ENERGY COMMISSION, GHANA

# 2010 ENERGY (SUPPLY AND DEMAND) OUTLOOK FOR GHANA

**April, 2010**

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## *Introduction*

THE ENERGY COMMISSION is required by law to prepare, review and update periodically indicative national plans to ensure that all reasonable demands for energy are met in a sustainable manner. In conformity with this mandate, the Commission has prepared this short term Annual Energy Outlook for 2010.

The 2010 Annual Energy Outlook covers demand and supply of energy and would look at what was projected in 2009, how it compared with actual consumption and make a forecast largely for 2010.

The 2010 energy forecast covers only electricity and petroleum (oil and natural gas).
It does not cover woodfuels because we have inadequate information to make any serious and reliable forecast. The power transmission system is also not covered since it is already well elaborated by the Ghana Grid Company[1].

The document was prepared by Joseph Essandoh-Yeddu, head of the Strategic Planning and Policy Division and therefore answerable to all the information provided.

Comments on this work are most welcome and should be submitted to me at the following email addresses: essandohyj@energycom.gov.gh , jeyeddu@hotmail.com .

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[1] 2010 Electricity Supply Plan (January 2010) and the Ghana Wholesale Power Reliability Assessment 2010 by the Ghana Grid Company (March 2010). Reports prepared by the Ghana Grid Company. ,

# *1.0 Power Subsector: Supply and demand*

## 1.1 Status as of December 2009

Installed power capacity of the country was about 1,860 Megawatt (MW) by January, 2010 capable of providing a firm generation of 9,800 Gigawatt-hour (GWh) which is equivalent to 9,800 million units of electricity (Table 1).

**Table 1. Bulk Grid Generation as of December, 2009**

| Plant | Type | Units | Installed Capacity | Available Capacity | Firmed Energy | Actual Energy produced |
|---|---|---|---|---|---|---|
| | | | MW | | GWh | |
| Akosombo | Hydro | 6 | 1,020 | 1,000 | 4,000 | 5,841 |
| Kpong | Hydro | 4 | 160 | 160 | 800 | 1,035 |
| TAPCO | CC-Thermal | 3 | 330 | 300 | 2,300 | 453 |
| TICO | SC-Thermal | 2 | 220 | 220 | 1,500 | 1,040 |
| VRA Tema Thermal 1 | SC Thermal | 1 | 120 | 120 | 700 | 570 |
| Mines Reserve | Thermal | 3 | 80 | 80 | 500 | 18 |
| **Total** | | | **1,930** | **1,850** | **9,800** | **8,957** |

SC is Single cycle;, CC is Combined cycle
Data source: GridCo, 2010; submissions to the Energy Commission.

New generation capacities under construction and expected to be completed by end of 2010 will add 600 MW and 4000 GWh (Table 2). Construction of Bui hydro plant is on course and is expected to be completed by 2013 and will provide 400 MW and about 1000 GWh additional capacity bringing the installed power plant capacity of the country to 2,860 MW and 14,800 GWh.

**Table 2. New Generation under construction and expected completion in 2010**

| Plant | Type | Units | Available Capacity | Firmed Energy |
|---|---|---|---|---|
| | | | MW | GWh |
| GeCAD-OSONO | SC-Thermal | 1 | 120 | 700 |
| SAP-1 | CC-Thermal | 6 | 200 | 1,500 |
| VRA Kpone 1 | CC-Thermal | 2 | 230 | 1,500 |
| VRA Tema 2 | SC-Thermal | 2 | 50 | 300 |
| *Bui | Hydro | 4 | 400 | 1,000 |
| **Total** | | | **1,000** | **5,000** |

*Source: GridCo, 2010*
** Bui will be available in 2013***.**

About 1,225 MW new generation plants with the potential to produce about 9,130 GWh of electricity have been proposed to commence construction by 2011 and completed by 2015 (Table 3).

