PROPOSAL FOR COMMERCIAL SOLAR APPLICATIONS

March 2018

Commercial Solar Power Solutions

This document focuses on energy solutions for the commercial and industrial sector in Nigeria. It supports the case for off-grid solar power to combat power outages which threatens economic growth in Nigeria.
1 | Executive Summary

Nigeria has long been a preferred destination for global investors, but the current economic outlook has been greatly affected by the decline in oil production and volatility in global commodities prices. The GDP growth rate, which had a compound annual growth rate (CAGR) of 5.3% between 2011 and 2014, fell to 2.97% in 2015 and subsequently to – 0.36% in the first quarter of 2016. During this period, unemployment rates also grew from 6% in 2011 to 12.1% in the first quarter of 2016.

Despite the economic downturn, there still exists significant potential for sustainable growth in Nigeria. There is a sizeable non-oil economy driven by the agriculture and service sectors. Aggressive and rapid industrialization in Nigeria is one possible avenue for the generation of exports and revenue, however, the lack of a stable supply of electric power has proved to be a major hindrance in attracting investors and convincing them to locate major production assets to Nigeria.

2 | The Effects of Poor Power Supply on the Economy

Power cuts and shortages have an adverse impact on the economy because Nigerian Consumers and businesses suffer due to disruptions. Cheap and abundant power supply is a pre-requisite for economic development and without this, the Nation cannot capitalize on its potential for sustainable growth through industrialization and generation of revenue from manufacturing and exports.

According to the World Bank, electricity is the biggest constraint to doing business in Nigeria. The average per capita energy consumption in Nigeria is 147KWh. Compared to the average energy consumption in a low middle-income Country (736KWh) and the global average consumption (3,298KWh), Nigeria is among the lowest globally in terms of electricity service delivery.

Industries are forced to pursue off-grid alternatives (primarily heavy-duty diesel generators) and this results in economic losses in excess of USD $25 Billion.1 Furthermore, Nigerian businesses experience an average of 239 hours of power outages per month, accounting for nearly 7% of lost sales and revenue.

3 | Current State of the Nigerian Power Sector

1. Generation: There are currently 23 grid-connected generating plants in operation in the Nigerian Electricity Supply Industry (NESI) with a total installed capacity of 11,165.4 MW. Despite this fact, Nigeria currently generates just 7,139.6 MW of electricity. An example of the problem was seen on 7 September 2017 when the Country had a peak demand of 19,100MW but was only able to generate 3,264MW of electricity.2

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1 World Bank Program for results information document; Report No. PIDC0122348
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2. Transmission: The lack of power generation in Nigeria is further compounded by the fact that despite having the capacity to produce 11,165.4MW of electricity, the Transmission Company of Nigeria only has the capacity to transmit 7,000MW of electricity.

3. Distribution: It is estimated that distribution companies in Nigeria are rejecting an average of 2,784.6MW of electricity on a daily basis. This is valuable energy that could be transmitted to industries but due to system failures and a constrained distribution infrastructure, the electricity goes to waste.

4. Renewable Energy: The National Electricity Regulatory Commission (NERC) established ‘feed-in-tariffs’ regulation for Independent Power Providers who generate power from renewables. NERC’s mandate seeks the generation of 2000MW of electric power from renewable sources for the National grid by 2020. Despite the implementation of feed-in tariffs for energy generated from clean renewable sources, low tariff rates have proved to be unattractive to investors as the tariffs are not cost reflective. As a result, the renewable energy sector in Nigeria has not seen the desired growth envisioned when the feed-in tariffs were implemented.

There is clearly a massive gap between the demand for electricity in Nigeria and the available supply. This limits the country’s potential for economic development on a global scale. To mitigate the shortage in energy supply, EGB Engineering LTD U.K. proposes an off-grid solar photovoltaic (PV) strategy on a commercial and utility scale. Our focus is to provide clean and low-cost electricity to support the industrial and commercial sectors in Nigeria in order to stimulate economic growth in the Country.

4 | What is Solar Power?

![Diagram of a typical solar energy cycle](image)

Solar power is the conversion of energy from the sun into electricity. A solar energy system consists of Solar PV panels, charge controllers, storage batteries and an inverter system. Figure 1 illustrates a typical solar PV system.

