	**870**	**870**
Max *Power only*	**400**	**446**	**1,128**	**1,128**	**1,140**	**1,140**
Estimated average supply range	**120-180**					

Source: Energy Commission, 2015

3.4.3 LNG Supply Option[80]

LNG supply option (*see Annex 3*) however would be relatively expensive compared to local or the WAGP gas but cheaper than crude oil.

The estimated demand of **350-400 mmscfd** for 2015 is above the breakeven point for a typical 200-250 mmscfd LNG re-gasification facility.

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.

Potential LNG supplies are likely to come from cargos plying between Western African (Nigeria and Angola) and the European markets. LNG cargoes from Nigeria accounted for 3% of United States' LNG supply in the past but there was no shipment in 2014, prompting shippers to look for alternative markets such as 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 21 presents a qualitative analysis of likely cost range for the country if such is built within the next two years.

[80] See Annex 3

Table 21. 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
Nigerian cargo originally destined to USA	6-7	8-9	9-10	1.0-2.0
From Nigeria en-route to Europe	7-8	9-10	11-12	
Angolan cargo originally destined 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*

4.0 Woodfuel Subsector: Charcoal demand and prices

Average prices of charcoal in the country rose from about GH¢13 per mini bag and GH¢21 per maxi bag in 2013 to GH¢17 and GH¢25 in 2014 respectively; increases of about 26% for mini-bag and 19% for the maxi-bag over the previous year. We projected that average charcoal price in 2014 could increase by 20-25% over 2013 average price nationwide due to the significant shortfall in LPG supply across the country during the year.

As usual, the coastal regions were the high-price regions but included Upper East Region this among the top four. However besides Greater Accra, the transitional regions of Brong-Ahafo, Northern and Upper West Regions experienced the most significant charcoal price increment in 2014 (*see Table 22)*.

The low-price regions were still Ashanti, Brong-Ahafo, Northern and Upper West Regions.

Table 22. Average price per bag of charcoal in the regions for 2013 and 2014[81].

Region	Mean Price per Mini bag in Ghana Cedi			Mean Price per Maxi bag in Ghana Cedi		
	2013	**2014**	***% change***	**2013**	**2014**	***% change***
Ashanti	09.15	12.71	*38.91*	16.62	19.32	*16.25*
Brong Ahafo	07.11	9.22	*29.68*	12.58	15.81	*25.68*
Central	19.83	23.53	*18.66*	26.49	31.09	*17.37*
Eastern	13.44	16.62	*23.66*	19.03	22.21	*16.71*
Gt. Accra	17.43	22.42	*28.63*	23.66	30.26	*27.79*
Volta	16.66	20.67	*24.07*	32.02	36.43	*13.77*
Western	15.30	18.20	*18.95*	25.79	28.58	*10.82*
Northern	09.10	12.88	*41.54*	18.30	22.15	*21.04*
Upper East	14.80	20.35	*37.50*	24.93	30.65	*22.94*
Upper West	09.42	11.86	*25.90*	15.56	18.25	*17.29*
National	*13.22*	*16.66*	*26.02*	*21.19*	*25.11*	*18.50*

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

In terms of the weights of the charcoal, [82]but for the Upper East Region, the coastal regions were the high-price regions with Volta being the highest, Central, Western and Greater Accra in 2014 (*see Table 23*).

Table 23. Average price per kilogramme of bag of charcoal in the regions for 2013 and 2014.

Region	2013			2014			*Percentage 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	*2012 /2013*	*2013 /2014*
Ashanti	0.35	0.32	***0.34***	0.49	0.37	***0.43***	*8.1*	*26.5*
Brong Ahafo	0.23	0.22	***0.23***	0.30	0.27	***0.29***	*15.4*	*23.9*
Central	0.63	0.44	***0.54***	0.75	0.52	***0.64***	*32.1*	*17.6*
Eastern	0.52	0.36	***0.44***	0.64	0.42	***0.53***	*14.3*	*20.5*
Gt. Accra	0.46	0.39	***0.43***	0.71	0.50	***0.61***	*21.4*	*40.7*
Volta	0.64	0.61	***0.63***	0.79	0.69	***0.74***	*21.4*	*17.5*
Western	0.59	0.49	***0.54***	0.70	0.54	***0.62***	*11.3*	*14.8*
Northern	0.29	0.32	***0.31***	0.42	0.39	***0.41***	*22.0*	*30.6*
Upper East	0.48	0.43	***0.46***	0.66	0.53	***0.60***	*24.7*	*29.3*
Upper West	0.30	0.27	***0.29***	0.38	0.32	***0.35***	*14.0*	*20.7*

The lowest-price regions in 2014 were Brong Ahafo, Upper West, Northern and Ashanti, just as in the previous years.