**Table 3. Planned New Generation Facilities expected to commence construction before end of 2010 and available by 2015.**

| Plant | Type | Units | Available Capacity | Firmed Energy |
|---|---|---|---|---|
| | | | MW | GWh |
| SAP-2 | CC-Thermal | 3 | 360 | 2,800 |
| Cen Power | CC-Thermal | 3 | 400 | 3,000 |
| Tema Thermal 3 | CC-Thermal | 1 | 120 | 800 |
| VRA Kpone 2 | CC-Thermal | 1 | 110 | 800 |
| TICO-2 | CC-Thermal | 1 | 110 | 800 |
| *Effasu barge | SC-Thermal | 2 | 125 | 1,000 |
| **Total** | | | **1,225** | **9,130** |

*Source: GridCo, 2010*
** Gas pipeline has to be constructed assuming gas-fired, grid connection has to be completed by 2015*

Net power imports since 2000, has on the average been dwindling over the years (Table 4).

**Table 4. Net Power imports since 2000**.

| **Year** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Net import (GWh)** | 472 | 160 | 534 | 336 | 213 | 176 | 123 | 186 | 176 | 198 |

### 1.2 What we projected for 2009

For electricity consumption in 2009, we projected under SNEP[2] that power generation required would range between 13,000 – 16,660 GWh (*with corresponding maximum projected demand of 1,592 MW*) if the economy had been growing over 7% per annum but had to downgrade the forecast to 8,500-10,000 GWh (1,400 MW maximum demand) due to the global credit crunch in 2008 which we predicted would affect economic growth in the country negatively, due likely to reduced remittances from abroad and international donor assistance. We assumed VALCO smelter operations would shut down completely in 2009.

The actual grid electricity supplied (transmitted) and our forecast for 2009 compared as follows:

| | Actual power transmitted | SNEP forecast | Forecast revised after global credit crunch |
|---|---|---|---|
| **Energy** | 9,131 GWh[3] | 13,161-16,660 GWh | 8,500-10,000 GWh |
| **Maximum Demand** | 1,423 MW | 1,592 MW | 1,400 MW |

In the SNEP, we expected VALCO to be fully operational by 2009, if thermal power were to run on natural gas, considering the favourable global market prices of aluminium.

[2] Strategic National Energy Plan (2006-2020) published by the Energy Commission, 2006.
[3] Ghana Grid Company quoted 10,116 GWh in their report – 2010 Electricity Supply Expansion Plan (January 2010) but their routine submissions to Energy Commission required by law indicated 9,131 GWh when computed.

We projected economically effective suppressed demand to be around 500 GWh for moderate economic growth and about 4,000 GWh for annual GDP growth exceeding 7%.

The low grid electricity supplied could be due to the higher than expected crude oil prices and non-corresponding adjustment in electricity tariff which made it difficult to operate thermal complementation at full capacity.

Natural gas expected from Nigeria which is less expensive than crude oil flowed in 2009 but for less than a month and was only enough to run a 110 MW turbine[4].

### 1.3 Our Forecast for 2010

We predicted in 2009 that 2010 was going to be a very challenging year for the utilities to meet the growing generation requirement due to supply shortfall (Figure 1).

