ENERGY COMMISSION, GHANA

2012 ENERGY
(SUPPLY AND DEMAND)
OUTLOOK FOR GHANA

April, 2012

Executive Summary

Energy Commission presents supply and demand forecasts for electricity, crude oil, petroleum products and natural gas for the year 2012.

Electricity:

In 2011, the total grid or public electricity generated in the country was 10,167 Gigawatt-hour (GWh)[1]. The Ghana load at peak on on the transmission grid was 1,665 Megawatts (MW) and the grid system peak was1,745 MW.

For 2012, the total electricity requirement of the country would be in the range of 12,394-14,673 Gigawatt-hour (GWh) of which 11,500 (±4%)GWh[2] could be supplied by the public utilities through the national grid. The shortfall in electricity supply would be largely met by private and back-up generation at the point of use. This also means that there is an installed capacity gap of 500-600 MW thermal gas plant-equivalent to meet the shortfall as well as reserved margin[3]requirement *which should have been in place by now*.

The Ghana peak demand and the system peak on the grid transmission system would be about 1,700 MW and 1,800 MW respectively.

The grid supply would be adversely affected if gas supply from Nigeria through the West African Gas Pipeline (WAGP) drops significantly; i.e. to about half of 2011 gas supply. It is expected that the trend of average annual precipitation for 2012 would either remain about the same as in 2011 or start dropping Indications from the Ghana Meteorological Agency (GMA) suggests the mean annual rainfall had peaked last year and expected to start dropping beginning this year. Higher inflows into the hydropower reservoir would have improved the overall power generation in case the gas supply reduces but the GMA forecast has given rise to the rainfall uncertainties. We therefore forecast but with cautious optimism that, 66-68% of the grid electricity requirement would come from hydropower as in 2011.

[1] Million units of electricity.
[2] Just as in 2011.
[3] Minimum of 20% of installed capacity.

Natural gas

In 2011, the WAPCo[4] tariff for transporting natural gas via the West African Gas Pipeline (WAGP) was $3.963 per MMBtu ($4.035 per mscf) for Foundation customers and $4.065 per MMBtu ($4.139 per mscf) for Standard customers. Average WAGP gas price in 2011 was $2.454 per MMBtu ($2.499 per mscf). Total delivered gas price[5] was $6.21 per MMBtu ($6.33 per mscf) for Foundation customers and $6.67 per MMBtu ($6.79 per mscf) for Standard customers. . The WAGP gas price is indexed to light crude oil (LCO) price and it is reviewed every six months, also against inflation.

For 2012 therefore, the new WAPCo tariff for transporting the natural gas expected would be around $4.08 per MMBtu ($4.15 per mscf) for Foundation customers and $4.18-4.19 per MMBtu ($4.25-4.27 per mscf) for Standard customers. The average WAGP gas price would be within $2.53-2.55 per MMBtu ($2.57-2.60 per mscf). The total delivered gas price would be $8-9 MMBtu ($8.15-9.16 per mscf).

Total natural gas supply required to run all the dual-fuelled thermal plants in optimum mode would range from 180-200 million standard cubic feet per day (mmscfd).

The average volume of natural gas expected from the West Africa Gas Pipeline (WAGP) is likely to reduce from 94-96 mmscfd (94,000-96,000 MMBtu)[6] to 65-70 mmscfd (about 65,000-70,000 MMBtu) in 2012, which is about half of what has been pledged for 2012 and also, about two-thirds of last year's, due to technical and other unforeseen challenges being encountered in Nigeria.

Petroleum

For 2012, the average purchase price of crude oil by Ghana would be between $120 and $130 per barrel for Brent crude and $105-115 per barrel for other[7] crudes. Average light crude oil price for Ghana was about $111 per barrel in 2011.

[4] West African Gas Pipeline Company Ltd.
[5] i.e. including duties, taxes, etc
[6] For WAGP gas from Nigeria, assume 1 mscf=1000 MMBtu
[7] Heavier-than-Brent

We estimate that the total crude oil and imported products required would increase to 3.0-3.6 million tonnes from 2.8 million tonnes[8] in 2011, in order to meet optimal refinery operations and imported products for local consumption as well as for export. At the expected high crude oil prices however, the high-side of the forecast would be difficult to meet.

Crude oil required for refinery operations would vary from 1.6-1.8 million tonnes (12-13 million barrels) during the year, depending upon the availability of the Tema Oil Refinery and its auxiliary units. The remaining 1.3-1.5 million tonnes of products would have to be imported..

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

Product	**National supply requirement**	**Exports included**
	Tonnes	
Total Gasoline[9]*	850,000 - 870,000	1,000,000
Total Diesel	1,600,000 - 1,700,000	1,900,000
Kerosene/ATK	200,000 - 230,000	250,000
LPG	250,000 - 300,000	350,000
Other	100,000	100,000
Total	**3,000,000 - 3,200,000**	**3,600,000**

For LPG, the total national requirement could likely be in the range of 250,000-300,000 tonnes per year due to the growing demand, particularly as transport fuel. However, limited nation-wide storage capacity and the inadequate revenues generated from its sales due to cross-subsidization could continue to constrain demand to the 220,000-250,000 tonnes range in 2012..

From Ghana's own fields, crude oil production averaged around 70,000 barrels per day from the Jubilee field in 2011. This is short of the target of 120,000 barrels per day projected by the field

[8] 3.5 million tonnes if exports were included
[9] NB: *Total gasoline includes Premix; **Total diesel includes supplies to the mining companies and bunkering

operators. With technical challenges almost resolved[10], production is expected to ramp up to 100,000 barrels per day by mid-2012 and possibly reaching about 120,000 barrels per day by the close of the year.

Charcoal

In 2011, the average price of mini bag of charcoal[11] in the country was GHc9 and for a maxi bag[12] was GHc15. The lowest-price areas were the Upper East and West and the Brong Ahafo regions. The average price increases as one descends from the north towards the coastal areas. Central and Greater Accra regions were the highest-price areas. In 2012, we estimate the average prices of charcoal countrywide to rise to Ghc10-11 and GHc16-17 per mini and maxi bags respectively.

Recommendations

To ameliorate the power supply situation, investments in alternative gas supply in the light of increasing crude oil prices should highly be encouraged. It is therefore commendable for the Ministry of Energy to charge the Energy Commission to coordinate all potential liquefied natural gas (LNG) investment initiatives taking place in the country.

The Energy Commission would intensify its energy efficiency and conservation campaigns during the course of the year.

In the light of the above, the following recommendations are made:

i. *The utilities supported by the Government should look for alternative sources of natural gas for the country's power plants, besides supplies from the West African Gas Pipeline to increase gas supply security.*

ii. *In this respect, Government should proactively create incentives to encourage investment in LNG regas facility built at her coast at the shortest possible time. An investment workshop for stakeholders where the government entities including Ghana*

[10] According to the operator, Tullow Oil plc, Tullow January 2012 Update.
[11] Average weight 26 kg
[12] Average weight 52 kg

Investment Promotion Centre and the Ministries of Energy and Finance can table the economic and investment incentives that the government could offer would be very essential.

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

iv. *On the other hand, Renewable Energy technologies can provide at least 5% of the country's electricity requirements at present. Thus, with the passage of the Renewable Energy Law (Act 832, 2011), the Energy Commission with the mandate to promote renewable energy in the country and with the support of the sector ministry would team up with the finance and the environment ministries, other stakeholders like the Environmental Protection Agency, Ghana Investment Promotion Centre, the international, regional and local financial institutions to organise investment fora on assessing carbon finance facilities for grid–connected Renewable energy projects in the country.*

v. *As part of the strategic oil stock of the country, BOST[13] should initiate steps to include storage of crude oil as soon as possible. Storing crude oil is cheaper, stable and more durable compared to storing products.*

vi. *Ministry of Energy, NPA, Energy Commission and the GIPC assemble other key stakeholders to identify the key barriers impeding investment in new oil refinery in the country and to institute the needed incentives, to encourage construction of new oil refineries to serve both the local and export markets.*

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

[13] Bulk Oil Storage and Transport company

Foreword

THE ENERGY COMMISSION has the mandate to prepare, review and update periodically indicative national plans to ensure that all reasonable demands for energy are met in a sustainable manner. In 2006, the Energy Commission released the Strategic National Energy Plan for Ghana (SNEP) covering the period 2006-2020. In addition, the Energy Commission is mandated to secure and maintain a comprehensive data base for national decision making for the efficient development and utilisation of energy resources available to the nation. Energy Commission's jurisdiction include promoting and ensuring uniform rules of practice for the production, transmission, wholesale supply, distribution and sale of electricity and natural gas.

In fulfilment of its mandates, the Energy Commission has been preparing annual energy demand and supply forecasts to provide some guide 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 2012 Annual Energy Outlook therefore is intended to give 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.

This document covers demand and supply of electricity, crude oil and petroleum products as well as natural gas. For woodfuels, only charcoal prices could be captured, others are not covered due to inadequate information to make a reliable forecast. We have however analysed some field data we collected in 2010 but we were hopeful that the 2010 census would have been released before finalising this report to enable us standardise and extrapolate our results for the country as a whole.

Even though, no forecast for electricity prices is included, higher thermal generation mix and increasing fuel price, relative to 2011, would lead to higher generation cost. The rate of increase would be lower if more natural gas is made available to replace oil fuels in the generation mix.

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

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

Comments are most welcome.

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Executive Secretary

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1.0 Power Subsector

1.1 Overview of grid power supply in 2011

Installed power capacity available for grid generation as at the end of 2011 was about 2,170 Megawatt (MW) (Table 1).

Table 1. Installed Electricity Generation Capacity as of December 2011.

GENERATION PLANT	FUEL TYPE	INSTALLED CAPACITY
		MW
Hydro Power Plants		
Akosombo	Hydro	1,020
Kpong	Hydro	160
Sub-Total		*1,180*
Thermal Power Plants[14]		
Takoradi Power Company (TAPCO)	LCO/NG/diesel	330
Takoradi International Company (TICO)	LCO/NG/diesel	220
Sunon–Asogli Power (SAPP)	NG	200
Tema Thermal Plant1 (TT1P)	LCO/NG/diesel	110
Mines Reserve Plant (MRP)	NG/diesel	80
Tema Thermal Plant2 (TT2P)	NG/diesel	49.5
Sub – Total		*989.5*
Total		**2,169.5**

The total electricity generated in 2011 was 11,200 GWh; as against 10,167 GWh (10,232 GWh)[15] in 2010. The 2011 generation comprised 7,561 GWh (67.5 %) hydropower and 3,134 GWh (32.5%) of thermal power. Even though, hydropower generation share decreased by about 0.8 percentage points over 2010, energy produced increased by about 566 GWh due to significant water inflows into the Akosombo reservoir in 2011.

Net power exported decreased by about 64% over 2010. Total power transmission losses in 2011 was 4.9% net of gross electricity transmitted (Table 2).

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

[15] GridCo in its 2011 Electricity Supply Plan included import as generation

Table 2. Transmission losses and Net Power exports since 2008.

Year	2008	2009	2010	2011
Net export (GWh)	263	555	930	610
Transmission losses as % of gross transmission	6.3	5.5	4.6	4.9

The share of power supplied to industries increased from 47% in 2010 to 49% in 2011, whilst that to non-residential sector which is largely, the commercial sector also increased from 14% (2010) to 16% in 2011. The share of supply to the residential sector in 2011 however, dropped by 5.8 percentage points compared to the previous year (Table 3).

Table 3. Share of Grid Electricity Supply to the Demand Sectors since 2008

YEAR	SECTORS						TOTAL
	Industrial		Non Residential		Residential		
	GWh	*% Share*	GWh	*% Share*	GWh	*% Share*	GWh
2008	2,966	*48.1*	928	*15.1*	2,269	*36.8*	6,163
2009	2,943	*47.2*	878	*14.1*	2,408	*38.7*	6,229
2010	3,156	*46.6*	966	*14.3*	2,738	*40.4*	6,860
2011	3,900	*49.0*	1,314	*16.0*	2,761	*35.0*	7,976

In quantitative terms, even though, all the sectors received more electricity in 2011 than 2010, the increases for industrial and non-residential sectors were higher(744 GWh and 348 GWh respectively) compared to what was supplied to residential sector (homes), which was only 23 GWh. Essentially, there was more power for wealth creation than for household activities, which in economic terms is more encouraging. Except for the residential sector which experienced a drop in annual supply growth in 2011 over 2010, average growth in supply since 2000 had increased for both the industrial and commercial sectors[16].

