A review of Ghana’s energy sector national energy statistics and policy framework

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Abstract: In this study, a review of Ghana’s energy sector national energy statistics and policy framework is done to create awareness of the strategic planning and energy policies of Ghana’s energy sector that will serve as an informative tool for both local and foreign investors, help in national decision-making for the efficient development and utilization of energy resources. The review of Ghana’s energy sector policy is to answer the question, what has been done so far? And what is the way forward? The future research in Ghana cannot progress without consulting the past. In order to ensure access to affordable, reliable, sustainable, and modern energy for all, Ghana has begun expanding her economy with the growing Ghanaian population as a way to meet the SDG (1), which seeks to end poverty and improve well-being. There are a number of intervention strategies by Ghana’s Energy sector which provides new, high-quality, and cost-competitive energy services to poor people and communities, thus alleviating poverty. Ghana’s Energy sector has initiated the National Electrification Scheme, a Self-Help Electrification Program, a National Off-grid Rural Electrification Program, and a Renewable Energy Development Program (REDP). The REDP aims to: assess the availability of renewable energy resources, examine the technical feasibility and cost-effectiveness of promising renewable energy technologies, ensure the efficient production and use of the Ghana’s renewable energy technologies, ensure the efficient production and use of the Ghana’s renewable energy technologies.
energy resources, and develop an information base that facilitates the establishment of a planning framework for the rational development and the use of the Ghana’s renewable energy resources.

**Subjects:** Bio Energy; Clean Tech; Clean Technologies; Environmental; Environmental Policy; Power & Energy; Renewable Energy; Supply Chain Management

**Keywords:** energy portfolio; Ghana; energy balance; energy sector; electricity demand; renewable energy resources; developing countries; Africa; sustainable development; Ghana Energy Commission

1. Introduction

Energy demand and its associated service to meet social and economic development and improve human health and welfare is increasing due to the requirement to meet basic human needs and productivity (Edenhofer et al., 2011). The energy development is closely linked with the economic development of a country. Supplying the energy needs of the citizens of a country will directly affect the economic growth of the country. Access to energy plays a critical role to achieve the Millennium Development Goals (MDGs). Certainly, there is a close connection between the energy inadequacies and poverty indicators like, illiteracy, life expectancy, infant mortality, total fertility rate, and rapid urbanization in developing countries like Ghana; this is because people in the rural areas migrate to search for better living conditions and social amenities in the urban areas (Lipton & Ravallion, 1993).

Access to energy has been linked to improving human development. Yet, 1.3 billion people, which is equivalent to 10% of the world’s population, lack access to electricity. From this percentage, 22% are those living in developing countries with almost 97% of this percentage without access to electricity living in sub-Saharan Africa and development Asia (International Energy Agency, 2015).

Globally, per capita income has been established to have a positive correlation with per capita energy use. Therefore, economic growth can be identified as the most pertinent driver behind increasing energy consumption within the last decades. Nonetheless, no agreement on the trend of the causal relationship between energy-use and increased macroeconomic output has been established (Edenhofer et al., 2011; Narayan & Smyth, 2008). For example, there is evidence from a multitude of studies using individual countries as a reference which has failed to reach a consensus as to the direction of causation. A study using United States of America was able to find a bidirectional causality between energy consumption or its usage and Gross Domestic Product (Abosedra & Baghestani, 1989; Lee, 2006; Stern, 2000). Another study found that Gross Domestic Product causes energy consumption (Asafu-Adjaye, 2000; Meng & Niu, 2015) in the contrary, other studies found out that Gross Domestic Product and energy consumption were independent (Cheng, 1995; Eden & Hwang, 1984; Oh & Lee, 2004).

The major global energy challenges are in three folds: securing energy supply to meet growing demand, providing everybody with access to energy services, and curbing energy’s contribution to climate change (Asif & Muneer, 2007; Helm, 2002; IPCC, 2011). Africa as a continent is rich in energy resources but poor in its supply. The Sub-Saharan Africa accounts for 13% of the world’s population, but only 4% of its populace have access to energy. Yet, there has been a rapid economic growth and energy by 45% since 2000 (International Energy Agency, 2014).

The main backbone of industrialized countries is the extensive nature of technological advancement through innovation and scientific research toward nation building. However, developing countries like Ghana have suffered many drawbacks in the field of health (Asumadu-Sarkodie & Owusu, 2015), water management (Asumadu-Sarkodie, Owusu, & Jayaweera, 2015; Asumadu-Sarkodie, Owusu, & Rufangura, 2015; Asumadu-Sarkodie, Rufangura, Jayaweera, & Owusu, 2015), energy management (Asumadu-Sarkodie & Owusu, 2016c, 2016d), etc., due to limited and sporadic scientific research in these areas that provide local and private investors with the required information to make decisive choices toward its investment. Therefore, a multidisciplinary approach that unveils
the core issues in Ghana in the scientific space would boost nation building. Ghana is one of the most successful countries in Sub-Saharan Africa in improving access to electricity, having showed long-term and strong political commitment since the establishment of its National Electrification Scheme in 1989 (International Energy Agency, 2014). Ghana has a huge potential to grow into a modernized economy and to reduce the high incidence rate of poverty to an acceptable level. The ultimate goal of the Growth and Poverty Reduction Strategy (GPRS II) by the Government of Ghana’s development agenda is to grow the economy to a middle-income status of US$1,000 per capita and to reduce the incidence rate of poverty among Ghanaians. To meet this development target, it requires an annual economic growth rate of about 10% from the current level of 6.7% through increasing accessibility and supply of energy (Ministry of Energy, 2009).

An effective energy policy creates measures that can support the innovation of new, alternative energy technologies required to meet a growing demand and meet the challenges of creating a sustainable future in the energy sector. The complexity of creating a sustainable future that meets the demands of a populace is not easy to create without an extensive energy policy framework. In order to create an extensive and effective energy policy framework, there is the need for a viable and working energy sector (Omer, 2008). Successful energy sectors follow some framing objectives which include but not limited: (a) stabilizing supply of energy which is an important infrastructural precondition for modern society to function; (b) reducing environmental impacts from energy production and usage; (c) introducing more efficient energy usage per unit of outcome; and (d) continual development of alternative energy sources in order to reduce dependency on degradable and limited natural resources (Jørgensen, 2005) which will serve as a bequest for future generations.

The energy sector is defined by the Intergovernmental Panel on Climate Change (IPCC) as “comprising all energy extraction, conversion, storage, transmission and distribution processes with the exception of those that use final energy in the end-use sectors (industry, transport, building, agriculture, and forestry)” (Climate everyone’s Business, 2014). Since climate change has become a global issue, a growing number of developing countries have become interested in energy policies with emerging renewable energy sectors (S. Asumadu-Sarkodie & P. Owusu, 2016; S. Asumadu-Sarkodie & P. A. Owusu, 2016a, 2016b; Asumadu-Sarkodie & Owusu, 2016c, 2016d; Choi, Park, & Lee, 2011). The energy sector is the largest contributor to global greenhouse gas emissions. In 2010, 35% of direct greenhouse gas emissions came from energy production. In recent years, the long-term trend of gradual de-carbonization of energy has reversed. From 2000 to 2010, the growth in energy sector emissions outpaced the growth in overall emissions by about 1% per year (Climate everyone’s Business, 2014). Developing a functional and proactive energy sector has been established to have a positive relationship with economic growth (AC00804425, 1993; Dowrick, 1994) puts forward qualitative changes such as interactions, competition, and the entry of new actors like renewable energy to describe a country’s economic growth.

This study reviews Ghana’s energy sector national energy statistics and policy framework. The review of Ghana’s energy sector policy is to answer the question of, what has been done so far? And what is the way forward? The future research in Ghana cannot progress without consulting the past and institutional capabilities. Both qualitative and quantitative research methodologies were employed in the study. As part of the research techniques, a secondary data on the national energy statistics were adopted from the archives of the Ministry of Energy and Petroleum, the Volta River Authority (VRA), the Ghana Grid Company (GRIDCo), Ghana National Petroleum Corporation (GNPC), the National Petroleum Authority (NPA), Tema Oil Refinery (TOR), the Public Utility Regulatory Commission (PURC), the Electricity Company of Ghana (ECG), the Northern Electricity Distribution Company (NEDCo), the West African Gas Pipeline Company (WAPCo), the West African Gas Pipeline Authority (WAGPA), the Bank of Ghana (BoG), and the Ghana Statistical Service (GSS). In this case, concepts, experiences, techniques, information gathered from the actors in the field of the study, peer-reviewed journals and other literature relevant to this study were analyzed and reviewed. The study brings to bear a number of intervention strategies by Ghana’s Energy sector which provides new, high-quality and cost-competitive energy services to poor people and communities, thus
alleviating poverty. Understanding Ghana’s energy sector strategic planning and energy policies
would serve as a useful tool for both local and foreign investments, help in national decision-making
for the efficient development and utilization of energy resources.

