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A Review of Installation, Operation and Maintenance of Internal Combustion Engine (ICE) Powered Lighting Sets in a Developing Country

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Abstract
This review presents the important of constant power supply as a great measure of developed economy. Nation with epileptic power supply was considered as developing or under develop nation trying to prolong her development. The risk of losing potential investors is a possibility. Nigeria was used as a case study of a developing country facing an extreme electricity shortage for many years. This deficiency was discovered to be multi-faceted, with causes that are financial, structural, and socio-political, none of which are mutually exclusive. The purpose of this paper is to inform the concern authority of developing nations understand the risks of having poor power supply and understand the role of carbon dioxide and other emissions from internal combustion engine powered set installations. These power sets are very important and popular in Nigeria. Some designs met emergency power needs, with automatic start-up device to supply emergency power to all vital loads requiring uninterrupted power. The national line was found to be the stand-by power source while the use of diesel generators became the main source for micro power grids in remote areas for Agricultural needs. Barge-Mounted generators supply power to marine areas. Information Technology (IT) and data centres are at the mercy of generators. Infrastructure development in Nigeria generally depends on generators; the sets are the solution bridging the gap between power demand and supply. It is a revolutionary product that brings clean and affordable power within the reach of millions of enterprises, homes and small businesses in a developing economy. The installations, operation and maintenance of stand by generators are the main solutions to domestic power needs and also high-energy requirements in developing nations.

Keywords: power supply, generators, ICE, developing countries.

INTRODUCTION
Nigeria, a country of over 140 million people (Punch, 2007) has for the past 33 years of establishment of the National Electric Power Authority (NEPA) an agency empowered with the electricity generation, transmission and distribution, witnessed frequent and persistent outages. The importance of power availability cannot be emphasized enough. The United Nations Development Program (UNDP) came up with a Human Development Index (HDI) to demonstrate the direct correlation between per capital energy consumption levels and economic/social well-being. The study found that countries high HDI values have higher per capita consumption levels of energy. Conversely, countries ranked low in HDI values have lower per capital consumption levels of energy (HDR,1990). Developing countries invariably demonstrate a significant dichotomy in energy consumption. Consumption patterns is affluent, households vary significantly from availability and consumption of power. Furthermore, the affluent populations typically represent only a small section of the country but consume a disproportionately large amount of power. For most of the developing countries, supplying electrical power from the main national grid for domestic and industrial use has not being an economically viable option. Despite the benefits of power availability, it is generally impracticable in Nigeria. The country has very minimal grid infrastructure. There are fewer substations or expansive transmission and distribution lines to run the grid through every locality and particularly, the remote areas. Survey conducted in 2010 by Manufacturing Association of Nigeria (MAN) revealed that about 834 Nigerian manufacturing companies closed down in 2009 (Punch, 2010). Incessant power outage and inadequate supply are among the unfriendly factors that have led to this predicament. Presently, the federal government has embarked on power sector reforms with the intention of improving the above unpalatable scenario and in turn reduced the scope of monopoly control of the nations’ power industry.

History of Electricity Generation in Nigeria
The history of electricity in Nigeria dates back to 1896 when electricity was first produced in Lagos, fifteen years after its introduction in England. The
total capacity of the generators used then was 60kW. In other words, the maximum demand in 1896 was less than 60kW. In 1946, the Nigerian government electricity undertaking was established under the jurisdiction of the public works department (PWD) to take over the responsibility of electricity supply in Lagos State. In 1950, a central body was established by the legislative council which transferred electricity supply and development to the care of the central body known as the Electricity Corporation of Nigeria, ECN. Other bodies like Native Authorities and Nigerian Electricity Supply Company (NESCO) has licenses to produce electricity in some locations in Nigeria. There was another body known as Niger Dams Authority (NDA) established by an act of parliament. The Authority was responsible for the construction and maintenance of dams and other works on the River Niger elsewhere generating electricity by means of water power, improving navigation and promoting fish brines and irrigation (Ijadi, 2005).

The energy produced by NDA was sold to ECN for distribution and sales at utility voltages. In first April 1972, the operation of ECN and NDA were merged in a new organization known as National Electric Power Authority (NEPA). Since ECN was mainly responsible for distribution and sales and DNA created to build and run generating stations and transmission lines, the primary reasons for merging the organizations were it would result in the vesting of the production and the distribution of electricity power supply throughout the country in one organization which will assume responsibility for the financial obligations. The integration of the ECN and NDA should result in the more effective utilization of the human, financial and other resources available to the electricity supply industry throughout the country. Since inception of NEPA, the authority expands annually in order to meet the ever-increasing demand. Unfortunately, majority of Nigerians have no access to electricity and the supply to those provided is not regular (Okoro and Chikuni, 2007). ECN and NDA merged to form NEPA (National Electric Power Authority), later metamorphosed to Power Holding Company of Nigeria (abbreviated PHC or PHCN), as a holding company for its imminent unbundling and subsequent privatization.