The significant increment in industrial sector share was largely due to VALCO which operated on average of one potline. VALCO's consumption was 597 GWh in 2011 compared to 7 GWh in 2010[17].

On the policy side, the country now has a Renewable Energy Law (Act 832, 2011) and this should allow other potential sources like wind power to be developed quickly to augment the existing installed capacity.

[16] See Table 8.
[17] See Table 9.

1.2 2011 forecasts and actuals

For 2011, we projected that the total electricity required would be between **13,000-14,000 GWh,** and that **11,000-12,000 GWh** would come from the **existing grid** if the average WAGP gas level would be at least, 90 mmscf per day and if crude oil price was within $90-97 per barrel (Table 4)[18]. We also projected that oil required for thermal generation would range from a minimum of 600,000 tonnes to a maximum of one million tonnes (about 4-7 million barrels) during the year, depending upon the availability of the thermal plants and the volatility of the oil price.

The average WAGP gas flow level for 2011 ranged between 94-96 mmscf per day (94,000-96,600 MMBtu) which was a significant improvement over the previous year (Table 4).

Table 4. Grid Electricity and associated fuels: forecasts and the actuals for 2011.

	2010	**2011**	
		Forecast	**Actual**
Grid Electricity (GWh)	10,232	11,000-12,000	11,200
Percentage hydro (%)	68.8	65-67	67.5
System Peak/Maximum Demand* (MW)[*])	1,391-1,506	1,610-1,720	1,664-1,744
Mean WAGP gas flow range (mmscf per day)	37-38	90-100	94-96
WAGP Gas transportation tariff ** US$ per mscf *($ per MMBtu)*	2.73-2.83 (2.68-2.78)	3.87-3.97 *(3.80-3.90)*	4.04-4.17 *(3.963-4.065)*
Average price for WAGP Gas*** US$ per mscf *($ per MMBtu)*	NA	3.54-4.07 *(3.48-4.00)*	2.44-2.50 *(2.40-2.45)*
Total delivered gas price US$ per mscf *($ per MMBtu)*		6.33-6.79 *(6.21-6.79)*	6.68-8.14 *(6.56-7.99)*
Oil consumed (Million barrels)	~ 5	4-7	~ 2
Average price for crude oil purchased US$ per bbl *($ per MMBtu gas equiv.)*	80	90-97 (*15.30-16.50*)	111 (*18.90*)

** Actuals data obtained from GridCo. Low-side is Ghana/local and high-side is total system peak*
***Low-side for foundation customers and high-side for standard customers. Actual data in $/MMBtu courtesy of WAPCo and VRA.*
**** Prices indexed to LCO and negotiated between the buyer and supplier and reviewed every six months. Actual data in $/MMBtu courtesy of WAPCo and VRA.*

The crude oil price however averaged $111 per barrel, about 40% higher than 2010 average and it was almost throughout 2011, staying within the $90-97 per barrel benchmark was for

[18] Ghana sourced mean crude oil price for 2010 was $80 per barrel whilst that for 2011 was $112.7 per barrel.. Source of data is Bank of Ghana.

only a month in January. Actual oil consumption was about 2 million barrels, far less than projected largely due to the relatively high cost of the oil.

1.3 Forecast for 2012

Ghana recorded a real Gross Domestic Product (GDP) growth of about 13.6% in 2011 as against 7.7% growth in 2010. Economic experts further project high but relatively modest GDP growth of 7.1-11% for 2012 largely on account of the Jubilee field commercial oil production[19]. At such high GDP growth rate, we projected under SNEP (2006-2020)[20] that the total electricity generation[21] required for the country in 2012 would be **20,144-24,650 GWh** with corresponding maximum peak (including suppressed demand) **between 1,888-2,378 MW** and VALCO to be operating at 4-5 potlines.

Table 5. Grid Power Generation Capacity available for 2012

GENERATION PLANT	CAPACITY (MW)		Plant Availability Factor	Expected Energy (GWh)
	Installed	Dependable		
Hydro Power Plants				
Akosombo	1,020	960	0.94	7,905.02
Kpong	160	140	0.90	1,103.76
Sub-Total	*1,180*	*1,100*		*9,008.78*
Thermal Power Plants[22]				
TAPCO (CC)	330	200	0.70	1,226.40
TICO (SC)	220	200	0.80	1,401.60
Sunon – Asogli (gas)	200	180	0.68	1,072.22
Tema Thermal Plant – TT1PP	126	100	0.85	744.60
Tema Thermal Plant – TT2PP	50	45	0.85	335.07
Takoradi 3 (T3)	132	120	0.50	525.6
Mines Reserve Plant (MRP)	80	35	0.75	229.95
Sub – Total	*1,006*	*880*		*5,535.44*
Total	**2,318**	**1,980**		**14,544.22**

However, this is not attainable considering the limited installed grid power capacity in the country and also lack of significant potential import. The technically dependable capacity

[19] IMF January 2012, update; Business Monitor International, Ghana: Business Forecast Report, 4th Quarter 2011.
[20] Strategic National Energy Plan (2006-2020, Energy Commission, available under documents at www.energycom.gov.gh
[21] Total electricity generation=grid/public generation + private back-up generation
[22] TAPCO is Takoradi Power Company, a combined cycle (CC) thermal plant; TICO is Takoradi International Power Company, a single cycle (SC) thermal plant

and grid power generation in 2012 is estimated at **1,980 MW** and **14,544 GWh** respectively (*see Table 5 above*).

The expansion of the Takoradi thermal plant expected to be completed by June 2012 would add 132 MW to the existing installed capacity.

1.3.1 Fuel supply challenge

The required supply of natural gas expected from Nigeria this year would be a great challenge. The West African Gas Pipeline Company (WAPCo), operator of the West African Gas Pipeline (WAGP) system resumed gas receipts into its pipeline in 2011 with the average supply ranging from 94-96 mmscf per day (94,000-96,000 MMBtu per day). However, in the early in the year, the company has reported poor quality delivery from Nigeria and for that matter was forced to shut down temporarily in February until the expected quality was restored. Since then supply to the country has been very erratic. Besides, political developments in Nigeria are also fuelling a conspiracy theory that gas may not flow at all for the rest of 2012. If WAGP gas supply is curtailed completely, the Sunon-Asogli-plant which is wholly natural gas fuelled would be out of operation (Table 6).

Table 6. Grid Generation Capacity available for 2012 assuming no or far less than expected natural gas flow[23].

GENERATION PLANT	CAPACITY (MW)		Reliability Factor	Expected Energy (GWh)
	Installed	Dependable		
Hydro Power Plants				
Akosombo	1,020	960	0.94	7,905.02
Kpong	160	140	0.90	1,103.76
Sub-Total	*1,180*	*1,100*		*9,008.78*
Thermal Power Plants[24]				
TAPCO (CC)	330	200	0.50	876.00
TICO (SC)	220	200	0.50	876.00
Sunon – Asogli (gas)	**200**	**180**	**0.0**	**0**
Tema Thermal Plant – TT1P	126	100	0.50	438.00
Tema Thermal Plant – TT2P	50	45	0.50	197.1
Takoradi 3 (T3)	132	120	0.50	525.6
Mines Reserve Plant (MRP)	80	35	0.75	229.95
Sub – Total	*1,006*	*880*		*3,142.65*
Total	**2,318**	**1,980**		**12,151.43**

On the other hand, if the Nigerian Commercial Group is able to resolve their challenges; the volumes pledged by the group for the WAGP supply for 2012 are as in **Table 7**.

[23] Adapted from GridCO's 2011 Electriicty Expansion Plan + Energy Commission's own estimates
[24] TAPCO is Takoradi Power Company, a combined cycle (CC) thermal plant; TICO is Takoradi International Power Company, a single cycle (SC) thermal plant

Table 7. Volumes of gas pledged by Nigerian Commercial Group for 2012

Period	Volume Pledged mmscfd (*MMBtu per day)*	
	Monthly Average	Minimum
1 November, 2011 - 31 January 2012	88 *(88,000)*	72 *(72,000)*
1 February - 30 April 2012	121 *(121,000)*	105 *(105,000)*
1 May, 2012 onwards	N.A	147 *(147,000)*

Source: Energy Commission

However, save the period to January 2012, the Nigerian Commercial Group has so far effectively reneged on their promise to the extent that the gas volumes as per their pledged estimates appear to be at their lowest ebb. With these developments, we estimate that the likely gas supply would be between 65-70 mmscfd (about 65,000-70,000 MMBtu per day) for 2012, which is about half of the total average pledged for this year and also, which is two-thirds of the gas supplied in 2011.

Meanwhile, Government has adopted a policy to increase the total national installed capacity to 5,000 MW by 2015. The 20,144-24,650 GWh projected under the SNEP (2006-2020) as the generation requirement for 2012 would have required an additional installed capacity of 1,300-1,600 MW.

In reality for 2012, i.e. depending on the contemporary situation, the incremental electricity required for 2012 would be a minimum of **1,194 GWh** and a maximum of **3,473 GWh** (Table 9), since the expected non-oil economic growth under SNEP has not materialized and alternatively, the required installed capacity is not yet in place. Therefore, the total electricity generation requirement for 2012 would be **12,394-14,673 GWh** of which **11,000-12,000 GWh** could be provided by the grid depending upon adequacy of gas supply. The net shortfall plus the requirement for reserve margin is estimated between 3,000-4,000 GWh and would require an additional installed capacity of 500-600 MW gas-power plant equivalent which should have been in place by 2012.

At the grid supply requirement of 11,000-12,000 GWh, the peak demand on the grid transmission system would range from 1,700-1,800 MW.

Tables 5, 6 and **10** also suggest that with lower then expected gas supply, electricity supply-demand balance which is already very tight due to limited reserve margin, would worsen and could be difficult for generating plants to go on scheduled maintenance without a significant impact on grid supply. Oil fuel alternative would be five-to-six times the cost of gas consequently making the grid power very expensive.

We expect the trend of average annual precipitations for 2012 either to remain about the same as in 2011 or start dropping as we approach maximum sunspot cycle of the sun within a year or two. The phenomenon is associated with higher conversion currents and consequently

higher rainfalls, but indications from the Ghana Meteorological Agency suggests the mean annual rainfall had either peak last year and expected to start dropping beginning this year. Higher inflows into the hydropower reservoir would have improved the overall power generation in case the gas supply reduces but with the predictions from the meteorological authority have given cause for the rainfall uncertainties. Nevertheless, we would forecast but with cautious optimism that 66-68% of the grid electricity requirement would come from hydropower.

1.3.2 The potential drivers for electricity consumption

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

- Aluminium production should VALCO be allowed to continue operation;
- Industry besides VALCO, largely influenced by gold production;
- On-going national electrification scheme;
- Natural or organic economic expansion;
- Petroleum up-stream and mid-stream activities.

Aluminium production

VALCO resumed operations in 2011 with not more than two potlines. However whenever there was nationwide supply shortage, VALCO had been forced to curtail operations. In 2003-2004, the nation experienced nationwide load shedding and VALCO which then accounted for 26-40% of the total electricity consumption and about 50% of electricity consumed by industry, was called upon to either shut down or reduced production significantly. Consequently, VALCO had been almost out of the electricity consumption share since 2004 except in 2006 when it was made to come on line. Since then it had never been allowed to operate beyond two potlines as a result of inadequate power.

In any case, the share of electricity supplied to the industrial sector (VALCO inclusive) has shown decreasing trend but with wide variability since 2000 and indeed it was the sector most severely affected during the load shedding in 2003-4 and 2007 (Table 8). The country underwent a nationwide load shedding from 2002-2004 due to low inflows into the Volta reservoir which culminated into reduced generation (about one-third to half capacity less) from the nation's hydropower.

For most of the local industries and also in times of supply unreliability, they had relied on own standby diesel generation where possible, or suspended production but imported finished products to maintain market shares[25].