2. Energy indicators and energy balance
The 1992 Earth Summit recognized the significant role that indicators can play in helping countries
to make informed decisions concerning sustainable development. ‘This recognition is articulated in
Chapter 40 of Agenda 21 which calls on countries at the national level, as well as international, gov-
ernmental and non-governmental organizations to develop and identify indicators of sustainable
development that can provide a solid basis for decision-making at all levels (United Nations, 3–14
June 1992; Vera & Langlois, 2007). Moreover, Agenda 21 specifically calls for the harmonization of
efforts to develop sustainable development indicators at the national, regional and global levels,
including the incorporation of a suitable set of these indicators in common, regularly updated and
widely accessible reports and databases’ (Summit, 1997; Vera & Langlois, 2007).

Energy indicators are not just energy statistics; rather, they go beyond basic statistics to provide a
deeper understanding of causal relationships in the energy–environment, economics nexus, and to
highlight linkages that may not be evident from basic statistics. Collectively, indicators can give a
clear picture of the whole energy system, including interlinkages and trade-offs among various di-
mensions of sustainable development, as well as the longer term implications of current decisions
and behavior (Vera & Langlois, 2007). In Table 1, the energy indicators of Ghana’s energy sector are
given.

In Table 1, the Population of Ghana increases from almost 22 million in 2006 to about 27 million
in 2013. With at constant 2006 prices, the Gross Domestic Product increases from about 19 million
Ghana Cedis in 2006 to about 32 million Ghana Cedis in 2013. With a correlation coefficient $r = 0.98$,
$p < 0.05$, increasing Population has a positive correlation with the increasing Gross Domestic Product.
In other words, there is a strong relationship between the two indicators. Total Energy Generated
increased from 8,430 GWh in 2006 to 12,870 GWh in 2013; Total Final Energy Consumed, that is, the
energy which is not being used for transformation into other forms of energy, increased from 5,177
ktoe to 6,886 ktoe; Total Electricity Consumed which includes commercial losses increased from
7,322 GWh in 2006 to 10,583 GWh in 2013; There were no significant changes in Total Biomass
Consumed in 2006 (2,671 ktoe) and 2012 (2,676 ktoe) yet, there was decline in its consumption in
2007 till 2011 before it began to rise again; Total Petroleum Products Consumed increased from
1,873 ktoe in 2006 to 3,422 ktoe in 2013. Total Final Energy Consumed per capita increased from
0.24 TOE/capita in 2006 to 0.26 TOE/capita; Total Electricity Generated per capita increased from 387
kWh/capita in 2006 to 486 kWh/capita; Total Electricity Consumed per capita increased from 338
kWh/capita in 2006 to 399 kWh/capita in 2013. Yet, there was a decline in the Energy Intensity of the
Economy from 0.28 TOE/GHS 1,000 of GDP to 0.21 TOE/GHS 1,000 of GDP and the Total Electricity
Consumed per GDP also declined from 394 kWh/GHS 1,000 of GDP in 2006 to 327 kWh/GHS 1,000 of
GDP. In Table 2, the Energy Balance as at 2013 is given.

Energy Balance shows in a consistent accounting framework, the production, transformation, and
final consumption of all forms of energy for a given country in a given period of time, with quantities
expressed in terms of a single accounting unit for purposes of comparison and aggregation. The
Energy balance presents an overview of the energy produced and consumed in a system, matching
input and output for a specific period of time, usually one year (Bhattacharyya, 2011; Mauritius,
2014). The energy balance (Table 2) shows the supply and final uses (demand) of energy and the
different types of fuel (crude oil, natural gas, petroleum products, wood, charcoal, hydro, solar, and
electricity). The energy supply is presented as the Total Primary Energy Supply. The energy demand
is presented as the Total Final Consumption. The difference between the supply and the demand is
mainly due to fuel transformed into electricity. Statistical Difference in Table 2 shows the difference
between calculated and observed inland consumption (International Energy Agency, 2010). It
includes the sum of the unexplained differences for individual fuels as they appear in the energy statistics.

### 3. Primary energy supply and final energy consumption

In Figure 1, Ghana’s primary energy supply is given. Ghana’s primary energy supply is calculated as the sum of imported fuels and locally available fuel, less re-exports to bunkers after adjusting for stock changes. Oil supply grew from 1,812 ktoe in 2000 to 4,011 ktoe in 2013; Natural gas supply started in 2009 with 5 ktoe and increased to 292 ktoe; hydro supply increased from 609 ktoe to 700 ktoe and wood supply declined from 3,888 ktoe to 3,553. This decline is due to a Government biomass policy which promotes the use of alternative fuels such as LPG as a substitute for wood fuel and charcoal by addressing the institutional and market constraints that hamper increasing access of LPG in Ghana (Ministry of Energy Ghana, 2009).

In Figure 2, Ghana’s final energy consumption is given. Ghana’s final energy consumption is the energy which is not being used for transformation into other forms of energy and it is calculated as the total amount of energy required by end-users as a final product. Final electricity consumption increased from 597 ktoe in 2000 to 910 ktoe in 2013; petroleum consumption increased from grew from 1,533 ktoe in 2000 to 3,303 ktoe in 2013; biomass consumption declined from 3,432 ktoe in 2000 to 2,588 ktoe in 2013 due to a switch in end-user preferences to Liquid Petroleum Gas.

### Table 1. Energy indicators (2006–2013)

| Energy indicator                  | Unit       | 2006     | 2007     | 2008     | 2009     | 2010     | 2011     | 2012     | 2013     |
|-----------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Total final energy consumed       | KTOE       | 5,176.9  | 5,274.1  | 5,209.8  | 5,731.7  | 5,670.2  | 6,192.1  | 6,887.9  | 6,886.0  |
| Total electricity generated       | GWh        | 8,430.0  | 6,978.0  | 8,324.0  | 8,958.0  | 10,167.0 | 11,200.0 | 12,023.8 | 12,870.0 |
| Total electricity consumed        | GWh        | 7,361.9  | 6,440.5  | 7,219.4  | 7,452.4  | 8,317.4  | 9,186.6  | 9,258.0  | 10,583.2 |
| Total petroleum products consumed | KTOE       | 1,872.6  | 2,126.6  | 2,071.3  | 2,597.7  | 2,491.1  | 2,826.6  | 3,171.5  | 3,422.3  |
| Total biomass consumed            | KTOE       | 2,671.3  | 2,593.7  | 2,517.8  | 2,493.3  | 2,463.9  | 2,575.6  | 2,588.8  | 2,676.0  |
| Population                        | million    | 21.8     | 22.3     | 22.9     | 23.4     | 24.7     | 25.3     | 25.9     | 26.5     |
| GDP (Constant 2006 prices)        | million Ghana Cedis | 18,705.1 | 19,913.4 | 21,592.2 | 22,454.0 | 24,252.0 | 27,891.0 | 30,099.0 | 32,322.0 |
| Energy intensity of the economy   | TOE/GHS 1,000 of GDP | 0.28 | 0.26 | 0.24 | 0.26 | 0.23 | 0.22 | 0.22 | 0.21 |
| Total final energy consumed/capita| TOE/capita | 0.24 | 0.24 | 0.23 | 0.24 | 0.23 | 0.24 | 0.26 | 0.26 |
| Total electricity generated/capita| kWh/capita | 386.7 | 312.9 | 363.5 | 382.8 | 411.6 | 442.7 | 464.2 | 485.7 |
| Total electricity consumed/capita | kWh/capita | 337.7 | 288.8 | 315.3 | 318.5 | 336.7 | 363.1 | 357.5 | 399.4 |
| Total petroleum consumed/capita   | TOE/capita | 0.09 | 0.10 | 0.09 | 0.11 | 0.10 | 0.10 | 0.13 | 0.13 |
| Total biomass consumed/capita     | TOE/capita | 0.12 | 0.12 | 0.11 | 0.11 | 0.10 | 0.10 | 0.10 | 0.10 |
| Total electricity consumed/GDP    | kWh/GHS 1,000 of GDP | 393.6 | 323.4 | 334.4 | 331.9 | 343.0 | 329.4 | 307.6 | 327.4 |

