

Social, Economic and Environmental Impacts of the Recent Electricity Crisis in Ghana: A Study of Winneba

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ABSTRACT Ghana like many countries in Africa, struggles with intermittent power supply, which affects the country's development. The power fluctuation worsened within the last three and half years. To ensure continuous power supply, some households, institutions, industries and businesses have resorted to self-generated power supply, which comes with extra cost as well as environmental and health hazards. The paper provides a history of Ghana's energy crisis and analyzes the socioeconomic and environmental impact of the crises on the various sectors of the economy. It uses evidence from the literature as well as a case study from Winneba to support its argument. The paper concludes that the power crisis has social and economic consequences in terms of cost and loss of productivity as well as environmental implications, threatening the success of the green energy debate.

INTRODUCTION

The economic advancement of any nation is greatly influenced by electricity generation. This relationship cannot be overlooked in any developmental analysis since there is a positive correlation between satisfactory standards of living and electricity utilization. Daily activities of almost every individual in the world, even for inhabitants in the least developed countries, revolve around the use of electricity. Access to electricity is seen as a right of the citizen and a public need (Brew-Hammond and Kemausuor 2009: 83). After conducting a study on the relationship between economic development and electricity use among a hundred countries, Ferguson et al. (2000) concluded that globally there is a correlation between electricity use and wealth creation amongst both wealthier and poorer countries. It was observed that this correlation was even stronger for the wealthier nations. The findings were much anticipated and did not surprise researchers within the field of energy.

Whilst Africa for instance, has immense energy generation potentials, generation and consumption are low (Karekezi and Kimani 2002; World Bank 2015). These findings corroborate the conclusions of Davidson and Sokona (2002)

that the average African uses less energy than the average person used in England over a century ago. Wealth creation in Africa is low compared to other continents because there is insufficient electricity on the continent as a whole. Less than a third of all households in sub-Saharan Africa has access to electricity (Brew-Hammond and Kemausuor 2009). In 2013, a World Bank's enterprise survey on African countries found rampant poor electricity supply as one of the biggest barriers to the growth of the continent's economy and this remains a hindrance to multinational investments (Antwi-Boasiako 2015). The World Bank (2015) indicates that twenty-five countries in sub-Saharan Africa are facing a crisis, which is attested to by electricity power blackouts. Apart from many households being deprived of electricity, those with access experience rationing, and even this is fraught with frequent fluctuations in voltage stability. With the burgeoning electricity crisis hanging over the continent and not many signs of it improving over the years, scholars like Steinbuks and Foster (2010) and Brew-Hammond and Kemausuor (2009) have intimated that the performance of Africa's public sector power providers is unsatisfactory, and subsequently describes them as inefficient in

providing reliable electricity sources and maintaining what is available.

In an attempt to mitigate the unreliable public electricity supply on the continent, self-generated electricity has become important in most parts of Africa, especially among businesses (Steinbuks and Foster 2010). Steinbuks and Foster (2010) indicated that self-generated electricity from 1990 to 2005 accounted for six percent of the installed generation capacity in sub-Saharan Africa. The study further concluded that this approach was very pronounced within the Economic Community of West African States (ECOWAS) with Nigeria, Guinea and Niger exceeding twenty percent, while in Ghana, Mali and Togo self-generation exceeded ten percent. Self-generated electricity, however, is costly in economic terms, and in most instances may be harmful to the environment (Dabelstein et al. 2007).

Electricity supply is an indispensable necessity for the daily life of every Ghanaian. The activities of businesses, industries and households, particularly the urban folk are hooked onto the dictates of electricity generation. Work, leisure, healthcare, daily domestic activities and the economy in general depend on a constant supply of electrical power. However, the country suffers from periodic electricity crises, which have worsened in recent times. The 2015 crisis has caused waves of panic among households and businesses. Workers have lost their jobs, businesses have either been crippled or have folded up, and individuals have lost their social life as a result of the unreliable power supply in the country, which is popularly called *dumsor* (literally meaning off and on). Households and businesses have resorted to the use of generators and power plants, which emit more poisonous compounds of carbon, sulphur and nitrogen into the atmosphere. This increased poisonous emission obviously dilutes the global call for the use of clean energy to safeguard depletion of the ozone layer. The high level of emissions from the generator sets has not only been causing harm to the environment, but it has also claimed some lives as a result of inhaling toxic exhaust fumes.