Table 8. Grid Electricity supply, share and growth to the Demand Sectors since 2000

YEAR	DEMAND SECTORS										
	Industry			Non Residential			Residential			Total	
	1000 GWh	% Share	% Gr	1000 GWh	% share	% Gr	1000 GWh	% share	% Gr	1000 GWh	% Gr
2000	4.31	68.0	*0*	0.55	8.7	0	1.49	23.5	*0*	**6.34**	***0***
2001	4.33	66.4	*0.5*	0.58	8.7	*5.5*	1.61	24.7	*8.1*	**6.53**	***3.0***
2002	3.90	63.2	*-9.9*	0.60	9.8	*3.4*	1.67	27.1	*3.7*	**6.17**	***-5.5***
2003	2.21	48.6	*-43.3*	0.62	13.6	*3.3*	1,73	38.0	*3.6*	**4.55**	***-26.3***
2004	2.03	448	*-8.1*	0.66	14.6	*6.5*	1.78	39.3	*2.9*	**4.53**	***-0.4***
2005	2.54	49.2	*25.1*	0.70	13.6	*6.1*	1.92	37.2	*7.5*	**5.16**	***13.9***
2006	3.59	55.1	*41.3*	0.79	12.1	*12.9*	2.13	32.7	*10.9*	**6.51**	***26.2***
2007	2.70	48.3	*-25.0*	0. 80	14.3	*1.3*	2.10	37.6	*-1.4*	**5.59**	***-14.1***
2008	2.97	48.2	*10.0*	0.93	15.1	*16.3*	2.27	36.9	*8.1*	**6.16**	***10.2***
2009	2.94	47.2	*-1.0*	0.88	14.1	*-5.4*	2.41	38.7	*6.2*	**6,23**	***1.1***
2010	3.16	46.1	*7.5*	0.97	14.1	*10.2*	2.74	39.9	*13.7*	**6.86**	***10.1***
2011	3.90	48.9	*23.4*	1.31	16.4	*36.1*	2.76	34.6	*0.7*	**7.98**	***16.3***
Geometric mean Growth[26]			***-0.9***			***8.2***			***5.8***		***2.0***

Note: Gr is growth rate

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

Primary aluminium production in general is energy-intensive. Electricity intensity of production at VALCO averaged 17 Megawatt-hour per tonne of aluminium in the early 1990s but has improved to the present average of 16.2 Megawatt-hour per tonne.

Aluminium has become the world's second most used metal after iron and is today the single-most important non-ferrous metal. Global demand was about 39 million tonnes in 2010 and this is projected to hit between 73 and over 100 million tonnes by 2020 with an estimated annual growth rate ranging between 6.5-10%[27] Global annual aluminium demand in 2011 was estimated at 41-43 million tonnes. Primary production was about 26 million tonnes and

[25] Association of Ghana Industries, 2010.
[26] Average growth based on geometric mean which is more appropriate than the arithmetic mean for describing proportional growth
[27] International Aluminium Institute, https://stats.world-aluminium.org/iai/stats; Alcoa group, www.alcoa.com/ extracted in March, 2011.

the global inventory was almost 31 million tonnes. Global demand is projected to reach 49 million tonnes by end of 2012, i.e. this year, driven largely by surging demand in Asia.

Aluminium smelting worldwide is very sensitive to electricity pricing and both are highly correlated. At larger production volumes, high electricity tariffs become cost competitive. Average world market price of the metal ranged from $2,600-$2,800 per tonne in 2011 from $2,400-2,650 per tonne in 2010. The global prices however would weaken this year as a result of expected drop in demand in Europe caused by the prevailing economic depression in the region. Experts project a drop to $2,300-$2,500 from the high range in 2011. Even at this price range and for production of 120,000-160,000 tonnes of aluminium per annum, i.e. operating three-to-four potlines, VALCO could still be in business even at a tariff of 6-7 cents per kWh[28]. The downside is that there would not be enough electricity generation capacity to support VALCO's operations at that production level (*see Table 6*).

For VALCO to operate between two-three potlines, we estimate electricity requirement of **600 GWh** for one more potline and **1,200-1,300 GWh** for two more potlines in 2012.

Gold production

With significant reductions in VALCO's power consumption share over the years, the Mining subsector of Industry which is dominated by the gold mining subsector and then the other industries[29] have taken over with the latter having the largest (Table 9).

Table 9. Industrial Sector Grid Electricity supply and shares since 2000

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

[28] Aluminium smelter economics is as such that the high the production levels, the easier to operate on higher tariffs. Refer to SNEP

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

Gold is a rare but precious metal. Global gold output has averaged between 2,500–2,600 tonnes every year since the beginning of the decade. Ghana, ranks as the world's 10th – 12th producer and the second highest in the continent after South Africa.

Gold surpassed cocoa as the country's number one foreign exchange earner in the 1990s, and had accounted for 43-47% of merchandised export earnings since 2006[30]. Gold which was around $400 per ounce in 2004 hit a record average of about $1,400 per ounce at the beginning of 2011 as the precious metal provides safe haven as well as alternative to the United States dollar (*which is said to be losing in value*) for investors worried by the general global economic uncertainty particularly of the United States [31]. Ghana's annual gold production increased from 77 tonnes in 2007 to 79.5 tonnes in 2008. We predicted that it could exceed 80 tonnes in 2010 due to favourable global price and it did, in fact reaching over 84 tonnes (2.97 million ounces) in 2010[32].

Production however dropped to about 83 tonnes (2.9 million ounces) in 2011, unable to reach the 3 million ounces projected. The drop was largely attributed to power supply shortages and increasing production cost[33]. The global gold price rose to almost $1,900 per ounce between July and September last year and then dropped to an average of $1,700 per ounce towards the end of the year. Despite the shortfall, the revenue for the country from the commodity was estimated at $5 billion in 2011 about 30% more over 2010 earnings[34].

Four main factors influence gold production technology, particularly, as whether to opt for surface or underground mining. They are the (i) richness or concentration of the ore; (ii) production costs, (iii) world market price of gold and (iv) energy price. For most surface mines in Ghana, the concentration of gold is between 2–3 grammes per tonne of ore, reducing to 1–2 grammes per tonne for workable tailings. For underground mining, concentration could go as high as 8–12 grammes per tonne of ore on the average in Obuasi underground but drops to a range of 3–5 grammes per tonne of ore for other areas of the country. In general for any given mining area, the ore is richer as one goes underground.

Electricity consumption for underground operations is about three times that for surface mining operations. Energy intensity of surface gold mining in the country is 8-9 GWh per tonne of gold whilst underground mining requires between 28-29 GWh per tonne of gold [35].

Electricity supply for surface mining is mainly for pumping and grinding of the ore. For underground mining, besides pumping and grinding, electricity is required for operating the transport-elevators, drilling, air-conditioning and ventilation.

[30] Bank of Ghana Statistical Bulletin, February, 2011.
[31] Moneynews.com, March, 2011
[32] 2010 Energy Outlook, Energy Commission.
[33] Ghana Chamber of Mines, 2011 report; Global gold-mining production, 2011, www.us-funds.com
[34] Bank of Ghana Statistical bulletin October 2011; http://goldprice.org
[35] SNEP 2006-2020, Volume 1, Energy Commission, 2006. page 34. (point 160)

The general observation is that the ambient temperature increases by 10 degrees Celsius for every kilometre below the surface of the earth.

Most operations thus shift from underground to surface mining, when cost of electricity per production of ounce of gold exceeds about 10 percent of the prevailing world market price of gold. Surface mining is a relatively cheaper technology but has more serious environmental consequences for surrounding communities and the nation as a whole.

Gold production in 2012 is projected to bounce back to 2010 levels due to upward surge in prices, despite the high production costs. Also, new mining operations are expected to add between 50,000-100,000[36] ounces in 2012.

For the additional or marginal production of about 60,000-90,000 ounces and the 50,000-100,000 ounces new gold expected in 2012, we forecast a range of just **24-200 GWh** where the low-side represent production from surface mining and the high-side, production from deep or underground mining.

National Electrification Scheme

The Ministry of Energy in 1989 instituted the National Electrification Scheme (NES) as Government's principal policy to extend electricity to all parts of the country over a 30-year period from 1990-2020. Around 4,813 communities have been connected to the grid achieving a national average coverage of about 72% as of December 2011, an increase of 5 percentage points over 2010[37]. All regional and district capitals have been connected to the national grid. 417 new communities were connected and 271 grid connected communities had their systems/network reinforced (or intensified) to make up for growing load in 2011. According to the Ministry of Energy, over 3,000 communities were earmarked for electrification since 2011 would continue. Intensification works in 159 more communities are on-going[38].

According to the Ministry of Energy, funding arrangement had been secured for about 2,806 communities earmarked for electrification in 2012 and beyond. As it was in 2011, it is not likely that all the 2,806 would be connected to the grid in 2012. We have therefore maintained the national average residential electricity consumption rate from 2000-2010 as the minimum growth rate and the consumption growth rate between 2009-2010 as maximum as used in the 2011 Energy Outlook, we thus estimate a net electricity requirement of **172-375 GWh** for 2012.

[36] Ghana Business forecast last quarter report, 2011, Business Monitor International, www.businessmonitor.com
[37] Ministry of Energy, Power Sector, National Electrification Scheme, 2011, www.energymin.gov.gh
[38] Ministry of Energy, 2012, personal communication with the schedule officer for National Electrification programme.

Natural or organic economic growth

Allowing for natural demand growth due the expansion of the economy, using national electricity growth from 2000-2011 as minimum and growth between 2010-2011 as maximum, we estimate additional 198-1,298 GWh to be required.

Table 10 presents the summary of the additional electricity requirement to top up the 2011 production in order the meet that of 2012.

Table 10. Summary of estimates for additional electricity requirement for 2012

Demand Drivers	Minimum	Maximum
VALCO	*One more Potline* 600 GWh	*Two more Potlines* 1,200 – 1300 GWh
Gold	*Surface mining* 24 – 25 GWh	*Deep mining* 150-200 GWh
National Electrification	172 GWh	375
Natural GDP growth	*National Average 2000-2011 electricity growth* 198 GWh	*2010-2011 electricity growth* 1,298 GWh
Pet. upstream	200	300
Total	**1,194-1,195**	**3,323-3,473**

Petroleum Up-stream and Mid-stream activities

The petroleum upstream covers offshore FPSO[39] vessel operations which involves the production of oil and gas from the Jubilee field. The midstream operations cover the gas evacuation through an undersea pipeline to the processing plant which will receive the associated natural gas from the Jubilee field in the Tano (Western) Basin and process it into lean gas, LPG and other condensates.

The oil production upstream requires between 15-40MW a day for its operations. This is expected to increase to 50-60MW when oil production reaches 120,000 barrels a day. Electricity consumption on the drilling ship is between 300-400 GWh per annum but the fuel supply is natural gas directly from the oil operations offshore. Construction of the gas processing plant onshore would require up to 200 GWh annually for its major welding and

[39] Floating, Production, Storage and Off-loading vessel.

utility operations until completion but it is not likely to commence in 2012 and so can be ignored.

Summary of forecast for the power sector for 2012 is as follows (Table 11):

Table 11. Summary of Power Sector forecast for 2012

Total electricity requirement GWh	12,394-14,673
Likely grid electricity supply GWh	11,000-12,000
Percentage Hydropower %	66-68
Shortfall in capacity and for reserve margin	500-600 MW
System Peak/Maximum Demand* MW	1,700-1,800
Mean Annual WAGP gas flow range mmscf per day (*MMBtu per day)*	65-75 *(60,000-68,000)*
WAGP Gas transportation tariff ** US$ per mscf *($ per MMBtu)*	4.15-4.27 *(4.08-4.19)*
Average price for WAGP Gas (cif) ** US$ per mscf *($ per MMBtu)*	2.57-2.60 *(2.53-2.55)*
Total delivery price of gas US$ per mscf *($ per MMBtu)*	8.15-9.16 *(8-9)*
Optimum crude oil (LCO) requirement Million barrels *(kilotonnes)*	3-5 *(400-700)*
Average price for light crude oil *dedicated for power production* US$ per bbl	120-125
Average price for Brent crude US$ per bbl	120-130
** Low-side is Ghana/local and high-side is total system peak.* ***Low-side is for foundation customers and high-side for standard customers.*	

1.3.3 Energy Efficiency and Conservation measures

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

In 2007, the Commission spearheaded the distribution of six million incandescent lamps which reduced peak load by 124 MW. For the succeeding years, the Commission intends to rigorously enforce the regulations banning the importation of incandescent filament lamps.

In 2009, automatic capacitor banks were installed in six public institutions, namely; Osu Castle, Parliament House, Accra Sports Stadium, Food and Drugs Board, Korle Bu Teaching Hospital and the Ministry of Defence. A total of 1,851kVA was estimated to have been saved by this intervention. The second phase involves 26 selected public institutions across the country to be completed by September 2012. The expected savings stands at 1875kVA.

In the last quarter of 2011, the Commission commenced the Refrigerator Energy Efficiency project which would run up to 2014. The project targets over 2 million inefficient refrigerators in use in the country. Each of these refrigerators consume on the average 1,200kWh per year as against 250kWh per year for very efficient ones. The project targets a gradual phase out of the inefficient refrigerators and intends to introduce very efficient refrigerators into the economy with the potential of reducing electricity consumption in refrigerators by 50% in the medium term.