Source: GDP and population data from Ghana Statistical Service.
### Table 2. Energy balance (KTOE)

| Source and consumption | Crude oil | Natural gas | Petroleum Products | Wood | Charcoal | Hydro | Solar | Electricity | Total |
|------------------------|-----------|-------------|--------------------|------|----------|-------|-------|-------------|-------|
| Indigenous production  | 5,371.8   | –           | –                  | 3,553.9 | –       | 708.0 | 0     | –           | 9,633.7 |
| Imports                | 1,328.3   | 291.6       | 3,070.4            | –    | –        | –     | –     | 2.3         | 4,692.7 |
| Exports                | −5,210.9  | –           | −216.5             | –    | −0.7     | –     | –     | −10.5       | −5,438.6 |
| Stock changes          | −160.9    | –           | −171.0             | –    | –        | –     | –     | −331.9      | −331.9 |
| Total primary energy supply | 1,328.4 | 291.6       | 2,682.9            | 3,553.9 | −0.7    | 708.0 | 0     | −8.2        | 8,555.9 |
| Electricity plants     | −881.1    | −290.0      | −5.2               | −    | −708.0   | 0     |       | 1,106.6   | −777.7 |
| Petroleum refinery     | −446.5    | –           | 437.8              | –    | –        | −708.0| 0     | −132.7      | −160.0 |
| Charcoal kilns         | –         | –           | −1,989.5           | 1,112.2| –       | –     | –     | −6.9        | −877.2 |
| Own use                | −41.2     | –           | −                    | −    | −        | −     | −     | −132.7      | −160.0 |
| Losses                 | −27.3     | –           | −                    | −    | −        | −     | −     | −132.7      | −160.0 |
| Final energy consumption | –       | –           | 3,300.1            | 1,564.4 | 1,111.6 | –     | –     | 910.2       | 6,886.2 |
| Residential sector     | –         | –           | 151.3              | 1,311.8 | 899.4  | –     | –     | 433.2       | 2,795.7 |
| Commerce and services sector | –      | –           | 22.9               | 31.0  | 86.1     | –     | –     | 152.9       | 292.9 |
| Industry               | –         | –           | 380.1              | 221.6 | 126.1    | –     | –     | 322.2       | 1,050.0 |
| Agriculture and fisheries sector | –    | –           | 101.0              | –     | –        | –     | –     | 1.8         | 102.8 |
| Transport              | –         | –           | 2,644.8            | –     | –        | –     | –     | 2,644.8     | –       |
| Statistical difference | −67.8     | 1.7         | −126.2             | –    | –        | –     | –     | 48.6        | −143.7 |

Source: Ministry of Energy and Petroleum, Ghana.

### Figure 1. Total primary energy supply.
4. Electricity

Electrification is considered primarily in the context of providing electrical energy to urban households and industries. In 2000, primary electricity generation was about 7,224 GWh, which dropped to 5,901 GWh by 2003. The electricity energy balance of Ghana from 2000 to 2003 is presented in Table 3 (Ghana Energy Commission, 2012; SWERA, 2012). It includes the officially recorded total national power outages and private diesel generation employed to meet shortfalls.

There is a constant increase in power supply from 0.9 to 1.8 percent per annum with the exception of 2003. The drop in power supply was generally due to the suspension of the operations of the Volta Aluminium Company (VALCO) aluminum smelter. Nevertheless, electricity demand was projected to increase from 6.58 TWh in 1997 to about 20 - 21 TWh by 2020. Volta River Authority's (VRA) forecast shows an increase of 20 TWh by 2020 considering average economic growth from 1990 to 2000 (Volta Aluminium, 2015).

As the electricity generation capacity of Ghana increased, many decisions concerning different power generation options had to be considered to meet the projected demand. A decision regarding the use of centralized power solutions had to be made as the present power sector is dominated by hydroelectric power which constitutes about 63% of the nation’s installed capacity (Energy Commission Ghana, 2013).

For the low-growth scenario, Volta River Authority’s projection was 16 TWh at an average demand growth of between 6 and 8% per annum. In Electricity Company of Ghana, the average demand growth was about 7% per annum (Electricity Company of Ghana, 2012).

The demand for petroleum was projected to rise from 1.6 million tonnes in 2000 to over 3 million tonnes in 2012 if the Ghana Poverty Reduction Strategy targets were to be met (Webapps01.un.org, 2012).

Demand for grid electricity grew from about 6,900 GWh in 2000 to a projected figure of about double by 2012 (Ghana Energy Commission, 2012; SWERA). Natural gas was expected to replace light crude oil by 2007 as a fuel for electricity generation should the West African gas pipeline project to commence as planned but was not the case. It was projected to overtake hydropower as the dominant primary fuel for power generation by 2010. However, overdependence on natural gas
from the West African gas pipeline for electricity generation could have put the nation's energy security at risk.

Without Volta Aluminium Company (VALCO), the residential sector of the economy consumes about 54% of the country’s generated electricity supply. Residential electricity consumption increased from 688.03 GWh in 1990 at an average growth rate of 11% to 2373.8 GWh in 2000 (Ghana. Valcotema.com, 2015). A comprehensive demand output and corresponding generation requirement for 2008, 2012, and 2020 are presented in Table 4. The two scenarios considered are the business-as-usual scenario and the Ghana Poverty Reduction Strategy (GPRS) high economic growth
scenario. In both scenarios, the power consumed by Volta Aluminium Company (VALCO) is considered because it is the biggest power consumer in Ghana.

In Table 5, Ghana's installed electricity generation capacity is given. From 1999 through 2002, approximately 75% of the overall supply of electricity in Ghana was hydro-generated. Since 2003, it has consistently been reduced to about 65%. The per capita electricity consumption was 358 kWh in 2000 indicating an increase of 15.9% as compared to 309 kWh in 1999. The per capita electricity consumption in Ghana is lower than the weighted average in the sub-Saharan region (Ministry of Energy Ghana, 2009). Currently, Ghana's electricity generation consist of hydropower, thermal, embedded generation, and renewables. Although a larger proportion of the nation's known hydropower potential, including the Akosombo and Kpong, have already been developed, there are some underdeveloped sites. Currently, Ghana's installed capacity from hydropower is 1, 580 MW (Akosombo-1,020 MW, Bui-400 MW and Kpong-160 MW); thermal generation constitutes 1,494 MW; embedded generation (Genser Power) constitutes 5 MW and renewables (Volta River Authority installed Solar) constitute 2.5 MW. In total, Ghana's current installed capacity as of December, 2013, is 3,081 MW. The target is to achieve installed power generation capacity of 4,000 MW and also universal access to affordable electricity by 2015. This would be achieved through the Private Public Partnership (PPP) in the development of new power plants as well as ensuring cost-recovery for the production, transmission, and distribution of electricity (Ministry of Energy Ghana, 2009, Figure 3).

The Volta River Authority (VRA) generates all the electricity consumed in the country and also for the export market. Over the last five (5) years, VRA imported approximately 1,000 GWh of electricity, which represents about 14% of overall supply. Crude oil imports account for approximately 10% of total commodity trade (i.e., import plus exports), and consume between 15 and 40% of the nation's export earnings.

In 2000, an amount of US$ 528 million, about 27% of the country's total export earning was spent on the importation of about 1.1 million tonnes of crude oil and 0.8 million tonnes of petroleum products (Beg.utexas.edu, 2005). The nature of world crude oil prices and the negative impact on the nation's balance of payment made the Ministry of Energy to constitute the National Petroleum Tender Board (NPTB) to coordinate the procurement of crude oil and petroleum products (Ministry of Energy Ghana, 2009).