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3 There are 11 distribution companies in Nigeria. The distribution network utilizes a 33KV infrastructure which is massively constrained.

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The sun's energy is harnessed using the solar panels to absorb the energy. The energy is converted to electricity by the modules contained in the solar panels. The electricity is then regulated by the charge controller and sent part of the electricity to the batteries for storage. The electricity stored in the batteries can be used directly or stored for use at night time or when weather conditions are poor. Electricity is also sent to the inverter which converts direct current from the solar modules to alternating current for domestic and commercial use. Nigeria has a lot of sunshine throughout the year. This means that it is possible to generate significant amounts of electricity from the sun using solar PV. The sun is a free resource and harnessing it has greater benefits for Nigeria in terms of reducing its dependence on fossil fuel power.

The Benefits of Solar Power (summarized in Table 1)

<table>
<thead>
<tr>
<th>SOLAR POWER</th>
<th>FOSSIL FUEL GENERATORS (DIESEL &amp; GAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar energy systems do not cause any atmospheric or noise pollution. It does not emit any harmful gases and is green and safe for the environment.</td>
<td>Fossil fuel generators cause a lot of atmospheric and noise pollution. They emit harmful gases that affect the environment and can be a health hazard.</td>
</tr>
<tr>
<td>Solar energy systems are the best cost option. The upfront costs are higher than fossil fuel generators but these costs offset the taxes due to depreciation. Furthermore they require virtually no maintenance. They also do not use any fuels because energy is provided by the sun.</td>
<td>Despite cheaper upfront costs, fossil fuel generators are more expensive to maintain due to the costs of parts and servicing. But the biggest costs associated with generators are the fuel costs.</td>
</tr>
<tr>
<td>Solar power systems can run uninterrupted with virtually no input from an operator. Its battery storage unit ensures that electricity is still available overnight or during off-peak times.</td>
<td>Fossil fuel generators require constant refueling and maintenance. They will need to be switched off overnight in order to save costs.</td>
</tr>
<tr>
<td>Solar power systems offer longevity. Most solar systems can last between 25-30 years with minimal maintenance required.</td>
<td>Generators have a much shorter lifespan due to mechanical moving parts. This means the units need to be serviced regularly and parts will need replacing.</td>
</tr>
</tbody>
</table>

Table 1: Comparison between solar energy systems and fossil fuel generators.

Solar energy is at the forefront of renewable sources due to the relative low cost when long term sustainability is factored in, coupled with the benefits to the environment. The system produces zero emissions and zero noise pollution making it a green and sustainable electricity source.

Solar energy is truly renewable as it is harnessed from the sun. Even in cloudy and rainy conditions, solar technology can still function at a lesser capacity to ensure continued energy generation. Maintenance costs will remain very low especially when compared to off-grid thermal solutions. The PV panels of a solar system only need to be kept clean and a cleaning exercise can be carried out twice a year to ensure optimum performance.

Perhaps the most important benefit of solar power is the running costs when compared to off-grid thermal solutions. Much of the cost of running a diesel or gas-powered generator is in the fuel consumption. The running cost of a diesel generator is 530% greater than that of a solar power system. Furthermore, fuel costs alone represent 99% of the operating and maintenance cost of the thermal off-grid plant.

Getting natural gas to power stations and industries is a major problem in Nigeria due to poor gas pipeline infrastructure. There are gas road delivery schemes which utilize transportation trucks in the delivery of gas,
however, transportation adds further expenses to the cost of generating electricity. The problem is also made worse by the lack of oil refining capacity in the Country meaning that there are quite often fuel scarcities which can potentially cut fuel supplies to power plants and industries.

With solar power systems, huge cost savings can be guaranteed when the cost of transportation, fuel consumption and the maintenance of generators are factored in.

5 | Off-grid Strategy

Our strategy is the construction of an off-grid solar system that will serve commercial and industrial users as well as Government organizations who rely on power to carry out their functions.

We aim to deliver commercial and utility scale solar power upwards of 5MW and up to 20MW for the commercial and industrial sectors in the Country.

We will deliver a bespoke and highly efficient off-grid system to give the commercial and industrial sectors a major advantage in an increasingly competitive West African Market.

Our engineering team specializes in commercial rooftop, off grid and mini grid applications of solar systems. The development, operation and management of the systems are done in-house which allows us to drive down costs, providing the least cost option in all of West Africa.