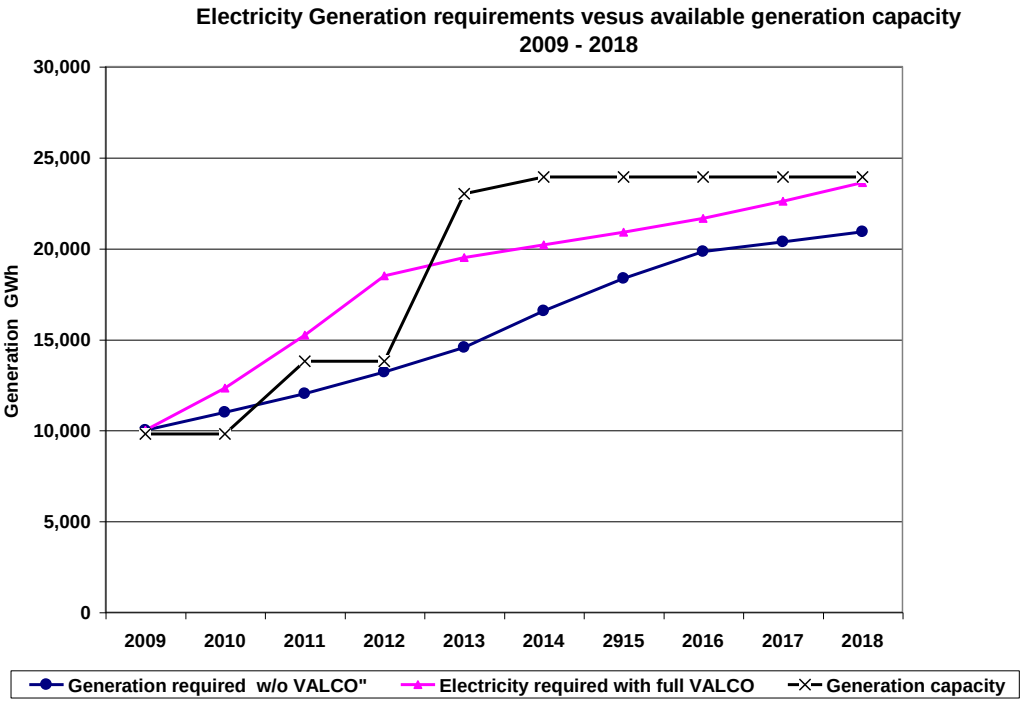


**Figure 1. Comparing electricity generation requirements and generation capacity from 2009 - 2018**

[4] WAPCO, November 6, 2009.

The supply shortfall exacerbates with VALCO coming on line

The following considerations would go into making the forecast for 2010:

- Expanding gold mining due to favourable global gold market price[5] (*We expect 20-50 MW additional demand in 2010)*
- Impending construction activities onshore in Western Region due to impending oil and gas production; welding and industrial estate development activities (*We expect 30-50 MW additional demand to be required initially*).
- Favourable aluminum prices attractive for VALCO to resume operations with two-three potlines (2-3x75MW).

Ghana's annual gold production increased from about 60 tonnes in 2004 to 77 tonnes in 2007 and could exceed 80 tonnes in 2010 due to favourable global price which has risen from $400 perounce in 2004 to over $1000 per ounce currently; it is projected to average $1,200-1,300/ounce in 2010[6]. Energy intensity of surface gold mining in the country is 8-9 GWh per tonne[7], thus require 600-720 GWh in 2010. Meeting the extra 100-300 GWh requires additional 20-50 MW demand. The mining industry owns a 80 MW thermal plant located at Tema. Underground mining however requires between 28-29 GWh per tonne and would demand more power.

With VALCO inclusive[8], we project electricity generation requirement of about **12,500 GWh** and maximum power demand to range from **1,610-1,720 MW** (*GRIDCO forecasts 1,780 MW*)[9].

Average price of alumina, the feedstock for aluminium production is about the levels in the early years of the last decade. Global alumina spot price averaged $225 per tonne in 2009 but is expected to increase to $310 per tonne in 2010. Average market price of aluminium on the other hand is expected to reach $2,400-2,650 per tonne by mid-2010

[5] Financial Times, FT Weekend Europe, 12-13 June, 2010.
[6] Financial Times, FT Weekend Europe, 12-13 June, 2010
[7] SNEP 2006-2020, Volume 1, Energy Commission, 2006. page 34. (point 160)
[8] Assuming VALCO to operate a maximum of 3 potlines
[9] 2010 Electricity Supply Plan, Ghana Grid Company Limited, January, 2010.

from a low range of $1,200-1,500 per tonne in 2009. At these prices and for production of 80,000-100,000 tonnes of aluminium per annum, VALCO could still be in business even at a tariff of 6 cents per kWh[10].