Ghana imports all her crude oil requirements, which amount to 60,000 bpsd. Out of this, 30000 bpsd imports are from Nigeria on government-to-government contract with an additional 15,000 bpsd purchased by bid-offers, through the National Petroleum Tender Board. 15,000 bpsd of light

| Table 4. Electricity demand to meet economic growth scenario |
|-------------------------------------------------------------|
| Operation | Electricity demand and generation requirement in Gigawatt-hour (GWh) |
|-----------|--------------------------------|
|           | 2008 | 2012 | 2020 |
| **Business—as—usual economic growth** | | | |
| Demand | Without VALCO | 6,960 | 8,530 | 12,780 |
| With VALCO | 9,550 | 11,450 | 15,500 |
| Generation required | Without VALCO | 8,400 (±3%) | 10,600 (±2%) | 15,500 (±2%) |
| With VALCO | 10,900 (±3%) | 13,100 (±2%) | 18,000 (±2%) |
| **GPRS high economic growth** | | | |
| Demand | Without VALCO | 15,640 | 19,065 | 27,380 |
| With VALCO | 17,540 | 21,065 | 29,180 |
| Generation required | Without VALCO | 17,500 (±3%) | 20,150 (±2%) | 30,400 (±2%) |
| With VALCO | 20,000 (±3%) | 22,650 (±2%) | 32,900 (±2%) |
Table 5. Installed electricity generation capacity (end of December, 2013)

| Plant                        | Fuel type        | Installed capacity (MW) |
|------------------------------|------------------|-------------------------|
|                              | Name Plate       | Dependable              |
| Hydro generation             |                  |                         |
| Akosombo                     | Water            | 1,020                   | 900                      |
| Bui                          | Water            | 400                     | 342                      |
| Kpong                        | Water            | 160                     | 140                      |
| Sub-Total                    |                  | 1,580                   | 1,382                    |
| Thermal Generation           |                  |                         |
| Takoradi Power Company (TAPCO) | LCO/Natural Gas | 378                     | 300                      |
| Takoradi International Company (TICO) | LCO/Natural Gas | 252                     | 200                      |
| Sunon Asogli Power (Ghana) Limited (SAPP) | Natural Gas     | 220                     | 180                      |
| IPP                          |                  |                         |
| Cenit Energy Ltd (CEL)       | LCO/Natural Gas  | 126                     | 110                      |
| Tema Thermal 1 Power Plant (TT1PP) | LCO/Natural Gas | 126                     | 110                      |
| Tema Thermal 2 Power Plant (TT2PP) | Natural Gas     | 49.5                    | 45                       |
| Takoradi T3                  | LCO              | 132                     | 120                      |
| Mines Reserve Plant (MRP)    | Diesel/Gas       | 85                      | 80                       |
| Effasu Power Barge           | Natural Gas      | 125                     | 100                      |
| Sub-Total                    |                  | 1,494                   | 1,245                    |
| Embedded generation          |                  |                         |
| Genser Power—IPP             | LPG              | 5                       | 2.1                      |
| Sub-Total                    |                  | 5                       | 2.1                      |
| Renewables                   |                  |                         |
| VRA Solar                    | Sunshine         | 2.5                     | 1.9                      |
| Sub-total                    |                  | 2.5                     | 1.9                      |
| Total                        |                  | 3,081.0                 | 2,631.0                  |

Source: Ghana Grid Company.

Figure 3. Trends electricity generation.
crude oil is also purchased by the Volta River Authority (VRA) to feed its thermal plants at Aboadze for electricity generation (Npa.gov.gh). Importation of crude oil and petroleum products and debt servicing have been a drain on the nation's hard currency earnings chopping off about 40% of export earnings in the early 1980s and dropping to an average of 13% by 2000. The pattern of importation of fossil fuels into Ghana since 1997–2000 is presented in Table 6.

In Figure 4, electricity import, export, and net import of Ghana's energy sector is given. The main imports include capital equipment, crude oil and petroleum products, food, consumer, and intermediate goods. Import of electricity decreased from 864 GWh in 2000 to 27 GWh in 2013. This decline is due to Ghana's energy efficiency and conservation policy that sought to discontinue, through legislation on standardization and labeling, the local production, importation, and use of inefficient electricity consuming equipment and appliances (Ministry of Energy Ghana, 2009). Electricity export in Ghana fluctuates depending on electricity generated in the country. The minimum electricity export occurred in 2013 selling 122 GWh and the maximum export made in 2010 selling 1,036 GWh. Volta River Authority exports about 4% of the electricity it generates to the neighboring countries. Communaute du Benin requested an additional supply of 387 GWh recently which Volta River Authority is supplying. Volta River Authority also supplies electricity to some border towns in Burkina Faso. In 2011, the total energy transmitted by the Ghana Grid Company (GRIDCo) outside Ghana to Compagnie Ivoirienne d'Electricité ("CIE"), La Communaute Electrique Du Benin ("CEB"), La Societe Nationale D'Electricite Du Burkina ("SONABEL"), and the Youga Mine in Burkina Faso came to 774,991GWh (Hogan Lovells, 2013). The highest net import is made in 2002 for 534 GWh, with the minimum net import made in 2001 for 160 GWh. This is because Ghana had a net export of electricity only in 2001 when there was unexpected abundant water in the Akosombo and Kpong hydroelectric reservoirs. The negative net import represents the net export made. Maximum net export was made in 2010 for 930 GWh, whiles the minimum net export was made in 2013 for 95 GWh. The negative values mean that the value of imports exceeded the value of export earnings.

In Figure 5, trends in peak load in Ghana are given. Peak load is an energy demand management term that describes a period in which electrical power is expected to be provided for a sustained period at a significantly higher than the average supply level. Ghana's load at peak consists of the maximum demand of the Electricity Company of Ghana, Northern Electricity Distribution Company, direct customers of the Volta River Authority and the Mines. System peak consists of Ghana load at

| Year | 1997 | 1998 | 1999 | 2000 |
|------|------|------|------|------|
| Oil imports (US$ m) | 234  | 221  | 323  | NA   |
| % of imports (fob)  | 11   | 10   | 12   | 20   |

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![Figure 4. Electricity net import, import, and export.](image-url)
peak, Volta Aluminium Company and export load. Ghana’s maximum peak load and the total system peak of the grid transmission system occurred in 2013 about 1,800 MW and 1,900 MW, respectively. For the Volta Aluminium Company to be operating between 3–4 potlines, Ghana’s peak load and the total system peak would increase to 1,980 MW and 2,500 MW, respectively (Energy Commission Ghana, 2013).

In Figure 6, Akosombo Dam Month End Elevation is given. The total electricity made available for gross transmission in 2013 was 12,870 GWh, as against 12,164 GWh in 2012 and 11,200 GWh in 2011. The 2012 generation comprised 8,071 GWh (67%) hydropower and 3,639 GWh (33%) of thermal power. Although hydropower generation share decreased by about 0.5 percentage points over 2011, energy produced increased by about 510 GWh due to significant water inflows into the Akosombo reservoir in 2012 (Energy Commission Ghana, 2013). The maximum water inflows into the Akosombo reservoir occurred in October, 2010, was almost 280 feet in height. Higher than expected average annual precipitation is expected this year – 2013, according to the Ghana Meteorological Agency (GMA). Higher inflows into the hydropower reservoir would improve the overall power generation to offset inadequate or delayed gas supply.

In Figure 7, the trends in transmission losses are given. Total power transmission losses in 2013 was 4.8% of gross transmission, which is 0.5 percentage point improvement over 2012; 2012 was 4.3% of gross transmission, 0.4 percentage point improvement over 2011 but the minimum
transmission losses occurred in 2000 which were 2.8% of gross transmission yet, the maximum transmission losses occurred in 2003 which were 5.9% of gross transmission, respectively.

In Table 6 and 7, electricity purchases and sales by the Electricity Company of Ghana (ECG) and Northern Electricity Distribution Company (NEDco) are given. The total purchases made by ECG grew from 3,989 GWh in 2000 to 8,479 GWh due to increasing population and increasing electricity demand. In the same vein, total sales increased from 2,910 GWh in 2000 to 6,476 GWh in 2013 coupled with distribution losses increasing from 1,079 GWh in 2000 to 2,003 GWh in 2013. However, there was a 0.4 percentage loss improvement over 2012. The total purchases made by NEDco grew from 330 GWh in 2000 to 937 GWh due to increasing population and increasing electricity demand. In the same vein, total sales increased from 232 GWh in 2000 to 737 GWh in 2013 coupled with distribution losses increasing from 1,079 GWh in 2000 to 2,003 GWh in 2013. However, the percentage losses increased by 1.3% over 2012.