2.0 Petroleum Subsector: Oil

2.1 Overview of petroleum supply in 2011

In 2010, total production from Jubilee and the Saltpond fields was 1.27 million barrels in 2010.

Production from the Jubilee field in 2011 was 23.8 million barrels. No production data on Saltpond field was received and indications suggest that there was marginal or almost no production last year. Oil lifted for export from the Jubilee field as at 3rd January 2012 was about 24 million barrels.

Daily oil production from the Jubilee field averaged around 70,000 barrels, unable to reach the target of 120,000 barrels per day as projected by the industry for 2011 (Figure 1). Tullow Oil plc, the operator of the field blamed it on mechanical issues and complications related to design of the well completions[40].

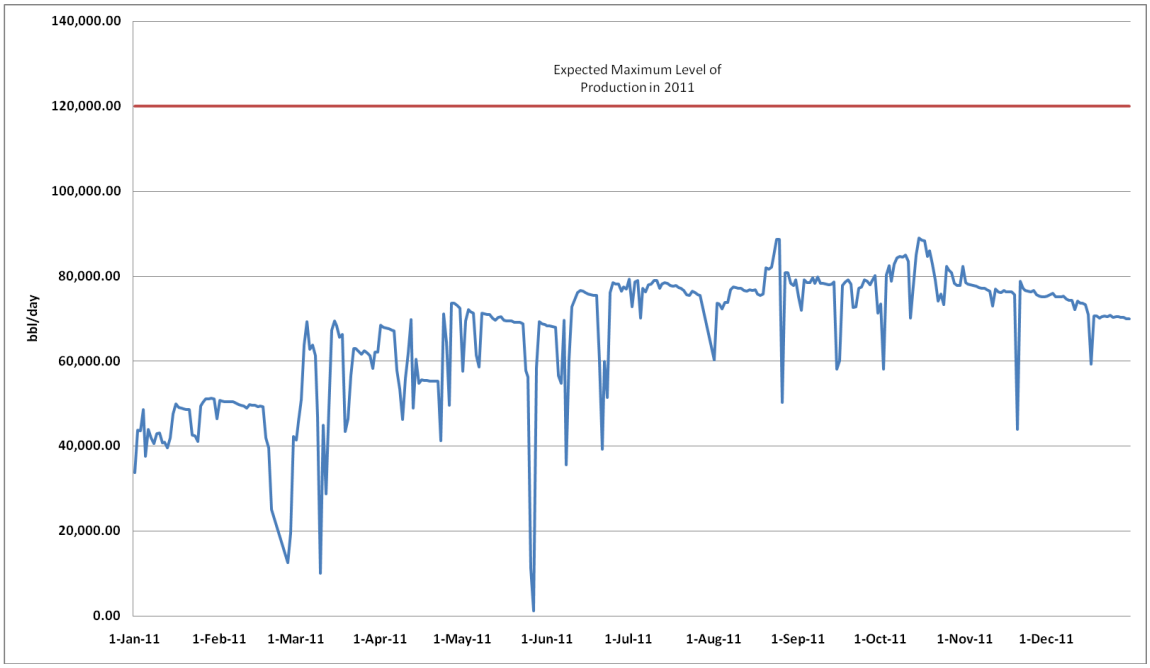

Figure 1. Jubilee field daily oil production in 2011

[40] Jubilee field operations update: Tullow, January 2012.

Imported crude oil consumption by the economy was about 10 million barrels in 2011 compared to 11.7 million barrels in 2010 and was for primary refinery operations (80%) and for electricity production (20%).

Monthly average prices of crude oil sourced for Ghana in 2011 fell within $106-110 per barrel for 25% of the year and within $111-115 per barrel, for 42% of the year except for January where it was about $97 per barrel. In 2010, the monthly average prices ranged between $74.4 per barrel (in February) and $92.35 per barrel (in December).

Table 12 compares the Ghanaian sourced oil prices and those of West Texas Intermediate (WTI) representing the United States and the London Brent representing Europe.

Table 12. 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		
2009	62.0	62.0	50.0
2010	80.0	79.4	70.0
2011	111	94.9	111

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

Total products consumed in 2011 amounted to about 2.8 million tonnes, about 17% over 2010[41]. The three highest movers were premix gasoline, kerosene and ATK (Table 13).

Table 13. Petroleum product consumption for 2011

PETROLEUM PRODUCT	2010	2011	*CHANGE*
	1000 tonnes		*%*
LPG	178.4	214.5	*20.2*
Gasoline	737.8	807.0	*9.4*
Premix	32.4	45.5	*40.4*
Kerosene	49.3	62.4	*26.6*
ATK	108.4	135.3	*24.8*
Gas oil	1,271.9	1,511.5	*18.8*
RFO	30.9	37.5	*21.4*
Total	**2,409.1**	**2,813.7**	***16.8***

Source: National Petroleum Authority, 2012.

[41] 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.

Petroleum products imported in 2011 was around 2.1 million tonnes, about 30% over imports in 2010. Total oil products supplied (comprising local production and imports) to the economy shows an upward trend; it was about 3.2 million tonnes in 2011 (Figure 2). Products exported totalled 665,900 tonnes.

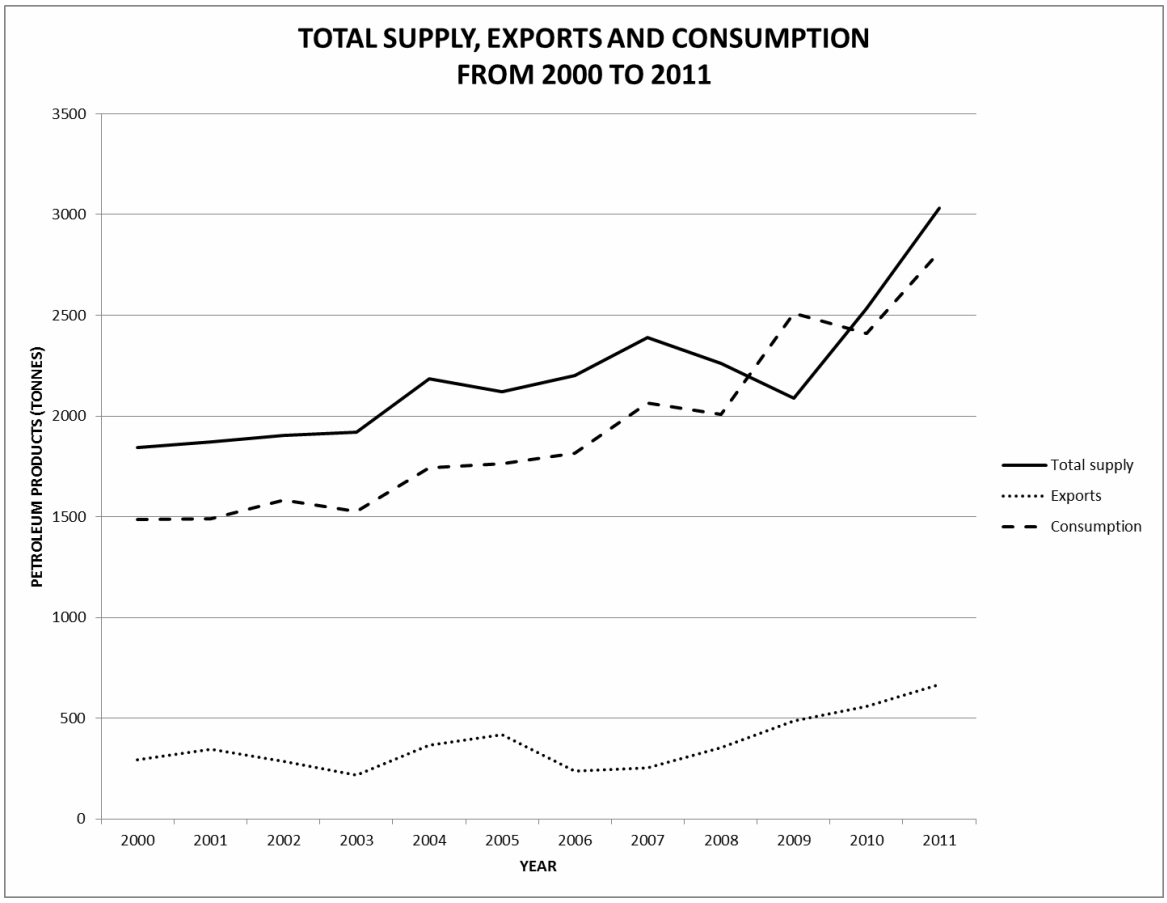

Figure 2.Total oil products supplied in 2011

Total national petroleum stocks or inventories in 2011 stood at about 224,880 tonnes as at December and before the Christmas holiday season (Table 14).

Table 14. National petroleum stocks as at 19 December, 2011.

Oil and Product	Stocks*		Estimated weeks to last	
	1000 Litres	Tonnes	NPA	EC
Crude oil	NA	NA	NA	0
Gasoline	141,100	104,414	5.8	5 - 6
Premix	1,000	740	8.5	Not estimated
Kerosene	3,600	2,902	2.6	Not estimated
ATK	10,900	8,785	3.0	Not estimated
Gas oil	124,600	104,539	3.5	3 - 4
LPG	-	3,500	0.7 *(4-5 days)*	0.5 *(3-4 days)*
	Total	**224,880**		

**Nearest whole number; NA – Data Not available*
NPA-National Petroleum Authority; EC-Energy Commission
Data adapted from NPA source.

2.2 2011 forecast and actuals

Table 15 presents the forecast and the actuals for 2011.

Table 15. Yearly average crude oil prices for 2011: Forecast and Actuals

	Ghana	WTI Gulf Coast/ United States	Brent Crude North Sea/ United Kingdom
Forecast	90-97	102-104	106-115
Actual	111	94.9	111

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

Ghana's crude oil supplies in 2011 came from Nigeria (an OPEC country) Crude oil from the Jubilee fields was sold at a price range of $112-117 per barrel[42].

About one million tonnes equivalent to about eight million barrels of crude oil were used for TOR refinery operations in 2011 as against 1.6-1.8 million tonnes (12-13 million barrels) that the Energy Commission forecasted as required.

[42] Sourced from Bank of Ghana and Ministry of Finance, 2012; first quarter - $113; second quarter-$117; third quarter-111; fourth quarter-$112.

Except for gasoline, our forecasts for 2011 were above actual products supplied to the economy in the year (Table 16).

Table 16. Comparing petroleum products consumption in Ghana in 2010 and 2011[43]

PRODUCTS	2010 CONSUMPTION			2011 CONSUMPTION		
	1000 Tonnes		Net /shortfall	1000 Tonnes		Net /shortfall
	Forecast	Actual	1000 Tonnes	Forecast	Actual	1000 Tonnes
Gasoline	750-800	770.2	within	800-850	852.2	2.2
Diesel	1,600-1,700	1,272	(328-428)	1,600-1,700	1,511.5	(88.5-188.5)
Kerosene /ATK	250-300	157.7	(92.3-142.3)	250-300	197.7	(52.3-102.3)
LPG	220-250	178.4	(41.6-71.6)	220-250	214.5	(5.5-35.5)
Total	***2,820-3,050***	***2,378.3***	***(416.9-641.9)***	***2,820-3,050***	***2,775.9***	***(146.3-236.3)***

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

The actual supplies however improved compared to the previous year and for that matter shortages of LPG and diesel were not as serious as in 2010. Significant increases in retail prices of LPG for vehicular fuel might have helped in reducing its consumption and on the other hand increased consumption of gasoline and invariably the sales of the latter as well. Inability to raise the required and adequate funds for the required LPG import due to cross-subsidisation enjoyed by the product might have also contributed to moderate LPG consumption compared to the Energy Commission's forecast during the year.

Our forecasts for 2011 however did not fall short if exports that year were included. In short, quantities of products supplied including exports totalled almost 3.5 million tonnes in 2011.

Fuel is a major input for economic production. Demand for LPG would continue to grow due to vehicle fuel-switch from gasoline to the LPG. It is clear from **Table 17**, that for a developing economy like Ghana, economic growth is directly and strongly related to injection of adequate energy. Experts projected real GDP growth for Ghana to increase from 7.7% in 2010 to between 14-15% in 2011 [44] but recorded 13.6% with non-oil activities accounting for 8.2 percentage points of the growth[45]. It was nevertheless, an improvement over 2010's where it was projected to increase from 4.7% in 2009 to over 12% but it ended up at 7.7% by close of that year.