**Problems of Electricity Generation and Supply in Nigeria**

Various sources indicate that Nigeria’s installed generating capacity is between 5000 and 6000 MW (Mohammed, 2007), while government admits that the actual output has never exceeded 4000MW. In reality, the actual output is usually far below this despite that the approximated demand includes the off-grid generators, it is believed to be closer to 10,000 MW (Sambo, 2005). The electricity supply-demand value of 1991 in Nigeria is as shown in Table 1. While the installed and available electrical capacities in Nigeria generating stations are shown in Table 2. Despite a total grid capacity of 5924.7MW, only 4586MW were available.

**Table 1: Electricity Supply – Demand Values of 1991 in Nigeria**

<table>
<thead>
<tr>
<th>Plant Capacities (MW)</th>
<th>Demand Situation (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Installed</td>
</tr>
<tr>
<td>Demand</td>
<td>4,633</td>
</tr>
<tr>
<td>Excesses</td>
<td>-</td>
</tr>
<tr>
<td>Shortages</td>
<td>2,291</td>
</tr>
<tr>
<td>Remarks</td>
<td>Unsatisfactory</td>
</tr>
</tbody>
</table>


**Table 2: Installed and Output Capacity of Nigeria Power Generating Grid Station.**

<table>
<thead>
<tr>
<th>Site</th>
<th>Type</th>
<th>Installed Capacity [MW]</th>
<th>Available Capacity [MW]</th>
<th>Nos. of Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afam</td>
<td>Thermal</td>
<td>700</td>
<td>488</td>
<td>18</td>
</tr>
<tr>
<td>Delta</td>
<td>Thermal</td>
<td>812</td>
<td>540</td>
<td>20</td>
</tr>
<tr>
<td>Egbin</td>
<td>Thermal</td>
<td>1320</td>
<td>1100</td>
<td>6</td>
</tr>
<tr>
<td>Ijora</td>
<td>Thermal</td>
<td>66.7</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>Sapele</td>
<td>Thermal</td>
<td>1020</td>
<td>790</td>
<td>10</td>
</tr>
<tr>
<td>Jebba</td>
<td>Hydro</td>
<td>540</td>
<td>450</td>
<td>6</td>
</tr>
<tr>
<td>Kainji</td>
<td>Hydro</td>
<td>760</td>
<td>560</td>
<td>12</td>
</tr>
<tr>
<td>Shororo</td>
<td>Hydro</td>
<td>600</td>
<td>600</td>
<td>6</td>
</tr>
<tr>
<td>Ogiyi</td>
<td>Thermal</td>
<td>60</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Others</td>
<td>diesel</td>
<td>46</td>
<td>18</td>
<td>-</td>
</tr>
</tbody>
</table>


PHCN’s severe technological deficiencies are prevalent throughout the power system both upstream and down. For example, with modern technology about 39% of the energy consumed in thermal plants can be converted to electrical energy. In the absence of this technology, as currently the case, this figure can be as low as 13% (Sambo, 2005). Of the power that is produced, there is further loss through transmission. One estimate claims that between 32 and 33% of power generated in Nigerian power stations (Mohammed, 2007) is lost in this way (Ikeome and Obas, 2005). By comparison, power losses across lines in the United States usually come to less than a percent, even across greater distances (Kennedy– Darling et al., 2008). It is impossible to determine exactly how much of this inefficiency is due to illegal users’ tapping the lines, but it seems likely that underinvestment in technology is the greater problem. Lack of modern standardized components and qualified maintenance staff pose...
serious problems for adequate electricity generation and supply (Kennedy–Darling et al., 2008).

**Powered Electricity from Standby Generators in Nigeria**

Today, the most common form of off-grid electricity is generators running on diesel or gasoline. Generators are used not only by rural households but also by grid-connected households and industries as a more stable supplement to grid power. The rural incidence of diesel generators is difficult to estimate, but 96 to 98% of the grid-connected firms surveyed reported ownership of private generators. For these systems, the value of the generator’s kVA rating should equal or exceed the wattage of estimated load. The estimated lifetime of a generator is between 10 and 13 years. When calculating the present value of the lifetime costs of fuel, one must consider not only the rising cost of petrol diesel due to Nigeria’s limited refining capacity, but also the disparity in Nigeria’s official, subsidized price of diesel and the significantly higher price that can be obtained in practice, which ranges from 1.5 to 4 times the official price. The actual market of diesel is highest for the most remote regions.