In Figure 8, the distribution losses by the Electricity Company of Ghana (ECG) and the Northern Electricity Distribution Company (NEDco) are given. Distribution losses from Electricity Company of Ghana (ECG) between the years 2000 and 2010 were better-off than the Northern Electricity Distribution Company (NEDco). However, there were improvements in distribution losses from the Northern Electricity Distribution Company (NEDco) between the years 2010 and 2013, whereas distribution losses started increasing from Electricity Company of Ghana (ECG) in the same years.

In Figure 9, the electricity consumption by customer class is given. The total electricity consumption increased from 6,367 GWh in 2000 to 9,355 GWh in 2013. The major energy consuming industries in Ghana are: the Volta Aluminium Company (VALCO), Electricity Company of Ghana, and the Northern Electricity Department. Industrial electricity consumption amounts to 4,224 GWh (45%) in 2013 compared to 4,153 GWh (48%) in 2012 with a decline of 3%; residential electricity consumption amounts to 3,228 GWh (35%) in 2013 compared to 2,805 GWh (35%) in 2012 with no change in percentage; non-residential electricity consumption amounts to 1,525 GWh (16%) in 2013 compared to 1,153 GWh (13%) in 2012 with a decline of 3% and street lighting electricity consumption was 377 GWh (4%) in 2013 compared to 315 GWh (3%) with an increase of 1%, respectively.

5. Petroleum
The discovery of the Jubilee field in Ghana in 2007 has fed expectations of more to come in this relatively under-explored basin stretching from Mauritania to the Niger Delta. The area under license has doubled in the last 5 years, with technical discoveries being made in Liberia, Sierra Leone, and Côte
Table 7. Electricity purchases and sales by ECG

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Total purchases (GWh) | 3,989 | 4,175 | 4,326 | 4,496 | 5,045 | 5,253 | 5,146 | 5,799 | 6,052 | 6,771 | 7,259 | 7,944 | 8,479 |
| Total sales (GWh) | 2,910 | 3,080 | 3,200 | 3,343 | 3,761 | 3,978 | 3,906 | 4,335 | 4,442 | 4,952 | 5,339 | 6,041 | 6,476 |
| Distribution losses (GWh) | 1,079 | 1,095 | 1,126 | 1,153 | 1,276 | 1,275 | 1,240 | 1,464 | 1,610 | 1,819 | 1,920 | 1,903 | 2,003 |
| Percentage losses | 27.0 | 26.2 | 26.0 | 25.6 | 26.5 | 25.5 | 24.3 | 24.1 | 25.2 | 26.6 | 26.9 | 26.4 | 24.0 | 23.6 |

Source: GRIDCo, VRA, and ECG.

Figure 8. Trends in distribution losses.

Figure 9. Electricity consumption by customer class.
D'Ivoire, but a further appraisal is required to ascertain their commerciality (International Energy Agency, 2014).

In Table 8, the crude oil production is given. Crude oil is produced from both Saltpond and Jubilee Field. The maximum crude oil produced was 30.5 kilotons in 2008. Presently, the crude oil produced is 15 kilotons from Saltpond field. Crude oil production in the Jubilee field began in 2010 at 181.1 kilotons. As at 2013, the crude oil produced from Jubilee oil was 5251.5 kilotons, which brings the total crude oil production to 5,266.5 kilotons, respectively.

In Table 9, the crude oil export is given. The quantity of crude oil exported grew from 62,474 bbls in 2002 to 36,048,290 bbls in 2013 at a value of US$ 3,885 million. In Table 10, the crude oil import is given. The maximum total import of crude oil made was in 2007 at about 2,000 kilotons. Crude oil imports are for two reasons: for refinery and electricity generation. Majority of crude oil import is used in the refinery. The maximum crude oil import for the refinery was in 2004 at 1,406.2 kilotons, whiles the maximum crude oil import for electricity generation was in 2013 at 927.8 kilotons (Figure 10). In Figure 10, the crude oil export is given.

In 2013, the average annual volume of natural gas expected from the West Africa Gas Pipeline (WAGP) is likely to reduce further to about 35–40 mmscfd (35,000–40,000 MMBtu), due to technical and demand challenges being encountered in Nigeria. Nevertheless, domestic gas from the Jubilee field is likely to ramp the annual average up to 45–50 mmscfd by the end of the year. 2013 also saw a commencement of development of other fields neighboring Jubilee, namely Sankofa, TEN, Sankofa East which are expected to bring along more associated gas by 2017–2018 depending upon the

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Total purchases (GWh) | 330 | 355 | 383 | 426 | 473 | 501 | 507 | 494 | 529 | 566 | 635 | 719 | 822 | 937 |
| Total sales (GWh) | 232 | 250 | 265 | 283 | 323 | 365 | 356 | 392 | 404 | 473 | 581 | 658 | 737 |
| Distribution losses (GWh) | 98 | 105 | 118 | 143 | 150 | 136 | 151 | 129 | 137 | 162 | 162 | 138 | 164 | 200 |
| Percentage losses | 29.7 | 29.6 | 30.8 | 33.6 | 31.7 | 27.1 | 29.8 | 26.1 | 25.9 | 28.6 | 25.5 | 19.2 | 20.0 | 21.3 |

Source: GRIDCo, VRA, and NEDCo.

| Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| From saltpond field | 8.9 | 10.3 | 22.9 | 11.8 | 22.9 | 27.1 | 30.5 | 24.8 | 13.9 | 10.8 | 15.1 | 15.0 |
| From jubilee field | NE | NE | NE | NE | NE | NE | NE | 181.1 | 3,394.0 | 4,118.7 | 5,251.5 |
| Total | 8.9 | 10.3 | 22.9 | 11.8 | 22.9 | 27.1 | 30.5 | 24.8 | 195.0 | 3,404.8 | 4,133.8 | 5,266.5 |

Note: ‘NE’ means non-existence.

Source: Ghana National Petroleum Corporation.
timing and rate of the development of the fields. These new fields are projected to yield an average, ranging from 100 to 500 mmscfd from the year 2020 (Ministry of Energy Ghana, 2009).

In Tables 10–13, petroleum products production, petroleum products, import, petroleum products, export and petroleum products supplied to the economy are given. The main petroleum products produced are: Liquid Petroleum Gas (LPG), gasoline, kerosene, Aviation Turbine Kerosene, gas oil, and fuel oil. The maximum amount of LPG was produced in 2005 at 75.3 kilotons; the maximum amount of gasoline was produced in 2004 at 553.1 kilotons; the maximum amount of kerosene was produced in 2008 at 168.6 kilotons; the maximum amount of ATK was produced in 2005 at 119 kilotons; the maximum amount of gas oil was produced in 2004 at 568.4 kilotons; and the maximum amount of fuel oils was produced in 2000 at 261.9 kilotons, respectively (Table 10).

Figure 10. Crude oil import.

Figure 11. Natural gas import through the West African gas pipeline.
The maximum petroleum product import for Liquid Petroleum Gas (LPG), premium gasoline, kerosene, gas oil, fuel oil, Dual Purpose Kerosene (DPK), and Aviation Turbine Kerosene (ATK) are 241.6 kilotons in 2012, 1,017.4 kilotons in 2013, 136.4 kilotons in 2008, 1,638.7 kilotons in 2013, 44.3 kilotons in 2013, 115 kilotons in 2012, and 65.6 kilotons in 2013 (Table 11).