The downside is that there is not enough capacity to support VALCO for the year 2010. This could however be averted if the limited WAGP gas is diverted to SAPP which is solely for gas operation whilst TAPCO and TICO are fired with LCO. Bringing in SAPP will make available additional 100 MW to the grid, which can likely support one potline operation of VALCO.

Without VALCO operations, we forecast that grid electricity supply requirements (i.e. total transmission) would be about 10,500 GWh if current WAGP gas level does increase to at least 100 million cubic feet per day but global light crude oil average price remains above US $75 per barrel *but without corresponding tariff adjustment* (Table 5)[11].

**Table 5. Generation shortfall forecast by Energy Commission and GRIDCo.**

Potential Grid Generation shortfall in 2010

| Generation* requirements GWh | Generation* Capacity GWh | Potential shortfall GWh | Forecasting Agency |
|---|---|---|---|
| 8,500*-12,500 *(10,500±19%)* | 9,000* - 10,600 *(9,800±8%)* | ≤ 2,700 | Energy Commission |
| 10,116 | 9,800 | 316 | GridCo |

*•Low-side electricity consumption, if crude oil price >$80 /barrel.*
*•Towards high-side electricity consumption if crude oil falls below $55/barrel or adequate natural gas (≥120 mmcfd) flows during the year for at least 6 calendar months.*

[10] A

[11] H :h in electricity consumption. Too high a tariff could reduce sale revenues due to non-payment and rather increase power theft.

We also project the maximum demand, without VALCO operations to lie between 1,450-1,483 MW.

Shortfall repercussions

In light of the potential electricity supply shortfall,

- the gold mining will remain surface-based and the companies are likely to supplement their power demand with on-site diesel gensets in order o maintain their global market shares.
- Construction activities in connection with onshore gas development should it commence this year-2010, will also supplement their power demand with on-site diesel gensets, to avoid delays.
- VALCO could remain shut-down, but may not be prudent and the continued and long term shut down could have detrimental negative impact on production equipment.

**Priority Issues**

In 2007, the Government distributed about 6 million energy-efficient lamps that led to power savings of about 124MW by 2008. Demand-side management and energy efficiency activities will need to be sustained and expanded.

Wind power is a renewable source that can supply bulk power and be deployed within a year. Also, excess generation by existing wood mills can be pumped into the grid to supplement power requirements, but this will require the passing of the Renewable Energy Law to provide legal support for such companies accessing the national grids.

One may investigate the aluminium metal supply needs of the impending onshore gas infrastructural and processing plant for the Jubilee field gas and the possibility of directly hooking up VALCO operations to the former. The economic benefits including job maintenance and creation may outweigh the financial losses due to subsidised power tariff for VALCO operations or for continued VALCO shut-down. (*Can Ghana take a*

*cue from elsewhere, e.g. the United States government bailed out her motor industry deemed too big to fail. It attracted some opposition, but two years down the line the bailed out companies have made enough revenues to pay back the government loans*)

### 1.4 Recommendations

*We recommend that:*

i. *a tripartite negotiation meeting is held between VALCO, Ghana Grid Company and Sunon_Asogli Power Plant (SAPP) Company chaired by the Ministry of Energy (with Energy Commission and PURC as observers) to explore the economics of swapping the natural gas meant for TAPCO for SAPP operation and potential supplies for VALCO operations*
ii. *Government expedite development of the natural 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.*
iii. *The nation considers alternative sources of natural gas for the power plants. (This is well elaborated in 3.0 Petroleum Subsector: Natural Gas)*
iv. *Government speeds up the passage of the Renewable Energy Law to allow wind and other bulk power renewable sources to be developed quickly to access the grid.*

## *2.0 Petroleum Subsector: Oil*

### 2.1 Status

Ghana discovered her first large-scale, commercially viable oil field in 2007. The first commercial production is slated to commence during the last quarter of the year - 2010 and output is expected to ramp up to 120,000 barrels per day in 2011.
Until then, the only commercial extraction currently is at Saltpond in the Central Region yielding between 350-1,000 barrels per day. Gas flared at Saltpond fields is about 2 million cubic feet per day.