Objectives

The paper gives an account of energy crises over different time periods in Ghana, focusing on the recent ones. It analyzes the socio-economic

and environmental impact of the energy crises in the country, using evidence from the literature and empirical study from the city of Winneba as a case study. Studies have previously been conducted on the effects of the electricity crises on Ghanaians, most of them focusing on the economic costs to small and medium scale enterprises (SMEs) in the country (Doe and Asamoah 2014; Forkuoh and Li 2015; ISSER 2015; Ibrahim et al. 2016). This paper does not only discuss the economic implications of the crises to the SMEs, but it also looks at the social effects on ordinary people as well as the environmental implications of the use of the self-owned generators and their harmful consequences on people's health. It does this by calculating the carbon dioxide emissions using the estimated daily usage of generators in the case study. The paper comprises the following sections of the research methodology, an overview of electricity supply in Ghana, the history of the crises, and the intensity of the recent one and its effects on the environment and on the social and economic lives of Ghanaians and businesses. It then discusses the effects in relation to data gathered from the literature as well as empirical.

METHODOLOGY

The first part of the paper dwells on the effect of the electricity crises on the country. The second section uses a case study with reference to Winneba township in the Effutu Municipality of the Central region of Ghana. Any other city like Winneba could have been selected for the study since any town or city in the country epitomizes a broad category of the crises in the country. Data from the study were from both secondary and primary sources. The secondary data were obtained from books, journals, media and Internet sources. The information from the secondary sources was used for the discussions on the national impact. Primary data were obtained from small-scale entrepreneurs such as tailors, dressmakers, hairdressers, and owners of saw mills, cold stores, stationery shops, barbering shops, fuels stations and provision shops in Winneba. The second author used three months for the data collection processes. All respondents were purposively selected for the research because the aim of the study was to measure the impact of the power crises on small-

scale enterprises. A few households were also selected for the study to include how the impact was felt in individual households. The information was collected using a semi-structured interview guide, informal interactions and personal observation. The information gathered from the fieldwork was used for the second part of the discussions.

Fifty respondents were selected for the study. All the shops selected for the study were those that depended on alternative sources of power for their businesses when the main power from the national grid went off. Questions posed to respondents were largely on the various survival strategies they employed to cope with the energy crises and their views on the effects of the crises on their lives and businesses. Table 1 gives the details of the respondents selected for the study. The information gathered was transcribed and analyzed qualitatively and statistically.

Table 1: Overview of respondents

<i>Firm/ Category of respondents</i>	<i>Number of respondents</i>
Barbering shops	5
Hairdressing shops	5
Dressmaking shops	5
Fuel stations	2
Cold stores	2
Stationers and printers	8
Wood processors	2
Provision stores	8
Households	10
Grinding mills	3
Total	50

Source: Field survey, 2015

Unless otherwise stated, all the information about Winneba was gathered from the Effutu Municipal Assembly (Effutu Municipal 2015). Winneba has a population of over 60,000. It is an historic fishing port in southern Ghana, lying on the south coast, 90 miles (140 km) east of Cape Coast. The town was important in the past due to its role as a harbor town and as a place of early European settlements. Winneba is the capital of the Effutu municipal assembly. The Effutu Municipality covers a total land area of 95 km² (Government of Ghana 2014). The topography of Winneba is generally characterized by lowlands. The town lies within the dry equatorial climatic zone. This is characterized by two rainfall patterns: the major rainy season from May

to June and the minor rainy season from September to October. The annual minimum and maximum temperature ranges from 26 to 30°C, respectively (Dadson 2008). The high temperatures and dry conditions along the coast also favor salt mining from the lagoons. The vegetation is made up of coastal savanna grassland, with patches of marginal forest and mangroves, especially in the wettest areas such as the lagoons and riverbanks. Rivers in Winneba include *Ayensu*, *Aboaku* and *Pratu* among others. The *Aboaku* and *Pratu* Rivers empty their waters into the Muni lagoon, while *Ayensu* enters the Atlantic Ocean directly. Muni Lagoon is a sanctuary for migratory birds, which come there to escape the cold winters and darkness of the Arctic and Antarctic. The birds go back after the summer.

Review of the Literature

Overview of Electricity Supply in Ghana

Ghana is endowed with different energy resources, including wind, which can be used to generate electricity, biomass, hydrocarbons, hydropower, solar and wind. The country also has the capacity to produce modern bio-fuels (Energy Commission 2012). Presently, electricity generation in Ghana is from three hydro power plants at *Akosombo*, *Kpong* and *Bui* and from thermal sources in *Aboadze* and *Tema*. In 2014, the total electricity available for gross transmission was 13,071 Gigawatt-hours (GWh) compared to 12,927 GWh in 2013. The net grid electricity transmitted to the whole country was 12,906 GWh in 2014 as against 12,823 GWh in 2013, that is, twelve to sixteen percent less than the projected requirement and equivalent to a 400-500 MW shortfall (Energy Commission 2015). According to the Commission, the installed generated electricity capacity in the country as at 2014 comprised: 8,387 GWh of hydro, consisting of 64.70 percent; 4,635 GWh of thermal, consisting of 34.75 percent and 4 GWh solar, consisting of 0.05 percent (Energy Commission 2015).