[43] In this analysis, products supplied to the economy were assumed to be consumed.
[44] Business Monitor International, 2010
[45] Ghana Statistical Services, March, 2011, First Quarter GDP Newsletter.

Table 17. Ghana's Oil Imports, costs and GDP growth compared

Year	Crude oil imported (million bbl)	Products imported (1000 tonnes)	Petroleum imported in US$1000 (cif)	Average Crude oil price	Real GDP at 2006 constant prices Million GH Cedis	Real GDP growth Rate
2006	15.0	906	1,686	66	18,705	6.4%
2007	14.6	1,200	2,145	73	19,913	5.7%
2008	13.6	1,096	2,413	98	21,592	7.3%
2009	6.6	1,890	1,472	62	22,598	4.7%
2010	11.7	1,450	2,134	80	24,187	7.7%
2011	10	2,075	NA	111	27, 490	13.6% (*non-oil-8.2%)*

Data source: Bank of Ghana, Ghana Statistical Services, 2012

2.3 Forecast for 2012

The year 2011 saw dramatic changes in the global oil and gas market, ranging from the Arab Spring to the nuclear tragedy in Japan. 2012 therefore is being faced with the aftermath of the Fukushima (Japan) energy crisis. The Arab Spring is still on-going with the Syrian crisis in the forefront. Following closely is the Iranian nuclear crisis. Military experts speculate that Israel is likely to go to war with Iran by close of the year. Another hot spot that would be elaborated include the South China Sea[46]. Besides the geopolitics, are the rising oil production costs, such as rising labour and material costs, and the shift to increasingly challenging operating areas, such as the deep- and ultra- deep-waters as in the Jubilee fields, have also emerged as factors in the increasing record oil price levels in 2011.

The main driver for oil forecast this year therefore is still going to be a mix of geopolitics and petroleum demand supply fundamentals, including the speculation factor due to trade in oil futures. The challenge is determining the right balance.

Geopolitical issues moved to the top of the energy agenda with the start of the political unrest across the Middle East and North Africa. Similar geo-energy events in 1971 that led to nationalization of many international oil companies, and the events associated with the Iranian revolution in 1979 led to dramatic increases in oil prices. Thus supply security, geopolitical sensitivity, price volatility would occupy the energy agenda for this year too and would serve as fuel for oil and commodity price speculation.

The Syrian crisis somehow is overshadowing the Iranian crisis, but in terms of influence on the petroleum industry, the county is nowhere near Iran. Iran produces between 4-6% of the

[46] We will encourage readers to check for Strait of Hormuz, the South China Sea and the Caspian Sea from any available global map to save space.

global oil and gas supplies. It has about 10% of the world's proved oil reserves and 15-16% of the global gas reserves[47]. It geographically controls the Strait of Hormuz, the sole maritime link between the oil-rich Persian Gulf region and the rest of the world. Tankers carry an average of 17 million barrels of oil a day from Iraq, Kuwait, Qatar, Saudi Arabia and UAE besides Iran itself, representing about 20% of the global daily supply pass through this vital artery. An attack on Iran would compel the country to attempt to block the strait and some analysts believe that any sustained blockage could trigger a 30-50% increase in the price of oil and could also trigger a full-scale global recession or depression.

The South China Sea is a semi-enclosed portion of the Western Pacific bounded by China to the north, Vietnam to the west, the Philippines to the east and the island of Borneo (shared by Brunei, Indonesia and Malaysia) to the south. Long an important fishing ground as well as commercial shipping routes has been transformed into a cockpit of international friction with the discovery of large oil and gas deposits. Some islands in this energy-rich area are claimed by each of the surrounding countries, including China which claims them all, and has demonstrated a willingness to use military force to assert dominance in the region.

Even though, South China Sea seems remote from Ghana, the global crude oil demand currently would continue to be driven by Asia's demand which is responsible for 70% of the world energy growth in the past 10-15 years and in which China was responsible for 40% of it. Opposing sides have been flexing their muscles through war of words and war games comprising series of conspicuous military exercises have been conducted in readiness against each other, particularly with the smaller countries forming alliances and receiving backing from the United States against China. Should the conflict intensify, it can affect the global demand for crude oil.

Irrespective however of the geopolitical events, demand and supply fundamentals still serve as the major drivers for crude oil price volatility. We elaborate the oil and gas fundamentals as follows:

i. **Global demand growth**: Global oil consumption increased from 86.7-87.4 million barrels per day in 2010 to about 88 million barrels per day in 2011 despite its relatively high cost and the escalation tensions in the Middle East[48]. Global demand in 2011 was estimated at 89.1 million barrels per day[49]. The world economy is expected to expand by 3.3% in 2012, a sharp deterioration from previously assumed 4.0% growth, which is largely due to economic contraction in the Eurozone[50].

[47] Syria on the other hand has just about 0.2% of the global oil and gas reserves; contributes just 0.3% of the global oil supplies.
[48] 89.9 million by IEA 2011 Market report, February 2012.
[49] IEA 2011 Market report, February 2012
[50] IMF January Update, 2012.

Consumption in 2012 is therefore expected to be at 89.6-89.7 million barrels per day, down from 89.8-89.9 million barrels per day previously forecasted by other major experts[51].

Higher oil forecast is made for Japan due to the Fukushima nuclear power accident which knocked out about 2% from her entire power capacity of 279 GW. Japan's nuclear disaster has also influenced demand for energy, besides leading to new questions around nuclear safety. The obvious alternative in Japan is thermal plants for power and fuel oil for heating. This means the country would have to buy more LNG (liquefied natural gas), oil and coal to make up the nuclear energy loss. These would be pushing up the price of oil and natural gas consequently.

ii. **U.S. economy**: Despite the economic downturn, the United States is still the largest and the most important economy in the world and was still responsible for about 20% of the global economy in 2011 as in 2010. The economy is projected to grow by 1.8% in 2012. U.S EIA forecasts an average crude oil price of $106-115 per barrel in 2012[52].

iii. **Euro-zone economic quakes**: The Euro-zone economy which is a key player in consuming crude oil is as large as that of the United States and for that matter equally important comprising about 21% of the global economy. 'However, it is still threatened by economic and political events in Greece and potentially Spain, Italy and Portugal. Europe is also directly and more affected by the geopolitical events in the Middle East and North Africa, since it gets most of its supplies from the affected regions than the United States. In line with the weak economic outlook, European oil demand is however expected to decline in 2012.

Unrest in the Middle East, the loss of Libyan oil for the better part of 2011 and the escalation of tensions with Iran has kept oil prices at elevated levels for Europe. The standoff conflict between the West and Israel on one side and Iran over the latter's nuclear crisis would keep pushing prices towards a high of $130 per barrel by close of 2012, more so when most European countries have decided to boycott Iranian oil. IMF projects that oil prices may increase by 30% if supplies from Iran are disrupted.

We estimate an average crude oil price in Europe to be a wide swing ranging from $110 -130 per barrel for most part of 2012, depending upon member countries' interventions using their strategic reserve stocks. Average price of Brent crude is likely to range from $125-130 per barrel by close of the year.

iv. **Meeting the global demand**: Global consumption has exceeded production for the past two decades and the gap on the average, is widening annually; from about 1.6 million barrels in 2002 to over 4 million barrels a day in 2011[53]. The market would

[51] IEA Oil Market report, 2012; U.S EIA 2012 Short term Energy Outlook, March 2012.
[52] Total U.S. average price and U.S. West Texas Intermediate (WTI) average spot price
[53] BP Statistical Review for 2011.

need an extra of about **1 million barrels a day** to meet the global demand in 2012. Meeting this excess demand would come from production in OPEC and Non-OPEC countries as well as existing inventories and strategic stocks.

v. **Supplies from OPEC countries** are expected to decline in 2012 due to the on-going crisis in the region, particularly with expected disruptions from Iran. New international sanctions targeting Iran's oil exports do not take effect until 1 July, 2012, but several European customers have already curtailed imports of Iranian crude and Asian buyers are also looking for alternative supplies. OPEC is responsible for about 40% of the world crude oil supply. Supplies from Libya, an OPEC member is expected to bounce back but reaching full recovery would depend on how the internal political crisis between Tripoli and Benghazi is resolved, else we do not expect the full supply for 1.6 million barrels per day that Libya delivers. OPEC members serve as the "swing" producers in the world market, since they largely possess surplus or "spare" oil production capacity estimated at 2.82 million barrels a day by close of 2011. OPEC maintains a production quota of 24.845 million barrels a day[54]. Increasing prices however means more revenue for producing countries and for that matter plays into the interest of some of the member countries. U.S EIA therefore projects that OPEC's surplus production capacity would increase from about 2.4 million barrels per day in January 2012 to take advantage of the high prices before Libyan production capacity recovers to pre-disruption levels. In actual fact, OPEC's production quota rose to about 31 million barrels per day in January 2012, the highest since 2008, but this may be short-lived[55].

vi. **Supplies from non-OPEC countries** on the other hand are expected to increase to make up any potential global shortfall, should supplies from Iran be disrupted. There has been however a drop in supply of about 500,000 barrels a day from the beginning of 2012 due to the following crises:

- Unresolved dispute between Sudan and its newly independent South Sudan over oil transit fees (through Sudan) has caused the newly independent country to suspend all its production. Production in both countries which averaged 430,000 barrels per day is expected to be reduced by about half because of the crisis;
- The continued crises in Syria and Yemen have also disrupted supplies of about 250,000 barrels a day from the market. Total production of both countries average 500,000 barrels a day in their regular mode.

[54] The quota was set in 2008 by OPEC. www.opec.org.
[55] US EIA Short Term Energy Outlook, March 2012.

Production in North America on the other hand is expected to increase by about 400,000 barrels per day during the year. This would come from U.S growing production from onshore shale formations and the Canadian tar oil sands. Further production increments are expected from Kazakhstan with about 170,000 barrels per day and Brazil with an average of 120,000 barrels per day from its offshore pre-salt oil fields[56]. Increases in production are also expected in China, Columbia and our own Jubilee field. The latter is expected to increase production by 20,000-30,000 barrels per day by close of 2012.

These new production volumes would deliver about 700,000-900,000 barrels of oil non-OPEC supplies into the market. This would however be offset by the supply disruptions in Sudan and South Sudan, Syria and Yemen delivering a net of about 300,000-500,000 barrels a day unto the global market. With this trend, supply-demand is still very tight and price is definitely going to increase in accordance with basic laws of economics.

vii. **Price speculation** due to activities of traders in oil futures cannot be ignored, unscientific, though**.** Current fundamentals could place the global oil price range to between US$80-90 per barrel but speculation is estimated to account for 20-26% of the current world market oil price range [57]. This is worsened by the on-going global crises elaborated above.

Experts speculate that the prevailing uphill prices are not sustainable and could send the fragile global economy into recession as occurred in 2008.

Therefore, in order to curb the increasing prices, we expect interventions from OECD countries[58] and perhaps from major OPEC members like Saudi Arabia which has adequate spare production capacity and the reserves to do so.

Commercial oil inventories or stocks held by OECD stood at 2.61-2.64 billion barrels equivalent to about 57 days of their supply. This may decline to 2.57 billion barrels, (about 56-55 days of supply) by close of 2012, should the rich-club decide to use it mitigate the rising oil prices.

On the other hand, high prices give field operators an opportunity to produce more oil from enhance oil recovery (EOR), unconventional sources as well as from deeper and offshore depths.

[56] U.S EIA Short Term Outlook, March 2012.
[57] Personal communication with Prof. Krishan Malik, President, Institute of Petroleum Development, Austin Texas and of Department of Petroleum and Geosystems Engineering, The University of Texas at Austin, April, 2011.
[58] Organisation for Economic Cooperation and Development; nicknamed a club of largely upper middle income and developed countries.

Forecast for Ghana: Since Ghana's supplies largely come from Nigeria (an OPEC country) and Equatorial Guinea (a non-OPEC country) all in West Africa, we forecast that average crude oil price that Ghana buys would be $120-130 per barrel for light crude[59] and $105-115 per barrel for heavier-than-Brent crudes (Table 18).

Table 18. Forecast for average crude oil prices for 2012

	Ghana	**United States** (WTI and NYMEX)	**Europe**
Brent crude / U.S refiner	120-130	110-115	120-130
Others[60]	105-115	105-106	110-120

As in 2011, we do not expect Ghana to source her crude oil from the Jubilee field, a high premium oil[61]. Rather, it sounds more prudent to use part of Ghana's proceeds from the sales to mitigate the impact of consequential high product prices at home.