The Tema Oil Refinery (TOR) refines all the crude oil needs of the country, except for consignments meant for power generation. It is a simple hydro skimming plant with 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 byproduct of crude oil processed by the CDU, into diesel, gasoline and LPG. Total capacity in tonnes is about 2 million per annum, but on the average has processed less than 1.5 million tonnes per annum.

Based on international standards, 95% capacity utilization is required for refineries to achieve economic viability. TOR had operated less than at 85% capacity on the average in the past but the situation worsened in 2009 since it was in most cases shut down.
Besides, demand has exceeded the capacity of TOR and the shortfall particularly in gasoline, diesel and LPG currently could be estimated to range between 40-50% if suppressed demand is considered. Products import currently therefore exceeds one million tonnes per annum.

## 2.2 What we projected for 2009

Actual consumptions in 2009 fell below our projected range, except for LPG (Table 6). LPG consumption exceeded our forecast range by 60,000-70,000 tonnes whilst gasoline consumption fell by 43,000 – 63,000 tonnes. In energy terms, the shortfall in gasoline consumption was close to or falls within the net excess consumption of LPG. This could suggest that significant number of vehicular users have shifted from gasoline to LPG as vehicular fuel.

**Table 6. Petroleum product consumption in 2009**

| Products | 2009 Consumption Tonnes | | Net /shortfall | |
|---|---|---|---|---|
| | Forecast | Actual | Tonnes | TOE |
| Gasoline | 800,000 - 820,000 | 756,956 | (43,044 - 63,044) | **45,196 – 66,196** |
| Diesel | 1,600,000 – 1,700,000 | 1,362,470 | (237,530 - 337,530) | 242,281 - 344,281 |
| Kerosene/ATK | 330,000 - 400,000 | 214,549 | (115,451 - 215,549) | 118,914 - 222,015 |
| LPG | 150,000 - 160,000 | 220,603 | 60,603-70,603 | **65,451 – 76,251** |

*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*

Fuel is input for economic production. It costs less to import crude oil for local production than importing the finished products as shown in Table 7. National expenditure on oil import was relatively high even though 2009 crude oil import was just about half of the previous years'(Table 7).

**Table 7. Ghana's Oil Imports, costs and GDP growth compared**

| Year | Crude oil imports (million bbl) | Products import (1000 tonnes) | Petroleum imports in US$1000 (cif) | Average Global Crude oil price# | Real GDP per capital US $ | Real GDP growth Rate |
|---|---|---|---|---|---|---|
| **2006** | 15.0 | 906 | 1,686 | 58 | 701 | 6.4% |
| **2007** | 14.6 | 1,200 | 2,145 | 72 | 745 | 5.7% |
| **2008** | 13.6 | 1,096 | 2,413 | 98 | 797 | 7.3% |
| **2009** | 6.6 | 1,890 | 1,472 | 58 | 636** | 4.7%* |

*Data source: Bank of Ghana, Ghana Statistical Services, 2009*

** 2010 Government of Ghana budget estimate.*

*** Business Monitor International, 2010*

*# data source: US Energy Information Administration*

The collapse in global oil prices in 2008 saw a drop from an average of $126/bbl in the second quarter of 2008 to about $59/bbl in the last quarter. There was a further drop in oil prices to an average of $42/bbl in the beginning of 2009 but prices appreciated to an average of $72/bbl by close of 2009.[12]

We predicted that light crude oil price would range from $40-70 per barrel. The mean of our prediction, $55 per barrel was just $3 less from the global average in 2009 (Table 7).