The Volta River Authority (VRA), the state-owned power generation agency, is the owner and operator of the three hydro plants at *Akosombo*, *Kpong* and *Aboadze*. The transmission network is owned and operated by the Ghana Grid Company (GRIDCo). The Electricity Company of Ghana (ECG) and the Northern Electric-

ity Department (NED) are responsible for the distribution to households and businesses in the southern and northern Ghana respectively.

Ghana comes third after Mauritius and South Africa on the sub-continent for generation capacity (Kemausuor et al. 2011). About 65.6 percent of electricity generation in Ghana is consumed by the industrial and service sectors, whilst that of the residential sector consumes about forty-seven percent (Energy Commission 2012). The government hopes to pursue a policy of extending electricity supply to all parts of the country by the year 2020 through the ongoing projects under the National Electrification Scheme (Energy Commission 2012; Kemausuor et al. 2011). As of 2008, 66.7 percent of national coverage had been achieved. It was extended to 4,070 electrified communities with a total population of 16 million. As at 2011, the national coverage had risen to seventy-two percent, and the target is to increase the access rate to eighty percent by the year 2015. About twenty-eight percent of communities remained non-electrified as at the end of 2014 (ISSER 2015).

In an attempt to achieve the set goals of ensuring energy efficiency and sustainability, different pieces of legislation were passed. The Legislative Instrument (LI) 1815-energy efficiency standards and labeling regulations, was passed in 2005 to promote the use of energy efficient air conditioners and fluorescent lamps. This was followed by in 2008, LI 1932-energy efficiency for the prohibition of the manufacture, sale or importation of incandescent filament lamp, used refrigerators, freezers, and air-conditioner, in 2009, the LI 1958-energy efficiency standards and labeling household refrigerating appliances regulations, and in 2011, the Renewable Energy Act 832 to support the development, utilization and efficient management of renewable energy sources. This Act seeks to increase the proportion of renewable energy, including solar, wind and biomass, in the national energy supply mix, and to contribute to the mitigation of climate change. The aim of the different pieces of legislation is to simply ensure green energy usage and production. Unfortunately, however, the frequent electricity crises experienced until the end of 2015 in the country have resulted in households, businesses and industries resorting to the use of power plants and generators, which are environmentally not sustainable, thereby questioning the potency of the different LIs.

The set objective to provide electricity in every community in Ghana by 2020 is undeniably commendable and essential to ensure rapid economic development. However, the fluctuation and the unreliability of power supply question the possibility of extending grid lines to remote areas when in fact the power supply cannot be guaranteed to the already connected communities. Should the state be applauded for and encouraged to continue with the policy initiative or rather be advised to ensure efficiency and reliability in power supply? Despite the total reliance on an electricity supply of the Ghanaian urban life especially, the country has been experiencing grave challenges with electricity generation and supply. What is seen as a power generation or supply crisis is not new in the country, but the intensity and duration of the recent crises lasting until the end of 2015 seem to have been the worst in the country's history (see also Bekoe and Logah 2013), with responsible stakeholders seemingly having no clue how to remedy the situation.

Ghana's Electricity Crises in Retrospect

The country has suffered from a series of peak energy crises. Whereas the country's electricity supply has never been consistent all the time, in contrast to what is experienced in most developed countries, there have been instances of severe periodic electricity supply crises. Within the periods of 1983-1984, 1997-1998, 2003, 2006-2007 and 2012 till date, Ghana has suffered from serious electricity power rationing processes. Table 2 provides an overview of the landmark crises in each period of the history of the country's power supply, their causes, the extent of the crises and the measures that were implemented to overcome the crises, as well as plans proposed to avert future occurrences.