[82] 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.

With the availability of more LPG for home cooking particularly due to the operations of the Atuabo gas processing plant, we expect pressure on charcoal for cooking to relax relatively and for that matter we estimate that the average charcoal price in 2015 would experience less increment compared to the previous year, most probably by 5-10% in the coastal areas of Greater Accra, Central, Western and Volta Regions. The average price is likely to increase by 10-15% for Ashanti and Eastern Regions. The transitional belt regions of Brong Ahafo, Northern and Upper West could experience increment of 15-20% some but could reach 25-30% in Upper East Region.

We project that the national average would drop from 26% to 15-20% for the minibags and from about 18% to 10-15% for the maxi-bags.

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 revised and published in 2012, 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. The following companies have been granted construction permit;
    a. Cenpower Generation Company was granted a construction permit to add 300 MW to Ghana's generation capacity.
    b. 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
    c. Volta River Authority (VRA), was issued a Construction Permit to construct a 220 MW Thermal Power Project at Kpone near Tema in the Greater Accra Region.

ii. The following companies have been issued with wholesale supply license;
    a. Three VRA thermal plants namely TAPCO (T1), Mines Reserve Plant and Tema Thermal 1 Power Plant (TT1PP) were issued permanent Wholesale Electricity Supply Licences.
    b. Three Wholesale Electricity Supply Licences have been issued to Independent Power Producers (IPP) to construct and operate thermal plants. This include, 200 MW from the Sunon Asogli Plant and 126MW from CENIT Energy Limited.
    c. Electricity Embedded Generation License was issued to Genser Power Limited an Independent Power Producer to distribute electricity to consumers within the distribution network.
    d. The TICO thermal generation plant in Takoradi, which is jointly owned by VRA and TAQA global, was issued permanent Wholesale Electricity Supply Licence to operate a 220MW thermal power plant.

i. In 2013 Provisional Licences were issued to the 132 MW Takoradi T3 Power plant and 400MW Bui Power Authority.
ii. A total of 10 Siting Permits expected to result to 4,325MW have been issued to potential Independent Power Producers.
iii. Thirty-one (31) Provisional Wholesale Electricity Supply licences have been issued to potential Independent Power Producers as well as Government owned VRA. These are expected to bring on line about 9,785 MW of power when the plants are constructed. Out of this 440MW is a power barge.
iv. 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.
v. 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.
vi. A Distribution and Sales Licence was issued to the Northern Electricity Distribution Company (NEDCo).
vii. Thirty three (33) 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 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.

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 electrician for certification as Certified Electrical Wiring Professionals (CEWPs). Subsequently two examinations were conducted in 2014 and currently 1,512 electrician have been certified as CEWPs and 19 as Certified Electrical Wiring Inspectors. Award ceremonies were organised at the Commission for successful candidates. Certificates and ID cards for successful candidates were issued on the awards day. 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 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.

Provision has been made for establishment of Brokerage licences and efforts are being made to bring this to reality by 2016.

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 very limited and unreliable. The arrival of the gas from the Jubilee field is therefore mitigating the supply situation.

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. The Natural Gas department of the Energy Commission has issued the following licences to players in the Natural Gas industry.

i. A Provisional Natural Gas Transmission Utility Licence has been issued to BOST to operate the Natural Gas Interconnected Transmission System (NGITS).
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. Quantum power was granted a Siting Permit for the LNG facility after a presentation and site appraisal from the Energy Commission siting committee.
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. The Rotan facility is to feed into a 660 MW power barge owned by Rotan.
iv. Provisional LNG facility license has been issued to Newstar Terminals at Atuabo. Newstar Terminals would regasify LNG supplied by Sage Petroleum.
v. Construction Permit has been issued to Amandi Energy for the construction of 203 MW thermal power plant. The Company had earlier been issued with a siting permit during the third quarter of 2013.
vi. Marina Energy has submitted application for Construction Permit for 80 MW thermal power plant after receiving a siting permit in August, 2013.