No strategic stock plan for crude oil for the country means Ghana could not take advantage of the low crude oil prices to stockpile.

### 2.3 Our Forecast for 2010

We expect the global crude oil prices to hover between $74-80 per barrel rising to $81-86 per barrel during the last quarter of 2010.

[12] U.S Energy Information Administration, 21 April, 2010

We do not expect the average world crude oil price to go beyond $90 per barrel since the total global economy is still fragile to sustain that price spike for considerable time (*more than a month*)[13]. Global crude oil price above $90 for more than a month is likely to lead to collapse in oil demand and eventually tumble the oil price to below $60 per barrel.

Demand for LPG will continue to grow and could go past 250 ktonnes to about 300 ktonnes due to vehicular fuel-switch from gasoline to the LPG. What could curtail the LPG consumption is artificial shortage occurring in the year, due Government's potential inability to raise the required and adequate funds for import due to cross-subsidisation enjoyed by the product and also physical constraint inhibiting nationwide distribution.

In general, high crude oil prices will inhibit significant growth in consumption of petroleum products and consequently economic growth onshore.
The expected significant growth of the economy in 2010 will come from the oil and gas operations in the Jubilee Fields. Experts estimate the offshore production to spike the GDP growth from the low of 4.7% to over 12% by close of 2010[14]. However, low fuel availability onshore has the potential to inhibit the GDP growth in 2010.

For 2010, we therefore forecast effective demand as follows[15]:

| | |
|---|---|
| Total Gasoline | 750,000 - 800,000 tonnes |
| Total Diesel | 1,600,000 - 1,700,000 tonnes |
| Kerosene/ATK | 250,000 - 300,000 tonnes |
| LPG | 220,000 - 250,000 tonnes |

*NB: Total gasoline includes Premix;*

*Total diesel includes supplies to the mining companies and bunkering*

[13] Financial Times Europe, April 9, 2010.
[14] Business Monitor International, 2010
[15] Effective demand means the real demand would be higher but would not be met due to import and distribution constraints as average crude oil price goes over $80 per barrel.

**Priority Issues**

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 falling oil prices to the fullest.

After 1983, most developed countries' petroleum strategic storage has been shifting towards crude oil. At the end of 2008, the United States petroleum stocks totaled 1.7 billion barrels, 59% crude oil and 41% products.[16]

Expand refinery capacity as soon as possible

Crude oil in stock will still have to be refined into usable end products. With the impending commercial oil production, Ghana stands to gain immensely if immediate steps are taken to expand the refinery capacity of the country.

Global refining capacity is expected to grow from 4,513 million tonnes per annum in 2009 to 5,395 million tonnes by 2015[17] and export opportunities in the West Africa sub-region abounds.

It is more expensive in the medium to long term to keep importing products to meet shortfalls. If the crude oil price is compared with those of refined products the average ratios are as follows (SNEP, 2006):

**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 |

[16] EIA, 2009

[17] Energy Business Review, April, 2010.

Ghana announced the intention to expand the Tema Oil Refinery (TOR) as well as building a new refinery in the late 1990s but virtually no serious action can be seen.

An expanded refining capacity will position the country to take advantage of the inadequate refinery capacity in West Africa. Total consumption in non-refinery countries[18] in West Africa has exceeded 80,000 barrels per day (*about 4 million tonnes per annum*). Besides, Nigeria has total refinery capacity of about between 500,000 BPD (about 20 million tonnes) but production has been below 50% capacity due to largely operational inefficiencies. Ghana could quickly use its comparative advantage to revamp the TOR to make it more efficient whilst it makes plans for expansion as well to construct new refinery to meet local demand as well as targeting the countries within the sub-region, particularly those without refineries and at least, capturing 50% of market by 2020. Since, building a new refinery of 50,000-100,000 bbl per day capacity takes between 3 – 4 years, such a facility in Ghana can be ready by 2015 if construction starts by 2012.