Adom et al. (2012) indicated that the 2006-2007 electricity power rationing of 24 hours of power availability within every 48 hours was the severest power rationing ever witnessed in the country. However, the current one of 12 hours of electricity supply in every 36 hours since the beginning of 2015 has surpassed all recent crises and seems to be the worst crisis so far in the country's energy crisis history. The effects of the crises have been devastating on every activity within the country (Frederick and Selase 2014; Forkuoh et al. 2015), resulting in daily dis-

Table 2: Historical overview of electricity crises in Ghana

<i>Time period</i>	<i>Reasons for crises</i>	<i>Strategy to remedy crises</i>	<i>Proposed measures to avert crises</i>
1982-1985	Poor rainfall in the Volta River catchment area from 1982-84	Negotiation between the state and VALCO to reduce its power consumption from 370 MW to 20 MW; Reduced residential, commercial and industrial usage of power	VRA to refrain from the country's sole dependence on hydro power; <i>Aboadze</i> Thermal Plant commenced from 1997
1998-2000	Drought in the sub-region resulting from El Nino climatic phenomenon; Growth in demand for power (10-12 percent per annum) resulting from delayed investment of additional thermal plant	A countrywide rotational load shedding; Lease and operation of a 30 MW diesel power units from Aggreko Plc; Increased imports from La Cote d'Ivoire; Reducing VALCO's energy consumption from 245 MW to 20 MW	Arrangement to increase capacity at <i>Aboadze</i> thermal plant with 330 MW Combined Cycle power plant
2006-2007	Poor rainfall resulting in reduction in amount of water in the <i>Akosombo</i> and <i>Kpone</i> dams; Insufficient thermal plants to support the growing demands of electricity in the country	Procurement, installation and operation of 126 MW diesel generating units; Lease of 25 MW of diesel units by Trans <i>Tema</i> Limited; Facilitated the procurement and installation of 80 MW mine reserve plant; Procurement of a 6 million-worth compact fluorescent lamps to reduce the lighting load; The Government bought VALCO and released about 370 MW of power available to VALCO to the national grid; Nationwide rotational power shedding	Acceleration of the construction of the 126 MW <i>Tema</i> thermal 1 Power Plant (TT1PP) from 2006 to 2008; Procurement and construction of the 50 MW <i>Tema</i> Thermal 2 Power Plant (TT2PP), completed in 2009; Development and construction of the 400 MW Bui Hydroelectric Power plant started in August 2007; Payment of Ghana's share of the cost of the West-African Gas Pipeline (WAGP) project allowed construction of the pipeline to commence in 2005. First gas delivered in December 2008; Development and financing of the 132 MW Takoradi 3 power plant (T3) at <i>Aboadze</i> ; Facilitation of 200 MW Sunon Asogli power plant; Facilitation of 126 MW Osonor power plant, which was subsequently acquired by SSNIT and re-named CENIT power plant.
2012-current	A technical problem in the WAGP facility resulted in the cut-off of gas supply from Nigeria; Poor rainfall, reducing power generation from <i>Akosombo</i> and <i>Kpone</i> hydro plants; Maintenance work on the thermal plants; Lack of finances for fuel procurement; Though Jubilee Gas was available since 2014, much of it could not be used by the <i>Tema</i> thermal plant for lack of interconnection pipe	Nationwide rotational power shedding	The state should facilitate the completion of the 220 MW <i>Kpone</i> thermal Power plant; Accelerate completion of the T2 plant expansion by 110 MW to full output of 330 MW; Procure 150-200 MW short-term generation; and provide funding for fueling the TT1PP and CENIT Power plants (220 MW).

Authors own tabulation of information adapted from Amin Adam (2015)

cussions of the crises in the print and electronic media, as well as highlights by research publications from institutions and corporate bodies. The challenges cut across a broad socioeconomic spectrum, involving individuals, households, corporate bodies, businesses, industries and the country as a whole. Power System Energy Consulting (PSEC) and GRIDCo estimated in 2009 that the value lost in the residential, industrial and commercial sectors as a result of the three 2007 crises, to be USD 217.2 million, USD 598.4 million and USD 129.6 million, respectively (Adom et al. 2012: 364). The rest of this section discusses the impacts of the crises on the study area and on the country as a whole.

RESULTS

The fifty respondents were categorized into business classes summarized in Table 1. The estimated and/or actual quantity of fuel consumed as well as the cost for running the businesses is summarized in Table 3. The figures for average fuel consumption were used to calculate the corresponding total emissions that were released into the surrounding area. Some assumptions were made in the estimation of the total emissions, for which details are provided in the discussion.

Fuel service stations and wood processing businesses consumed the highest amount of fuel per day as an alternate power source. Every fuel service station used an average of 9 gallons per day, whereas a wood processor used about 5 gallons per day. Each cold store and stationery and printing business used up to 4 gallons of fuel per day. Up to 3 gallons of fuel per day were

used by each respondent belonging to the other business categories, except for the households and respondents that dealt in groceries who used not more than 2 gallons of fuel per day.