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

Provisional licences so far issued for Renewable Energy electricity had risen to 62 with capacity totaling 5,074 MW compared with 36 totaling 3,905 MW in 2013. . Out of this 44 are for Solar photovoltaic (PV) generation with a total capacity of 2,472 MW. Last year was 29 with 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, 554.MW and 876 MW respectively *(see Table 24).*

Table 24. Provisional Licences issued for Renewable Energy Electricity as of March, 2015

Category	Number	Total Capacity (MW)
Solar	44	2,472
Wind	7	876
Hydro	3	101
Biomass	2	68
Waste-to Energy	9	554.01
Wave	1	1000
Total	**62**	**5,074.01**

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 Energy Commission in 2014 therefore suspended issuing of licence. The suspension however has been lifted but the Commission has reviewed the procedure for processing of licence application for wholesale electricity supply licence for utility-scale grid-connected solar PV plants (see *Annex 4 for the details*).
The applicant is required to submit an approved dynamic grid impact studies from the Electricity Transmission Utility (ETU) or the Distribution Utility, among other requirements, before a construction permit is granted. Furthermore, the determination of the capacity of the plant a licensee can construct now include the ability of the grid to evacuate the power safely.

The Energy Commission and the PURC[83] currently are still working on the Renewable Energy Purchase Obligations (REPO).

[83] Public Utility and Regulatory Commission

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).