At the Jubilee field, production is currently from eight wells. With technical challenges almost resolved and new wells earmarked to be drilled during the year, production is expected to ramp up to 100,000 barrels by mid-2012 reaching about 120,000 barrels per day by the close of the year[62].

Quantities of imported crude oil refined at TOR and products imported to meet shortfall totaled about 3.17 million tonnes, about 19% over 2010's. Growth since 2000 has been 5.2% per annum (Figure 3).

We estimate that the total crude oil and imported products required would increase to 3.3-3.5 million tonnes in order to meet optimal refinery operations and products for local consumption as well as for exports. At the expected high crude oil prices however, the high-side of the forecast would be difficult to meet. Crude oil required for refinery operations would vary from 1.6-1.9 million tonnes (12-14 million barrels) during the year, depending upon the availability of the Tema Oil Refinery and its auxiliary units. The remaining 1.4-1.5 million tonnes balance would be imported products.

[59] With characteristics almost or similar to Brent crude.
[60] Basket of sour and or heavier crudes.
[61] With API equal or greater than 37.
[62] Tullow Operational Update, November 9, 2011.

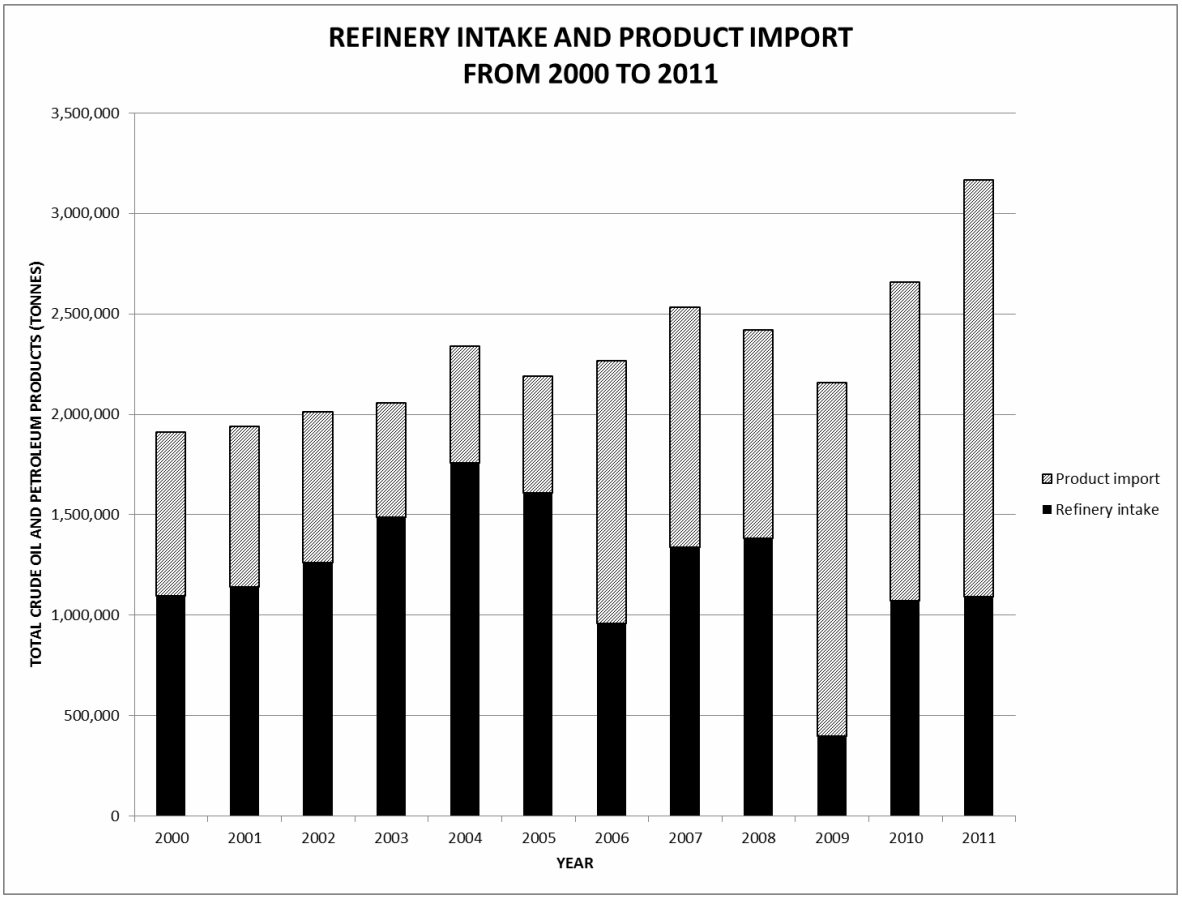

Figure 3. Total crude oil for refinery and product import for 2011

Table 19 presents estimated the total products required for 2012.

Table 19. Petroleum product forecast for 2012.

PRODUCT	National supply requirement	Exports included
	Tonnes	
Total Gasoline	850,000 - 870,000	1,000,000
Total Diesel	1,600,000 - 1,700,000	1,900,000
Kerosene/ATK	200,000 - 230,000	250,000
LPG	250,000 - 300,000	350,000
contingencies[63]	100,000	100,000
Total	***3,000,000 3,200,000***	***3,600,000***
NB: Total gasoline includes Premix; *Total diesel includes supplies to the mining companies and bunkering*		

[63] Others, including losses and internal use at refinery.

About one million tonnes of crude oil (equivalent to about 8 million barrels) were used for TOR refinery operations in 2011. Capacity utilisation at Tema Oil Refinery (TOR) in 2011 was around 78%, about the same as in 2010 but significant improvement over 2009. However, based on international standards, 95% capacity utilization is required for refineries to achieve economic viability. TOR is supposed to refine all the crude oil needs of the country, except for consignments meant for power generation. It comprises of 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 diesel, gasoline and LPG.

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

Half of the total LPG requirement could be met if TOR is operating at over 90% capacity on the average during the year (Table 20). This would also reduce the LPG import requirement to half of the national demand.

Table 20. Operating performance of Tema Oil Refinery with and without the RFCC[64]

	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

However, local production in the range of 30,000-70,000 tonnes since 2006 means about two-thirds or more of the national requirement would be imported. Cross-subsidization of the ex-depot price of LPG means gasoline and diesel are made to carry most of the tax and levy burden[65]. The shift from gasoline to LPG by the vehicle users also suggests the necessary

[64] RFCC is Residual Fuel Catalytic Cracker.

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

revenues expected are not generated from the gasoline sales to augment or beef up LPG imports[66].

Total national LPG storage capacity is also a challenge. In summary, storage limitations and insufficient revenue generation could constrain the supply to 220,000-250,000 tonnes in 2012. Otherwise, total LPG requirement of the country could exceed 300,000 tonnes up to 350,000 tonnes due to the increasing requirement by the transport sector as fuel, considering that demand growth for LPG as fuel for transport in southern sector had ranged from 11-26% per year since 2006[67].

Priority Issues

We wish to repeat some of the issues raised in the earlier Outlooks since they were hardly implemented.

i. Include Crude oil in strategic stocks

We are of the opinion that existing strategic stock based on products storage alone is more expensive to stockpile and in addition limits the country's ability to take advantage of any falling oil prices to the fullest. Besides, products have limited shelf life.

After 1983, developed countries' petroleum strategic storage has been shifting towards crude oil. As at the end of 2008, the United States petroleum stocks totaled 1.7 billion barrels, 59% crude oil and 41% products.[68]

ii. 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 21**.

[66] LPG price for vehicular fuel is slightly higher than for domestic cylinders but still far lower in energy terms when compared to gasoline.
[67] Energy Commission, Liquefied Petroleum Consumption survey, 2003-2007. Energy Survey in Households, Industries, Commercial and Services, 2011.
[68] EIA, 2009

Table 21. 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 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[69] in West Africa has exceeded 80,000 barrels per day (*about 4 million tonnes per annum*). Besides, Nigeria has total refinery capacity of about 500,000 BPD (about 20 million tonnes) but production has been below 50% capacity due largely to operational difficulties. Ghana could quickly expand TOR whilst it makes plans to construct a new refinery to meet local demand as well as targeting the economies within the sub-region, particularly those without refineries and at least, capturing 50% of the market by 2020. Since, building a new refinery of about100,000 barrels per day capacity takes between 3 – 5 years, such a facility in Ghana could be operational by 2016 if construction starts by 2012.

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 will therefore not be economically wise to build say 100,000 barrel per day refinery in the short term, where capacity utilisation will be less than 80%, unless an export market is guaranteed. In this stance, locating such a 100,000 barrel per day refinery plant in the Export Processing Zone with export market as the initial target is recommended.

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

iii. LPG Supply

Increasing refinery capacity and revamping of TOR would increase the production of LPG at TOR. Limited storage capacity however would continue to constrain local consumption as well as export.

2.4 Recommendations

We recommended therefore that[70]

i. *BOST[71] initiate steps to include storage of crude oil as part of the strategic stock of the country as soon as possible. Storing crude oil is quicker, far cheaper, stable and more durable compared to storing products.*

ii. *Ministry of Energy, NPA, Energy Commission and the GIPC assemble other key stakeholders to identify the key barriers impeding investment in new oil refinery in the country and to institute the needed incentives, to encourage construction of new oil refineries to serve both the local and export markets.*

iii. *National Petroleum Authority encourages the OMCs to set up more LPG distribution centres to increase access and consumption.*

[70] SNEP, 2006
[71] Bulk Oil Storage and Transport company

3.0 Petroleum Subsector: Natural Gas

3.1 Overview of natural gas supply in 2011

The average WAGP gas flow level for 2011 ranged between 94-96 mmscfd (94,000-96,000 MMBtu) (Figure 4), which was a significant improvement over the previous year; about 50,000 MMBtu per day destined for the thermal plants in Tema and 40,000 MMBtu for Takoardi thermal power plants.

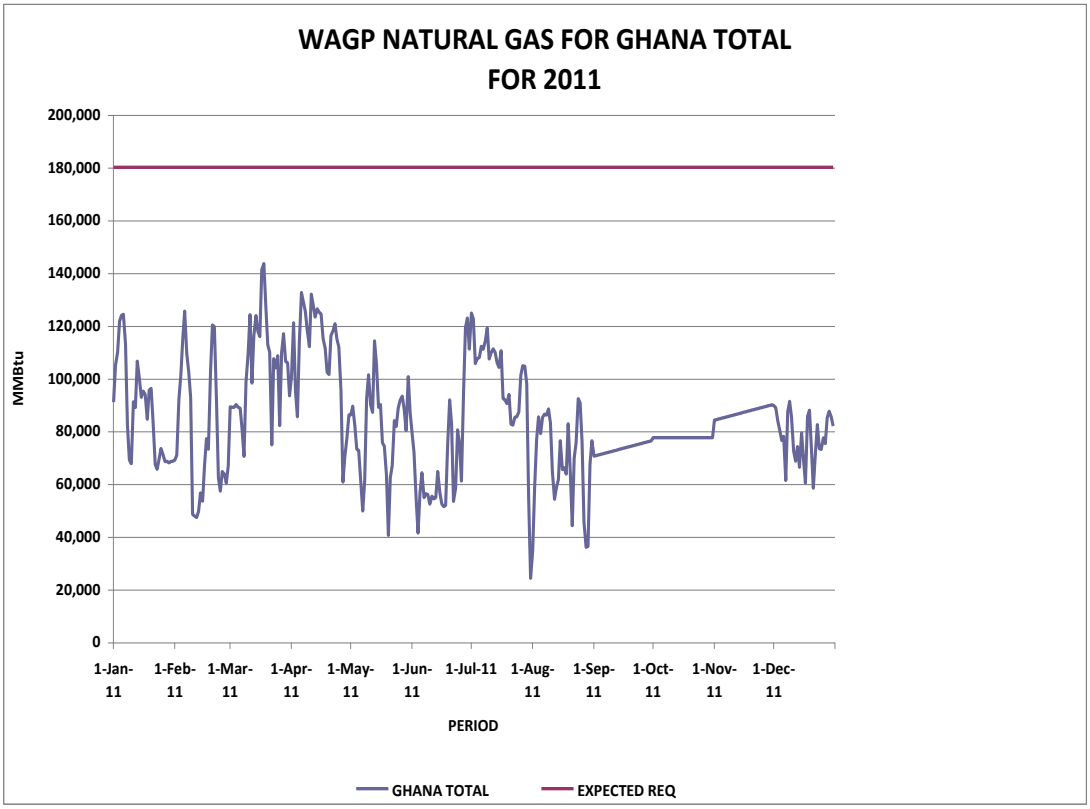

Figure 4. Total WAGP gas supply for Ghana in 2011

In 2011, the WAPCo tariff for transporting natural gas via the West African Gas Pipeline was $3.963 per MMBtu ($4.035 per mscf) for Foundation customers and $4.065 per MMBtu ($4.139 per mscf) for Standard customers. Average WAGP gas price in 2011 was $2.454 per MMBtu ($2.499 per mscf)[72].