Overall, the stationery and printing businesses and the fuel stations each as a category consumed as much as 32 gallons of fuel per day, estimated at GHC 499 daily. The high fuel consuming categories, particularly fuel service stations, used fuel throughout the period that the national grid was off. All the fuel service stations contacted relied on industrial plants with a capacity of 24 gallons of petrol or diesel. This amounts to about GHC 312 daily, whereas consumption per respondent for the barbering, hair-dressing, dressmaking shops and households are comparatively not substantial. Collectively as a category, each significantly consumed high amount of fuel of up to GHC 234 daily. Although average consumption by the wood processing businesses was favorably high, the average amount spent on fuel collectively amounted to GHC 187. Only two respondents belonged to this category. The cold stores and grinding mill businesses spent the least on fuel, that is, collectively GHC 125 and GHC 140 per category daily, respectively.

DISCUSSION

Social Impacts of Erratic Power Supply

Social cost is discussed less in the literature, but the evidence in this research and most of the media reports bring to light the seriousness of the social challenges most Ghanaians face as

Table 3: Estimated and or actual cost of fuel used per day

<i>Firm category</i>	<i>Number of respondents</i>	<i>Gallons of fuel used per day</i>	<i>Gallons of fuel used per day per firm category</i>	<i>Cost of fuel per category (A gallon is GHC 15.6)</i>
Barbering shops	5	2 - 3	10 - 15	156 - 234
Hair dressing shops	5	2 - 3	10 - 15	156 - 234
Dressmaking shops	5	3	15	234
Fuel stations	2	8 - 10	16 - 20	249.6 - 312
Cold stores	2	4	8	124.8
Stationery & printing	8	3 - 4	24 - 32	374.4 - 499.2
Wood processor	2	4 - 6	8 - 12	124.8 - 187.2
Provision stores	8	1 - 2	8 - 16	124.8 - 249.6
Households	10	1 - 2	10 - 20	156 - 312
Grinding mill	3	2 - 3	6 - 9	93.6 - 140.4
Total	50		115 - 162	1,794 - 2,527.2

Source: Field survey 2015

a result of the power fluctuations. Several social problems resulting from the erratic power supply were identified by respondents. Households depend on electricity to power their household electrical appliances and to carry out other household activities.

Thefts and robbery are common everywhere in the world but they are much pronounced in the developing countries because of high levels of poverty and unemployment. Such crime thrives in darkness and as most of the respondents indicated they are afraid to leave their homes in the night for fear of robbery whilst away. Attendance of church services in the evening is part of the evening life of most Ghanaians but due to the power fluctuations, most of the respondents indicated that they do not attend evening services for fear of their homes being burgled whilst they are away or of being robbed as they walk in the dark.

Social gatherings such as funerals, weddings and other social activities are negatively affected. Such gatherings are a source of entertainment for most Ghanaians especially on weekends. Such programs have become expensive since the cost of hiring and fueling generators has been added to the original cost of organizing these programs. Routine lifestyles like attending weddings and funerals cannot be stopped because of the fluctuations in power supply, but people adjust to them, mostly by developing coping strategies, which comes back to the economic costs incurred. Renting generators for such occasions will be discussed later in the section. Temperatures in Ghana are generally high. Air conditioners or fans are used in offices and homes to stay comfortable indoors. The respondents said they could not enjoy their normal sleep due to warm rooms and disturbances from mosquitoes.

At the national level too, there have been reports of human lives lost as a result of the crises. There was a media report in April 2015 of a couple who, for fear of losing their generator to thieves, decided to keep it operating inside their room and were found dead the following morning, obviously from the inhalation of the poisonous exhaust fumes from the generator. The headline from the newspaper read 'Two lovers put to death by generator fumes in Dansoman all because of *dumsor*' (Daily Guide 2015). In April 13, 2015, the Daily Guide newspaper had a heading '*Dumsor* kills boy 16, in Ashaiman'¹

because the boy mistakenly poured petrol instead of kerosene into a lantern he was using to study (Kubi 2015).

Economic Impacts of Erratic Power Supply

The study has identified that the small-scale businesses located within the Effutu Municipality depend on an electricity supply by VRA through ECG for their operations. The study revealed that the printing businesses used electricity to power their computers, photocopiers and printers in their activities. Per the printing press operators interviewed, whose businesses were located within the North Campus of the University of Education, Winneba, they directly depend on electricity in running the business and without it operation ceases. This underscores the critical role that electricity plays in the operation of the printing press business in providing services for the daily printing needs of the students in printing their reading materials and assignments for academic purposes.

The cold store operators interviewed also revealed that they used electricity to power their refrigerators to preserve the fresh meat and fish. Likewise, operators of the grinding mills indicated the critical role that electricity plays in the operation of their business. Grinding of foodstuffs such as corn, cassava, wheat and millet is common in Ghana and a major means of processing by vendors and restaurants. Households as well depend very much on the operators of grinding mills in preparing their food. Power fluctuations not only cause the grinding millers to lose their jobs, but also many food processors suffer the consequences. Barbers also constantly rely on electricity to carry on their barbering activities.