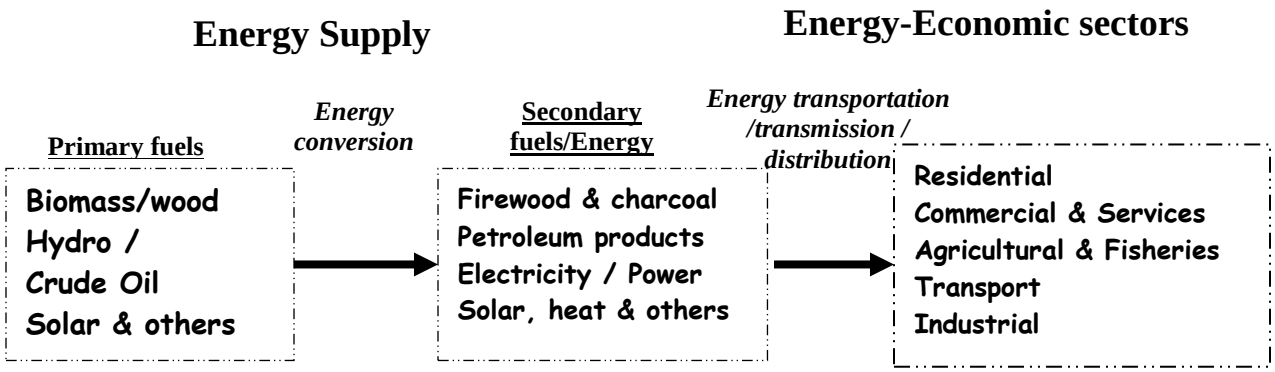

Figure Annex A1. Energy supply continuum

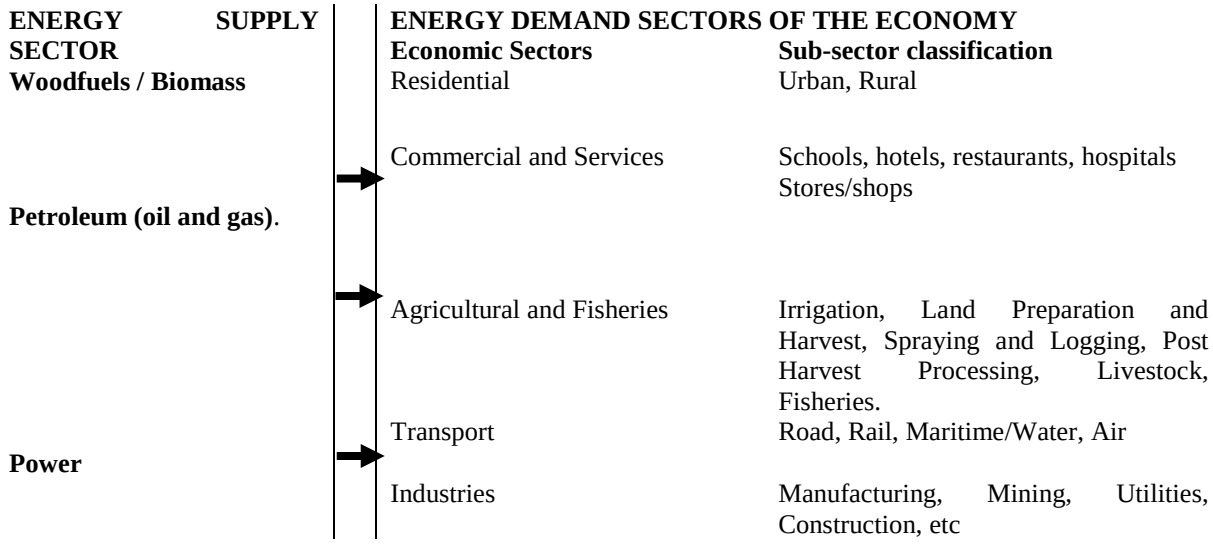

Figure A2. Energy supply continuum

Annex 2 – Eleven year Sunspot Cycle

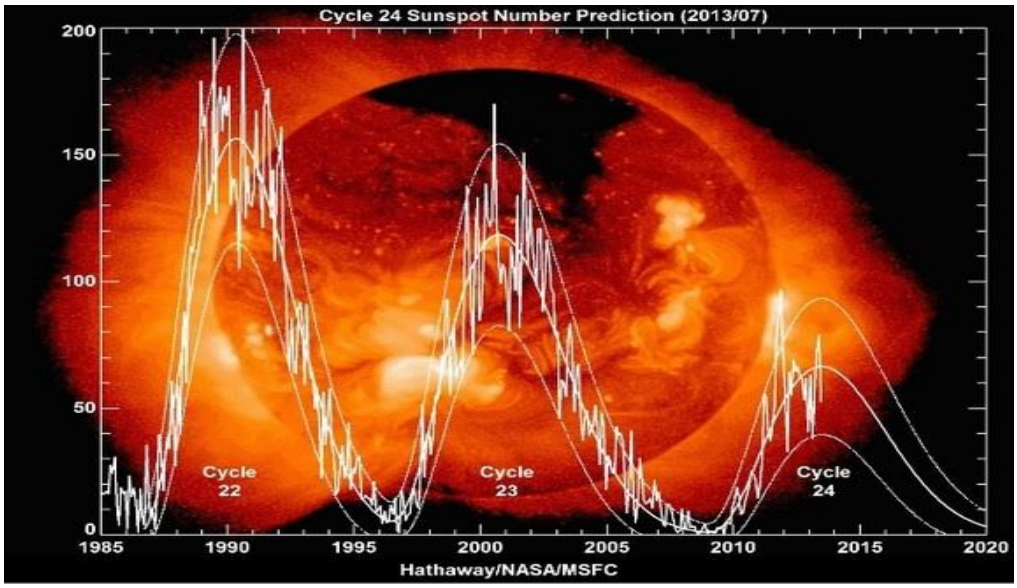

Figure A3. Sunspot Cycle from 1985-2013

Annex 3 – Liquefied Natural Gas Regas Terminal Technologies

LNG could be delivered through the following terminal technologies:

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

Energy Bridge Regasification Vessels

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

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

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

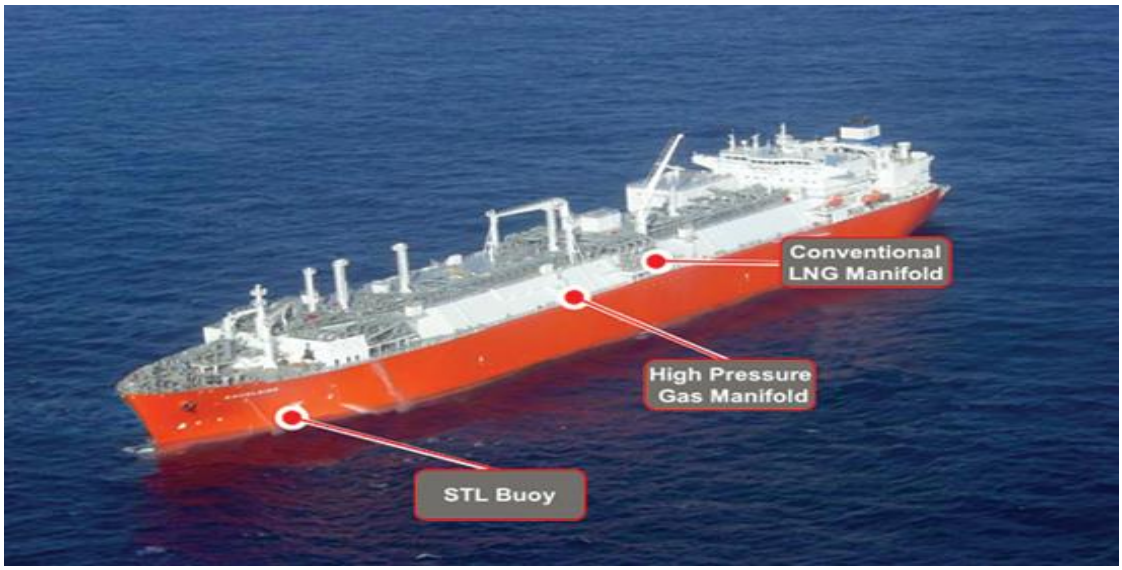

Figure A4.