[72] Source: WAPCo, 2012. Communications with the statistical personnel.

Comparatively, average spot (Henry Hub) price in the United States was $3.594 per MMBtu ($3.662 per mcf) whilst Europe had an average of $8.70 per MMBtu ($8.859 per mcf) during the year[73].

3.2 2011 forecast and actuals

We projected that the WAGP gas supply would be in the range of 90-100 mmscfd in early 2011 and ramp up to an average range of 100-120 mmscfd after compressor stations were brought on line by mid-2011[74]. The Energy Commission's forecast thus was in line with the actuals in 2011.

3.3 Forecast for 2012 and beyond

Despite the encouraging flows in 2011, Ghana is not likely to see the same fortune in 2012. Restoring the high supply levels Ghana had in 2011 would depend upon demand and political developments in Nigeria due to demand constraints in Nigeria itself (Figure 5).

Nigeria resolves to increase her installed power capacity to 13,000 MW from about 6,000 MW[75] at present by close of 2012 and 15,000 MW by 2020[76]. Should this ambition be aggressively be pursued, there would be a greater strain on the existing supply situation. Nigeria is unable to achieve its domestic supply and export plans. Supply requirement totals about 5 billion cubic feet per day (bcfd) for domestic consumption, LNG contractual shipments and WAGP commitments. The country needs to develop new fields and bring them on line to meet the projected demand but experts in the industry do not expect even up to half supply to be realised until 2016-2017 (Figure 5).

The current policy of the Nigeria government somehow seems to be meeting local gas demand first before considering exports to neighbours.

[73] Spot prices usually do not include transportation cost. The US average was from $4.075 per MMBtu at the beginning of 2011 dropping to $3.172 per mscf. The average in Europe was about $8.42 per MMBtu at the beginning of 2011 rising to about $8.70 MMBtu in December, 2011.
[74] WAPCo planned to commission new compressors on the pipeline by June, 2011. It flows were "free-flow". Information also available at www.WAPCo.com
[7575] Installed capacity is estimated at 6,000 MW (5,898 MW according U.S EIA), but the available capacity is about 4,000 MW.
[76] Energy Commission of Nigeria, website news update, 4th Quarter, 2011.

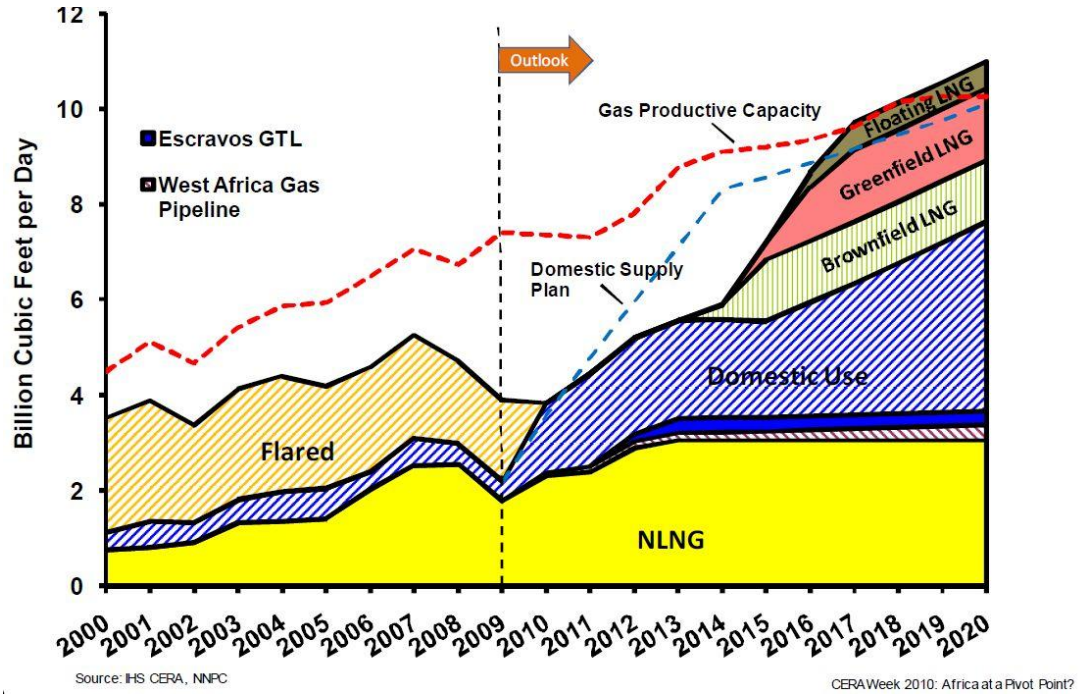

Figure 5. Projected Nigerian natural gas supply plan. Courtesy of CERA, 2010

For 2012, reliable indications from WAPCO suggest that the new WAGP gas transportation tariff rates would increase to about **$4.08 per MMBtu ($4.15 per mscf)** for Foundation customers and **$4.18-4.19 per MMBtu ($4.25-4.27 per mscf)** for Standard customers. The WAPCo tariffs are adjusted for inflation every calendar year. We further estimate the average WAGP gas price to be within **$2.53-2.55 per MMBtu ($2.57-2.60 per mscf)** for 2012. Total delivery price of the gas is likely to range from **$8-9 per MMBtu.**

Unlike crude oil, the geopolitical events in the North Africa and Middle East have affected largely natural gas supplies to Europe. International supply to North America is the least affected, thanks to the region's own production from shale gas fields. Besides the high impact due to the North African crisis, Europe is yet to commence significant commercial operations in its shale gas formations due to strong debate on environmental concerns.

Average gas price in the U.S had been decreasing since the second quarter of 2011, reaching $2.50 per MMBtu in February 2012, the lowest average monthly price since 2002. US EIA however estimates that the average spot price would increase to $3.17 per MMBtu as the average for 2012. Europe on the other hand would see average monthly gas spot prices in the range of $8-11 per MMBtu in 2012.

Priority Issues

There is currently no pipeline infrastructure to transport the associated gas being produced from the Jubilee fields, from the FPSO[77], onshore for processing. The minimal infrastructure to utilize the associated gas would consist of a pipeline to the shore and a processing plant to strip the heavier molecules for largely LPG production and other chemicals. GNPC had constructed a 14-kilometre deepwater pipeline from the FPSO, out of the 50-kilometre distance from the vessel to onshore[78]. Front End Engineering Design (FEED) for the remaining 36-kilometre shallow water pipeline to transfer the dense gas from the Jubilee field operations to the onshore location of the proposed Central Processing Facility has however been completed.

The initial natural gas demand at Takoradi Thermal Power Plant if the WAGP pipeline were to be operational in 2006 was 36 mmscfd. With the number of thermal power plants currently installed and expected to be in operation by 2015, the current demand is between 180-200 mmscfd which is about the breakeven point for a typical 200-250 mmscfd LNG re-gasification facility. The local demand is expected to ramp up to 280-300 mmscfd by 2015 and (Table 22)[79].

Table 22. Natural gas forecast for Ghana in mmscfd, 2012-2015

Year	2012	2013	2014	2015
Min	180	200	256	280
Max	200	250	282	310

Source: Energy Commission, 2012

[77] Floating Production, Storage and Offloading (FPSO) Kwame Nkrumah MV 21
[78] URL: http://www.ghanaweb.com/GhanaHomerPage/NewsArchive/Date: 2011-06-17, 'Energy Minister foils Hijack'
[79] See 2010 Energy Outlook, Energy Commission, 2010.

3.4 Alternative natural gas supply sources

3.4.1 Supply from the Jubilee field

At 60,000-77,000 barrels of oil a day at the Jubilee field in 2011, associated gas produced was 80-104 million cubic feet per day of which about 4-8% was used as fuel for on-board operations (Figure 6).

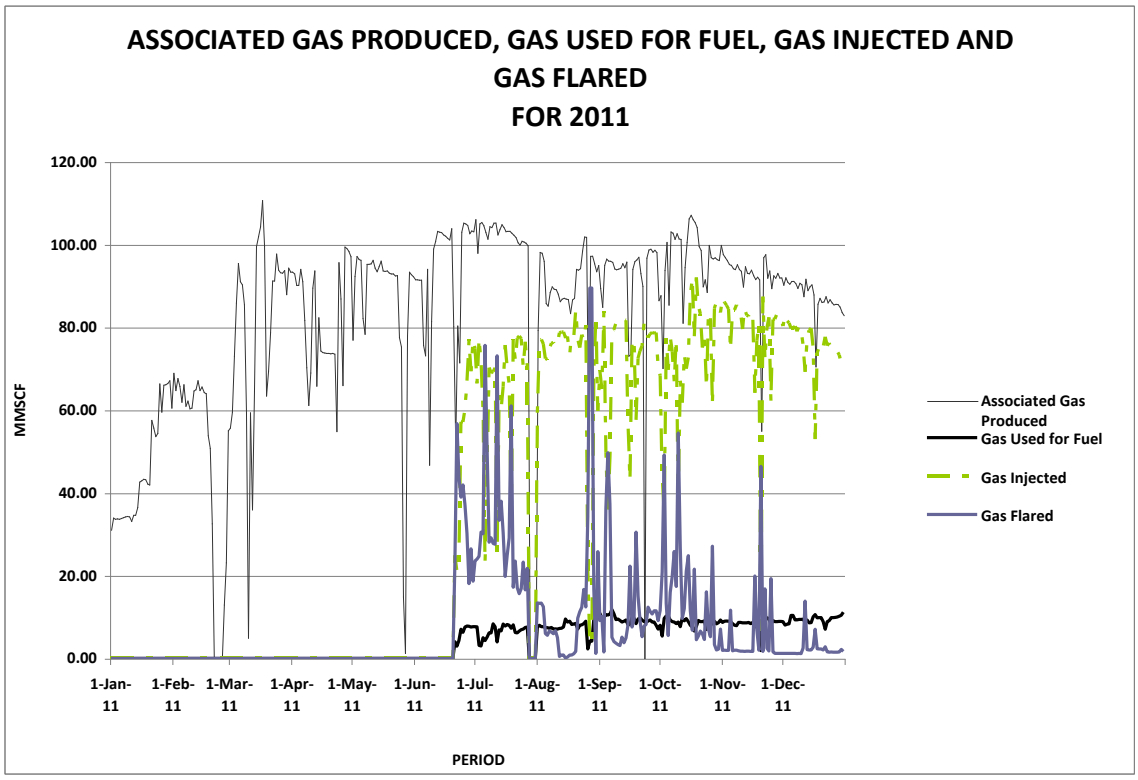

Figure 6. Jubilee field daily gas production in 2011

Associated gas flared had reduced from about 96% at the beginning of commercial production in 2010 to less than 5% per daily production in December 2011%. This is also an indication that the field operators are understanding the geology of the formations and so are confident in doing more re-injection of the gas. There is however still some uncertainties as to how long the geological formation would allow re-injection beyond 8-24 months of operation.

Besides, processing the raw associated gas at 160 mmscfd would yield about 1,000 tonnes of LPG a day, which would be enough to meet the country's short term; 1-2 years demand[80].

Nevertheless, there is still a fact that the associated gas from the Jubilee field even at 160 mmscfd alone would still not be adequate to meet the current gas requirements for medium-to-long term, albeit for now.

3.4.2 Supply from LNG re-gas facility

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

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

For N-Gas of Nigeria to limit gas supply to WAGP at contract volume of 128 mmscfd instead of the full capacity of 440 mmscfd as originally agreed in the supply contract is of concern but not hopeless[81]. The supply balance of 312 mmscfd reinforces the opportunity for the development of a viable LNG terminal. Furthermore, the un-utilised space in the pipeline can be used as gas storage through a technique known as "line packing" to serve as back-up for the potentially alternative gas supply sources but to only to offset very short interruptions in supply.

Under the WAGP sales agreement, **Open access** to the pipeline would commence from **1 July 2012**. This would allow third parties to access the pipeline if convenient.

To meet the 200 mmscfd gas for the first year in Ghana will require visits of thirteen (13)-twenty (20) LNG 120,000-125,000 capacity liquid cubic metre (lcm) vessels every year for the next five years assuming natural gas supplies from Nigeria remains limited but with some additional supplies from Ghana's indigenous fields such as Jubilee.