### Table 11. Petroleum products production (kilotons)

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LPG  | 9.7  | 7.0  | 24.4 | 52.6 | 65.5 | 75.3 | 35.8 | 67.3 | 54.6 | 14.0 | 31.6 | 44.6 | 26.8 | 25.6 |
| Gasolines | 238.6 | 286.3 | 346.2 | 433.8 | 553.1 | 567.1 | 294.4 | 493.0 | 391.2 | 135.0 | 337.7 | 344.3 | 157.7 | 167.3 |
| Kerosene | 51.8 | 98.1 | 61.1 | 109.6 | 111.1 | 87.7 | 65.1 | 122.0 | 168.6 | 48.7 | 71.0 | 52.6 | 21.1 | 14.6 |
| ATK  | 108.3 | 64.0 | 81.6 | 85.6 | 106.9 | 119.0 | 46.2 | 65.8 | 21.3 | 1.3 | 116.7 | 116.1 | 47.6 | 59.8 |
| Gas Oil | 358.1 | 353.5 | 446.5 | 506.6 | 568.4 | 486.3 | 294.2 | 398.2 | 360.5 | 102.8 | 292.6 | 309.8 | 121.5 | 113.3 |
| Fuel Oils | 261.9 | 261.1 | 195.7 | 163.5 | 199.1 | 205.4 | 155.5 | 48.7 | 225.4 | 25.3 | 96.8 | 90.6 | 79.2 | 43.5 |

Source: Tema Oil Refinery.

### Table 12. Petroleum products import (kilotons)

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LPG  | 35.4 | 35.6 | 32.0 | 16.7 | 11.0 | 7.1  | 67.8 | 47.2 | 67.8 | 150.6 | 148.0 | 177.8 | 241.6 | 203.9 |
| Premium gasoline | 387.0 | 389.4 | 370.8 | 232.1 | 255.4 | 167.5 | 360.5 | 274.9 | 254.5 | 563.4 | 570.1 | 712.8 | 811.5 | 1,017.4 |
| Kerosene | 30.4 | 21.5 | 48.8 | 34.6 | 0.0  | 0.0  | 99.9 | 66.7 | 136.4 | 77.7 | 0.0  | 0.0  | 0.0  | 0.0  |
| Gas Oil | 363.2 | 354.3 | 298.0 | 285.7 | 313.1 | 403.7 | 780.0 | 806.9 | 579.0 | 969.5 | 871.7 | 1,200.6 | 1,309.4 | 1,638.7 |
| Fuel oil | 0.3  | 0.1  | 0.1  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 44.3  |
| DPK  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 17.5 | 115.0 | 0.0  |
| ATK  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 65.6  |

Source: National Petroleum Authority (2015).

### Table 13. Petroleum products export (kilotons)

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LPG  | 6.2  | 1.2  | 4.5  | 11.2 | 6.0  | 12.5 | 10.4 | 9.6  | 5.0  | 1.1  | 0.0  | 0.0  | 0.0  | 0.0  |
| Gas oil | 0.6  | 1.0  | 1.9  | 12.0 | 42.4 | 37.7 | 66.1 | 52.7 | 88.4 | 381.9 | 290.9 | 356.5 | 80.8 | 51.8 |
| Residual fuel oil | 190.7 | 215.7 | 151.7 | 89.4 | 168.9 | 162.8 | 45.9 | 26.2 | 148.4 | 30.2 | 40.6 | 43.5 | 44.5 | 3.7  |
| Heavy gasoline | 97.1  | 126.7 | 129.2 | 103.0 | 146.5 | 161.9 | 99.8 | 133.7 | 73.0 | 20.5 | 93.6 | 141.1 | 54.3 | 36.0  |
| Premium gasoline | 0.0  | 0.0  | 0.0  | 1.1  | 4.4  | 42.0 | 13.5 | 30.1 | 38.8 | 51.6 | 119.4 | 116.9 | 0.0  | 0.0  |
| ATK  | 0.0  | 0.0  | 0.0  | 0.8  | 0.0  | 0.1  | 0.4  | 2.5  | 0.3  | 0.0  | 18.0 | 0.0  | 0.0  | 0.0  |

Source: Tema Oil Refinery and National Petroleum Authority.
The maximum petroleum product export for Liquid Petroleum Gas (LPG), gas oil, residual fuel oil, heavy gasoline, premium gasoline, and Aviation Turbine Kerosene (ATK) are 12.5 kilotons in 2005, 381.9 kilotons in 2009, 215.7 kilotons in 2001, 161.9 kilotons in 2005, 119.4 kilotons in 2010, and 18 kilotons in 2011 (Table 12).

The maximum petroleum product supplied to the economy for Liquid Petroleum Gas (LPG), premix gasoline, premix, kerosene, Aviation Turbine Kerosene (ATK), gas oil, and Residual Fuel Oil (RFO) are; 268.5 kilotons in 2012, 1,080.6 kilotons in 2013, 58.9 kilotons in 2012, 89.3 kilotons in 2009, 141.3 kilotons in 2012, 1,722.6 kilotons in 2013, and 57.1 kilotons in 2000, respectively (Table 13).

6. Biomass

Biomass is Ghana’s dominant energy resource in terms of endowment and consumption. Biomass resources cover about 20.8 million hectares of the land mass of Ghana (23.8 million hectares) and is the source of supply of about 60% of total energy used in the country (Energy Commission Ghana, 2013). The enormous arable and degraded land mass of Ghana has the potential for the cultivation of crops and plants which can be converted into a wide range of solid and liquid biofuels Ministry of Energy Ghana, 2009; Reegle, 2015; Sustainable Development Action Plan (SDAP), 2015). Since the mid-1990s, the composition of energy consumption in Ghana has been approximately 71% biomass, 20% crude oil, 8% hydropower, and less than 1% solar energy. In 2000, the composition changed significantly to 60% biomass, 28% oil products, and 11% electricity (Ministry of Energy Ghana, 2009). In Figure 12, the biomass supply is given. The main supply of biomass is in the form of charcoal, firewood, and others (saw dust, saw mill residue, etc.). The maximum biomass supply in the form of charcoal, firewood, and others is as follows: 1,989 ktoe in 2013, 2,742 ktoe in 2000, and 55 ktoe in 2000 which brings the total biomass supply from 3,891 ktoe in 2000 to 3,554 ktoe, respectively (Figure 12). This decline is due to the replacement of biomass with biogas and LPG for cooking and heating purposes.

In Table 14, the biomass consumption is given. Biomass consumption in the form of firewood declines from 2,747 ktoe in 2000 to 1,535 ktoe in 2013; other biomass consumption also declined from 55 ktoe in 2000 to 30 ktoe in 2013. Nevertheless, biomass consumption in the form of charcoal increased from 636 ktoe in 2000 to 1,112 ktoe in 2013. This sharp increase is due to increased energy demand for cooking and heating purposes. Moreover, the cost of charcoal is far cheaper than any of the alternative sources of energy for cooking and heating purposes.

In Table 15, charcoal export is given. The quantity of charcoal export declines from 3.0 kilotons in 2000 to 0.8 kilotons in 2013 representing a growth rate of -61.4%. This decline in export is due to overconsumption by local consumers.
7. Energy prices

High prices of crude oil and petroleum products in the world market also create some difficulties for oil-importing developing countries, including Ghana because when domestic energy prices in developing countries fall below opportunity costs, price increases are recommended to conserve fiscal revenue and to ensure efficient use of resources (Hope, 1995). In Table 16, the average crude oil prices are given. The maximum average price of crude oil in the first quarter was US$121.02/barrel in 2012, the maximum average price of crude oil in the second quarter was US$122.84/barrel in 2008, the maximum average price of crude oil in the third quarter was US$116.92/barrel in 2008, and the maximum average price of crude oil in the fourth quarter was US$110.08/barrel in 2012. In Figure 13, the trends in crude oil prices are given from January, 2005–December, 2013. It is evident that April, 2008, had the highest crude oil price getting closer to almost US$140/barrel (Figure 13).

In Table 17, detailed retail prices of major petroleum product are given. A summary of it is displayed in Figure 14. In Figure 14, a summary of retail prices of major petroleum product is given. The major petroleum products are: premium gasoline, gas oil, kerosene, LPG, and refined fuel oils. Apart from a decline in 2009 due to a drastic oil reduction in the world market, there is a constant rise of retail prices in Ghana with increasing years (Figure 14).

In Table 18, the average electricity end-user tariff is given. There is a rapid increase in average end-user tariff from 0.017 GHS/kWh in 2000 to 0.307 GHS/kWh in 2013.