For this, the Energy Commission reiterates a recommendation made in the SNEP:

With the limited refining capacity worldwide 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

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

100,000 barrel per day refinery plant in the Export Processing Zone with export market as the initial target makes sense.

### 2.4 Recommendations

We recommended therefore that[19]

i. *We therefore wish to advise that Government 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. *Government creates attractive investment climate to encourage construction of new oil refineries to serve both the local and export markets.*

[19] SNEP, 2006

## 3.0 Petroleum Subsector: Natural Gas

### 3.1 Status

The West Africa Gas Pipeline (WAGP) has restarted flows of Nigerian natural gas to Ghana beginning March, 2010, following about one-year outage allegedly due to vandalism and fuel quality problems[20]. The volume of gas flowing is approximately 30 million cubic feet per day (mmcfd), enough only to power a 110 MW turbine.

This supply-level from Nigeria is not likely to be exceeded during the year – 2010 due to demand constraints in Nigeria.[21].

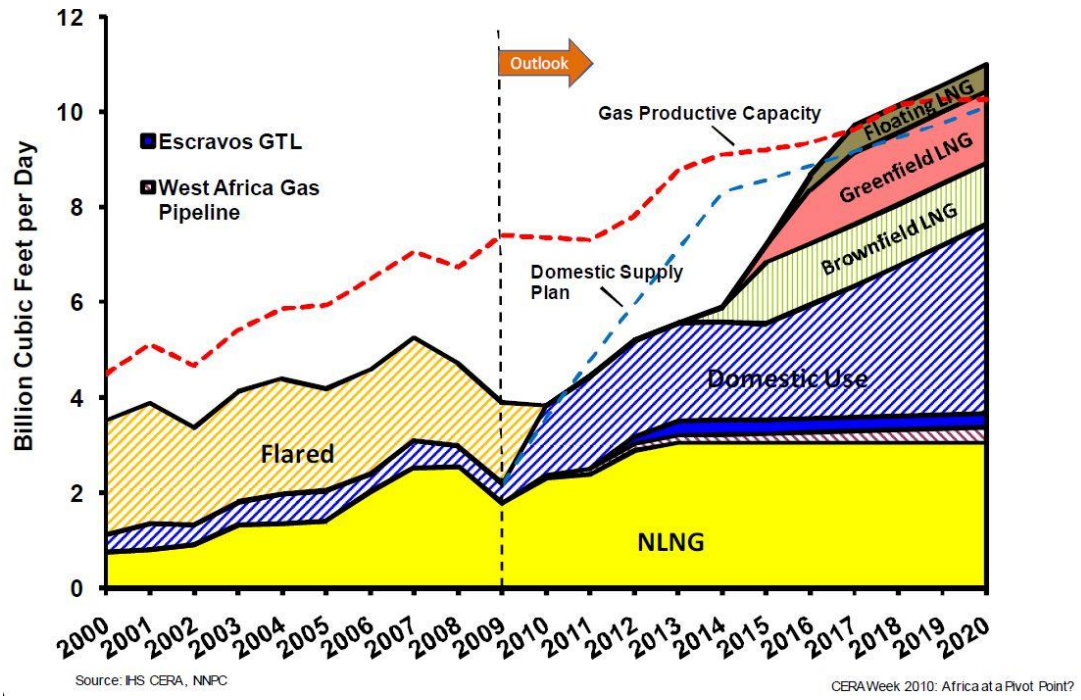


**Figure 2. Projected Nigerian natural gas supply plan. Courtesy of CERA, 2010**

[20] Sourced information from VRA, WAGPCO and Reuter s, April 2010.
[21] Except for strong political will on the Nigerian side

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. She needs to develop new fields but experts in the industry do not expect it to happen now until 2016-17 when new gas fields are developed and brought on line (Figure 2).

### 3.2 What we projected for 2009

As a Commission, we expected natural gas from WAGP to start flowing, but it did not happen. About 30 mmcfd was delivered for a brief period – less than a month.