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 storage LNG re-gasification unit or facility (FSRU). Typical LNG ship has capacity of 120,000-125,000 liquid cubic metres (lm^3). The larger the containment the greater the application for floating storage and regasification

applications[84]. 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 two and half years** to allow for initial paper work.

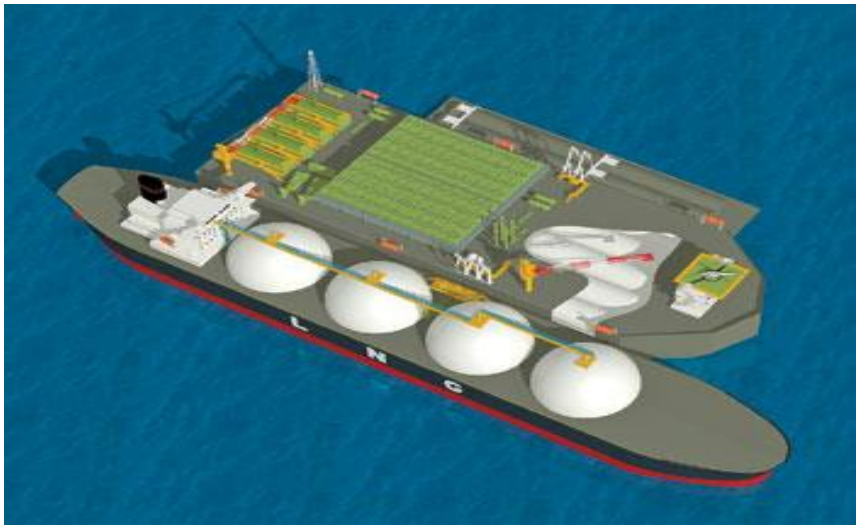

Figure A5.

Permanent LNG discharge/re-gasification terminal

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

Figure A6.

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

Annex 4 – Revised procedure Wholesale Electricity Supply Licence for Utility Scale Grid Connected Solar PV Plants.

PUBLIC NOTICE

March 2015

REVISED LICENCE PROCEDURE FOR PROCESSING OF WHOLESALE ELECTRICITY SUPPLY LICENCE FOR UTILITY SCALE GRID-CONNECTED SOLAR PV PLANTS

The Energy Commission has reviewed the procedure for processing of licence application for WHOLESALE ELECTRICITY SUPPLY LICENCE FOR UTILITY SCALE GRID-CONNECTED SOLAR PV PLANTS as follows:

1. Upon an application and submission of an approved Dynamic Grid Impact Studies from the Electricity Transmission Utility (ETU) or the Distribution Utility and Exhibits 19 – 30 of the Renewable Energy Licensing Manual, the licensee may be granted a Construction Permit to construct the solar PV plant.
2. Subject to the acquisition of a Construction Permit, the capacity of the plant a licensee can construct shall be determined by:
   (i) The ability of the grid to evacuate the power safely;
   (ii) The ability of the off-taker to take up and pay for the power; and
   (iii) A Power Purchase Agreement (PPA) approved by the Public Utilities Regulatory Commission (PURC) specifically for the capacity of the project.
3. For any particular project site to be connected to the National Interconnected Transmission System (NITS), the maximum amount of solar PV capacity without energy storage system shall not exceed the maximum capacity the ETU is able to evacuate safely from the site without energy storage system.
4. For any particular project site to be connected to the distribution network, the maximum amount of solar PV capacity without energy storage system shall not exceed the maximum capacity the Distribution Utility is able to evacuate safely from the site without energy storage system.
5. Any capacity in excess of the maximum determined by the ETU or the Distribution utility shall have equivalent energy storage capacity or grid stability systems.
6. The ETU or the Distribution Utility concerned shall confirm in writing that it is capable of evacuating the power from the facility to be constructed in addition to the total cumulative intermittent power sources already connected to the NITS or the Distribution Utility's System.
7. Where the land for the installation of the solar PV plant is arable or has economic trees, the design of solar PV installation shall be such that part of the land is reserved for the cultivation of appropriate food crops/economic trees. Evidence of such design shall be part of the documentation in the application for Construction Permits for the solar PV plant.
8. The use of land as equity by land owners in Solar PV power plants is encouraged.

Thank you.

Ag. Executive Secretary
(Michael Opam)