Average prices of charcoal in the Ghana rose from GH¢9 per mini bag and GH¢15 per maxi bag in 2011 to GH¢11 per mini bag and GH¢18 per maxi bag in 2012. Regions with the high price of charcoal in 2012 were Western and Central. Regions with the low price were Northern, Brong-Ahafo, and Ashanti. Northern region saw a drop in the average mini bag price of charcoal. There was a drop in

| Table 14. Petroleum products supplied to the economy (kilotons) |
|---------------------------------------------------------------|
| **Year** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| LPG | 45.0 | 42.5 | 50.0 | 56.7 | 65.7 | 70.5 | 88.0 | 93.3 | 117.6 | 220.6 | 178.4 | 214.4 | 268.5 | 251.8 |
| Premium gaso-line | 524.4 | 535.1 | 570.2 | 479.8 | 575.6 | 537.8 | 511.9 | 544.2 | 545.0 | 701.4 | 737.8 | 807.0 | 992.7 | 1,080.6 |
| Premix | 30.6 | 27.0 | 26.8 | 28.9 | 27.5 | 31.4 | 33.7 | 41.0 | 50.7 | 55.1 | 32.4 | 45.6 | 58.9 | 53.4 |
| Kero-sene | 67.6 | 70.5 | 74.8 | 68.8 | 73.2 | 74.3 | 76.5 | 63.3 | 34.6 | 89.3 | 49.3 | 62.4 | 45.6 | 27.8 |
| ATK | 96.9 | 76.4 | 90.5 | 89.8 | 107.4 | 119.3 | 114.7 | 122.8 | 119.2 | 124.7 | 108.4 | 135.3 | 141.3 | 131.9 |
| Gas oil | 665.8 | 685.4 | 717.8 | 755.3 | 848.9 | 880.4 | 934.0 | 1,147.0 | 1,092.1 | 1,280.0 | 1,271.9 | 1,431.2 | 1,665.0 | 1,722.6 |
| RFO | 57.1 | 52.0 | 51.9 | 45.7 | 45.2 | 47.8 | 56.8 | 51.3 | 47.9 | 40.3 | 30.9 | 37.5 | 33.5 | 39.3 |

**Source:** National Petroleum Authority.

| Table 15. Biomass consumption (kt) |
|-----------------------------------|
| **Year** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Fire-wood | 2,742 | 2,539 | 2,350 | 2,176 | 2,017 | 1,873 | 1,742 | 1,644 | 1,566 | 1,520 | 1,490 | 1,535 | 1,520 | 1,535 |
| Char-coal | 636 | 649 | 684 | 705 | 782 | 835 | 894 | 917 | 921 | 943 | 944 | 1,010 | 1,039 | 1,112 |
| Other | 55 | 51 | 47 | 44 | 40 | 37 | 35 | 33 | 31 | 30 | 30 | 31 | 30 | 30 |
| Total bio-mass | 3,432 | 3,238 | 3,082 | 2,925 | 2,839 | 2,745 | 2,671 | 2,594 | 2,518 | 2,493 | 2,464 | 2,576 | 2,589 | 2,676 |
the average prices for maxi bag in Greater Accra. Average charcoal price for a mini bag doubled in the Upper East and Upper West Regions. Eastern and Western Regions also experienced significant charcoal price increment. Energy Commission of Ghana estimated that an average charcoal price in 2013 could range between 20 and 25% over the 2012 average price nationwide due to a general

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Quantity | 3.0 | 2.8 | 3.5 | 4.6 | 4.6 | 5.7 | 2.9 | 3.6 | 2.9 | 4.3 | 1.4 | 0.8 | 2.0 | 0.8 |
| Growth rate (%) | - | -6.7 | 25.0 | 31.4 | 0.0 | 23.9 | -49.1 | 24.1 | -19.4 | 48.3 | -67.4 | -42.9 | 150.0 | -61.4 |

Table 16. Charcoal export (kilotons)

Figure 13 Trend in crude oil prices since January, 2005–December, 2013 (Energy Commission Ghana, 2013).

Table 17. Average crude oil prices (US$/barrel)

| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|------|------|------|------|------|
| First quarter | 48.00 | 62.67 | 58.63 | 96.47 | 45.56 | 77.19 | 105.18 | 121.02 | 112.64 |
| Second quarter | 52.89 | 70.43 | 68.67 | 122.84 | 59.71 | 79.44 | 117.19 | 110.38 | 103.31 |
| Third quarter | 61.83 | 70.53 | 74.67 | 116.92 | 69.01 | 76.94 | 112.15 | 109.67 | 109.61 |
| Fourth quarter | 57.75 | 60.89 | 88.68 | 57.31 | 75.54 | 87.32 | 109.04 | 110.08 | 109.27 |

Source: Adapted from Bank of Ghana.

Figure 14. Retail prices of major petroleum product.
| Effective date | Exchange rate (Gh¢/US$) | Premium gasoline (Gh¢/Lt) | Gas oil (Gh¢/Lt) | Kerosene (Gh¢/Lt) | LPG (Gh¢/kg) | RFO (Gh¢/Lt) |
|---------------|-------------------------|---------------------------|------------------|------------------|--------------|--------------|
| 16-Feb-08     | 0.98                    | 1.04                      | 1.04             | 0.94             | 1.02         | 0.57         |
| 01-Mar-08     | 0.98                    | 1.09                      | 1.11             | 1.01             | 1.04         | 0.59         |
| 16-Mar-08     | 0.98                    | 1.11                      | 1.16             | 1.09             | 1.05         | 0.60         |
| 01-Apr-08     | 0.98                    | 1.11                      | 1.18             | 1.20             | 1.05         | 0.61         |
| 16-Apr-08     | 0.98                    | 1.14                      | 1.21             | 1.17             | 1.01         | 0.65         |
| 03-May-08     | 0.98                    | 1.19                      | 1.25             | 1.19             | 1.00         | 0.67         |
| 26-May-08     | 0.98                    | 1.19                      | 1.20             | 1.14             | 1.00         | 0.67         |
| 16-Oct-08     | 1.14                    | 1.19                      | 1.20             | 1.14             | 1.00         | 0.67         |
| 01-Nov-08     | 1.15                    | 1.07                      | 1.10             | 1.02             | 0.92         | 0.58         |
| 16-Nov-08     | 1.16                    | 1.03                      | 1.08             | 1.00             | 0.88         | 0.55         |
| 01-Dec-08     | 1.17                    | 0.99                      | 1.04             | 0.97             | 0.84         | 0.53         |
| 12-Dec-08     | 1.20                    | 0.82                      | 0.89             | 0.70             | 0.65         | 0.40         |
| 09-Mar-09     | 1.33                    | 0.78                      | 0.85             | 0.67             | 0.59         | 0.38         |
| 16-Mar-09     | 1.36                    | 0.78                      | 0.85             | 0.67             | 0.59         | 0.38         |
| 01-Apr-09     | 1.38                    | 0.86                      | 0.86             | 0.67             | 0.61         | 0.21         |
| 16-Apr-09     | 1.40                    | 0.86                      | 0.86             | 0.67             | 0.61         | 0.43         |
| 06-Jun-09     | 1.44                    | 1.11                      | 1.12             | 0.86             | 0.80         | 0.56         |
| 16-Jul-09     | 1.49                    | 1.11                      | 1.12             | 0.86             | 0.80         | 0.64         |
| 31-Oct-09     | 1.45                    | 1.17                      | 1.18             | 0.91             | 0.84         | 0.67         |
| 04-Jan-11     | 1.46                    | 1.52                      | 1.53             | 0.91             | 1.05         | 0.84         |
| 29-Dec-11     | 1.55                    | 1.76                      | 1.77             | 0.91             | 1.36         | 0.84         |
| 11-Feb-12     | 1.66                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Mar-12     | 1.68                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Mar-12     | 1.68                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Apr-12     | 1.68                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Apr-12     | 1.70                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-May-12     | 1.71                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-May-12     | 1.71                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Jun-12     | 1.73                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Jun-12     | 1.83                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Jul-12     | 1.87                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Jul-12     | 1.88                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Aug-12     | 1.88                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Aug-12     | 1.89                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Sep-12     | 1.89                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Sep-12     | 1.89                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Oct-12     | 1.89                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Oct-12     | 1.89                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Nov-12     | 1.89                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 16-Nov-12     | 1.88                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
| 01-Dec-12     | 1.88                    | 1.71                      | 1.72             | 0.91             | 1.30         | 0.84         |
increase in Liquid Petroleum Gas price, an alternative but cleaner cooking fuel. Increases could rise between 30 and 35% on an average in the southern sector due to Liquid Petroleum Gas (LPG) supply shortages and a further expected rise in transportation and labor costs (Energy Commission Ghana, 2013).