Our off-grid technology utilizes a storage system integrated with hybrid inverters, battery banks, and software controls to optimize performance and efficiency. The technology is a multifunctional highly efficient clean energy storage solution which offers an uninterrupted power supply (UPS), increased cost-savings, and enhanced flexibility.

The integrated system also includes a battery management system (BMS) which is optimized to ensure long product life cycle and safe operation. The system is compatible with all DC Modules.

Needs Analysis

EGB shall conduct a feasibility study on the proposed sites where the solar energy system is to be installed. The feasibility study requires a detailed review of the loads and the energy requirements of the client in order to provide accurate capacity estimates.

The feasibility study shall be focused on the following (but not limited to):

- Review of Proposed Renewable Solar Power Technology
- Generating and Operational Cycle Configuration
- System Performance Feasibility, Sensitivity Analysis and Limitations
- Resource Availability and Capabilities
- Project Delivery and Commissioning Schedule
- Detailed Capital and Operating Costs estimates
- Techno-economic and Environmental Risk Assessments (TERA)
Cost Analysis of Solar

The below table (table 2) compares solar PV panel installation to diesel and natural gas fired plants. It shows that the cost associated with solar are significantly less.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Diesel</th>
<th>Natural Gas</th>
<th>Solar PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCOE* (USD cts/kWh)</td>
<td>18.53</td>
<td>7.45</td>
<td>5</td>
</tr>
<tr>
<td>O&amp;M** (kWh/USD yearly)</td>
<td>5.45</td>
<td>14.22</td>
<td>59.75</td>
</tr>
<tr>
<td>Operating Fuel*** (kWh/USD yearly)</td>
<td>5.53</td>
<td>15.53</td>
<td>4x10^6</td>
</tr>
</tbody>
</table>

Table 2: Comparison between solar energy systems and fossil fuel generators.

* LCOE Levelized Cost of Electricity = Data shows that the solar PV is cheaper than diesel and natural gas
** Op. & maintenance = Amount of elec. produced for every $ spent on O&M. Solar PV produces more electricity
*** Operating Fuel = Solar PV uses no fuel. It produces a significant amount of electricity for every $1 assumed to be spent on fuel

NB: Analysis is for a 12 hour daylight period

Socio-economic Impact

Our goal is to have a positive and direct impact on a wide range of socio-economic activities in the employment and commercial sectors. Our systems provide a stable electricity source which will allow an increased output, better productivity in the work place, and minimize financial loss associated with power outages.

At our end, there will be employment opportunities for skilled local workforce stemming from the planning, development, construction, maintenance and services. There will also be opportunities for training and career development.

Corporate Social Responsibility – CSR

We at EGB are committed to helping our clients fulfill their CSR obligations by constantly monitoring our activities to ensure active compliance with regulations, ethical standards and further the environmental and social good beyond the interest of the partnership. We will:

1. Implement best working practices in the installation of our systems;
2. Maintain all facilities to prevent waste, pollution, energy losses and inefficiency;
3. Champion renewable initiatives and environmental sustainability by recycling technology at the end of its life span. We will also implement measures for waste management, initiate greener supply chains and adopt Leadership in energy and environmental design.
About EGB Engineering LTD U.K

EGB Engineering is a UK registered company with expertise in the field of power and propulsion. We provide quality engineering products and services to OEM and End User clients such as the Ghanaian Energy Commission, Niger Delta Power Holding Company (Nigeria), Rolls-Royce (U.K. & Germany), Safran (France) and United Technologies (US). The company operates in the Energy (low carbon and renewables), Aerospace, Defence and Nuclear sectors.

The company is headed by Eur. Ing. Arnold Gad-Briggs (B.Sc M.Sc CEng MIMechE, MIET, MIDGTE) who boasts academic and professional qualifications and experiences in the energy sector.

With the continued growth of emerging markets in Africa, EGB is passionate about driving the development of low cost renewables energy in the ECOWAS area, which will help maximize the economic potential of the region. EGB is also committed more than ever to bridging the gap between the technologies and capabilities of the developed world; and the resources and growth potential of developing countries. Through our team of experts and our links with academia in the U.K. and industries in Europe, EGB is the best partner to help meet the energy capacity deficit and improve Nigeria’s economic competitiveness on the global stage.

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