The wood processors indicated that they use electricity to operate their machinery (planes, mortises, saws) to cut, saw, split, plant, tread and mortise logs into usable forms for the manufacturing of furniture, beams and planks. They process logs at wood processing centers and sell to carpenters for the manufacturing of wood furnishings including beds, wardrobes and other furniture. Electricity is needed in every stage of these processes.

The information given by the small-scale businesses mentioned above indicate the extent to which these businesses rely on an electricity supply for their businesses. This finding buttresses the argument made by authors such as

Brew-Hammond and Kemausuor (2009), Antwi-Boasiako (2015) and Steinbuks and Foster (2010), who wrote that businesses in Africa like in any other place depend very much on an electricity supply to operate, hence the unreliable power supply is harmful to the expansion of most of these businesses. There is no way any of these businesses can function without electricity supply. It is therefore very common to see those without self-generated power supply, to either be sitting idle waiting on the public supply or to have closed their businesses temporarily when there is no power.

Individual entrepreneurs, industries, businesses and corporate organizations are forced to buy diesel and petrol to fuel their generating plants as alternative sources to ensure a regular power supply for work. This obviously increases the cost of production (Forkuoh et al. 2015), which ultimately is passed on to the consumer. Eventually, the poorer local businesses' cost of production cannot match up to the more resourceful competitors. The small-scale businesses interviewed indicated their economic costs include the cost of fuel, which all the respondents have to pay directly or indirectly. As also discussed in the work done by Frederick and Selase (2014) and Forkuoh et al. (2015), those who operate the businesses have to buy fuel to feed their generators and they then pass on the cost to the customers, who also complain of the increased cost for services. The result is low productivity because of the loss of customers. The businesses interviewed indicated that the customers who cannot afford the high increase in service cost, stay away from patronizing the services, or reduce the frequency of patronizing the businesses. This has negatively affected their businesses.

Their concerns are not different from what happens to other businesses in the country. Employees lose their jobs as businesses struggle to survive in the country as a whole. For instance, the Association of Ghana Industries (AGI) in February 2013 threatened that industries may have to be forced to lay off thousands of workers if the energy crises continued (Ghanaweb 2015). In his submissions about the effect of the crises on the economy of the country, Antwi-Boasiako (2015) writes that the Ghana Ports and Harbors Authority (GPHA) disclosed that the company loses over USD 100,000 in a 24-hour continuous power failure at the *Tema*

Harbor site alone. The Chief Executive Officer (CEO) of the Accredited Oil Marketing Companies (AOMCs) in Ghana also told the Ghana Business and Financial Times newspaper that before the power crisis, fuel service stations spent about GHC 300 per month to provide standby power in case of unscheduled power outages. However, he asserts that since the onset of the crises, they spend an average of GHC 10,000 per month to power a single service station, and this amount excludes the cost of maintaining the generators. This stems from the recent power rationing schedule of 12 hours on and 24 hours power off for businesses and industries (Abbey 2015). The country had 59 AOMCs as of April 2014 (Ghana News Agency 2014). Indeed, this is a large additional cost incurred by these outlets, and taking into account 20 days of power outage in a month, it computes to an average of GHC 590,000 spent by the AOMCs every month on fuelling generator plants.

The country suffers economically because of the power crises. The Ghana Statistical Service (GSS) attributed the reduction in real GDP growth rate in the country from 7.3 percent in 2013 to 4.2 percent in 2014 to the energy supply constraints and to the rising input costs that reduced economic activity (Acheampong and Essilfie 2015). In the same report, they also asserted that the power crises make Ghana lose an estimated two to six percent of GDP annually (Acheampong and Essilfie 2015). Again, a report released by the Institute of Statistical, Social and Economic Research (ISSER) in 2015 on the 2014 social development outlook, showed that the country had lost between GHC 320 million and GHC 924 million in 2014 because of the power crisis, amounting to between two and six percent of the country's annual GDP (ISSER 2015). This confirmed the earlier report made by the GSS.

The most severely affected groups in terms of costs are the small and medium scale enterprises (see also Frederick and Selase 2014; Forkuoh et al. 2015), most of which cannot afford the self-owned generators. Most of the workers in this group become redundant and are laid off, or at best, they work when there is power and stay out of jobs when there is no power. Many enterprises record loss of business and customers. For instance, the CEO of

the AOMCs in his interview did not rule out the possibility of their sector laying-off some of their 40,000 workforce across the country (Abbey 2015). The deputy general secretary of the Union of Industrial and Commercial Workers in an interview with the Starr Business in February, 2015 indicated that for the week ending on 17th February alone, four companies namely, Cadbury, Mantrac, Coca-Cola and Fan Milk, sent letters to the union of their intention to reduce the numbers of their workforce because of the high cost the companies were incurring due to the power crises (Pertersson 2015).