**Principle and Benefits of Industrial Diesel Engine**

The diesel engine is a type of internal combustion engine, more specifically; it is a compression ignition engine. The fuel in a diesel engine is ignited by suddenly exposing it to the high temperature and pressure of a compressed gas containing oxygen (usually atmospheric air), rather than a separate source of ignition energy (such as a spark plug). This process is known as the diesel cycle after Rudolf Diesel, who invented it in 1892. While traditional diesel engine generators may not fit into our definition of ‘alternative energy’ sources, they are still a valuable addition to a remote power or grid back-up system. There are two classes of diesel engines: two-stroke and four-stroke. Most diesel engines generally use the four-stroke cycle, with some larger engines operating on the two-stroke cycle. Normally, banks of cylinders are used in multiples of two sometimes 16 to 32 depending on the design, though any number of cylinders can be used as long as the load on the crankshaft is counterbalanced to prevent excessive vibration during operations.

Generator sets produce either single or three phase power. Most homeowners require single phase whereas industrial or commercial applications usually require three phase power. Diesel engine generators are recommended due to their longevity and lower operating costs. Modern diesel engines are quiet and generally require much less maintenance than comparably sized gas (natural gas or propane) units. Diesel generators are designed to meet the needs of small and medium-sized businesses apart from heavy usage in industries. Reducing the cost of backup power and making generators easy to install is becoming the norm these days. Businesses lose money when they shut down during a blackout. Most modern generators are engineered to meet emergency power needs. These units continuously monitor the electrical current and automatically start up if power is interrupted and shut off when utility service is returned. In industries, during critical processes, generators can supply emergency power to all vital and selected loads as desired. This quality leads to widespread use of diesel-powered generators across recreational, residential, commercial, communication, and industrial applications. Today, most state-of-the-art-hospitals, five star hotels, business process outsourcing centers, manufacturing plants, telecommunications organizations, commercial buildings, data centers, emergency facilities, large industries, and mining companies require uninterrupted power and have backup diesel engine generators.

**Benefits of Diesel Generator**

(a) **Use of Diesel Generators as Micro Power Grids in Remote Areas**

In countries where grid infrastructures are very minimal for expansive transmission and distribution to rural areas and less cities, powering up such locations faces budgetary constraints. In this situation, the installments of diesel generators are an ideal solution to meet domestic needs and also high-energy requirements in rural areas. Diesel generators are easy to install and can either be used as standalone systems or as part of hybrid systems in conjunction with other sources like solar power.

(b) **Agriculture**

Diesel generators have established themselves as versatile and durable sources of power generation in developing countries for use in lighting, irrigation pumping, cottage industries, and rural processing facilities, just to name a few.

(c) **Barge-Mounted Diesel Generators (BMDs)**

BMDs are simple diesel engines and generators that are mounted on offshore barges. These units are available in a range of capacities from 5MW to 50MW and several units can be coupled together on a single barge to provide more than 100MW of power. These units can be linked to the power grid through a substation based on the shore. Unlike land-based power generation plants, BMDs makes them attractive alternative to land-based fixed power generation plants in mining and offshore drilling projects.

(d) **Information Technology (IT) and Data Centers**

Developing nations are increasingly becoming preferred outsourcing locations for IT projects and
for setting up data centers. As it is in the developed world, diesel generators serve as one of the most efficient backup power systems in the event of power failures to prevent loss of data and to enable business continuity.

(e) Infrastructure Development
Growing economies are invariably accompanied by development in infrastructure. Diesel generators ensure round-the-clock power supply not only in remote locations but also in the event of grid failure.

(f) Bridging the Gap between Power Demand and Supply
Even as power-generating utilities in developing nations are trying to keep pace with the rapid surge in re requirements, demand for power always seems to outpace supply, leading to peak power deficits. This can lead to scheduled and unscheduled load shedding or brownouts. The use of diesel generators as backup power units in residential and commercial building is also an attractive and widely prevalent alternative.

CONCLUSION
A generator is a revolutionary product that brings clean and affordable standby power within the reach of millions of enterprises, homes and small businesses. The installations of stand by generators are solutions to meet domestic needs and also high-energy requirements in rural areas. Standby generators are easy to install and can either be used as stand-alone systems or as part of hybrid systems in conjunction with other sources like solar power. The main advantage of such a system is the sourcing of power by the lowest cost option depending on the operating environment and time of day. This review can be used for training both in the private and public enterprises. The outcome of this review serves as an information source for engineers and students.

REFERENCES