About 43 LNG regas plants of 100-200 mmscfd capacity existed globally as at 2010. 11 new ones have either been approved or under construction and 22 new projects were announced (Annex 2). Of course larger capacity LNG regas plants are also available.

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

[80] Assuming short term is 1-2 years; 2011-2013 and medium term; 2013-1016.
[81] Energy Commission source

3.4.3 Deployment of LNG regas facility

Permanent LNG discharge/re-gasification terminal

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

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

Energy Bridge Regasification Vessels

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

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

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

Floating Re-gasification plants

Average lifetime of most LNG vessels is 25 years. This means LNG vessels built more than 25 years ago have become less competitive for transport services. Such an LNG ship is retired and reconfigured as floating LNG re-gasification facility. Typical LNG ship has capacity of 120,000-125,000 liquid cubic metres (lcm). The larger the containment the greater the application for floating storage and regasification applications[82]. Some 59 ships built worldwide before 1983 with containment between 122,000-133,000 lcm are due for retirement.

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

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. Another six are under construction; two in Brazil, one in Italy, one in Dubai, two in Chile all intending to use retired converted LNG carriers[83].

Floating Regas facility would take between **one-two years** to build if a project is approved and money is available today.

There is also a possibility for such floating vessel to pick the LNG cargo just from the FPSO operating on the Jubilee field, provided it has a liquefaction facility or there is enough space on the FPSO to accommodate a liquefaction facility. This is tenable for now as the undersea gas pipeline which will transport the associated gas from the Jubilee field for onshore processing is yet to be completed and the onshore gas processing plant yet to be built.

3.5 Recommendation

As more shippers move from long term to short term delivery contracts, it makes more LNG carriers readily available for supply contracts.

We reiterate the recommendation made since 2010 that:

> *Government should proactively create incentives to encourage investment in LNG regas facility built in Ghana at the shortest possible time.*

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

4.0 Woodfuel Subsector: Charcoal Prices

Average prices of charcoal in the country for 2011 were about GHc9 per mini bag and GHc GHc15 per maxi bag. By end of the first quarter of this year, the prices have risen to about Ghc10 and GHc16 per mini- and maxi- bags respectively.

The high-price regions were apparently Central and Greater Accra and the apparent low-price regions were Upper East, Upper West, Ashanti, Eastern and Northern (Table 23).

Table 23. Average price per mini and maxi bags of charcoal in the regions for 2011 and first quarter of 2012[84].

Region	Average Price per Mini bag in Ghana Cedi			Average Price per Maxi bag in Ghana Cedi		
	2011	1st Q 2012	*% change*	2011	1st Q 2012	*% change*
Ashanti	06.00	06.17	*2.8*	12.00	14.00	*16.7*
Brong Ahafo	05.00	06.42	*28.4*	10.00	11.00	*10.0*
Central	11.00	13.50	*22.7*	21.00	22.00	*4.8*
Eastern	07.00	06.25	*-10.7*	12.00	16.00	*33.3*
Gt. Accra	13.00	13.00	*0.0*	20.00	24.00	*20.0*
Volta	10.00	11.36	*13.6*	20.00	20.64	*3.2*
Western	10.00	10.37	*3.7*	15.00	12.53	*-16.5*
Northern	09.00	10.00	*11.1*	14.00	15.00	*7.1*
Upper East	05.11	06.67	*30.5*	10.00	12.00	*20.0*
Upper West	05.00	06.00	*20.0*	10.00	12.00	*20.0*

In terms of the charcoal weight however, the picture could be different for the following reasons:

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

- 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. 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.

In terms of weight, the lowest-price areas were still Upper East, Upper West and the Brong Ahafo regions. For the highest-price areas, average charcoal price in Volta Region becomes more expensive than in Central Region, whilst charcoal in Greater Accra is on the average the most expensive. In general, the average price increases as one moves from the northern parts of the country towards the coast (Table 24).

Table 24. Average price per kilogramme weight of bag of charcoal in the regions for 2011 and first quarter of 2012.

Region	2011			First quarter of 2012		
	Average Price per kg in Ghana Cedi			Average Price per kg in Ghana Cedi		
	Mini Bag	Maxi Bag	Mean	Mini Bag	Maxi Bag	Mean
Ashanti	0.27	0.27	0.27	0.28	0.31	0.30
Brong Ahafo	0.19	0.19	0.19	0.25	0.21	0.23
Central	0.35	0.35	0.35	0.44	0.37	0.40
Eastern	0.27	0.23	0.25	0.24	0.31	0.27
Gt. Accra	0.50	0.38	0.44	0.50	0.40	0.45
Volta	0.38	0.38	0.38	0.44	0.40	0.42
Western	0.38	0.29	0.34	0.40	0.24	0.32
Northern	0.29	0.27	0.28	0.32	0.29	0.31
Upper East	0.20	0.19	0.19	0.26	0.23	0.24
Upper West	0.19	0.19	0.19	0.23	0.23	0.23

The pricing of charcoal however is purely by demand and supply. There is no price regulation authority for woodfuels and neither is there an association of suppliers responsible for pricing of woodfuels in the country. Large proportion of charcoal produced in the savannah woodlands of the north, are transported to the south, mainly through the Afram Plains. We therefore estimate that average charcoal price in 2012 would go up by about 15-20% in the south due to expected rise in transportation and labour costs.

5.0 The Regulatory environment

5.1 The Electricity supply industry

5.1.1 Licensing and Permitting

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

Under the Licensing framework, permanent 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 gives the Commission the authority to hold the licensees to terms and conditions stipulated in the licence.

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

i. Three new Wholesale Electricity Supply Licences were issued to Independent Power Producers (IPP) to construct and operate thermal plants. Out of this, 200MW from the Sunon Asogli Plant has been realized since last quarter of 2010. Tema Osonor Power Plant (now Cenit Energy Limited) and Cenpower Generation Company, are at various stages of construction and when completed they are expected to add 126MW and 300MW respectively to Ghana's generation capacity.

ii. Volta River Authority (VRA), a Government owned utility, has been issued a licence to construct and operate the 220MW Kpone Thermal Power Project in Tema.

iii. Operations of two VRA thermal plants namely TAPCO (T1) and Tema Thermal 1 Power Plant (TT1PP) were regularized by issuing them with permanent wholesale supply licences.

iv. Operation of the T2 thermal generation plant in Takoradi, which is jointly owned by VRA and TAQA global, has been regularized by issuing them with a permanent wholesale supply licence.

v. 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.

vi. 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.

vii. Twenty eight (28) Bulk Customers of electricity have been issued permits to enable them operate in the deregulated Wholesale Electricity Market.

The licensing Manual has been reviewed in 2012 to make it simpler and more precise in guiding prospective licence applicant through the licensing process. Also, new licences including Electricity Import, Export and Brokerage licence have been added.

5.1.2 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. This further ensures that, the open access to the NITS is truly fair to all players. The Grid Code since its inception has been the reference guide for all grid participants.

Complementary to the National Electricity Grid Code, The Energy Commission is developing an ***Electricity Distribution Code***, to set in detail, the minimum acceptable technical standards for the development of the electricity distribution networks, provide 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.

Pursuant to safe delivery of electricity mandate of the Commission, the Energy Commission has caused to be enacted by the Parliament of Ghana in 2012, the ***Electrical Wiring Regulation, L.I. 2008***, which outlines who is qualified to undertake domestic electrical wiring, the suitable materials to be used for the wiring and how the wiring shall be done. The certification manual to certify electrical wiring professionals is under development as part of the efforts to implement the provisions of the regulation.

5.1.3 Establishment of wholesale electricity market

The Electricity Regulation 2008 provides for the establishment of a competitive wholesale electricity market to facilitate wholesale electricity trading and the provision of ancillary services in the NITS. The operator of this wholesale electricity market 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 which is expected to be functional by the end of 2012, will allow for choice and competition in the wholesale supply of electricity subsequently create an enabling environment to attract Independent Power Producers and enhance Ghana's strive towards increasing its installed capacity from the current 2000MW to 5000MW by 2015.

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

The Energy Commission took the initiative to develop a draft Electricity Market Rules which it passed on to the ETU to finalise and re-submit to the Commission for approval and subsequent implementation.

5.2 The Natural Gas supply industry

Electricity supply is heavily dependent on the availability of fuel to power the thermal plants. The dependence on natural gas from the West African Gas Pipeline (WAGP) has proven unreliable. The development of the gas from the Jubilee field is expected to boost the setting up of more gas fired plants to increase Ghana's generation capacity.

5.2.1 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 is currently under review to facilitate the development of the natural gas industry.

i. In January 2010 a Construction Permit was issued to BOST to enable them install an interconnection header in the yard of WAPCo's Regulating and Metering Station (RMS).

ii. In 2010, applications for Construction and Siting Permits were received from the Volta River Authority (VRA) and Sunon Asogli Power (Gh) Limited in respect of the individual pipeline connection to its Thermal Power Plant and interconnection header arrangement to the WAPCo Regulating and Metering Station in Tema. Permits were not issued to VRA and Sunon Asogli Power (GH) Limited as expected because they did not submit appropriate documents for issuance of the permits.

iii. Permit applications have been received in 2012 from the newly established Ghana National Gas Company (GNGC) for the construction of a gas processing plant at Atuabo and gas transmission pipelines from the processing plant to Prestea and to Takoradi to link the West African Gas Pipeline at Aboadze. The Siting Committee of the Commission is scheduled to sit on the submissions made.

iv. An application has also been received from BOST to be licensed as the Natural Gas Transmission Utility (NGTU)

5.2.2 Codes of Practice and Regulation

Since the natural gas industry is 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, which is about to be placed before parliament for enactment.

The Commission is also in the process of developing an ***Occupational Health and Safety Regulation*** with adopted Ghana Standards.

A ***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, is also currently being developed in accordance with Sections 24, 27 and 28 of the Energy Commission Act, 1997 (Act 541).

5.2.3 Liquefied Natural Gas

The Energy Commission is leading the coordination of efforts to procure Liquefied Natural Gas (LNG) through a Floating Regasification Storage Unit (FRSU) to ensure adequate supply of gas in the short to medium term as the country awaits the completion of infrastructure to deliver gas from the Jubilee Field.

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).

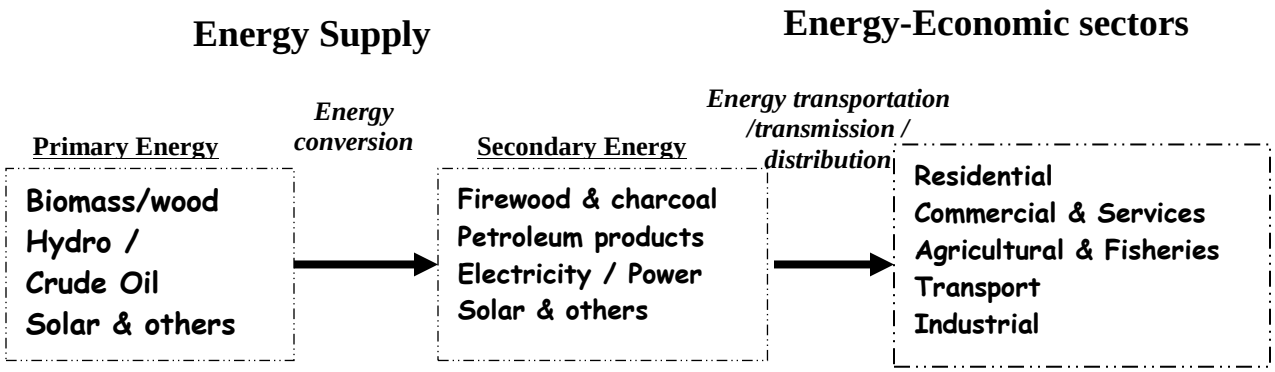

Figure Annex A1. Energy supply continuum

ENERGY SUPPLY SECTOR	ENERGY DEMAND SECTORS OF THE ECONOMY	
	Economic Sectors	**Sub-sector classification**
Woodfuels / Biomass	Residential	Urban, Rural
	Commercial and Services	Schools, hotels, restaurants, hospitals Stores/shops
Petroleum (oil and gas).		
	Agricultural and Fisheries	Irrigation, Land Preparation and Harvest, Spraying and Logging, Post Harvest Processing, Livestock, Fisheries.
	Transport	Road, Rail, Maritime/Water, Air
Power		
	Industries	Manufacturing, Mining, Utilities, Construction, etc

Figure A2. Energy supply continuum

Annex 2 – Existing 100-200 mmscfd LNG plants worldwide

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