The estimated cost was difficult to quantify in the study. Notwithstanding, the cost of fuel is considered as an additional operational cost. One gallon of fuel by the last week of June 2015 sold at GHC 15.60². Thus, the gallons of fuel used multiplied by cost of a gallon represents a large additional cost. This is computed in Table 3 based on the estimated gallons of fuel used per day by the small-scale businesses interviewed in June 2015.

The estimated daily amount of fuel used by the fuel stations in Winneba, 8-10 gallons, is about half of the estimated figure the CEO of AOMCs gave above, which is about 21 gallons. There are possible reasons for the conflicting figures. Firstly, Winneba is a smaller town, hence the power fluctuations in the bigger cities are much more severe than they are in smaller towns. Secondly, the sizes of the stations in Winneba are much smaller and therefore smaller plants are used instead of bigger ones used in the big cities. However, even where there are bigger plants, fuel consumptions are much lower compared to consumptions in the cities. Moreover, the duration of *dumsor* in Winneba is much lower than in Accra and other cities. Some of the businesses also adopt some coping strategies to economize on the use of generator fuels as discussed later in the paper.

Environmental Impact of the Use of Generators

Environmentally, the usage of generators by homes, businesses and industries emits substances, which are harmful not only to humans, but also to animals and the environment in general. In general, generator sets emit carbon dioxide as the primary environmental pollutant, along with water vapor from hydrocarbon-based fuels on complete combustion. However, apart from

these compounds, emissions, depending on the degree of combustion, also usually contain varying fractions of very toxic substances such as the lethargy inducing carbon monoxide, nitrogenous oxides (nitric oxide, along with a small fraction of the relatively more harmful nitrous oxide), sulphur dioxide that may cause acid rain and diesel particulate matter regarded as being a probable human carcinogen. Diesel is constituted of an average of sixteen carbon atoms, that is, between eight and twenty-four carbon atoms (Dabelstein et al. 2007).

Most of the businesses rely on alternative power supply for their operations whenever the national grid goes off. It was difficult to estimate the direct impact on the environment. The effect of emissions from the use of generators on businesses could not be estimated, and respondents would not even agree that the emissions could have dire consequences on the environment and possibly directly or indirectly on their businesses. The impact is thus, based on estimated and actual emissions of greenhouse gases mostly carbon dioxide and monoxide from generators. Some of the generators were obviously very old (used generators are the commonest ones on the market), and thus fuel combustion by these sets was incomplete and they were emitting noxious gases. Combustion also depends on the capacity and type of generator set used, which in turn depends on the generation capacity demanded by the operations of the business.

Fuel service stations and grinding mills used relatively higher capacity plants compared to the rest of the businesses, as they use fuel (especially fuel stations) throughout the period that the national grid is off. For instance, the fuel stations contacted for the survey depended on industrial plants that could take twenty gallons of petrol or diesel in a day. This gives about GHC 312/day, and GHC 9,630/month, that is multiplying by 30. Obviously, the amount of emissions also depends on whether the generators use diesel or petrol. It is a fact that those that run on petrol emit less carbon than those that run on diesel. Total emission also depends on the duration of the power outage and the use of an alternative power supply like rechargeable lamps by households in the night. Table 3 shows the gallons of fuel used per day by the small-scale businesses interviewed. Regarding the information in Table 3 an attempt has been made to calculate the carbon dioxide emissions by

these businesses, in order that the environmental effects of the use of the generators could be estimated.

Petrol molecule on the average, eight carbon atoms (that is, four to twelve carbon atoms) (Dabelstein et al. 2007). Again, assuming the complete combustion of petrol, the generator sets would release 19 pounds of carbon dioxide per gallon (that is, a half of that produced by diesel). For the estimated 115-162 gallons of petrol used, between 2,185 and 3,078 pounds, that is, an average of about a 1,200 kg of carbon dioxide, is emitted within the Winneba vicinity environment alone per day. A gallon of petrol emits 19 pounds of carbon dioxide. The environmental consequences of excessive carbon cannot be overemphasized.