8. The way forward
The provision of energy services contributes directly or indirectly to poverty alleviation. In order to ensure access to affordable, reliable, sustainable, and modern energy for all, Ghana has begun expanding her economy with the growing Ghanaian population as a way to meet the Sustainable Development Goal 1, which seeks to end poverty and improve well-being (Griggs et al., 2013).

Increasing the country’s prosperity and sustainable modern way of life requires improved universal, affordable access to clean energy that minimizes local pollution and health impacts and mitigates global warming (Griggs et al., 2013). In order to stimulate economic growth and reduce poverty, the Government of Ghana has, since 2001, initiated the Ghana Poverty Reduction Strategy (GPRS) as a strategic framework to tackle both economic growth and poverty reduction. The Ghana Poverty

Table 19. Average electricity end-user tariff

| Year         | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Average end user tariff (Gh¢/kWh) | 0.017 | 0.034 | 0.065 | 0.071 | 0.074 | 0.073 | 0.078 | 0.097 | 0.148 | 0.148 | 0.211 | 0.245 | 0.232 | 0.307 |
| Exchange rate (Gh¢/US$) | 0.70 | 0.73 | 0.84 | 0.88 | 0.90 | 0.91 | 0.92 | 0.97 | 1.20 | 1.43 | 1.45 | 1.55 | 1.88 | 1.97 |
| Average end user tariff (US$/kWh) | 0.024 | 0.047 | 0.077 | 0.080 | 0.082 | 0.080 | 0.084 | 0.100 | 0.123 | 0.104 | 0.145 | 0.158 | 0.124 | 0.156 |

Source: Bank of Ghana.
Reduction Strategy was to transform Ghana’s low-income status to middle-income status with a target of about US$ 1,000 per capita by 2012 (Ministry of Energy Ghana, 2009). Such a transformation requires energy-intensive economic activities, such as job creation, improving quality of education, and reaching out to communities where the national electricity grid is inaccessible, through decentralized sustainable energy systems which are already in place (Ministry of Energy).

There are a number of intervention strategies by Ghana’s Energy sector which provides new, high-quality, and cost-competitive energy services to poor people and communities, thus alleviating poverty. There are provisions of services to support small, local, income generating activities, thereby enhancing employment opportunities, such as the provision of jobs in industries that result from the macroeconomic growth enabled by access to energy services, infrastructure, and technical capacity (Ministry of Energy Ghana, 2009).

The Ghana energy sector has initiated the universal access to electricity since 1988 known as the National Electrification Scheme (NES) at a time when access to electricity by the whole population was 33% (International Energy Agency, 2014). The initiative deems to support the economic recovery program which had been initiated by the Government to increase the overall socioeconomic development of the nation. The extension of electricity to rural areas was a way to open up the country for socioeconomic development thereby slowing down rural–urban migration. Currently, all regional and district capitals have been connected to the national grid system since its inception (Energy Commission Ghana, 2013).

As a follow-up to the National Electrification Scheme, a Self-Help Electrification Program (SHEP) was initiated with the sole aim of assisting rural communities to get access to electricity. Since its inception, Ghana’s population access to electricity has increased from 33% to 76% (Ghana Energy Commission, 2015).

The Energy Commission of Ghana initiated a National Off-grid Rural Electrification Program (OEP) which targets remote communities for the provision of electricity through renewable energy technologies. The aim of the initiative was to achieve a substantial level of penetration of solar electrification as a platform for the promotion of solar photovoltaic (PV) systems for basic lighting in rural off-grid communities. The initiative established solar battery charging service centers for the promotion of solar photovoltaics (PVs), thereby endorsing ownership of solar home systems. The initiative led to the establishment of a solar photovoltaic (PV) market in Ghana while improving the socioeconomic conditions in rural communities as a result of the extension of electricity coverage in rural areas. Currently, there are more than solar battery charging stations and over 5,000 solar home systems in Ghana. The National Off-grid Rural Electrification Program was scheduled for implementation in six phases throughout the country for a period of 15 years. A total of 19,000 communities was targeted for electrification and 2,000 satellite solar battery charging centers are planned for installation to serve communities within a 5 km radius. Table 19 shows the phases of the off-grid solar electrification program (Table 20).

Ghana’s Energy sector continues to improve access to electricity by the introduction of the Eight Hundred and Thirty-Second ACT of the Parliament of the Republic of Ghana entitled: Renewable Energy Act, 2011, which has assented to provide for the development, management, utilization,
sustainability, and adequate supply of renewable energy for the generation of heat and power by the year 2020. Ghana’s Renewable Energy Development Program aims to: (i) assess the availability of renewable energy resources; (ii) to examine the technical feasibility and cost-effectiveness of promising renewable energy technologies; (iii) to ensure the efficient production and use of the country’s renewable energy resources; and (iv) develop the relevant information base that will facilitate the establishment of a planning framework for the rational development and use of the country’s renewable energy resources (Ghana Energy Commission, 2011).

9. Conclusion
In this study, a review of Ghana’s energy sector national energy statistics and policy framework was done to create an awareness of the strategic planning and energy policies of Ghana’s energy sector to serve as a useful tool for both local and foreign investors, help in national decision-making for the efficient development and utilization of energy resources. The review of Ghana’s energy sector policy answered the question, what has been done so far? And what is the way forward? The future research in Ghana cannot progress without consulting the past and institutional capabilities. Both qualitative and quantitative research methodologies were employed in the study. As part of the research techniques, a secondary data on the national energy statistics were adopted from the archives of the Ministry of Energy and Petroleum, the Volta River Authority (VRA), the Ghana Grid Company (GRIDCo), Ghana National Petroleum Corporation (GNPC), the National Petroleum Authority (NPA), Tema Oil Refinery (TOR), the Public Utility Regulatory Commission (PURC), the Electricity Company of Ghana (ECG), the Northern Electricity Distribution Company (NEDCo), the West African Gas Pipeline Company (WAPCo), the West African Gas Pipeline Authority (WAGPA), the Bank of Ghana (BoG), and the Ghana Statistical Service (GSS). In this case, concepts, experiences, techniques, information gathered from the actors in the field of the study, peer-reviewed journals and other literature relevant to this study were analyzed and reviewed. The study brought to bear a number of intervention strategies by Ghana’s Energy sector which provides new, high-quality, and cost-competitive energy services to poor people and communities, thus alleviating poverty. The summary of findings is as follows:

- With a correlation coefficient \( r(8) = 0.98, \ p < 0.05 \), Ghana’s increasing Population has a positive correlation with the increasing Gross Domestic Product.

- Total Energy Generated increased from 8,430 GWh in 2006 to 12,870 GWh in 2013.

- Total Final Energy Consumed, that is, the energy which is not being used for transformation into other forms of energy, increased from 5,177 ktoe to 6,886 ktoe.

- The total electricity consumption increased from 6,367 GWh in 2000 to 9,355 GWh in 2013.

- There was a decline in the Energy Intensity of the Economy from 0.28 TOE/GHS 1,000 of GDP to 0.21 TOE/GHS 1,000 of GDP.

- Ghana’s primary energy supply is made up of oil, hydro, wood, and natural gas.

- Final electricity consumption increased from 597 ktoe in 2000 to 910 ktoe in 2013.

- Biomass consumption declined from 3,432 ktoe in 2000 to 2,588 ktoe in 2013 due to a switch in end-user preferences to Liquid Petroleum Gas.

- Import of electricity decreased from 864 GWh in 2000 to 27 GWh in 2013.

- Ghana’s installed capacity from hydropower is 1,580 MW (Akosombo-1,020 MW, Bui-400 MW and Kpong-160 MW); thermal generation constitutes 1,494 MW; embedded generation (Genser Power) constitutes 5 MW; and renewables (Volta River Authority installed Solar) constitute 2.5 MW. In total, Ghana’s current installed capacity as of December, 2013, is 3,081 MW.

It was evident in the study that the current shortage in power supply prevalent in Ghana originates from inadequate and unreliable fuel supply for the operation of the thermal power plant, transmission, and distribution losses. There is a need for expansion of power generation capacity to meet the growing power demand. In the light of this, a research on how Ghana’s energy portfolio can be upgraded to meet the increasing energy demand is encouraged.
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