Average global natural gas spot prices fell from a high of US $12 per mmBTU in mid-2008 to about $3.7 per mmBTU rising to between $4-4.5 mmBTU by end of 2009 but there is no liquefied natural gas terminal to take advantage of the fallen prices.

### 3.3 Forecast for 2010 and beyond

The initial natural gas demand at Takoradi Thermal Power Plant if the pipeline were to be operational in 2006 was 36 mmcfd. With the number of thermal power plants currently installed and expected to be in operation by 2015, the current demand is between 180-200 mmcfd which is about the breakeven point for a typical 200-250 mmcfd LNG re-gasification facility. The local demand is expected to ramp up to 280-300 mmcfd by 2015 (Table 8).

**Table 8**

## Natural Gas forecast for Ghana (*mmscfd*)

| Year | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| Min | 165 | 182 | 200 | 200 | 256 |
| Max | 181 | 201 | 250 | 250 | 282 |

| Year | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| Min | 279 | 279 | 279 | 280 | 280 |
| Max | 307 | 307 | 307 | 310 | 310 |

| Year | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|
| Min | 287 | 287 | 287 | 346 | 346 |
| Max | 316 | 316 | 316 | 381 | 381 |

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| Min | 350 | 350 | 355 | 355 | 355 | 360 |
| Max | 385 | 385 | 390 | 390 | 390 | 400 |

Source: Energy Commission, 2010

### 3.4 Alternative natural gas supply source

Alternative natural gas supply source therefore needs to be sought and will include local (domestic) supply as expected from the Jubilee fields.

There are also 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 170 mmscfd as maximum supply throughput instead of the full capacity of 440 mmcfd as originally agreed in the supply contract is of concern but not hopeless[22]. The supply balance of 270 mmcfd 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.

There are currently about 43 existing 100-200 mmcfd capacity LNG regas plants globally. 11 new ones have either been approved or under construction and 22 new projects announced (Table 9). Of course larger capacity LNG regas plants are available.

Current global average gas price (Henry Hub spot average) is about US $4.3 per mmBTU ($4.4 per mscf). Assuming there is a local re-gasification plant and the re-gasification fee is $1 per mscf and a profit margin of $1 per mscf, the total delivery cost is $6.4 per mscf which translates into about US $37 per barrel of crude oil equivalent, and thus less expensive than the prevailing crude oil price[23].

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$4.5-6.5 per mmBTU for the next five years.

[22] Energy Commission source
[23] $6.4 per mscf gas price will produce electricity at 7cents/kWh for combined cycle and about 9 cents/kWh for single cycle plants.

**Table 9. Existing 100-200 mmcfd LNG plants worldwide**

| Continent | Country | Capacity mmcfd | 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** |

### 3.5 Deployment

Permanent LNG discharge/re-gasification terminal

Development of permanent LNG re-gasification plant of 250 mmcfd capacity however require at least two years even if a project is approved and money is available today.

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 onboard 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 infront 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[24]. Some 59 ships built worldwide before 1983 with containment between 122,000-133,000 lcm are due for retirement.

[24] 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[25].

To meet the 200 mmcfd 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 as it is now but with some additional supplies from Ghana's indigenous fields like Jubilee. The shipping rounds will increase to 20-30 visits per year by 2016, if there happens to be no natural gas from Nigeria and if an LNG regas plant is available in the country by 2012.

In the long term and for permanent LNG regas facility, we can bring Ivory Coast on board such a project. Ivory Coast has been looking for ways for additional gas supplies to supplements her dwindling indigenous supply. One should not be surprised, if such a project end up supplying gas to neighbouring Togo and Benin in the long term, provided the WAGP facility allows reverse directional flow.

### 3.6 Recommendations

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

We recommend therefore that:

*Ghana should as soon as possible explore the opportunities of having an LNG regas facility built at her coast at the shortest possible time.*

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