With the estimation from the carbon dioxide emission by generators in the study area, an attempt was made to quantify the emissions released into the environment. The revelations were made above by the CEO of the AOMCs, that they alone spend GHC 590,000 every month to fuel generator plants to provide energy for their operations. Based on the above figures, and with the cost of diesel at GHC 15.06 per gallon in June 2015, AOMCs alone used 37,820.5 gallons of diesel to power their generator plants. Assuming the complete combustion of diesel by generator sets for this exercise, the plants would release 38 pounds of carbon dioxide per gallon of diesel. Thus, with the 37,820.5 gallons of diesel fuelling the generator sets to ensure provision of power for activities, the AOMCs alone are responsible for the emission of close to 1.45 million pounds (over 650 metric tons) of carbon dioxide.

Respondents' Coping Strategies Against Erratic Power Supply

The research found that various coping strategies were employed by individual households and businesses to circumvent the electricity supply challenges. With businesses, the major strategies were to operate an alternative power supply from a stand-by generator as already discussed, or to suspend operations. The study revealed that most small-scale businesses like the ones interviewed adopt the use of generators so as not to lose their customers. However, to minimize the operational cost, some businesses use their generators strategically, by

switching them on only when the services are demanded. Two respondents had these to say during the interviews when asked about how they cope in managing their businesses amidst the challenges:

'I use two to three gallons of petrol a day depending on the period of power outage. I only put on the generator when customers are around. If the generator should be on continuously for about twelve hours, I will use more than three gallons of petrol, which I cannot afford.' (a barber)

'I know the peak periods for our work, which is Monday to Friday, between 9 am and 6 pm. I therefore switch off the generator on weekends where there is no light. I do not need to waste fuel on weekends.' (A photocopy operator)

One other strategy by the grinding mills is to grind several items at once rather than to do them as and when they come. They gather all the items and grind them when the power comes on. Businesses which cannot afford generators open their shops when the power is on or close their shops and stay idle waiting for the power to come on as soon as the power goes off, per some of the respondents. Households, which can afford generators, have also acquired them. These households are mostly the elites' households with higher income levels. Not all households that depend on generators use them throughout the period of power outage. They are mostly used during the early part of the night and put off before going to sleep. Those who cannot afford generators use rechargeable lamps, among other simple alternative light provision gadgets, such as invertors, which they usually use for lighting at night. Less well-off households resort to the use of candles and lanterns at night, which have been the cause of many fire outbreaks in the country.

CONCLUSION

Ghana has set itself the target of achieving universal access to electricity by the year 2020, in with its national energy strategy 2010, which indeed is a laudable policy. One of the visions of the policy is to ensure energy efficiency through renewable resources, which often are referred to as the 'twin pillars' of sustainable energy policy, per the country's energy commission. Though the target of universal access might be achieved,

the recent energy crises in the country suggest that efficiency and sustainability are not achievable. This paper has provided the energy outlook of the country and analyzed both past and current power crises facing the country. This is a national catastrophe, as proven by the discussions with the Winneba respondents and from the media and other written reports.

The respondents in Winneba were frustrated with the social and economic challenges they face as a result of the erratic power supply. Such frustrations are also expressed by many Ghanaians who have to suffer from the effects of power fluctuations. The study goes further to estimate the amount of carbon dioxide released by generators into the atmosphere, with its dire consequences on the green energy goals, threatening the environmental gains the country wishes to make. With the data available from the AOMCs and also from the operators of the small scale businesses interviewed, Ghanaians are less concerned with the threat the use of generators pose to the environment. They are either ignorant of or give little regard to the issue of air pollution emanating from the use of the generators. The social and the economic costs are their immediate concern and does not consider the environmental repercussions as urgent problem. In addition, we have quantitatively evaluated the impact of alternative power generation sources on the environment, which most research studies conducted on energy issues have been silent on.

RECOMMENDATIONS

What then needs to be done to eliminate the crises and improve electricity power supply in the country. The lasting solution from a series of research projects conducted over the years is not farfetched. The above discussions suggest the state should facilitate the completion of the 220 MW Kpone thermal power plant, accelerate completion of the T2 plant expansion by 110 MW to the full output of 330 MW; procure 150 200 MW short-term generation, and provide funding for fuelling the TT1PP and CENIT Power plants (220 MW). If these measures are put in place, it would in the short run solve the power crises in the country. In the long term, however, the lasting solution is still doubtful, should the country continue to rely on hydro-electric renewable energy whose renewability has been

proven time and time again not to be sustainable enough to keep pace with the present population growth and over-politicization of the issue. Or should the country adopt nuclear energy, which has proven to supply lasting power at cheaper prices in other countries? What about solar energy? Much more research is needed until these questions are satisfactorily answered. A long-term sustainable electricity development plan is needed in the country.

NOTES

- ¹ Ashaiman: A suburb of Tema
- ² USD 1.0 was GHC 4.42 (as at June 2015)

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